Autonomic Modulation of Heart Rate in Men and Women following Coronary Artery Bypass Graft Surgery

by

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Abstract

Four studies were conducted to assess autonomic modulation of heart rate in men and women with ischemic heart disease before and following coronary artery bypass graft (CABG) surgery. In the first three studies, R-R interval and systolic blood pressure data were collected in the supine and standing postures; in study 4, in the supine posture and during low intensity steady-state exercise. Breathing frequency was paced at 12 breaths per minute in the supine position. Autonomic modulation of heart rate was determined by spontaneous baroreflex (SBR) sensitivity and spectral analysis of heart rate variability (HRV).

The first study examined the differential effects of ischemic heart disease in 25 men and 13 women. There were no significant differences in HRV measures between men and women in the supine posture, but women had significantly lower SBR sensitivity than men in both supine and standing postures. The change in position from supine to standing revealed that women decreased high frequency power, low frequency power, parasympathetic indicator, and total harmonic power, and increased sympathetic indicator; SBR sensitivity did not change. Men decreased parasympathetic indicator and SBR sensitivity.

The second study evaluated the early effects of CABG surgery. Eleven women and 23 men were tested preoperatively and 5 days postoperatively. Autonomic modulation of heart rate declined in men after surgery, but not in women. Men decreased the indices of parasympathetic modulation of heart rate, that included high frequency power, parasympathetic indicator and SBR sensitivity.

The third study assessed the course of recovery for 12 weeks following CABG surgery in 6 women and 16 men. Men, but not women, exhibited an increase

in the indices of parasympathetic modulation of heart rate (i.e., the parasympathetic indicator and SBR sensitivity) throughout 12 weeks of recovery. Neither men nor women showed any significant change in the sympathetic indicator. There were significant effects of posture (supine vs. standing) in both men and women on indices of parasympathetic modulation of heart rate that were similar to responses in older healthy individuals. Women decreased high frequency power and the parasympathetic indicator in the standing position compared with supine; men decreased the parasympathetic indicator and baroreflex sensitivity.

The fourth study measured the effects of time from 6 to 12 weeks and low intensity steady-state exercise in 6 women and 16 men. Men improved the indices of parasympathetic modulation of heart rate, as seen by increases in high frequency power and parasympathetic indicator. The improvement in parasympathetic modulation of heart rate was manifested in increased supine SBR sensitivity and R-R interval in men. Women showed no improvement from 6 to 12 weeks in these measures. Exercise significantly decreased SBR slope and R-R interval, and increased systolic blood pressure in men and women. The effects of exercise on heart rate variability measures were different in men and women; exercise significantly decreased low frequency power and high frequency power in men only.

The results of these studies suggest that men and women responded differently to CABG surgery and during the course of recovery for 12 weeks. The significantly higher age of the women, the small sample of women, and large variability in our measures may have contributed to the findings.

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CHAPTER 1

Introduction

Cardiovascular disease remains the leading cause of death and disability in Canada, accounting for 36% of all deaths in men and 39% in women (Heart and Stroke Foundation of Canada, 1999). Ischemic heart disease, also known as coronary artery disease, continues to cause 21% of all deaths in Canada (Heart and Stroke Foundation of Canada, 1999). The mortality rates in men increase gradually from 35-84 years, whereas in women, the rates increase at age 45 years and increase dramatically after menopause (Cardiovascular Disease and Women, 1996; Heart and Stroke Foundation of Canada, 1997). The performance of coronary artery bypass graft (CABG) surgery as a method of treatment for ischemic heart disease has increased during the last decade, particularly in women and in the age groups over 55 years (Heart and Stroke Foundation of Canada, 1997; 1999).

Autonomic modulation of heart rate is impaired in people with cardiovascular disease (Schwartz *et al.*, 1988a; Ryan *et al.*, 1989; Lipsitz *et al.*, 1990; Craelius *et al.*, 1991; Huikuri *et al.*, 1995) and following CABG surgery (Niemela *et al.*, 1992; Piha & Hamalainen, 1994; Yang *et al.*, 1994; Komatsu *et al.*, 1997). Heart rate variability decreases with increasing age (Docherty, 1990; Ryan *et al.*, 1994), and during physiological perturbations, such as orthostatic stress and exercise (Pomeranz *et al.*, 1985; Lipsitz *et al.*, 1989; Butler *et al.*, 1990; Kamath *et al.*, 1991; Yamamoto *et al.*, 1991;

Nakamura *et al.*, 1993; Fei *et al.*, 1995). Decreased heart rate variability is an independent risk factor for sudden cardiac death in individuals with cardiovascular disease (Schwartz *et al.*, 1988a; Ryan *et al.*, 1989; Lipsitz *et al.*, 1990; Craelius *et al.*, 1991; Huikuri *et al.*, 1995).

The issue of whether cardiac baroreflex sensitivity declines after CABG surgery has not been reported. However, a reduction in cardiac baroreflex function has been observed following myocardial infarction (Schwartz *et al.*, 1988), with increasing age (Docherty, 1990; Folklow & Svanborg, 1993; Poller *et al.*, 1997; Laitinen *et al.*, 1998; Brodde & Michel, 1999), and during submaximal exercise (Fei *et al.*, 1995; Shi *et al.*, 1995). Damage to aortic baroreceptors during surgery could limit afferent input; damage to autonomic nerves could reduce autonomic output to the sinoatrial node.

Men and women differ in measures of heart rate variability and baroreflex sensitivity. Ryan *et al.* (1994) and Liao *et al.* (1995) found higher high frequency power and ratio of high frequency to low frequency power, and lower low frequency power, in women. Huikuri *et al.* (1996) reported that women had lower low frequency power, lower low frequency to high frequency power ratio, and a lower baroreflex sensitivity than men. Laitinen *et al.* (1998) found that baroreflex sensitivity was lower in women. Dougherty (1999) revealed that middle-aged women had higher high frequency power than men in supine and standing positions, and that supine baroreflex sensitivity was higher in women.

Decreased heart rate variability reflects an imbalance in the competing efferent influences of the parasympathetic and sympathetic divisions of the autonomic nervous system on the modulation of heart rate; specifically, it reflects a reduction in the parasympathetic modulation of heart rate (Akselrod *et al.*, 1981; Goldberger, 1991). A decrease in parasympathetic modulation of heart rate reduces the ability of the cardiovascular system to adapt to rapidly changing stimuli, and increases the potential for sympathetically-mediated cardiac dysrhythmias to occur (Huikuri *et al.*, 1995; Task Force of the European Society of Cardiology & the North American Society of Pacing & Electrophysiology [TFESCNASPE], 1996). These factors may explain, in part, the sinus tachycardia and cardiac dysfunction observed during the early postoperative and post-discharge periods (Niemela *et al.*, 1992; Komatsu *et al.*, 1994; Piha & Hamalainen, 1994; Yang *et al.*, 1994; Huikuri *et al.*, 1995; TFESCNASPE, 1996). Thus, the measurement of beat-by-beat arterial blood pressure and spectral analysis of heart rate variability will greatly enhance the amount of information that can be gained regarding responses to common physical perturbations during early recovery following CABG surgery.

Purpose of the Study

The primary purposes of this research were (1) to describe the effects of ischemic heart disease on autonomic modulation of heart rate in men and women, as measured by heart rate variability and spontaneous baroreflex sensitivity, (2) to describe the effects of CABG surgery on these measures,

(3) to document the course of recovery for 12 weeks following CABG surgery, and (4) to examine the effects of standing and low intensity steady-state exercise. A secondary purpose was to determine the influence of tidal volume and breathing frequency on the outcome measures.

The present investigation is at the interface of the two disciplines of health science and exercise physiology, and integrates the knowledge from both in order to study a high risk clinical population. Both disciplines use basic and biological sciences; each applies the basic and biological sciences in a unique way. The present study incorporated concepts from neurocardiac physiology and exercise physiology in a clinical human population with ischemic heart disease before and following coronary revascularization surgery. Newer techniques of non-invasive measurement of arterial blood pressure and sophisticated computer data acquisition and analysis programs were used to collect the data, to conduct the spectral analysis of heart rate variability, and to determine spontaneous baroreflex sensitivity. The study contributed to the body of knowledge of women's health by documenting the similarities and differences in autonomic modulation of heart rate between women and men with ischemic heart disease prior to and during recovery from CABG surgery. The research extended our knowledge (1) by extending the duration of study to 12 weeks following CABG surgery, (2) by studying the responses of women as well as men, and (3) by determining the influence of respiratory variables on the cardiovascular responses.

CHAPTER 2

Review of the Literature

Coronary artery bypass graft (CABG) surgery is done primarily to improve coronary blood flow and, thus, relieve cardiac ischemia due to narrowing or obstruction of coronary arteries (Heart and Stroke Foundation of Canada, 1999). Although newer medical and surgical techniques are evolving, the most common method of coronary revascularization is achieved by bypassing large epicardial coronary arteries with grafts using the saphenous vein, the internal mammary artery, the intrathoracic artery and the gastroepiploic artery (Merrilees *et al.*, 1988; Weinstein *et al.*, 1989; Grondin *et al.*, 1989; Pym *et al.*, 1997). Individuals recovering from CABG surgery not only have undergone major cardiac surgery with the associated peri- and postoperative risks, but also still have the chronic risk factors predisposing them to progressive coronary atherosclerosis and the vasoconstrictor effects of diffuse ischemic heart disease in small coronary arteries. During CABG surgery, several cardiac control mechanisms are affected (1) by the surgical manipulation of the heart, cardiac autonomic nerves and coronary arteries; (2) by aortic clamping and vein grafting to the aorta; and (3) by cardiopulmonary bypass. In addition, general anaesthesia, mechanical ventilation and the intravenous infusion of various pharmacological agents affect cardiovascular function intraoperatively and possibly postoperatively (Yang *et al.*, 1994; Haggenmiller *et al.*, 1996).

The purpose of this literature review is to discuss the autonomic and baroreflex modulation of heart rate. In addition, the respiratory influence on heart rate modulation will be examined. The discussion will focus specifically on cardiac baroreflex sensitivity and heart rate variability before and after CABG surgery during supine rest, standing and low intensity steady-state exercise. Due to the characteristics of the population under investigation, the effects of increasing age and gender on autonomic and baroreflex modulation of heart rate will be reviewed.

Regulation of Heart Rate

Autonomic Nervous System Modulation of Heart Rate

The regulation of heart rate is controlled primarily by the autonomic nervous system (Berne & Levy, 1997). Both sympathetic and parasympathetic nerve fibres synapse on the SA node and influence heart rate. Parasympathetic fibres also synapse on the atrioventricular node and junction, whereas sympathetic fibres innervate atrial and ventricular myocardial tissue. In resting healthy adults, parasympathetic modulation predominates. Parasympathetic activity, mediated by the neurotransmitter acetylcholine (ACh) acting on muscarinic receptors in the SA node, inhibits pacemaker activity and slows heart rate. The parasympathetic effects terminate within milliseconds after cessation of stimulation due to the rapid hydrolysis of acetylcholine, a process catalyzed by acetylcholinesterase, at vagal nerve endings (Hainsworth, 1996; Berne & Levy, 1997). The brief latency (50-100 ms) and rapid decay of parasympathetic responses enable the vagus nerve to exert a beat-by-beat control of SA nodal function within 400 ms (Hainsworth, 1996; Berne & Levy, 1997).

In contrast, sympathetic activity, mediated by the neurotransmitter norepinephrine (NE) acting on beta adrenergic receptors, stimulates pacemaker activity and increases heart rate; sympathetic stimulation requires approximately 5 sec for the effects to occur (Hainsworth, 1996). The effects of sympathetic stimulation decay gradually because most norepinephrine released at sympathetic nerve endings is taken up again by the cardiac nerves and the remainder is carried away in the circulating blood. Moreover, the released ACh by vagal nerves inhibits the release of NE at nearby sympathetic nerve endings, effectively inhibiting sympathetic effects on heart rate (Berne & Levy, 1997). Rapid changes in heart rate, therefore, are due to the parasympathetic pathway (Akselrod *et al.*, 1981; Akselrod *et al.*, 1985; Hainsworth, 1996; Berne & Levy, 1997).

Spontaneous variability in heart rate occurs on a beat-by-beat basis in healthy individuals (Akselrod *et al.*, 1981; Goldberger, 1991). This variability is an important mechanism for adaptability and flexibility in cardiovascular responses to unpredictable and varying internal and external stimuli (Akselrod *et al.*, 1981; Goldberger, 1991). Pharmacological and physiological studies support the hypothesis that the R-R interval varies on a beat-to-beat basis, depending on the interaction of sympathetic and parasympathetic autonomic influences on the SA node (Akselrod *et al.*, 1981;1985; Goldberger, 1991; Hainsworth, 1996).

Measurement of Heart Rate Variability

Heart rate variability refers to the beat-by-beat variations in cardiac cycle or the instantaneous variation in heart rate (TFESCNASPE, 1996). Terminology in the literature has been inconsistent and, thus, confusing. Other terms that are used synonymously with heart rate variability include heart period variability, cycle length variability, R-R interval variability and instantaneous heart rate variability. Because the term heart rate typically refers to the number of cardiac cycles per minute, the other terms describe more accurately that it is the interval between consecutive heart beats that is being analyzed rather than variability in heart rate, but have not gained general acceptance (TFESCNASPE, 1996).

Time domain methods. Time domain methods of analysis of heart rate variability calculate the beat-by-beat variations in heart rate with respect to time from a continuous electrocardiograph (ECG) recording (TFESCNASPE, 1996). Each QRS complex originating from a sinus node depolarization is detected, and the intervals between adjacent QRS complexes are referred to as the normal-to-normal (NN) R-R intervals. Time domain variables are calculated from the NN R-R intervals; some examples include the mean NN interval, the mean heart rate, the difference between longest and shortest NN interval. Statistical analysis can be conducted on either the direct measures of NN intervals, or the differences between NN intervals. For example, the standard deviation of NN intervals (SDNN), which reflects all cyclic variations during the period of recording, can be calculated (TFESCNASPE, 1996). These analyses can be obtained from both short-term 5 minute recordings and traditional long-term recordings of 24 hours.

Frequency domain methods. Frequency domain methods of analysis of heart rate variability, using power spectral density analysis, provide data on how power (variance) distributes as a function of frequency (TFESCNASPE, 1996). Akselrod (1995) explains that, by definition, "spectral analysis separates the components of a signal based on their frequency and should thus directly discriminate between the frequency ranges to which slower or faster mechanisms contribute" (P. 151). Spectral analysis of R-R interval variability transforms the time signal of continuous R-R interval data into their frequency components. After filtering the raw R-R interval data for extra or missing beats, fast Fourier transformation (FFT) converts the time series data into an interval tachogram. By using the techniques of spectral analysis, Akselrod *et al.* (1981; 1985) verified that the sympathetic and parasympathetic nervous systems are the principal mechanisms involved in short-term cardiovascular control on the time scale of milliseconds (parasympathetic) to seconds (sympathetic), and that they make frequency-specific contributions to the heart rate power spectrum. In addition to the well-known high frequency variations in heart rate associated with the respiratory cycle, the authors reported that there were two other periodic variations at lower frequencies, typically 0.04 and 0.12 Hz., that were attributed to cyclic variations in vasomotor tone and the frequency response of the baroreflex, respectively.

Akselrod et al. (1981) confirmed that power spectrum analysis of heart rate variability provides a quantitative noninvasive method of studying the short-term, beat-to-beat cardiac control mechanisms in conscious trained dogs. By selectively blocking either the parasympathetic nervous system by glycopyrrolate, or the sympathetic nervous system by propranalol, or combined blockade of both parasympathetic and sympathetic divisions, the authors found that parasympathetic blockade abolished the mid- and high-frequency peaks of the power spectrum, and decreased the low frequency peak. Combined β- sympathetic and parasympathetic blockade eliminated all R-R interval variations. Sympathetic blockade tended to decrease the low frequency peak; however, this effect was inconsistent due to the low level of resting sympathetic activity. Subsequently, under the same conditions of selective autonomic blockade, the authors varied arterial blood pressure by administering the vasodilator sodium nitroprusside or the vasoconstrictor methoxamine by intravenous bolus. They found that increasing either parasympathetic or sympathetic activity increased the low frequency peak. Their data showed that the parasympathetic nervous system mediates R-R interval variations in the mid- and high frequency peaks of the power spectrum, and that both sympathetic and parasympathetic systems mediate the low frequency peak. Akselrod *et al.* (1981) also showed that blockade of the renin-angiotensin system resulted in large increases in the low frequency peak at 0.04 Hz, suggesting that the renin-angiotensin system contributed to short-term cardiovascular modulation. The authors suggested the possibility that the renin-angiotensin system attenuates the normal fluctuations in peripheral vasomotor tone. They also supported the conclusions of others, that the lower frequency peak (0.04 Hz) was related to cyclic variations in vasomotor tone associated with thermoregulation and the mid-frequency peak (0.12 Hz) was related to the frequency response of the baroreflex in humans. Cerutti, Bianchi, & Mainardi (1995) concluded that very low frequency power (<0.03 Hz) reflected long term regulatory mechanisms, probably related to thermoregulation, the renin-angiotensin system, and humoral factors.

Spectral analysis methods are recommended for short-term (2 to 5 min) recordings of R-R interval under physiologically stable conditions (TFESCNASPE, 1996). Spectral analysis yields three main components: very low frequency, low frequency and high frequency power. In general, studies which have employed spectral analysis methods support the concept that high frequencies of heart rate variability (>0.15 - < 0.40 Hz) are the result of parasympathetic influences, lower frequencies of heart rate variability (> 0.04 Hz - < 0.15 Hz) result from both sympathetic and parasympathetic activity and baroreflex modulation, and the very low frequency component is inversely proportional to frequency (1/f) (Akselrod *et al.*, 1981; Akselrod *et al.*, 1985; Saul *et al.*, 1988; Lipsitz *et al.*, 1990; Yamamoto *et al.*, 1991; Malliani *et al.*, 1994; Persson, 1996; TFESCNASPE, 1996). Malliani *et al.* (1994) and Malliani (1995) maintained that the low frequency component reflects sympathetic activity, and that sympathetic and parasympathetic activities interact in modulating heart rate.

In 1991, Yamamoto and Hughson developed a new method of spectral analysis, the coarse-graining spectral analysis (CGSA) method, a modified version of general spectral analysis. The CGSA extracted the very low frequency component (1/f) from the total power of the power spectrum, thereby facilitating the definition of the high frequency and low frequency power peaks. In the general spectral analysis method, after searching and filtering the raw R-R interval data for extra or missing beats, fast Fourier transformation converted the time series data into an interval tachogram; the filtering process either deleted ectopic beats or inserted missing beats. In CGSA, after filtering, each R-R interval was repeated so that the length of the data set was twice as long as the original. The CGSA was conducted on the first half of the data set. Total power was separated into harmonic and nonharmonic (fractal) components; the harmonic component was further divided into low frequency (0.0-0.15 Hz) and high frequency (0.15-0.50 Hz) components (Yamamoto & Hughson, 1991; Yamamoto *et al.*, 1991; Nakamura *et al.,* 1993). In comparing the results of CGSA with general spectral analysis on the same data, Yamamoto & Hughson found that the low frequency peak was more easily identifiable in CGSA, and that there was no significant effect of duration of data sampling on the results, in contrast with the results from general spectral analysis. In general spectral analysis, the low frequency component of the power spectrum was affected by duration of data set; very short data sets (1.5 min vs. 4 and 12 min) reduced the low frequency power, but not the high frequency power. Consequently, the ratio of low frequency power to high frequency power was reduced.

Baroreceptor Reflex Modulation of Heart Rate

The baroreflex is a negative feedback system of neural and hormonal pathways to maintain arterial blood pressure within a normal range for any given individual, that involves input via an afferent limb, central processing in the medulla oblongata, and output via an efferent limb (Dampney *et al.*, 1994; Smit, 1996). Baroreflex afferents arise from two types of receptors: high pressure arterial receptors in the carotid sinus and aortic arch that respond to stretch, and low pressure cardiopulmonary receptors in the atria that respond to changes in blood volume. Input from the afferent receptors is transmitted via afferent nerve fibres to the nucleus tractus solitarius and a complex wiring system ending in the nucleus ambiguus and ventrolateral medulla (Dampney *et al.*; Smit *et al.*). The efferent limb consists of pathways from the latter brain stem structures to the heart and blood vessels, influencing heart rate, cardiac contractility, venous capacitance and systemic vascular resistance (Hainsworth, 1996; Smit, 1996). In addition, central nervous system activity may alter the degree of parasympathetic nervous system and sympathetic nervous system output (Persson, 1996). Thus, to counteract a reduction in arterial blood pressure, heart rate and cardiac contractility are increased and vasoconstrictor tone is augmented (Hainsworth, 1996; Smit, 1996). The change in heart rate occurs within one heart beat by influencing parasympathetic outflow from the nucleus ambiguus to the SA node (Blaber *et al.*, 1995; Hainsworth, 1996; Smit, 1996). The change in blood pressure is achieved by withdrawal of inhibitory influence on the rostroventrolateral medulla, resulting in increased sympathetic outflow to, and vasoconstriction of, the resistance and capacitance vessels (Hainsworth, 1996; Smit, 1996).

Adaptation and resetting are important properties of baroreceptors (Hainsworth, 1996). Adaptation is a property of many sensory receptors to a sustained application of a stimulus, in which the discharge frequency declines after the initial high frequency response. Baroreceptors adapt only partially, because their discharge frequency decreases only part way toward the initial level following an increase in pressure. Resetting is a phenomenon that occurs after a sustained stimulus, i.e., a sustained change in pressure; the response may be acute (partial resetting) or chronic (complete resetting). Acute resetting of the baroreceptors occurs within 30 seconds after the beginning of the sustained change in pressure and continues for 20-30 minutes, such that if blood pressure increases, there is a shift of the stimulus-response curve to the right so that the baroreceptor range moves toward the pressure change, and a decrease in the slope of the stimulus-response curve (Hainsworth, 1996). Posture change or acute exercise might elicit acute resetting. Chronic resetting requires prolonged pressure changes from months to years; this response changes the position of the stimulus-response curve and reduces the overall sensitivity of the baroreceptors.

This thesis will focus on the function of cardiac arm of the arterial baroreflex, i.e., the short-term beat-by-beat change in heart rate as a consequence of a change in arterial blood pressure. The cardiac baroreflex reflects the sensitivity of the arterial baroreceptors in the aortic arch and carotid sinus to detect and respond to changes in arterial pressure, the central integration and processing of afferent neural inputs from the baroreceptors, and the competing influences of the two efferent divisions of the autonomic nervous system on the sinoatrial (SA) node (Goldberger, 1991; Dampney *et al.*, 1994; Smit, 1996). Beat-by-beat changes in heart rate are mediated by the parasympathetic division of the autonomic nervous system via the vagus nerve to the SA node (Akselrod *et al.*, 1981; Hainsworth, 1996; Smit, 1996). The minimum time needed for a baroreflex-mediated change in R-R interval is 750-775 ms (Blaber *et al.*, 1995; Hainsworth, 1996).

The R-R interval response to a sustained arterial pressure change, rather than to an abrupt pressure change as a consequence of vasoactive drugs, has been termed the "steady-state" cardiac baroreflex response, and is quantified by a sigmoidal curve that relates variations in blood pressure to changes in pulse interval (Parlow, 1993). Three properties of the cardiac baroreflex curve have been identified and include set-point, sensitivity and range. The set-point, or BP50, is defined as the arterial pressure at the pulse interval which is equidistant from the upper and lower plateau of the curve. The sensitivity is the slope of the curve that joins the two plateaux, and reflects the magnitude of the pulse interval response to a given change in blood pressure. The upper and lower plateaux represent the minimum and maximum responses (Parlow, 1993).

A decline in the sensitivity of the baroreflex reflects a decrease in the magnitude of the pulse interval response to a given change in blood pressure. A decline in the beat-by-beat interaction between arterial blood pressure and heart rate could be due to (1) decreased or impaired afferent input from the aortic baroreceptors, (2) altered central integrating and processing functions in the medulla oblongata, (3) altered efferent nerve activity in both parasympathetic and sympathetic nerves, and (4) impairment of the SA node (Docherty, 1990).

Methods of Measurement of Baroreflex Function

Traditional methods of baroreflex assessment. Historically, the function and sensitivity of the cardiac baroreflex have been evaluated by acutely altering arterial pressure, and measuring the degree of pulse interval change in response to the degree of change in arterial pressure (Parati *et al.*, 1988). Arterial pressure can be altered either by infusion of vasoactive drugs (Parlow, 1993; Parlow *et al.*, 1995) or by mechanical stimulation of carotid receptors by the application of external neck pressure or suction (McDonald *et al.*, 1993; Potts *et al.*, 1993; Shi *et al.*, 1993; 1995).

Vasoactive drugs, such as phenylephrine and sodium nitroprusside (Parlow *et al.*, 1995), administered intravenously by bolus injection, acutely alter arterial blood pressure. Baroreflex sensitivity is determined by the slope of the linear interaction between increasing (or decreasing) blood pressure and the resultant increase (or decrease) in R-R interval (Parlow *et al.*, 1995).

The neck chamber method, either neck suction or neck pressure, provides mechanical activation or deactivation of carotid baroreceptors. Baroreflex sensitivity is determined by the slope of the carotid transmural pressure, i.e., mean arterial pressure minus neck chamber pressure, and the resultant effect on R-R interval. This method is limited to measuring the sensitivity of the carotid baroreflexes, or the combined sensitivity of carotid and aortic baroreceptors. However, Shi *et al.* (1993) and Shi *et al.* (1995) reported that aortic baroreceptors predominate over carotid baroreceptors in the modulation of heart rate in healthy young men.

These methods have advantages and several general limitations. One advantage of the pharmacological method is that it measures range and BP50, and differentiates resetting of the baroreflex from changes in sensitivity (Parlow, 1993). The invasive nature of the techniques limits their usefulness in long term testing. The extreme and potentially dangerous elicited response to the stimuli limits their use in high risk individuals.

Moreover, the acute and brief elicited responses do not represent normal physiological adaptation in range or sensitivity of baroreflex response (Parlow, 1993).

Spontaneous methods of baroreflex assessment. Spontaneous variations in blood pressure and pulse interval response can be observed at rest and during normal daily activities, or elicited experimentally by postural changes, deep-breathing, mental stress, and exercise in healthy individuals (Goldberger, 1991; Rimoldi *et al.*, 1990; Hughson *et al.*, 1993; Parlow, 1993; Potts *et al.*, 1993; Blaber *et al.*, 1995; Parlow *et al.*, 1995; Smit *et al.*, 1996).

Recently, a noninvasive method of assessing spontaneous baroreflex (SBR) sensitivity during any given set of conditions has been developed (Hughson *et al.*, 1993; Blaber *et al.*, 1995; Parlow *et al.*, 1995). The spontaneous baroreflex method has been shown to be a valid measure of baroreflex sensitivity when compared with the drug-induced method (Parlow, 1993; Parlow *et al.*, 1995). Spontaneous baroreflex sensitivity is determined either by the sequence method or by spectral analysis; Hughson *et al.* (1993) found that the sequence method of data analysis yielded similar results for baroreflex slope as the spectral analysis method.

In the sequence method, computer analysis of continuous recordings of beat-by-beat blood pressure and R-R interval data identified sequences of spontaneously fluctuating blood pressure accompanied by parallel variations in R-R interval (Hughson *et al.*, 1993; Blaber *et al.*, 1995; Parlow *et al.*, 1995). A baroreflex sequence was defined as a series of at least 3 consecutive heart beats in which systolic blood pressure and the following R-R interval either both increased or both decreased (Parati *et al.*, 1988; Hughson *et al.*, 1993; Blaber *et al.*, 1995). Computer analysis of continuous recordings of beat-by-beat blood pressure and R-R interval data identified sequences of spontaneously fluctuating blood pressure accompanied by parallel variations in R-R interval. Linear regression was calculated to determine the slope for each SBR sequence; subsequently, the mean slope for all SBR sequences with r^2 values > 0.85 was calculated. SBR sensitivity was expressed as the mean slope of the SBR sequences, which represented the beat-by-beat interaction between systolic blood pressure (mmHg) and R-R interval (ms), in ms/mmHg. (Appendix, Figure 3). The authors found that 23-27% of all beats were baroreflex sequences in healthy adults, concluding that this was a negative feedback physiological response of the arterial baroreflex.

A non-baroreflex sequence was defined as a series of at least three consecutive heart beats in which systolic blood pressure and the following R-R interval changed in opposite directions (Hughson *et al.*, 1993). Both baroreflex and non-baroreflex sequences occurred in their analyses; however, there were three to four times more baroreflex than non-baroreflex sequences. The finding of non-baroreflex sequences suggests that changes in

R-R interval influenced systolic blood pressure via a positive feedback or feed forward mechanism. The authors speculated on this interesting finding, but suggested that further research was necessary.

Until recently, our knowledge of the normal beat-to-beat blood pressure variability, and the interaction between changes in blood pressure and heart rate was limited to data collected during invasive direct arterial blood pressure monitoring. The development of the Finapres (**Fin**ger **A**rterial **Pres**sure) 2300 (Datex-Ohmeda, Rexdale, Ontario) allows the noninvasive detection of beat-by-beat changes in blood pressure, which, along with spectral analysis of heart rate variability, yields important new information about blood pressure regulation and heart rate control mechanisms.

The main advantages of the spontaneous method are that it assesses SBR sensitivity noninvasively in the normal physiological range over a period of time, can be used for serial measurements, requires minimal subject cooperation and causes little distress. The limitations of the method are that it assesses only the baroreflex gain and resting point, and that it measures only the rapid parasympathetic heart rate response to a change in blood pressure. Moreover, as in the pharmacological method, the vasomotor efferent arm of the baroreflex is not evaluated (Parlow, 1993).

Parlow *et al.* (1995) compared two methods of assessment of cardiac baroreflex sensitivity, the vasoactive drug-induced method and the spontaneous method, in 8 healthy supine men, aged 25-46 years. Data were collected on three consecutive days. On day 1, measurements were made under conditions of parasympathetic blockade with atropine sulphate, β-adrenergic blockade with propranalol, and combined parasympathetic and β-adrenergic blockade. On day 2, data were collected following β-adrenergic blockade with propranalol. On day 3, data were collected following oral ingestion of clonidine hydrochloride, a central nervous system sympathetic inhibitor. For the spontaneous baroreflex method, data were collected during supine rest for 20 min prior to the administration of vasoactive drugs. For the drug-induced method, intravenous bolus injections of the vasopressor phenylephrine hydrochloride, alternating with the vasodilator sodium nitroprusside, were administered serially in increasing doses over 45-60 min. The sequence method of baroreflex determination was used (Blaber *et al.*, 1995). The findings showed that both the spontaneous and drug-induced methods resulted in a substantial decrease in slope during parasympathetic blockade, and an increase in slope during propranalol or clonidine alone. The authors found that the spontaneous and drug-induced methods yielded baroreflex slopes that were highly correlated. Rimoldi *et al.* (1990) studied the neural determinants of spontaneous variations in R-R interval and arterial pressure in conscious dogs. The investigators simultaneously measured R-R interval and arterial pressure variabilities. Under a variety of experimental conditions, including denervation of the aortic arch and carotid sinus, they studied the effects of baroreceptor loading and unloading. The authors found that both neural and mechanical factors of respiration influenced the high frequency component of arterial pressure variability; that neural factors were responsible for R-R variability; and that the sympathetic nervous system influenced the low frequency component of arterial pressure variability.

Respiratory Modulation of Heart Rate

Rhythmic variations in R-R interval and heart rate occur in response to respiration. Typically, during inspiration, sympathetic neural activity increases and heart rate increases, whereas during expiration, parasympathetic neural activity increases and heart rate decreases (Haggenmiller *et al.*, 1996; Berne & Levy, 1997). The very rapid removal of acetylcholine released at parasympathetic nerve endings means that rhythmic changes in respiratory activity elicit rhythmic changes in R-R interval and heart rate. In contrast, the slow removal of norepinephrine released at sympathetic nerve endings means that sympathetically-mediated changes in respiratory activity cannot exert instantaneous changes in heart rate and R-R interval. The phrase "respiratory sinus arrhythmia" describes the rhythmic changes in R-R interval that occur in response to respiratory activity, with R-R interval decreasing during inspiration and increasing during expiration (Haggenmiller *et al.*, 1996).

In addition, reflex and central nervous system factors influence the variations in R-R interval associated with respiratory activity (Berne & Levy, 1997). During inspiration, intrathoracic pressure decreases, facilitating an increase in venous return to the heart. Consequently, cardiac output and arterial blood pressure increase, causing a baroreflex-mediated reduction in heart rate. Similarly, moderate inflation of stretch receptors in the lungs during inspiration may increase heart rate reflexly. Central nervous system factors contribute to respiratory cardiac arrhythmia through the influence of the respiratory centre in the medulla on cardiac autonomic centres (Haggenmiller *et al.*, 1996; Berne & Levy, 1997).

Haggenmiller *et al.* (1996) used spectral analysis to analyze the effects of active and controlled breathing, by measuring the effects of breathing frequency, tidal volume, and mechanical ventilation, on high frequency power as an indicator of respiratory sinus arrhythmia, in 12 healthy men. In part 1, breathing frequency was paced at 8/min, 12/min and 18 breaths/min; tidal volume was not controlled. In part 2, breathing frequency was controlled by mechanical ventilation via a face mask at 8/min, 12/min and 18 breaths/min; tidal volume was adapted to physiologic condition and controlled by end-tidal pCO_2 monitoring. In part 3, breathing frequency was controlled by mechanical ventilation via a face mask at 8/min, 12/min and 18 breaths/min; tidal volume was controlled at 700 ml. Subjects were in the supine position and awake without medication. Mechanical ventilation decreased respiratory sinus arrhythmia at all breathing frequencies. Increasing breathing frequency (active and passive breathing) resulted in decreasing respiratory sinus arrhythmia; increasing tidal volume resulted in increasing respiratory sinus arrhythmia. During active breathing, breathing frequency correlated with power spectral density; during passive breathing, tidal volume correlated linearly with power spectral density.

The heart rate response to deep-breathing and the valsalva manoeuver are standard tests of cardiac parasympathetic control and baroreflex sensitivity (Saul *et al.*, 1989; Niemela *et al.*, 1992; Novak *et al.*, 1993; Brown *et al.*, 1993; Piha & Hamalainen, 1994). Novak *et al.* (1993) examined the effect of respiration on heart rate and blood pressure variations in 14 men and 2 women (aged 23-37 years). Subjects were tested in the supine position in a light-attenuated room. Using a taped recording, the deep-breathing test consisted of inspiration-expiration in synchrony with each tone in a sequence of 100-ms beeps, with a progressive lengthening of the respiratory cycle from 2.17 to 20 seconds within an 8.5 minute interval. This resulted in a continuous slowing of the respiratory rate, from 0.46 to 0.05 Hz. Tidal volume was measured but not controlled. Data acquisition consisted of heart rate (by electrocardiogram, Lead II), respiratory signal (by nasal thermistor), and beat-to-beat blood pressure (noninvasively, by photoplethysmographic transducer, Ohmeda Finapres). The findings revealed a close nonlinear coupling between the respiratory and cardiovascular systems. The authors concluded that the amplitude of R-R variations was proportional to the tidal volume, and, for a given tidal volume, the amplitude of R-R interval variations increased as respiratory frequency decreased.

Saul *et al.* (1989) investigated the effect of respiration over a broad range of frequencies on autonomic regulation in both the supine and upright postures. Eighteen healthy non-smoking adult volunteers (10 male and 8 female, aged 21-34_years) participated in the study. Ventilatory intervals were controlled in an erratic manner, but mean respiratory frequency was 12 breaths/minute. Tidal volume was not controlled. Their findings indicate that rising heart rate is synchronous with respiration only at typical respiration frequencies between 0.15 and 0.25 Hz (9 and 15 breaths per min), and that the respiratory modulation of heart rate was lower in the upright posture.

Brown *et al.* (1993) determined the effect of breathing frequency and tidal volume on R-R interval power spectra in 9 healthy young adults (8 men and 1 woman, age 23-32 years) in the supine position. The authors also reviewed the literature to determine how the potential influence of respiration on the measurements of R-R interval power was being investigated in human studies. Their results showed that respiratory frequency (6 to 24 breaths/min) and nominal tidal volumes of 1000 and 1500 ml influenced low frequency (0.06-0.14 Hz) and respiratory frequency R-R interval power spectra. The R-R interval variability and_spectral power decreased as breathing frequency increased from 10 to 15_breaths/min. Slow breathing yielded large increases in low frequency power; low frequency power declined at $\geq$10 breaths/min. The R-R interval power at respiratory frequencies increased as tidal volume increased. The authors concluded that breathing frequencies of $\leq$ 10 breaths/min resulted in maximum R-R interval power; breathing frequencies of $\geq$ 10 breaths/min resulted in decreased R-R interval power in an inverse relationship to frequency. The authors also revealed that only 51% of human studies controlled respiratory rate, 11% controlled tidal volume, and 11% controlled both rate and tidal volume. Controlled ventilation, however, may confound the variables under investigation by increasing the psychological stress response or by altering the normal mechanics of ventilation (Haggenmiller *et al.*, 1996).

Effects of Physiologic Perturbations on Modulation of Heart Rate

Effects of Orthostatic Stress

The effects of orthostatic stress due to posture changes, i.e., sitting, standing or passive head up tilt, on heart rate variability and baroreflex sensitivity have been examined in numerous studies (Pomeranz *et al.*, 1985; Lipsitz *et al.*, 1989; Saul *et al.*, 1989; Rimoldi *et al.*, 1990; Butler *et al.*, 1993; Kamath *et al.*, 1991; Fei *et al.*, 1995; Smit, 1996). Normally, the upright posture produces deactivation of afferent nerve impulses from arterial baroreceptors, resulting in an increase in efferent sympathetic activity and a concurrent withdrawal of parasympathetic activity, to the SA node (Kamath *et al.*, 1991; Persson, 1996). Consequently, parasympathetic modulation of heart rate decreases and sympathetic modulation increases. Kamath *et al.* (1991) measured the power spectrum of heart rate variability in 19 healthy subjects in response to orthostatic stress and steady-state exercise, two physiologic stresses normally associated with increased sympathetic activity. To test the effects of orthostatic stress, subjects were asked to stand upright after 15 minutes of supine rest, and then to maintain a free standing posture for 10 minutes. As the subjects stood upright, there was a substantial (51%) increase in the ratio of the low frequency to high frequency power, indicating an increase in sympathetic activity.

Pomeranz *et al.* (1985) used autonomic blocking agents and posture changes (supine, sitting, standing) to assess autonomic function in healthy men by heart rate spectral analysis. They also examined the effects of respiratory frequency and depth on these responses, by using a metronome to regulate respiratory rate. In the supine position, low frequency fluctuations (< 0.12 Hz) were mediated by the parasympathetic nervous system. On standing, the low frequency fluctuations increased and were mediated by both the sympathetic and parasympathetic nervous systems. In contrast, the high frequency fluctuations at a respiratory rate of 15 breaths per minute (0.25 Hz) decreased on standing, and were mediated solely by the parasympathetic nervous system in both the supine and standing postures. The authors concluded that sympathetic influences on heart rate are present only in the standing posture, whereas parasympathetic activity influences heart rate at both low and high frequencies in both supine and standing postures.

Fei *et al.* (1995) assessed responses to passive head up tilt by spectral analysis of heart rate variability. They found a significant decrease in high frequency power, a non-significant increase in low frequency power, and an increase in the ratio of low frequency to high frequency power in their healthy middle-aged control subjects. In survivors of sudden cardiac death, there was a significant decrease in high frequency power.

Lipsitz *et al.* (1990) analyzed heart rate variability by spectral analysis in response to 60 degree passive head up tilt in healthy young (18-35 years) and old (71-94 years) subjects. Old subjects had lower total power, high frequency power and low frequency power in both supine and tilt position than young subjects. During tilt, young subjects increased total power and low frequency power.

Butler *et al.* (1993) used CGSA to assess heart rate variability in response to 70 degree passive head up tilt in healthy young women and men. During tilt, the authors found a decrease in low frequency power, high frequency power and parasympathetic indicator, and an increase in sympathetic indicator.

Effects of Acute Exercise on Modulation of Heart Rate

Cardiovascular responses to exercise are regulated by neural, humoral and autoregulatory mechanisms (Stone, 1983). The neural factors include the autonomic nervous system, reflex mechanisms in working muscle and the baroreceptor reflexes. Central activation of the autonomic nervous system during exercise normally inhibits parasympathetic activity while stimulating sympathetic discharge, producing increases in heart rate, myocardial performance, and levels of catecholamines in plasma. The heart rate increases linearly in proportion to metabolic demand during physical exercise. Myocardial oxygen demand is determined by the type and amount of cardiac work and is estimated from the rate-pressure product (RPP). Active tissues respond to the metabolic demands of exercise by local vasodilation. Increased cardiac output, decreased peripheral vascular resistance, redistribution of blood flow to active muscles, venoconstriction, and increased oxygen extraction constitute these initial responses to exercise (Stone, 1983).

Several investigators have examined the effects of exercise on heart rate variability and baroreflex function (Kamath *et al.*, 1991; Yamamoto *et al.*, 1991; Nakamura *et al.*, 1993; O'Leary & Seamans, 1993; Potts *et al.*, 1993; Fei *et al.*, 1995; Shi *et al.*, 1995). Fei *et al.* (1995) found that submaximal exercise on a motorized treadmill (modified Bruce protocol) reduced total power, high frequency power, low frequency power and the sympathetic indicator.

Kamath *et al.* (1991) investigated the effects of steady-state exercise at 50% of maximum predicted power output on a cycle ergometer on the power spectrum of heart rate variability. In contrast to the effects of orthostatic stress, which increased the sympathetic indicator by 51%, steady-state exercise produced a suppression of both low and high frequency power spectra. The authors concluded that neuroregulatory factors exerted a major influence during orthostatic stress, but humoral factors were responsible for maintaining heart rate during steady-state exercise. However, the authors did not provide any evidence to support the latter conclusion. Similar results were reported by Arai *et al.* (1989), that moderate exercise on a cycle ergometer decreased both low and high frequency power, with no change in the ratio of low frequency to high frequency power.

Yamamoto *et al.* (1991) and Nakamura *et al.* (1993) studied the autonomic control of heart rate during exercise by measuring heart rate variability in healthy men and women. They reported that, during low intensity exercise, the parasympathetic effects on heart rate predominated; the parasympathetic effects diminished when exercise intensity exceeded 50% of peak oxygen uptake or a work rate equivalent to 60% of the ventilatory threshold (Tvent), allowing heart rate to increase. The sympathetic effects increased initially at 50-60% of peak oxygen uptake, and increased significantly further at >60% of maximal oxygen uptake, coinciding with marked increases in plasma epinephrine and norepinephrine.

Potts *et al.* (1993) studied carotid baroreflex responsiveness during exercise on a cycle ergometer to volitional fatigue in 7 healthy men (age 18-35 years). They utilized brief (5 seconds) perturbations to the carotid sinus by the neck pressure and neck suction method, at rest and during steady-state exercise at 25% and 50% of previously measured peak oxygen uptake. Arterial pressure was measured directly from the radial artery, and by finger photoplethysmography (Finapres, Model 2300, Ohmeda). Data were collected during a 10-12 second held breath at end expiration, to minimize the respiratory modulation of heart rate and mean arterial pressure. Results suggested that there was an upward resetting of the carotid baroreflex to a higher range of systemic pressure during exercise at 50% peak oxygen uptake, with no attenuation in maximal gain or sensitivity.

Shi *et al.* (1995) studied aortic-cardiac baroreflex responsiveness to low intensity cycle exercise (25% of previously measured maximum oxygen consumption) in 10 young adults. Carotid and aortic baroreceptors were isolated during the measurements by using neck pressure, low level lower body negative pressure, and phenylephrine infusion. Baroreflex function was calculated as the ratio of the change in heart rate to change in mean arterial pressure. Their results showed that, during supine rest and steady-state exercise, aortic baroreceptors predominated over carotid baroreceptors in the modulation of heart rate.

O'Leary and Seamans (1993) examined the effects of moderate exercise on the baroreflex control of heart rate in conscious dogs, and whether the autonomic mechanisms mediating arterial baroreflex control differed between rest and exercise. Studies were conducted before and after infusions of either phenylephrine or nitroglycerine, and were repeated after parasympathetic blockade by atropine, then beta-adrenergic sympathetic blockade by propranolol, during rest and exercise. Results revealed that, during control studies at rest and during moderate exercise, baroreflex-mediated changes in heart rate were greater in response to decreases than to increases in mean arterial pressure. Furthermore, at rest, bradycardia was mediated by parasympathetic activation, but tachycardia was the result of combined parasympathetic inhibition and sympathetic activation. During moderate exercise, the authors found that the magnitude of the baroreflex response was unchanged. However, the autonomic mechanisms mediating the baroreflex changes in heart rate were altered, in that baroreflex tachycardia and bradycardia were due to changes in both parasympathetic and sympathetic tone.

Effects of Cardiovascular Disease on Modulation of Heart Rate

Craelius *et al.* (1991) measured heart rate variability during early recovery after a myocardial infarction (MI) to determine autonomic nervous system activity. Eight men who had suffered an MI within the previous 2-6 weeks were compared with 8 age matched controls free of cardiac disease, and with 8 patients who had had an MI more than 1 year previously. Postural changes, using a motorized tilt table were used to elicit changes in heart rate and heart rate variability. Breathing rates were within normal range (11-17 breaths per minute). Their results indicated that, during early recovery following MI, parasympathetic nervous system activity is depressed. These findings were consistent with the early results of Kleiger *et al.* (1987) and Bigger *et al.* (1988), who found reduced heart rate variation in recent MI patients, and Schwartz *et al.* (1988), who found reduced baroreflexes in patients following MI. Decreased heart rate variation and depressed baroreflex activity are suggestive of reduced parasympathetic activity. Moreover, Lombardi *et al.* (1987) demonstrated increased sympathetic activity in addition to decreased parasympathetic activity in subjects within 2 weeks of an MI. These findings have implications for sympathetically-mediated cardiac rate and rhythm disturbances.

Effects of CABG Surgery on Modulation of Heart Rate

During the surgical procedure several cardiac control mechanisms are disrupted by manipulation of the heart, cardiac autonomic nerves and coronary arteries; by aortic clamping and vein grafting; and by cardiopulmonary bypass (Yang *et al.*, 1994). Mechanical injury to cardiac autonomic nerves, baroreceptors in the aortic arch, and the SA node can alter heart rate regulation postoperatively (Piha & Hamalainen, 1994; Yang *et al.*, 1994). These factors may contribute to the sinus tachycardia and labile blood pressure observed during the early postoperative and post-discharge periods (Niemela *et al.*, 1992; Komatsu *et al.*, 1994; Piha & Hamalainen, 1994). Trauma to the efferent fibres of either the sympathetic or the parasympathetic division of the cardiac autonomic nervous system alters the balance between the two divisions on the modulation of heart rate. Damage to aortic baroreceptors due to aortic clamping and manipulation during vein grafting may limit afferent input. The duration of these effects during early recovery from surgery has not been established.

Yang *et al.* (1994) utilized power spectral analysis to examine changes in autonomic function during unspecified cardiac surgery in 10 patients. Results were as follows: the sympathetic indicator decreased after induction of anaesthesia, during bypass, and after surgery; low frequency and very high frequency areas decreased during bypass. These findings may indicate a shift in dominance to the parasympathetic division of the autonomic nervous system during surgery. Baroreflexes, however, were not studied.

Niemela *et al.* (1992) studied the effect of CABG surgery on parasympathetic function by spectral analysis of heart rate variability and heart rate response to deep-breathing. Thirty-five patients (27 men, 8 women) were studied on the day before and one week after CABG surgery; twenty-six of these patients were also evaluated six weeks after surgery. In the supine position, subjects performed four maximal inspirations and expirations at the rate of six cycles per minute. The heart rate response to deep-breathing was assessed as the mean difference between maximum and minimum heart rates during the deep-breathing cycles. Tidal volume during deep-breathing was not reported. The authors observed depressed autonomic function in low frequency (0.00-0.07 Hz), mid-frequency (0.07-0.15 Hz) and high frequency (0.15-0.50) power after surgery, and a marked attenuation of heart rate variability and heart rate response to deep-breathing. These reductions persisted for six weeks after surgery. Thus, the authors concluded that CABG surgery caused irreversible impairment of parasympathetic modulation of heart rate, which they attributed to perioperative mechanical injury to the autonomic nerve fibres or the SA node. However, loss of afferent input from aortic baroreceptors may contribute to this impairment, in addition to injury to efferent parasympathetic fibres.

Komatsu *et al.* (1994) analyzed heart rate variability in 9 patients before and 1, 3, 7, 14, 21, and 28 days after unspecified open heart surgery. Results were that low frequency, mid-frequency, and high frequency components of the power spectral analysis all decreased postoperatively, compared with the preoperative (control) values. These findings suggest that cardiac surgery inhibits all autonomic control of the heart, and are consistent with the results of Niemela et al. (1992). However, the effects of surgery on cardiac baroreflexes were not studied.

Piha & Hamalainen (1994) studied the effects of CABG surgery on cardiovascular reflexes in 15 subjects, by measuring the heart rate and beat-to-beat blood pressure responses to the deep-breathing test, the Valsalva manoeuver and standing. Their results revealed that supine and standing heart rate increased after CABG surgery, that the indices reflecting parasympathetic function were attenuated after CABG surgery, and that CABG surgery had no effect on beat-to-beat blood pressure. The authors concluded that the attenuation of heart rate was due to perioperative damage to efferent nerves or to the effector organ (i.e., the SA node), and not to baroreceptor dysfunction. These findings have not been confirmed by other investigators.

Effects of CABG Surgery on Myocardial Function

Cardiac function may be altered as a result of CABG surgery, due to decreased autonomic (both sympathetic and parasympathetic) nervous control (Komatsu *et al.* 1994). Injury to efferent parasympathetic nerves during surgery may attenuate the inhibitory effects on atrioventricular conduction tissue and on the atrial and ventricular myocardium (Berne & Levy, 1997). Attenuation of parasympathetic effects, which reportedly persists for at least 6 weeks after surgery, may lower the threshold for the stimulatory effects of sympathetic stimuli or circulating catecholamines to occur during stress or physical activity (TFESCNASPE, 1996). Consequently, the sympathetic effects may occur even at a low intensity of exercise or physical activity during the early post-discharge period. This resulting sensitivity of myocardial tissue to local or circulating vasoconstrictors may trigger cardiac irritability, atrial and ventricular dysrhythmias and distressing symptoms during moderate intensity exercise. Moreover, the depressed autonomic nervous function of the heart has been implicated in postoperative cardiac dysfunction and failure (Komatsu *et al.*, 1994).

Effects of Acute Exercise following CABG Surgery

Moderate intensity exercise. Performing moderate intensity exercise during the early weeks after CABG surgery increases the incidence, symptoms, and potential risks of cardiac arrhythmias, coronary artery spasm, myocardial ischemia, and sudden cardiac death (Dion *et al.*, 1982; Rod *et al.*, 1982; Silvidi *et al.*, 1982; Ehsani *et al.*, 1984; Christopherson *et al.*, 1984; Foster *et al.*, 1984; Gwirtz & Stone, 1984; Bove & Dewey, 1985; Hanson *et al.*, 1985; Hands *et al.*, 1987; DiCarlo *et al.*, 1988; Chilian *et al.*, 1989; Grondin *et al.*, 1989). Dion *et al.* reported that the incidence of ventricular arrhythmias was 70% during exercise two weeks postoperatively, whereas Hartman *et al.* (1981) reported an incidence of 22% at four weeks recovery. Evidence for myocardial ischemia occurred in 30% of patients at two weeks post-surgery (Silvidi *et al.*, 1982), and only 14% at twelve weeks (Hanson *et al.*, 1985). These responses may be due to the combined effects of (1) impaired neural regulation which may lower the threshold for the stimulatory sympathetic effects on heart rate to occur (TFESCNASPE, 1996), (2) the supersensitivity of myocardial tissue and coronary arteries to circulating plasma catecholamines during the first few weeks after CABG surgery, and, (3) the increased plasma catecholamine levels which rise as a function of exercise intensity (Yamamoto *et al.*, 1991; Nakamura *et al.*, 1993; TFESCNASPE, 1996).

Attenuation of the parasympathetic modulation of heart rate has implications for heart rate response during acute moderate intensity exercise. In addition, the early supersensitivity of cardiac tissue may trigger atrial or ventricular arrhythmias at a lower concentration of plasma catecholamines than usual (Grondin *et al.*, 1989), and may account, in part, for the frequency of atrial and ventricular arrhythmias observed during the early post-discharge period (Huikuri *et al.*, 1995; TFESCNASPE, 1996). Moreover, individuals with cardiovascular disease are more sensitive than others of similar age to the vasoconstrictor effects of circulating catecholamines (Shephard, 1982).

Low intensity exercise. The guidelines of the American College of Sports Medicine (ACSM) (1995) recommend low intensity exercise, between 40 and 60% of maximum oxygen uptake (VO_{2max}) for deconditioned people and during early recovery after CABG surgery. During low intensity exercise in healthy adults, parasympathetic modulation of heart rate predominated; parasympathetic modulation diminished when exercise intensity exceeded 50% of peak oxygen uptake (Yamamoto *et al.*, 1991; Nakamura *et al.*, 1993). Thus, low intensity exercise after CABG surgery reduces the sympathetically-mediated risks associated with moderate intensity exercise (TFESCNASPE, 1996).

Two recent studies by this investigator evaluated the cardiovascular responses of men to a low-level graded exercise test at discharge, and six and twelve weeks following discharge after CABG surgery (Brown, 1990; Brown *et al.*, 1992; Brown *et al.*, 1994). In the first study (Brown, 1990; Brown *et al.*, 1994), in subjects who were on a low intensity exercise conditioning regime, resting heart rate declined from 101 to 86 beats·min^{-1} six weeks later. Responses to acute treadmill exercise, using a modified Naughton protocol, revealed that peak exercise heart rate increased linearly with increases in functional capacity, from 121 beats·min^{-1} at discharge, to 134 beats·min^{-1} at six weeks, and 136 beats·min^{-1} at twelve weeks. Systolic blood pressure at peak exercise also increased, from 146 mm Hg at discharge to 166 mm Hg at six weeks. Whether the increase in heart rate with acute exercise was due to decreased parasympathetic and/or increased sympathetic effects was not determined. Similarly, the autonomic mechanisms responsible for the decline in resting heart rate after a conditioning program were not studied.

The second study (Brown *et al.*, 1992) replicated the exercise conditioning and low-level graded exercise testing components of the first. Resting heart rate and rate-pressure product declined, and systolic blood pressure increased from discharge to twelve weeks. Peak exercise heart rate, systolic blood pressure, and rate-pressure product increased in relation to the increase in functional capacity during treadmill testing. The autonomic and baroreflex mechanisms responsible for these responses, however, were not measured. Neither of these studies investigated the responses of women.

Effects of Age on Modulation of Heart Rate

Increasing age is reported to be associated with a loss of heart rate variability and baroreflex sensitivity (Pagani *et al.*, 1986; Docherty, 1990; Lipsitz *et al.*, 1990; Ryan *et al.*, 1994; Liao *et al.*, 1995; Shi *et al.*, 1996; Stanley *et al.*, 1996; Poller *et al.*, 1997; Laitinen *et al.*, 1998; Brodde & Michel, 1999). Lipsitz *et al.* assessed changes in autonomic function in two conditions: aging and vasovagal syncope, representing extremes of autonomic activity. Healthy human subjects included 12 young (5 women, 7 men; median age, 21.5 years; range, 18-35 years) and 10 old individuals (6 women, 4 men; median age, 76.5 years; range, 71-94 years). After 1 hour of supine rest, subjects were inclined, over 10 seconds, from 0 degrees to 60 degrees, by means of a tilt table. They were maintained in the inclined position for 15 minutes. During postural tilt, heart rate variability was unchanged for the old subjects, but increased for the young subjects. The findings revealed that old subjects have lower total power in supine and tilt positions, lower high frequency power in both positions, and either absent or attenuated low-frequency activation during tilt than younger subjects, confirming earlier reports that elderly subjects have a restricted range of responsiveness to physiological stress.

Poller *et al.* (1997) examined baroreceptor sensitivity and muscarinic receptor function in young (22-29 years) and older (54-67 years) healthy men. Baroreceptor function was evaluated by acutely altering arterial pressure by intravenous injection of phenylephrine, and measuring the degree of R-R interval change in response to the degree of change in arterial pressure. Muscarinic receptor function was evaluated by intravenous injection of atropine sulphate and pirenzepine over 5 min in increasing doses and measuring the blood pressure at one min intervals. The results showed that atropine sulphate in low doses caused a significant decrease in heart rate in young but not older subjects; in higher doses, there was a dose-dependent decrease in heart rate that was similar in both groups. Low dose pirenzepine had similar effects on heart rate as atropine sulphate; in contrast, higher doses caused a slight increase in heart rate for both groups. Phenylephrine resulted in a significantly larger increase in systolic blood pressure and a smaller decrease in R-R interval in the older subjects than in the younger subjects. The authors concluded that cardiac muscarinic receptor activity diminished with increasing age and may explain the decrease in baroreceptor function.

Effects of Gender on Modulation of Heart Rate

Several cardiac structural and functional differences exist between women and men. Women have smaller left ventricular chamber size and myocardial mass, even after body surface area and height have been considered, and lower cardiac pump and myocardial performance than men (Cowley & Dzau, 1992; Douglas et al., 1992). Heart rate in women is higher than that of men for any given absolute cardiac output or oxygen uptake;

women have smaller hearts and smaller stroke volumes (Cowley & Dzau, 1992; Douglas *et al.*, 1992). Gender-related differences in plasma catecholamines and the autonomic nervous system may contribute to differences in responses to exercise and non-exercise stress (Cowley & Dzau, 1992; Douglas *et al.*, 1992). Women secrete more plasma catecholamines during exercise than men and the age-related increase in blood pressure during exercise is greater in women. Women have a 14%-15% lower maximal oxygen uptake than men and a lower arterial oxygen content at rest, which may be attributed to lower hemoglobin levels in women (Cowley & Dzau, 1992; Mitchell *et al.*, 1992).

The comparison of the effects of gender on heart rate variability and baroreflex sensitivity has been reported for healthy women and men. Ryan *et al.* (1994) analyzed heart rate variability by spectral analysis in 67 healthy subjects in three age groups: young (20-39 years, n = 21), middle-aged (40-64 years, n = 26) and elderly (> 65 years, n = 20). Measurements were made in the supine position during spontaneous breathing and during metronome breathing at 15 breaths/min. Results revealed that, overall, women had higher high frequency power and higher high frequency to low frequency power ratio, and lower low frequency power than men. The high frequency to low frequency power ratio was used as an index of parasympathetic relative sympathetic nervous system tone, and was significantly different between women and men in the young and elderly groups, but not in the middle-aged group. Most of the gender differences occurred in the high frequency power; high frequency power was enhanced by metronomic breathing.

Liao *et al.* (1995) studied the influence of age, race, and sex on autonomic cardiac function in the supine position by spectral analysis of heart rate variability in a large random sample of the general population; low frequency (0.25-0.15 Hz) and high frequency (0.16-0.35 Hz) bands were calculated from the power spectrum. This investigation was part of the Atherosclerosis Risk in Communities (ARIC) study. Results were that women, after adjusting for age and race, showed lower low frequency power, and higher high frequency to low frequency ratio than men; high frequency power was not significantly different between women and men.

Huikuri *et al.* (1996) studied heart rate variability in middle-aged (mean age, 50 + 6 years) women (n = 186) and men (n = 188) in supine and sitting positions, and studied baroreflex sensitivity in the sitting position only. Results showed that blood pressure, baroreflex sensitivity, low frequency power and low frequency to high frequency power ratio were lower in women than men; high frequency power was higher in women. The authors concluded that baroreflex responsiveness is attenuated in women, that low frequency power reflects baroreflex-mediated oscillations in arterial pressure, and that tonic vagal activity is augmented in women. In addition, women's responses to cardiovascular unloading in the sitting position compared with supine was smaller than men's responses, suggesting that vagal responses were attenuated in women.

Laitinen *et al.* (1998) reported that baroreflex sensitivity was dependent on age and gender in 117 healthy subjects. The subjects were divided into three age groups: young (23-29 years, n = 44), middle-aged (40-59 years, n = 38) and old (60-77 years, n = 35), with approximately an equal number of men and women in each group. Heart rate variability and baroreflex sensitivity were assessed in the supine position, in response to intravenous injections of phenylephrine, and in response to exercise to capacity on a cycle ergometer. Venous blood samples for plasma levels of catecholamines, insulin, arginine vasopressin, and plasma renin activity were taken prior to the phenylephrine tests. Results were that women had lower body mass index, exercise capacity and very low frequency power (0-0.07 Hz) than men, and higher heart rate than men. Baroreflex sensitivity correlated inversely with aging in men and women; baroreflex slopes were lower in women over all age ranges. Young and middle-aged women had lower baroreflex slopes than men in the same age groups. Age and gender together accounted for 52% of the variance in baroreflex sensitivity. Baseline plasma norepinephrine increased with aging whereas baseline plasma renin activity decreased with aging; there were no differences between women and men. An important finding was that 24% of middle-aged and old healthy women had markedly depressed baroreflex sensitivity, which has been associated with increased risk of arrhythmias following myocardial infarction. Low baroreflex sensitivity was correlated with elevated blood pressure, and inversely correlated with plasma norepinephrine concentration, an indicator of sympathetic activity. Baroreflex sensitivity also correlated with heart rate variability. Thus, the authors concluded that baroreflex sensitivity was influenced by both divisions of the autonomic nervous system.

Dougherty (1999) studied heart rate variability and baroreflex sensitivity in healthy middle-aged (40-60 years) men and women in supine and standing positions, with breathing frequency paced at 12 breaths/min. She reported that middle-aged women had higher high frequency power in both supine and standing postures than men. Dougherty also found that supine baroreflex sensitivity was higher in women compared with men, that baroreflex sensitivity decreased in the standing position compared with supine in men and women, and that there was no significant difference between men and women in standing baroreflex sensitivity.

In general, women bypass patients are older than men, have a greater reported incidence of post-surgical complications and symptoms of chest discomfort consistent with angina, shortness of breath, and a lower graft patency rate, particularly of saphenous vein grafts (Zyzanski *et al.*, 1981; Becker, 1990; Cowley & Dzau, 1992; Wenger *et al.*, 1993; Heart & Stroke Foundation of Canada, 1999). Despite gender differences in body composition, cardiac size and function, neural and hormonal influences, very little is known about the course of recovery for women after CABG surgery. In women with ischemic heart disease following CABG surgery, baroreflex and autonomic modulation of heart rate has not been studied.

Summary

Cardiovascular disease and aging are associated with decreased heart rate variability and reduced baroreflex sensitivity (Schwartz *et al.*, 1988; Craelius *et al.*, 1991; Lipsitz *et al.*, 1990). Typically, men who undergo CABG surgery are over 40 years of age; women are approximately 10 years older than men (Heart & Stroke Foundation of Canada, 1997). Thus, in addition to gender differences, the higher age of women than men in this population may contribute to differences between them in autonomic modulation of heart rate. Healthy women and age-matched men differ in measures of heart rate variability and baroreflex sensitivity (Ryan *et al.*, 1989; Huikuri *et al.*, 1996; Dougherty, 1999). Elderly subjects have a restricted range of cardiovascular responsiveness to physiological stress in both supine and tilt positions (Lipsitz *et al.*, 1990).

Physiological factors, such as breathing frequency and tidal volume, influence heart rate and rhythmic variations in R-R interval (Saul *et al.*, 1989; Brown *et al.*, 1993; Novak *et al.*, 1993; Haggenmiller *et al.*, 1996). Novak *et al.* (1993) concluded that the amplitude of R-R variations was proportional to the tidal volume, and, for a given tidal volume, the amplitude of R-R interval variations increased as respiratory frequency decreased. Saul *et al.* (1989)

reported that increasing heart rate is synchronous with respiration only at typical respiration frequencies between 0.15 and 0.25 Hz (9 and 15 breaths/min), and that the respiratory modulation of heart rate was lower in the upright posture. Similarly, Brown *et al.* (1993) showed that R-R interval variability and spectral power decreased as breathing frequency increased above 10 breaths/min; the R-R interval power at respiratory frequencies increased as tidal volume increased from 1000 to 1500 ml. The authors concluded that breathing frequencies of <10 breaths/min resulted in maximum R-R interval power; breathing frequencies of >10 breaths/min resulted in decreased R-R interval power in an inverse relationship to frequency. Typically, in subjects during the first week following CABG surgery, breathing frequency is higher than 10 breaths/min in the resting state and during physical perturbations. Several factors contribute to this rapid respiratory rate: 1) reduced oxygen carrying capacity postoperatively due to low hemoglobin, 2) altered mechanics of ventilation due primarily to the sternal incision, resulting in low tidal volume and 3) atelectasis due to prolonged immobility during surgery and postoperatively. Consequently, respiratory rate increases; the combination of low tidal volume and increased respiratory frequency may decrease heart rate variability in this population.

Physiologic perturbations, such as orthostatic stress and acute physical exercise decrease heart rate variability and baroreflex sensitivity (Pomeranz *et al.*, 1985; Lipsitz *et al.*, 1989; Saul *et al.*, 1989; Rimoldi *et al.*, 1990; Kamath *et al.*, 1991; Yamamoto *et al.*, 1991; Butler *et al.*, 1993; Nakamura *et al.*, 1993; O'Leary & Seamans, 1993; Potts *et al.*, 1993; Fei *et al.*, 1995; Shi *et al.*, 1995; Smit, 1996). Pomeranz *et al.* (1985) reported that high frequency heart rate variability decreased on standing, but was mediated solely by parasympathetic activity in both supine and standing postures. Kamath *et al.* (1991) revealed that, compared with the supine position, the free standing posture elicited a substantial (51%) increase in sympathetic activity. Fei *et al.* (1995) found that submaximal exercise reduced total power, high frequency power, low frequency power and the sympathetic indicator. Yamamoto *et al.* (1991) and Nakamura *et al.* (1993) reported that, during low intensity exercise, the parasympathetic effects on heart rate predominate; the parasympathetic effects diminish when exercise intensity exceeds 50% of peak oxygen uptake. The sympathetic effects increase initially at 50-60% of peak oxygen uptake, and increase further at >60% of maximal oxygen uptake, coinciding with marked increases in plasma epinephrine and norepinephrine.

CABG surgery may attenuate the rapid and short-term adaptations in heart rate variability and baroreflex sensitivity required by standing and exercise. In addition to intraoperative trauma to efferent cardiac autonomic nerves and the SA node, the postoperative increase in respiratory frequency could contribute to the reduced autonomic modulation of heart rate during supine rest and in response to standing and exercise. The duration of the postoperative decline in autonomic modulation of heart rate beyond six weeks postoperatively has not been reported. Yang *et al.* (1994) found that there was a decrease in sympathetic indicator during and after CABG surgery, and a shift in dominance of the parasympathetic modulation of heart rate. Komatsu *et al.* (1997) and Niemela *et al.* (1992) reported that CABG surgery attenuated all autonomic activity. Niemela *et al.* concluded that the attenuation of parasympathetic activity was irreversible.

Purpose of the Study

The primary purposes of this research were 1) to describe the effect of ischemic heart disease on heart rate variability and spontaneous baroreflex sensitivity in men and women in supine and standing postures (Study 1); 2) to assess the effect of CABG surgery on heart rate variability and spontaneous baroreflex sensitivity, in men and women in supine and standing postures Study 2); 3) to assess effect of 12 weeks recovery following CABG surgery on heart rate variability and spontaneous baroreflex sensitivity, in men and women in supine and standing postures (Study 3); 4) to assess the effect of low intensity exercise 6 and 12 weeks recovery following CABG surgery on heart rate variability and spontaneous baroreflex sensitivity, in men and women (Study 4). A secondary purpose in Study 4 was to determine the influence of tidal volume and breathing frequency in the supine posture and during exercise.

CHAPTER 3

Study 1

Autonomic Modulation of Heart Rate in Women and Men with Ischemic Heart Disease

Ischemic heart disease, defined as any condition in which cardiac muscle is damaged, or functions inefficiently, due to inadequate coronary blood flow, causes 21% of all deaths annually in Canada (Heart and Stroke Foundation of Canada, 1999). Mortality rates in men increase gradually after 35 years of age; in women, the rates increase dramatically after menopause (Cardiovascular Disease and Women, 1996; Heart & Stroke Foundation of Canada, 1997; 1999).

Decreased heart rate variability, implying a reduction in the parasympathetic modulation of heart rate, has been reported following myocardial infarction (Akselrod *et al.*, 1981; Kleiger *et al.*, 1987; Pagani *et al.*, 1988; Schwartz *et al.*,1988; Billman & Hoskins, 1989; Bigger *et al.*, 1992; Huikuri *et al.*, 1995; Copie *et al.*, 1996), in hypertension (Guzzetti *et al.*, 1988; Pagani *et al.*, 1988; Parati *et al.*, 1988; Malliani *et al.*, 1991; Craelius *et al.*, 1992), and during unstable angina (Huang *et al.*, 1995). Moreover, sympathetic activity increases following myocardial infarction (Lombardi *et al.*, 1987). This shift in autonomic balance, due to decreased parasympathetic activity and increased sympathetic activity, increases the

cardiovascular system to adapt to rapidly changing stimuli (Akselrod *et al.*, 1981), 2) an increase in the potential for sympathetically-mediated cardiac dysrhythmias, and 3) an increase in the risk for sudden cardiac death (Algra *et al.*, 1993; Huikuri *et al.*, 1995; TFESCNASPE, 1996). Decreased SBR sensitivity reflects a reduced ability of the cardiovascular system to adapt to rapidly changing stimuli (Akselrod *et al.*, 1981; Dampney *et al.*, 1994; Smit *et al.*, 1996; Hainsworth, 1996). Decreased heart rate variability following myocardial infarction is predictive of mortality. Thus, it is important to identify men and women with ischemic heart disease who may be at risk for sudden cardiac death.

This study assessed SBR sensitivity and autonomic modulation of heart rate in middle aged men and women with ischemic heart disease in the supine posture and during free standing. Based on gender differences in healthy men and women, we hypothesized that women would show lower SBR sensitivity and low frequency power, and higher high frequency power and parasympathetic indicator, than men. We hypothesized that the indices of parasympathetic modulation, including SBR sensitivity, high frequency power, and the parasympathetic indicator would decrease, and that low frequency power and the sympathetic indicator would increase, as a function of posture from supine to standing in men and women.

Methods

Subjects

Subjects were recruited from a population of men and women with ischemic heart disease who were scheduled for elective coronary artery bypass graft (CABG) surgery at Kingston General Hospital. Those who met the eligibility criteria were recruited following admission to hospital on the day prior to their scheduled CABG surgery. The study design and informed consent form was approved by the Queen's University Faculty of Health Sciences and Affiliated Hospitals Research Ethics Board.

Patients were eligible to participate in the study if they were English-speaking, $\leq$ 70 years of age, whose preoperative ejection fraction was $\geq$ 40% as determined by coronary angiography, and whose physician confirmed health status and consented to patient participation. Exclusion criteria were: myocardial infarction (MI) within the previous 3 months; unstable angina pectoris at rest or with minimal exertion; cardiac electrical instability; extreme fatigue or dyspnea at rest; postural or supine hypotension (systolic BP $<$ 90 mmHg) or hypertension (systolic BP $>$ 240 mmHg) at rest. Thirty-eight eligible patients, 13 women and 25 men, participated in the study.

Procedure

Prior to testing, subjects provided biographical information on age, marital status, occupation & occupational status, family and personal history, lipid profile, blood pressure, smoking behaviour, normal activity profile, and current use of cardiovascular medications. Body height, body mass, and results from coronary angiography, exercise stress testing and pre-admission medical examination were obtained with permission from their medical records.

Supine Position. Subjects lay in the supine position on a comfortable cot in a quiet, light attenuated room on the hospital unit. They remained awake, but relaxed during 20 minutes of data recording (Parlow *et al.,* 1995). They were advised not to speak or move during this time. With the help of a metronome, subjects paced their respiratory rate at a frequency of 12 breaths per minute. R-R interval and beat-by-beat blood pressure data were collected for 20 minutes; data collected during the last 10 minutes, for at least 512 cardiac cycles, were analyzed (Blaber *et al.*, 1995a; 1995b).

Standing Position. Following supine testing, subjects stood upright beside the cot and maintained a free standing posture for a period of 15 minutes (Kamath *et al.*, 1991). They were advised not to speak or move during the testing, unless they experienced symptoms of dizziness or light-headedness, shortness of breath, or palpitations. Spontaneous breathing rate was between 12 and 16 breaths per minute. Following 5 minutes of equilibration in the standing position, R-R interval and beat-to-beat blood pressure data were collected for 10 minutes during standing, for a minimum of 512 cardiac cycles (Blaber *et al.*, 1995a; Blaber *et al.*, 1995b).

Data Collection. The computer program "Data Collection of Beat-by-Beat Heart Rate and Blood Pressure" (Hughson & Yamamoto, 1993) was used for data acquisition of R-R interval and beat-by-beat finger arterial blood pressure. Standard surface electrocardiographic (ECG) electrodes were placed on the subjects; lead II was employed to provide the best amplitude of R waves of the QRS complexes. The R-R interval data were obtained continuously for a minimum of 512 cardiac cycles (Blaber *et al.*, 1995), using a Spacelab 514T cardiac monitor with a QRS detector. The analog R-R interval output from the cardiac monitor was digitized by an analog-digital converter (DAS-16, Metrabyte) at a sampling rate of 1000 Hz.(Yamamoto *et al.*, 1991; Parlow *et al.*, 1995). This provided an R-R interval accuracy of 1ms. The digital R-R output from the cardiac monitor was stored on an IBM-compatible personal computer for later spectral analysis according to the methods of (Yamamoto & Hughson, 1991; Parlow *et al.*, 1995).

Arterial blood pressure was measured on a beat-by-beat basis by the Finapres 2300 digital automated blood pressure monitor (Datex-Ohmeda, Rexdale, Ontario), by finger photoplethysmography, using the unloaded artery principle. This method is reliable in tracking beat-by-beat changes in arterial blood pressure (Lal *et al.*, 1995; Iellamo *et al.*, 1996). A finger cuff was placed on the middle phalanx of the middle finger and connected to a transducer that was placed on top of the hand and aligned with the left ventricle of the heart, at approximately the fourth intercostal space in the mid-axillary line. In the supine position, this was achieved with a pillow under the arm to raise the level of the transducer. In the standing position, the hand was positioned comfortably on a cushioned vertically movable table (Iellamo *et al.*, 1996).

Spectral Analysis of Heart Rate Variability. The computer program "Analysis of Beat-by-Beat Heart Rate and Blood Pressure" (Hughson & Yamamoto, 1993) was used for spectral analysis of R-R interval variability. Frequency domain methods of analysis of heart rate variability, using power spectral analysis, provide data on how power (variance) distributes as a function of frequency (TFESCNASPE, 1996). Spectral analysis transforms the time signal of continuous R-R interval data into their frequency components, including both harmonic and nonharmonic (fractal) components. After searching and filtering the raw R-R interval data for extra or missing beats, fast Fourier transformation converts the time series R-R interval data into an interval tachogram. Spectral analysis methods are recommended for short-term data recordings, from 2 to 5 minutes (TFESCNASPE, 1996).

For this study, coarse graining spectral analysis (CGSA) was used to analyze the R-R interval data (Yamamoto *et al.*, 1991; Yamamoto & Hughson, 1991). This method extracted the very low frequency component (i.e., the fractal dimension) from the total power of the power spectrum, thereby facilitating the definition of the high frequency and low frequency power peaks. Thus, total power was separated into harmonic and nonharmonic (fractal) components; the harmonic component was further divided into low frequency and high frequency components (Yamamoto & Hughson, 1991; Nakamura *et al.*, 1993). Low frequency (0-0.15 Hz) and high frequency (0.15-1.00 Hz) power, expressed in ms^2/Hz, were calculated from R-R interval data obtained in the supine position and during standing (Yamamoto *et al.*, 1991; Yamamoto & Hughson, 1991). Parasympathetic modulation was considered to be the ratio of high frequency power to total spectral power; sympathetic modulation, the ratio of low frequency to high frequency power (Yamamoto & Hughson, 1991).

SBR Sensitivity. SBR sensitivity (ms/mmHg), determined by the sequence method, reflects the R-R interval (ms) response to changes in arterial blood pressure (mmHg) (Hughson *et al.*, 1993; Blaber *et al.*, 1995a; Blaber *et al.*, 1995b; Parlow *et al.*, 1995). The SBR method is a valid measure of SBR sensitivity when compared with the drug-induced method (Parlow, 1993; Parlow *et al.*, 1995). Hughson *et al.* (1993) found that the sequence method of determining SBR sensitivity yielded similar results for SBR slope as the spectral analysis method (Hughson *et al.*, 1993; Blaber *et al.*, 1995a; b).

A SBR sequence was defined as a series of at least 3 consecutive heart beats in which systolic blood pressure and the following R-R interval either both increased or both decreased (Parati *et al.*, 1988; Hughson *et al.*, 1993; Blaber *et al.*, 1995a; b). Computer analysis of continuous recordings of beat-by-beat blood pressure and R-R interval data identified sequences of spontaneously fluctuating blood pressure accompanied by parallel variations in R-R interval. Linear regression was calculated to determine the slope for each SBR sequence; subsequently, the mean slope for all SBR sequences with r^2 values > 0.85 was calculated. SBR sensitivity was expressed as the mean slope of the SBR sequences, which represented the beat-by-beat interaction between systolic blood pressure (mmHg) and R-R interval (ms), in ms/mmHg.

Statistical Analysis

The variables of importance for statistical analysis of SBR sensitivity included SBR slope, systolic blood pressure and R-R interval. The variables of importance for statistical analysis of heart rate variability included fractal power, high frequency power, low frequency power, total harmonic power, total power, the ratio of high frequency to total power (parasympathetic indicator) and the ratio of low frequency to high frequency power (sympathetic indicator). The standard deviation (SD) of the normal to normal (SDNN) R-R interval was also analyzed as a time-domain measure of heart rate variability. Student *t*-statistics were done to determine if the two groups differed in any of these variables.

Descriptive statistics were used to determine the means and standard deviations of the following characteristics in the male and female groups: age, body surface area (BSA) and ejection fraction (EF). Student *t*-statistics were used to determine if the two groups differed in any of these variables.

Repeated measures analysis of variance (ANOVA), with gender (two levels: women, men) as the between-subjects factor, and condition (two levels: supine, standing) as the within-subjects factor, was done to determine if there were any significant differences due to the experimental condition between men and women. Subsequently, repeated measures ANOVA was conducted separately for women and men to determine the differential effect of condition on each group. Differences for all analyses were significant at $p < .05$.

Results

Sample Characteristics

The characteristics of the sample are presented in Table 3.1. Women (n = 13) were significantly older, and had significantly lower BSA, than men (n = 25). The mean age for women was 64 years (range 54-70 years); for men, the mean age was 56 years (range 45-68 years). For clinical and ethical reasons, subjects continued to take their cardiovascular medications until the day of CABG surgery. These included ß-adrenergic antagonists (men, 56%; women, 50%), calcium channel antagonists (men, 32%; women, 83%), nitrates (men, 32%; women, 42%) and angiotensin converting enzyme (ACE) inhibitors (men, 12%; women, 0.2%). Twelve of the 13 women were postmenopausal; three women were taking unopposed estrogen replacement.

Table 3.1: Sample Characteristics for Women and Men

Variable	Women (all) (n = 13)	Men (all) (n = 25)	Women > 55 years (n = 12)	Men > 55 years (n = 12)
Age (years)	64 ± 5	56 ± 8#	65 ± 4	63 ± 4
Body Surface Area (m^2)	1.8 ± 0.1	2.0 ± 0.2#	1.8 ± 0.1	2.0 ± 0.2#
Ejection Fraction (%)	55 ± 8	60 ± 8	56 ± 8	58 ± 8

Values are means ± SD.
Significant difference between genders, $p < .05$.

Because the male and female groups were significantly different in age, the data were analyzed for all women and men over 55 years (women, n=12; men, n=12). Women had significantly smaller BSA than men (Table 3.1). All women were postmenopausal; three (25%) were taking unopposed estrogen replacement.

Heart Rate Variability

Heart rate variability results for the whole sample are presented in Table 3.2; for the subset of subjects over 55 years, in Table 3.3. In the supine position, women had significantly lower total harmonic power than men. In subjects over 55 years, there were no significant differences between women and men in the supine position.

In the whole sample, there was a significant main effect of gender on low frequency power, total harmonic power, and total power; men were significantly higher than women. There was a significant main effect of standing on the parasympathetic indicator; compared with the supine position, the parasympathetic indicator declined in the standing position. The analysis of each group separately showed a main effect of standing in women; women significantly decreased high frequency power, low frequency power, and total harmonic power, and increased sympathetic indicator. There was a main effect of standing on parasympathetic indicator in men that showed a decrease in the standing posture.

Please Note: For the purpose of this dissertation, the **Tables** contain the following analyses:

1. Repeated measures analysis of variance (ANOVA), with gender (two levels: women, men) as the between-subjects factor and condition (two levels: supine, standing) as the within-subjects factor. The data are represented by "Total" in the Tables.

2. Repeated measures ANOVA, with condition (two levels: supine, standing) as the within-subjects factor, for each gender separately to determine the effect of condition on each group. The data are presented for "Women" and "Men" separately in the Tables.

Table 3.2: Effects of Posture (Supine to Standing) on Heart Rate Variability Measures in Women (n=12) & Men (n=23)

Measure	Gender	Supine Mean ± SD	Standing Mean ± SD
Fractal Power (ms²/Hz)	Women	289 ±285	246 ±176
	Men	546 ±435	451 ±405
	Total	458 ±405	381 ±355
High Frequency Power (ms²/Hz)	Women	46 ±46	9 ±8 !
	Men	207 ±413	45 ±57
	Total	152 ±342	32 ±49
Low Frequency Power (ms²/Hz)	Women	103 ±75	64 ±51 !
	Men	132 ±146	250 ±338
	Total	122 ±125	186 ±287 #
PNS Indicator (high/total)	Women	.12 ±.1	.03 ±0 !
	Men	.19 ±.2	.06 ±.0 !
	Total	.17 ±.2	.05 ±.0 !
SNS Indicator (low/high)	Women	4 ±3	16 ±17 !
	Men	7 ±20	47 ±136
	Total	6 ±16	36 ±111
Total Harmonic Power (ms²/Hz)	Women	149 ±85	73 ±54 !
	Men	342 ±437	301 ±365
	Total	276 ±367	223 ±315#
Total Power (ms²/Hz)	Women	439 ±325	319 ±196
	Men	900 ±748	768 ±625
	Total	742 ±668	614 ±559#

* Significant change from supine to standing, $p < .05$.
# Significant difference between genders, $p < .05$.

Table 3.3: Effects of Posture (Supine to Standing) on Heart Rate Variability Measures in Women (n = 11) and Men (n = 11) over 55 Years

		Supine	Standing
Measure	Gender	Mean ± SD	Mean ± SD
Fractal Power (ms^2/Hz)	Women	255 ±272	222 ±163
	Men	625 ±474	560 ±510
	Total	440 ±422	391 ±408#
High Frequency Power (ms^2/Hz)	Women	39 ±41	8 ±7 !
	Men	234 ±547	60 ±68
	Total	136 ±392	34 ±54 #
Low Frequency Power (ms^2/Hz)	Women	105 ±78	65 ±53 !
	Men	112 ±98	247 ±428
	Total	108 ±87	156 ±312
PNS Indicator (high/total)	Women	.12 ±.1	.03 ±.0 !
	Men	.15 ±.2	.08 ±.0
	Total	.13 ±.2	.05 ±.0 #!
SNS Indicator (low/high)	Women	5 ±3	18 ±18 !
	Men	3 ±3	9 ±21
	Total	4 ±3	14 ±20 !
Total Harmonic Power (ms^2/Hz)	Women	145 ±87	73 ±56 !
	Men	349 ±582	320 ±455
	Total	247 ±419	197 ±341 #
Total Power (ms^2/Hz)	Women	400 ±310	295 ±187
	Men	1000 ±951	914 ±746
	Total	700 ±755	605 ±618 #

! = Significant change from supine to standing, $p < .05$.
= Significant difference between genders, $p < .05$.

In subjects over 55 years, there were significant main effects of standing on the parasympathetic indicator and the sympathetic indicator; the parasympathetic indicator decreased, and the sympathetic indicator increased, in the standing position compared with supine. There were significant gender effects on fractal power, total harmonic power, and total power; women were lower than men. When the data were analyzed separately for men and women over 55 years for the effects of standing, women showed significant decreases in high frequency power, low frequency power, parasympathetic indicator, and total harmonic power, and a significant increase in sympathetic indicator. The men over 55 years of age in the present study showed no significant effects of standing.

In summary, there was only one difference in the effects of standing between the whole sample and the subjects over 55 years. Men in the whole sample decreased parasympathetic indicator from supine to standing; in the sample of men over 55 years, there were no effects of standing. Women in the whole sample and in the subset over 55 years had the same effects of standing.

SBR Sensitivity

The baroreflex data for the whole sample are presented in Table 3.4; for the subset over 55 years, in Table 3.5. Supine SBR slope was significantly lower in women than men. Women over 55 years had significantly lower SBR slope in the supine posture than men.

There was a significant main effect of standing on SBR slope, R-R interval, and systolic blood pressure; a condition X gender interaction on systolic blood pressure was also present. SBR slope and R-R interval decreased, and systolic blood pressure increased, during standing compared with supine; the increase in systolic blood pressure was greater in women than men. When the data were analyzed separately for men and women, men decreased SBR slope from supine to standing; women and men decreased R-R interval from supine to standing; and women increased systolic blood pressure from supine to standing.

Similarly, in subjects over 55 years, there was a significant main effect of standing on SBR slope, systolic blood pressure and R-R interval; SBR slope and R-R interval decreased, and systolic blood pressure increased, from supine to standing. Women over 55 years had a significantly lower SBR slope and shorter R-R interval than age-matched men. When the data were analyzed separately for men and women over 55 years, men decreased SBR slope from supine to standing; men and women decreased R-R interval from supine to standing; and women increased systolic blood pressure from supine to standing. Thus, the effects of standing were the same for the subjects over 55 years and the whole sample.

Table 3.4: Effects of Posture (Supine vs. Standing) on Baroreflex Measures for Women (n=12) and Men (n=23).

		Supine	Standing
Measure	Gender	Mean ± SD	Mean ± SD
R-R Interval (ms)	Women	991 ± 152	834 ± 131!
	Men	1024 ± 136	906 ± 165!
	Total	1013 ± 141	881 ± 156!
Systolic Blood Pressure (mmHg)	Women	116 ± 21	144 ± 187!
	Men	120 ± 18	128 ± 19
	Total	119 ± 18	133 ± 20!∇
Baroreflex Slope (ms/mmHg)	Women	5.6 ± 2.8#	3.89 ± 2.0
	Men	10.2 ± 5.0	5.6 ± 2.8!
	Total	8.7 ± 4.9	5.1 ± 2.7!#

Table 3.5: Effects of Posture (Supine vs. Standing) on Baroreflex Measures for Women (n=12) and Men (n=12) Over 55 Years

		Supine	Standing
Measure	Gender	Mean ± SD	Mean ± SD
R-R Interval (ms)	Women	968 ± 135	819 ± 127 !
	Men	1076 ± 126	981 ± 160 !
	Total	1022 ± 139	900 ± 163 !#
Systolic Blood Pressure (mmHg)	Women	116 ± 22	142 ± 18 !
	Men	126 ± 20	134 ± 22
	Total	121 ± 21	138 ± 20 !
Baroreflex Slope ms/mmHg	Women	5.9 ± 2.7	3.8 ± 2.1
	Men	10.4 ± 5.6	6.0 ± 2.6 !
	Total	8.3 ± 4.8	4.9 ± 2.6 !#

! Significant change from supine to standing, $\underline{p} < .05$.
Significant difference between genders, $\underline{p} < .05$.
∇ Significant condition x gender interaction, $\underline{p} < .05$.

Discussion

The sample of 13 women and 25 men represented a higher proportion of women relative to men with ischemic heart disease; typically, women comprise about 25 to 30% of this population (Heart and Stroke Foundation of Canada, 1997; 1999). The women were significantly older than the men, and 12 of the women were postmenopausal; these findings reflect the characteristics of the general population of people with ischemic heart disease in Canada (Cardiovascular Disease and Women, 1996; Heart & Stroke Foundation of Canada, 1997; 1999).

The major new finding in this study was that there were no differences between men and women with ischemic heart disease in the supine heart rate variability indices of parasympathetic modulation, including parasympathetic indicator and high frequency power, or the sympathetic indicator. In contrast, women had significantly lower SBR sensitivity than men. The second finding was that the effects of standing on the indices of parasympathetic modulation, including SBR sensitivity, parasympathetic indicator and high frequency power, were different in men versus women with ischemic heart disease.

Some of the differences between our findings and those of others in healthy subjects could be due to four factors: cardiovascular medications, the significantly higher age of the women compared with the men, the hormonal effects of female gender and estrogen replacement, or the extent of cardiovascular disease in our subjects. In addition, due to the large variance in some of our measures, the small sample size may have precluded statistical significance in some of our findings.

Cardiovascular medications were continued until the time of surgery, and may have affected our results. Both ß-adrenergic antagonists and calcium channel antagonists have been reported to increase heart rate variability, by decreasing sympathetic activity (Airaksinen *et al.*, 1996; Kontopoulos *et al.*, 1996; TFESCNASPE, 1996). The attenuated sympathetic activity shifted the balance in autonomic modulation, resulting in increased parasympathetic influence in heart rate modulation. In our study, a high proportion of men (50%) and women (56%) received ß-adrenergic antagonists that may have attenuated the overall sympathetic influences on heart rate. Moreover, 83% of women and only 32% of men received calcium channel antagonists; the effects may have masked actual gender differences in sympathetic influences on heart rate.

The lack of significant differences between men and women in supine heart rate variability measures in our study contrasts with the reported findings in healthy age-matched middle aged and older subjects. Women are reported to have higher high frequency power, lower low frequency power and lower sympathetic indicator than men (Ryan *et al.*, 1994; Liao *et al.*, 1995; Huikuri *et al.*, 1996; Dougherty, 1999). Our finding that SBR slope was significantly lower in women than men was consistent with the reports of Huikuri *et al.* (1996) and Laitinen *et al.* (1998) in middle aged and older women. In contrast, Dougherty (1999) found that supine SBR sensitivity was higher in age-matched middle aged women than men. However, in the present study, when the subjects were matched for age over 55 years, there were still no significant differences between men and women in the supine position in the indices of parasympathetic modulation, including the parasympathetic indicator and high frequency power, or in the sympathetic indicator; SBR sensitivity was lower in the women. The lower supine SBR slope for women suggests that there was lower parasympathetic activity in women than men, resulting in less beat-by-beat interaction between systolic blood pressure and R-R interval. However, in the present study, the difference between men and women in parasympathetic indicator did not reach statistical significance.

The higher mean age of the women (64 years) versus the men (56 years) in our overall sample may have contributed to our results; higher age has been reported to blunt the range of autonomic responses in the supine posture (Lipsitz *et al.*, 1990). Lipsitz *et al.* revealed that old subjects (71-90 years) have lower high frequency power and lower total power in the supine position, and either absent or attenuated low-frequency activation during tilt than younger subjects. Aging has been shown to decrease both SBR function and parasympathetic modulation of heart rate; these effects have been attributed to reduced muscarinic receptor density and function with increasing age (Docherty, 1990; Poller *et al.*, 1997; Brodde *et al.*, 1998; Brodde & Michel, 1999). Stimulation of cardiac muscarinic receptors in the atria results in negative chronotropic effects, due to the high density of parasympathetic innervation in the SA and atrioventricular nodes (Brodde & Michel, 1999). Loss of muscarinic receptors in the SA node would attenuate the decrease in heart rate mediated by parasympathetic modulation.

The hormonal effects of estrogen may have affected our results. Huikuri *et al.* (1996) found that women on estrogen replacement therapy (ERT) had higher SBR sensitivity than men of the same age, and higher SBR sensitivity than age-matched women who were not taking ERT. Twelve of the 13 women in our study were postmenopausal, three of whom were taking estrogen replacement; one woman, age 54 years, was menopausal. However, our women subjects had lower SBR sensitivity than men, thus, the effect of estrogen in some of our subjects does not explain our overall findings on autonomic modulation. The women over 55 years were all postmenopausal; three (25%) were taking estrogen replacement. The mechanism by which estrogen exerts a cardioprotective effect may be via the effects on coronary arteries (Williams *et al.*, 1990). Estrogen potentiates endothelium-dependent vasodilation in healthy postmenopausal women, and in postmenopausal women with risk factors for atherosclerosis (Gilligan *et al.*, 1994). Collins *et al.* (1995) reported that estrogen attenuated acetylcholine-induced coronary artery responses in women with ischemic heart disease, but not men. Thus, the primary benefit of estrogen may be its contribution to improved coronary blood flow prior to, and following, the development of ischemic heart disease in women, and not its effect on autonomic modulation.

The extent of cardiovascular disease and autonomic deterioration may be comparable in the men and women in our study, and may have contributed to the lack of significant differences in heart rate variability measures. The incidence of ischemic heart disease increases dramatically in women only after menopause, whereas there is a gradual increase in incidence in men after 34 years of age (Cardiovascular Disease and Women, 1996). The length of time since onset of ischemic heart disease may have been similar in the men and women in the present study, thus, the degree of cardiovascular autonomic deterioration may have been comparable.

The second major finding was that the effects of standing on the indices of parasympathetic modulation, including SBR sensitivity, parasympathetic indicator and high frequency power, were different in men versus women with ischemic heart disease. Men decreased parasympathetic indicator and SBR sensitivity; men over 55 years decreased SBR sensitivity only. Women decreased parasympathetic indicator, high frequency power and low frequency power, and increased sympathetic indicator; SBR did not change significantly. The increase in sympathetic indicator during standing in women was accompanied by an increase in systolic blood pressure and heart rate.

The most likely mechanism for the decline in SBR slope in men from supine to standing was the decrease in efferent parasympathetic activity to the SA node. The low supine SBR sensitivity in women may have precluded any decrease in the standing posture, in spite of the decrease in parasympathetic indicator and concurrent increase in sympathetic indicator and systolic blood pressure. Normally, the upright posture produces deactivation of afferent nerve impulses from arterial baroreceptors, resulting in an increase in efferent sympathetic activity and a concurrent withdrawal of parasympathetic activity, to the SA node (Kamath *et al.*, 1991; Persson, 1996). Consequently, parasympathetic modulation of heart rate decreases and sympathetic modulation increases, thereby increasing heart rate, consistent with our results.

Using spectral analysis of heart rate variability, Kamath *et al.* (1991) reported that, in 19 healthy young subjects, there was a 51% increase in the sympathetic indicator as they stood upright. Fei *et al.* (1995) found that passive head up tilt resulted in a significant decrease in high frequency power, a non-significant increase in low frequency power, and an increase in the sympathetic indicator, in healthy middle-aged subjects. Lipsitz *et al.* (1990) revealed that old subjects (71-94 years) had lower total power, high frequency power and low frequency power in both supine and tilt position, than healthy young subjects (18-35 years). Butler *et al.* (1993) found a decrease in low frequency power, high frequency power and parasympathetic indicator, and an increase in sympathetic indicator, during 70 degree head up tilt, in healthy young women and men.

Our findings were consistent with results in older healthy individuals to the upright posture. The absence of changes in men over 55 years in parasympathetic or sympathetic indicators suggests a decline in their autonomic responsiveness with increasing age. However, SBR sensitivity declined during standing, indicating that the integrated function of the SBR was maintained in the older men.

Summary and Conclusions

There were two major findings in this study. Women and men with ischemic heart disease have similar supine autonomic modulation of heart rate, as seen by the lack of significant differences in heart rate variability measures. However, the women were significantly older than the men, suggesting that they maintained cardiovascular adaptability comparable to the younger men, despite their older age. Cardiovascular autonomic deterioration may have begun at a later age for women, due to the cardioprotective effects of estrogen until menopause. Although most of the women were postmenopausal, three women were taking estrogen replacement, which may have contributed to our findings. Medications, such as ß-adrenergic antagonists and calcium channel antagonists, may have altered our results, by decreasing the sympathetic influence in the autonomic modulation of heart rate.

The effects of posture from supine to standing were consistent with responses of healthy middle aged and older men and women to the upright posture. These findings suggest that men and women with ischemic heart disease maintain cardiovascular adaptability to the upright posture. Eliminating the age bias in the sample showed that autonomic adaptability in men over 55 years may be reduced, as seen by the lack of parasympathetic withdrawal to the upright posture. However, these men maintained the integrated response of the arterial SBR to standing.

CHAPTER 4

Study 2

Effects of Coronary Artery Bypass Graft Surgery on Autonomic Modulation of Heart Rate in Women and Men

The use of coronary artery bypass graft (CABG) surgery to treat ischemic heart disease has risen during the last decade in women and in the age groups over 55 years (Heart and Stroke Foundation of Canada, 1997;1999). During CABG surgery, cardiac control mechanisms are perturbed by the manipulation of the heart, cardiac autonomic nerves and coronary arteries, aortic clamping and vein grafting to the aorta, and cardiopulmonary bypass (Yang *et al.*, 1994; 1995; Haggenmiller *et al.*, 1996; Komatsu *et al.*, 1994; 1997). Furthermore, general anesthesia, mechanical ventilation and intravenous medications alter cardiovascular function during and following cardiac and non-cardiac surgery in patients with ischemic heart disease (Yang *et al.*, 1994; Haggenmiller *et al.*, 1996; Dworschak *et al.*, 1997; Komatsu *et al.*, 1997). Potential postoperative consequences of CABG surgery include alterations in autonomic modulation of heart rate and spontaneous baroreflex (SBR) sensitivity, due to impaired afferent input via the aortic baroreceptors, impaired efferent parasympathetic and sympathetic modulation of the sinoatrial (SA) node, or dysfunction of the SA node.

Spectral analysis of heart rate variability has shown that autonomic modulation of heart rate, as reflected by parasympathetic and sympathetic indicators, decreases during and following CABG surgery (Niemela *et al.*, 1992; Piha & Hamalainen, 1994; Yang *et al.*, 1994; Komatsu *et al.*, 1997), and during physiological perturbations, such as orthostatic stress (Pomeranz *et al.*, 1985; Lipsitz *et al.*, 1989; Butler *et al.*, 1990; Kamath *et al.*, 1991; Fei *et al.*, 1995). Consequently, beat-by-beat changes in heart rate and SBR sensitivity may be compromised (Akselrod *et al.*, 1981; Dampney *et al.*, 1994; Hainsworth, 1996; Smit *et al.*, 1996). The loss of beat-by-beat parasympathetic modulation of heart rate decreases the ability of the cardiovascular system to respond to rapidly changing stimuli, increases the potential for sympathetically-mediated cardiac dysrhythmias, and increases the risk of sudden cardiac death (Akselrod *et al.*, 1981; Alga *et al.*, 1993; Huikuri *et al.*, 1995; Task Force of the European Society of Cardiology & the North American Society of Pacing & Electrophysiology [TFESCNASPE], 1996). These effects may persist at the time of discharge, typically 5 days following CABG surgery.

Whether the effects of CABG surgery are similar in women and men has not been reported. In our preoperative study (Study 1), we found that there were no significant differences in heart rate variability measures between men and women in the supine posture, but women had significantly lower SBR sensitivity than men in both supine and standing postures. The change in position from supine to standing revealed that women decreased high frequency power, low frequency power, parasympathetic indicator, and total harmonic power, and increased sympathetic indicator; SBR sensitivity did not change. Men decreased parasympathetic indicator and SBR sensitivity.

This study assessed the effects of CABG surgery 5 days postoperatively on SBR sensitivity and autonomic modulation of heart rate in the supine and standing positions, in women and men. We hypothesized that, compared with preoperative levels, the indices of parasympathetic modulation of heart rate, including high frequency power, parasympathetic indicator and SBR sensitivity, would decline postoperatively, based on findings by Yang *et al.* (1994) and Komatsu *et al.* (1997, and on expected consequences of surgery. We also hypothesized that the indices of parasympathetic modulation would decline in the standing position compared with supine, and that the sympathetic indicator would increase, based on overall results from our preoperative study of these subjects. We predicted that women would show lower SBR sensitivity than men postoperatively, based on our preoperative findings.

Methods

Subjects

Subjects were recruited preoperatively from a population of men and women scheduled for elective CABG surgery in Kingston General Hospital (Study 1). Patients who participated in the preoperative study were eligible to continue in the postoperative study, unless they withdrew or were declared off-study. The off-study criteria included the following intraoperative or postoperative complications: MI; cardiac electrical instability; hypotension; neurological, pulmonary or vascular complications (e.g., stroke, pulmonary embolus, thromboemboli, sternal wound infection).

Thirteen women and 25 men participated in the preoperative study; 11 of the women and 23 of the men were eligible to participate in the postoperative study. Postoperatively, four subjects were excluded for the following reasons: one woman died, one man had frequent multifocal premature ventricular contractions (bigeminy) and moderately severe anxiety, and one woman and one man withdrew for personal reasons. Preoperatively, subjects took their usual cardiovascular medications on the day of testing. These included β-adrenergic antagonists, calcium channel antagonists, nitrates and angiotensin converting enzyme (ACE) inhibitors. Preoperative cardiovascular medications were not resumed postoperatively. Ten of the 11 women were postmenopausal; three women were taking unopposed estrogen replacement on the day of preoperative testing, as prescribed.

Procedures

Subjects were tested preoperatively and 5 days postoperatively. The procedures and measurements were the same as in Study 1, with one exception. In addition to the information obtained preoperatively, the following information was obtained postoperatively: operative details regarding the number and types of grafts; postoperative course of recovery; intraoperative and postoperative complications.

Data Analysis

The data analyses were the same as Study 1, with these exceptions. Descriptive statistics were used to determine the means and standard deviations of the following variables in the men and women who completed both the preoperative and the postoperative studies: age, body surface area (BSA), ejection fraction (EF), number and types of grafts. Student-*t*-statistics were done to determine if the two groups differed in any of these variables.

Repeated measures ANOVA, with 1-between factor (gender) and 2-within factors (time [preoperative, postoperative] and condition [supine, standing]), was done to identify any significant differences due to CABG surgery or the standing posture between men and women. Subsequently, to understand the interactions more fully, repeated measures ANOVAs were done separately for each gender. Differences for all analyses were significant at $p < .05$.

Results

Sample Characteristics

Eleven women and 23 men completed both the preoperative and postoperative supine studies; 10 women and 21 men completed both supine and standing studies. One man fainted during standing preoperatively, one woman was unable to complete the standing test postoperatively due to postural hypotension and dizziness, and one man had frequent premature ventricular contractions postoperatively that precluded data analysis. Women were significantly older, had significantly smaller BSA, and received fewer arterial grafts and more venous grafts, than men (Table 4.1). Nine women were postmenopausal; two women were taking oral estrogen replacement medication. As prescribed preoperatively, subjects took their cardiovascular medications on the day of preoperative testing. These included β-adrenergic antagonists, (men, 56%; women, 50%), calcium channel antagonists (men, 32%; women, 83%), nitrates (men, 32%; women, 42%) and ACE inhibitors (men, 12%; women, 0.2%). Preoperative medications were not resumed postoperatively.

Subsequently, since the female and male groups were significantly different in age, the data were analyzed for all subjects over the age of 55 years. The subset of subjects over the age of 55 years consisted of 9 women and 11 men. Women over 55 years had significantly lower BSA than age-matched men (Table 4.1).

Table 4.1: Sample Characteristics for Women and Men

Variable	Women (n = 10)	Men (n = 23)	Women > 55 years (n = 9)	Men > 55 years (n = 11)
Age (years)	65 ± 5	56 ± 8 #	66 ± 4	64 ± 4
Arterial Grafts (number)	1.0 ± 0	1.8 ± 1 #	1.0 ± 0	1.5 ± 1
Venous Grafts (number)	2.7 ± 1	1.4 ± 1	3.0 ± 1	2.0 ± 1
Total Grafts (number)	3.7 ± 1	1.4 ± 1	4.0 ± 1	3.5 ± 1
Body Surface Area (m^2)	1.8 ± 1	2.0 ± 0 #	1.8 ± 1	2.0 ± 0 #
Ejection Fraction (%)	56 ± 9	60 ± 9	56 ± 9	58 ± 8

Values are means ± SD.
Significant difference between genders, $p < .05$.

Heart Rate Variability

Effects of CABG Surgery. The heart rate variability data for the whole sample are presented in Table 4.2. There were significant main effects of time, from preoperatively to postoperatively, on heart rate variability measures. There were significant decreases in fractal power, low frequency power, total harmonic power, and total power. There was a significant time X gender interaction on low frequency power, total power and parasympathetic indicator. Parasympathetic indicator and high frequency power decreased significantly in men postoperatively; low frequency power and total power decreased in men and women. Separate analyses for each gender revealed that both women and men decreased fractal power, low frequency power, total harmonic power and total power postoperatively.

The heart rate variability data for the subjects over 55 years are presented in Table 4.3. In subjects over 55 years, there were significant overall decreases postoperatively in fractal power, low frequency power, and total power. A time X gender interaction was present on total power; total power decreased significantly less for women than men. In women over 55 years, there were significant decreases postoperatively in fractal power, low frequency power, total harmonic power and total power. In men over 55 years, fractal power, low frequency power and total power decreased postoperatively.

Effects of Posture. There were significant main effects of posture on the parasympathetic indicator; compared with the supine posture, the parasympathetic indicator decreased in both women and men in the standing position. The sympathetic indicator increased significantly in men only. Men showed a time X posture interaction in the parasympathetic indicator; the parasympathetic indicator decreased postoperatively, and decreased in the standing posture. The effects of posture in women over 55 years revealed that the parasympathetic indicator decreased and the sympathetic indicator increased in the standing position.

Table 4.2: Effects of Time (Preoperatively to Postoperatively) and Posture (Supine to Standing) on Heart Rate Variability (HRV) Measures.

		Preoperatively		Postoperatively	
		Supine	Standing	Supine	Standing
Measure	Gender	Means±SD	Means±SD	Means±SD	Means±SD
Fractal Power (ms^2/Hz)	Women	361±415	266±186	37±35	70±99 *
	Men	571±447	481±412	65±68	78±156 *
	Total	503±441	411±366	56±61	75±138 *
High Frequency Power (ms^2/Hz)	Women	36±35	9±8	16±45	12±31
	Men	220±430	48±59	4±5	12±50 *
	Total	161±362	35±51	8±25	12±44
Low Frequency Power (ms^2/Hz)	Women	98±77	69±53	11±13	18±18 *
	Men	136±152	269±348	16±17	18±33 *
	Total	123±132	204±301	14±16	18±29 *▫
PNS Indicator (high/total)	Women	.11±.11	.03±.02	.16±.17	.04±.05 !
	Men	.20±.21	.06±.06	.04±.04	.02±.03 *!○
	Total	.17±.18	.05±.06	.08±.11	.03±.04 !▫
SNS Indicator (low/high)	Women	5 ±3	18±18	10±26	15±17
	Men	7±21	53±146	8±9	32±44 !
	Total	6±18	42±119	10±17	26±38 !
Total Harmonic Power (ms^2/Hz)	Women	134±88	79±55	29±48	38±61 *
	Men	359±453	324±374	25±25	101±402 *
	Total	286±388	245±328	26±34	80±332 *
Total Power (ms^2/Hz)	Women	495±434	344±204	66±79	107±156 *
	Men	943±770	822±629	91±87	178±557 *
	Total	799±705	668±572	82±84	156±464 *▫

! Significant change from supine to standing, $p < .05$.
* Significant change from preoperatively to postoperatively, $p < .05$.
○ Significant time x posture interaction, $p < .05$.
▫ Significant time x gender interaction, $p < .05$.

Table 4.3: Effects of Time (Preoperatively to Postoperatively) and Posture (Supine to Standing) on HRV Measures for Women (n=7) and Men (n=10) Over 55 Years

		Preoperatively		**Postoperatively**	
		Supine	**Standing**	**Supine**	**Standing**
Measure	Gender	Means±SD	Means±SD	Means±SD	Means±SD
Fractal Power (ms^2/Hz)	Women	236±279	276±182	34±39	70±118 •
	Men	667±478	602±518	51±65.6	107±227 •
	Total	490±453	467±437	44±55	92±186 •
High Frequency Power (ms^2/Hz)	Women	28±19	10±8	23±53	16±37
	Men	245±575	65±70	2±3	24±72
	Total	156±446	42±59	11±34	21±59
Low Frequency Power (ms^2/Hz)	Women	113±88	79±61	6±7	21±22 •
	Men	108±103	266±446	9±13	20±45 •
	Total	110±94	189±350	8±11	21±36 •
PNS Indicator (high/total)	Women	.12±.1	.03±.0	.20±.2	.05±.0 !
	Men	.14±.2	.09±.0	.04±.0	.03±.0
	Total	.13±.2	.06±.0	.10±.1	.04±.0 !
SNS Indicator (low/high)	Women	6±4	19±21	4±7	19±20 !
	Men	3±3	10±23	5±6	13±18
	Total	4±4	14±22	4±6	15±18 !
Total Harmonic Power (ms^2/Hz)	Women	142±94	89±64	31±58	46±72 •
	Men	357±613	346±472	17±17	193±584
	Total	268±476	240±379	23±39	132±447
Total Power (ms^2/Hz)	Women	378±304	365±198	65±94	115±190 •
	Men	1052±985	983±748	68±76	299±810 •
	Total	775±835	729±654	67±81	223±626 •▫

! Significant change form supine to standing, $p < .05$.
• Significant change from preoperatively to postoperatively, $p < .05$.
▫ Significant time x gender interaction, $p < .05$.

Spontaneous Baroreflex Sensitivity

Effects of CABG Surgery. The baroreflex data for the whole sample are presented in Table 4.4. There were significant main effects of time (preoperatively to postoperatively) on baroreflex measures; SBR slope, systolic blood pressure and R-R interval decreased postoperatively compared with preoperative levels. There was a time X gender interaction on SBR slope; men showed a significant decrease in SBR slope postoperatively. Women decreased systolic blood pressure postoperatively; men and women decreased R-R interval following surgery.

The baroreflex data for subjects over 55 years are presented in Table 4.5. In subjects over 55 years, there were significant overall decreases postoperatively in SBR slope, systolic blood pressure, and R-R interval. A time X gender interaction was present for SBR slope. In women over 55 years, there were significant decreases postoperatively in systolic blood pressure and R-R interval; a time X posture interaction was present on R-R interval. In men over 55 years, there were significant decreases postoperatively in SBR slope and R-R interval; SBR slope and R-R interval decreased following CABG surgery. A time X posture interaction on SBR slope was also present.

Effects of Posture. There were significant main effects of posture (supine vs. standing) on SBR slope, systolic blood pressure, and R-R interval. SBR slope and R-R interval decreased in the standing posture compared with

Table 4.4: Effects of Time (Preoperatively to Postoperatively) and Posture (Supine to Standing) on Baroreflex Measures for Women and Men (n=30).

		Preoperatively		Postoperatively	
		Supine	Standing	Supine	Standing
Measure	Gender	Means±SD	Means±SD	Means±SD	Means±SD
R-R Interval (ms)	Women	996±146	852±128	673±105	641±107 •!○
	Men	1039±127	920±162	719±91	631±110 •!
	Total	1025±132	898±153	704±96	634±108 •!○
Systolic Blood Pressure (mmHg)	Women	117±21	144±19	96±20	119±27 •!
	Men	120± 19	129±19	114±29	123±18
	Total	119±20	134±20	108±28	122±21 •!
Baroreflex Slope (ms/mmHg)	Women	5.7±2.9	3.8±2.1	3.8±3.9	3.6±3.1
	Men	9.9±5.3	5.1±2.6	2.5±1.6	1.8±1.5 •!○
	Total	8.5±5.0	4.7±2.5	3.0±2.6	2.4±2.3 •!○

Table 4.5: Effects of Time (Preoperatively to Postoperatively) and Posture (Supine to Standing) on Baroreflex Measures for Women and Men Over 55 Years.

		Preoperatively		Postoperatively	
		Supine	Standing	Supine	Standing
Measure	Gender	Means±SD	Means±SD	Means±SD	Means±SD
R-R Interval (ms)	Women	942±121	843±138	681±122	656±20 •!○
	Men	1084± 129	990±166	748±90	679±114 •!
	Total	1026±141	929±168	721±106	669±113 •!
Systolic Blood Pressure (mmHg)	Women	118±24	141±19	92±21	114±28 •!
	Men	128±20	138±20	116±37	121±19
	Total	124±22	139±19	106±32	118±23 •!
Baroreflex Slope (ms/mmHg)	Women	6.0±3.1	3.3±2.0	4.2±4.3	3.3±3.0 !
	Men	10.2±5.8	5.7±2.5	2.6±1.8	2.1±1.8 !○
	Total	8.4±5.1	4.6±2.5	3.3±3.2	2.6±2.4 •!○□

! Significant change from supine to standing, $p < .05$.
• Significant change from preoperatively to postoperatively, $p < .05$.
○ Significant time x posture interaction, $p < .05$.
□ Significant time x gender interaction, $p < .05$.

supine; systolic blood pressure increased. There were time X posture interactions on SBR slope and R-R interval. SBR slope decreased postoperatively compared with preoperative levels and decreased in the standing position compared with supine. Similarly, the R-R interval decreased postoperatively compared with preoperative levels and decreased in the standing position compared with supine. Separate analyses for men and women showed that men decreased SBR slope significantly from supine to standing; men and women decreased R-R interval from supine to standing; women increased systolic blood pressure from supine to standing.

In subjects over 55 years, there were significant main effects of standing on SBR slope, systolic blood pressure, systolic blood pressure and R-R interval; SBR slope and R-R interval declined in the standing position, systolic blood pressure increased. There were significant time X posture interactions for SBR slope and R-R interval. In women, there were significant effects of standing on SBR slope, systolic blood pressure, and R-R interval; SBR slope and R-R interval decreased in the standing posture, systolic blood pressure increased. In men, there were significant effects of standing on SBR slope and R-R interval; both measures decreased in the standing position.

In summary, in women over 55 years, SBR slope and R-R interval decreased during standing compared with supine; R-R interval decreased postoperatively compared with preoperative levels. Systolic blood pressure increased during standing compared with supine, and decreased postoperatively compared with preoperative levels. In men over 55 years, SBR slope and R-R interval decreased postoperatively compared with preoperative levels, and decreased during standing compared with supine.

Discussion

Our sample of men and women reflected the age characteristics of the population who typically undergo elective CABG surgery; women were approximately 10 years older than men (Heart and Stroke Foundation of Canada, 1999). Our small sample size, consistent with others, illustrates the difficulties in conducting such studies following CABG surgery; Niemela *et al.* (1992) studied 8 women and 27 men, Piha and Hamalainen (1994) and Yang *et al.* (1995) each studied 15 subjects, and Komatsu *et al.* (1997), 10 subjects. Despite these limitations, there were two interesting findings that warrant discussion: 1) CABG surgery had different effects on heart rate variability measures and SBR sensitivity in men and women, and 2) women and men responded differently to the standing posture.

Effects of CABG Surgery

The major new finding in this study was that CABG surgery had different effects on autonomic modulation of heart rate in men and women. Men significantly decreased the indices of parasympathetic modulation of heart rate that included high frequency power, parasympathetic indicator and SBR sensitivity postoperatively. In our age-matched subjects over 55 years, the main difference between men and women was that men decreased SBR sensitivity postoperatively, whereas women did not. Thus, aging may have accounted for the differential effects of CABG surgery in men and women.

Postoperatively, in women, there were no significant changes in the indices of parasympathetic modulation of heart rate, nor was there a significant change in the sympathetic indicator. The low preoperative SBR sensitivity in women may have precluded any decline postoperatively. These findings suggest that cardiac parasympathetic activity in women was not attenuated as a consequence of CABG surgery, in contrast to findings in men (Niemela *et al.*, 1992; Komatsu *et al.*, 1997). The results in women postoperatively were unexpected findings and have not been reported by other investigators.

In contrast to our results, Yang *et al.* (1994) found a decrease in the sympathetic indicator immediately after CABG surgery that indicated damage to the sympathetic division of cardiac autonomic nerves. Consequently, the authors speculated that there may be increased dominance of the parasympathetic modulation of heart rate following CABG surgery. Preoperatively, our subjects had taken their usual cardiovascular medications that included β-adrenergic antagonists (men, 56%; women, 50%), calcium channel antagonists (men, 32%; women, 83%), nitrates (men, 32%; women, 42%) and ACE inhibitors (men, 12%; women, 0.2%). These medications were not resumed following surgery. Both β-adrenergic antagonists and calcium channel antagonists have been reported to increase heart rate variability (Airaksinen *et al.*, 1996; Kontopoulos *et al.*, 1996; TFESCNASPE, 1996). Thus, the sympathetic indicator should have increased following cessation of those medications postoperatively. The lack of significant change in sympathetic indicator postoperatively may reflect an actual decrease in sympathetic activity following surgery, and indicate sympathetic dysfunction.

In men following CABG surgery, there were decreases in the indices of parasympathetic modulation of heart rate; the sympathetic indicator did not change. These results were in accordance with reported findings in studies on men (Niemela *et al.*, 1992; Piha & Hamalainen, 1994; Yang *et al.*, 1994; Komatsu *et al.*, 1997). Niemela *et al.* (1992) and Komatsu *et al.* (1997) found that, compared with preoperative levels, all autonomic activity was significantly lower one week after surgery. Piha & Hamalainen (1994) reported that cardiac parasympathetic activity was depressed one week postoperatively, which they attributed to local damage to the parasympathetic division of cardiac autonomic nerves or to the SA node.

Our results support their conclusions of damage to cardiac autonomic nerves. Typically, an external temporary cardiac pacemaker remains *in situ* for 3 to 4 days following CABG surgery, due to the high potential for postoperative dysfunction of the SA node during this period. In our subjects, as per standard practice, the temporary pacemaker wires were removed the day before discharge, after confirmation by ECG that the SA node had resumed its beat-by-beat pacemaker function. Thus, during autonomic testing on the day of discharge, loss of parasympathetic efferent modulation of heart rate was most likely due to damage to cardiac autonomic nerves, and not to SA node dysfunction.

Effects of Posture

Preoperatively, as reported in Study 1, the effects of posture, supine vs. standing, were consistent with responses of healthy middle aged and older men and women to the upright posture (Pomeranz *et al.*, 1985; Lipsitz *et al.*, 1989; Butler *et al.*, 1990; Kamath *et al.*, 1991; Fei *et al.*, 1995). Men decreased SBR slope and parasympathetic indicator; women decreased parasympathetic indicator and increased sympathetic indicator. Women had lower supine SBR sensitivity than men, which may have precluded any reduction in the upright posture. These findings suggested that men and women with ischemic heart disease maintained cardiovascular adaptability to the upright posture. Eliminating the age bias in the sample showed that autonomic adaptability in men over 55 years may be reduced, as seen by the lack of parasympathetic withdrawal to the upright posture. However, the older men maintained the integrated response of the arterial baroreflex to standing.

Similarly, postoperatively, the effects of posture were consistent with preoperative effects and responses of healthy middle aged and older men and women to the upright posture (Pomeranz *et al.*, 1985; Lipsitz *et al.*, 1989; Butler *et al.*, 1990; Kamath *et al.*, 1991; Fei *et al.*, 1995). Men decreased SBR sensitivity and parasympathetic indicator, and increased sympathetic indicator, in the standing position. Women decreased the parasympathetic indicator in the standing posture, but not SBR sensitivity. Our results were consistent with the attenuated responses of older subjects to head up tilt (Lipsitz *et al.*, 1990).

In the subset of subjects over 55 years, the effects of standing showed some interesting differences between women and men, and between the subset over 55 years and the larger sample. In women over 55 years, SBR sensitivity and R-R interval decreased, and systolic blood pressure increased during standing, consistent with the observed decrease in parasympathetic activity and increase in sympathetic activity. In men over 55 years, SBR sensitivity and R-R interval decreased during standing. The lack of significant changes in parasympathetic and sympathetic indicators in men over 55 years was similar to the diminished responses of healthy older subjects to orthostatic stress (Lipsitz *et al.*, 1990).

The decline in parasympathetic indicator from supine to standing for women over 55 years probably accounted for the decrease in SBR slope, reflecting the reduction in parasympathetic modulation of heart rate and the beat-by-beat interaction between systolic blood pressure and heart rate. The concurrent increase in sympathetic indicator for the women over 55 years contributed to the autonomic imbalance in heart rate modulation. In contrast, the decrease in SBR slope from supine to standing for men over 55 years cannot be explained by the same mechanism, given the lack of significant change in parasympathetic and sympathetic indicators.

Our findings suggest that standing following CABG surgery resulted in autonomic changes that are similar to those in healthy older men and women (Lipsitz *et al.*, 1990; Butler *et al.*, 1993; Fei *et al.*, 1995; Dougherty, 1999), and that these changes were not affected by CABG surgery. The age factor alone did not account for all the posture related differences between women and men in our study, consistent with Laitinen *et al.* (1998), who found that age and gender together accounted for 52% of the variance in SBR sensitivity.

Summary and Conclusions

The major new finding in this study was that CABG surgery had different effects on autonomic modulation of heart rate in men and women. Postoperatively, in women, there were no significant changes in the indices of parasympathetic modulation of heart rate, nor was there a significant change in the sympathetic indicator. These findings suggest that the efferent autonomic nerve fibres in women were not attenuated as a consequence of CABG surgery. In contrast, in men following CABG surgery, there were decreases in the indices of parasympathetic modulation of heart rate; the sympathetic indicator did not change. These findings in men suggest that efferent cardiac autonomic nerves may have been damaged during CABG surgery.

The lack of significant change in sympathetic indicator following surgery may be masked by the effects of cardiovascular medications preoperatively that were not resumed postoperatively. β-adrenergic antagonists and calcium channel antagonists increase heart rate variability (Kontopoulos *et al.*, 1996; TFESCNASPE, 1996). Thus, following cessation of those medications postoperatively, the sympathetic indicator should have increased. The lack of significant change in sympathetic indicator postoperatively may reflect an actual decrease in sympathetic activity, and indicate sympathetic dysfunction.

Some of the differences between men and women may be due to the higher age of the women. The extent of autonomic deterioration may be similar in our sample of men and women undergoing CABG surgery, due to the later onset of ischemic heart disease in women. Other differences could have been due to the hormonal effects of estrogen in two post-menopausal women. Increased technical difficulty during surgery in small women with small coronary arteries could account for greater variation in damage to nerve fibres. The women in our study were significantly smaller than the men, as measured by body surface area. However, the women did not show significant decreases in the indices of parasympathetic modulation of heart rate as a consequence of CABG surgery.

These findings suggest that men may be more vulnerable than women following CABG surgery to the risks of sympathetically-mediated cardiac dysrhythmias and sudden cardiac death. In addition, the decrease in SBR sensitivity means that the interaction between blood pressure and heart rate was attenuated postoperatively, thereby decreasing the ability of the cardiovascular system to respond to rapidly changing stimuli. Despite these findings, both men and women responded appropriately to the standing posture, compared with responses in healthy older individuals.

CHAPTER 5

Study 3

Autonomic Modulation of Heart Rate in Women and Men during Twelve Weeks Recovery Following Coronary Artery Bypass Graft Surgery

Although newer methods of coronary revascularization have evolved, the most common surgical procedure for improving coronary blood flow continues to be coronary artery bypass graft (CABG) surgery (Heart and Stroke Foundation of Canada, 1999). The incidence of CABG surgery has risen in women and in the age groups over 55 years. The improvement in coronary perfusion is achieved by bypassing stenosed or blocked epicardial coronary arteries with arterial and venous grafts (Grondin *et al.*, 1989; Pym *et al.*, 1997).

During CABG surgery, short-term cardiac control mechanisms that regulate beat-by-beat heart rate and blood pressure are perturbed by the manipulation of the heart, cardiac autonomic nerves and sinoatrial (SA) node, and by trauma to the aortic baroreceptors due to aortic clamping, cardiopulmonary bypass and vein grafting (Yang *et al.*, 1994; Komatsu *et al.*, 1997). Consequently, heart rate variability and spontaneous baroreflex (SBR) sensitivity are decreased during and immediately after surgery (Yang *et al.*, 1994; Komatsu *et al.*, 1997). The intraoperative trauma and subsequent autonomic dysfunction would be expected to be temporary, because cardiac nerves remain structurally intact throughout the surgical procedure.

Decreased heart rate variability reflects a reduction in the parasympathetic modulation of heart rate (Akselrod *et al.*, 1981; Goldberger, 1991; Hainsworth, 1996; Smit *et al.*, 1996). A reduction in SBR sensitivity following CABG surgery reflects either impaired afferent input via the aortic baroreceptors, or decreased efferent parasympathetic influence on the SA node (Dampney *et al.*, 1994; Smit *et al.*, 1996). Shi *et al.* (1995) reported that aortic baroreceptors predominate over carotid baroreceptors in the modulation of heart rate in healthy young men.

In our previous study of patients preoperatively and 5 days following CABG surgery, we found that autonomic modulation of heart rate declined in men after surgery, but not in women. Men decreased the indices of parasympathetic modulation of heart rate, that includes high frequency power, parasympathetic indicator and SBR sensitivity. These findings suggested that cardiac parasympathetic nerves were damaged in men as a consequence of CABG surgery, but not in women. Our results in men were consistent with the findings of others (Niemela *et al.*, 1992; Piha & Hamalainen, 1994; Yang *et al.*, 1994; Komatsu *et al.*, 1997). Komatsu *et al.* (1997) found that CABG surgery resulted in decreased autonomic function that persisted 4 weeks postoperatively. Niemela *et al.* (1992) reported that parasympathetic function remained low 6 weeks after CABG surgery, which the authors attributed to irreversible damage to cardiac autonomic nerves or to the SA node.

By decreasing the parasympathetic modulation of heart rate, CABG surgery attenuated the short-term adaptations in heart rate and SBR sensitivity required by changing internal and external conditions, and increased the risk of heart rate and rhythm disturbances immediately postoperatively (Huikuri *et al.*, 1995; Task Force of the European Society of Cardiology & the North American Society of Pacing & Electrophysiology [TFESCNASPE], 1996). Decreased heart rate variability persists in men for 6 weeks following surgery (Niemela *et al.*, 1992). Whether autonomic function remains depressed for 12 weeks in men after CABG surgery is not known; the course of recovery in women has not been studied.

This study assessed the effects of recovery time and posture on autonomic modulation of heart rate for 12 weeks following CABG surgery in men and women. We hypothesized that, compared with Day 5 postoperatively, the indices of parasympathetic modulation of heart rate, i.e., high frequency power, parasympathetic indicator and SBR sensitivity, would increase throughout 12 weeks postoperatively, due to improved coronary circulation and postoperative healing. We hypothesized that the indices of parasympathetic modulation of heart rate would decline in the standing position compared with supine, and that the sympathetic indicator would increase, based on our preoperative findings.

Methods

Subjects

Subjects were recruited preoperatively, as described in Study 1. Patients who participated in the preoperative study were eligible to continue in the postoperative study for 12 weeks, unless they withdrew or were declared off-study because of the following intraoperative or postoperative complications: myocardial infarction, cerebral vascular accident (CVA), pulmonary embolus, thromboemboli.

Preoperatively, 38 eligible patients (13 women and 25 men) signed informed consent and completed testing; postoperatively, on Day 5, 11 women and 23 men completed testing. Following hospital discharge, 5 women and 5 men withdrew from the study, citing travel distance as the reason. A sample of 22 subjects, 6 women and 16 men, completed testing at all three postoperative times: on postoperative day 5 (T1), 6 weeks after surgery (T2) and 12 weeks (T3) after surgery.

Procedures

At all three testing times, cardiovascular responses were measured in two postures: supine and standing. The procedures and measurements were the same as in the previous study, with one exception. The following information was obtained from the subjects prior to each post-discharge testing session: activity profile (mode, intensity, frequency, and duration of activity), cardiovascular status, responses to physical activity, and medications which could affect the study variables.

Data Analysis

Descriptive statistics was used to determine the means and standard deviations (SD) of the following variables in the men and women who completed testing at all four times: age, body surface area (BSA), ejection fraction (EF), total number of grafts, number of arterial grafts and number of venous grafts. Student *t*-statistics were used to determine if the two groups differed in any of these variables.

Repeated measures analysis of variance (ANOVA), with 1-between factor (gender) and 2-within factors (time: 3 levels [Day 5 (T1), 6 weeks (T2) and 12 weeks (T3) postoperatively] and posture: 2 levels [supine, standing]), was employed to determine if there were significant differences over time throughout 12 weeks recovery following CABG surgery, or significant differences in the effects of posture, in men and women. Subsequently, repeated measures ANOVAs were done separately for each gender. Within-subjects contrasts were done to identify trends, and to determine at which time there were significant differences compared with day 5 postoperatively. Differences for all analyses were significant at $p < .05$.

Results

Sample Characteristics

Twenty-two subjects (women, n = 6; men, n = 16) completed testing at all three times following CABG surgery. The women were significantly older, received fewer arterial grafts, and had lower BSA, than men (Table 5.1). Enteric coated aspirin was prescribed, as per standard practice, for all subjects at discharge. Postoperative cardiovascular medications at discharge (T1) only was a β-adrenergic antagonist for one man. Postoperative cardiovascular medications at all three times for women included ACE inhibitor (1), calcium channel antagonist (1), β-adrenergic antagonist (1) and digoxin (1); for men, ACE inhibitor (1) and β-adrenergic antagonist (1).

Table 5.1. Sample Characteristics for Women and Men

Variable	Women (n = 6)	Men (n = 16)
Age (years)	65 ± 6	57 ± 8 #
Body Surface Area (m^2)	1.8 ± .1	2.0 ± .2 #
Ejection Fraction (%)	56 ± 11	58 ± 7
Total Grafts (number)	3 ± 1	3 ± 1
Arterial Grafts (number)	1 ± 0	2 ± 1#
Venous Grafts (number)	2 ± 2	1 ± 1

Values are means ± SD.
Significant value, $p < .05$ between Genders

Heart Rate Variability Day 5 (T1) to 12 Weeks Postoperatively (T3)

The heart rate variability data are presented in Table 5.2. There were no significant differences between women and men in baseline supine heart rate variability measures.

The ANOVA for the effects of recovery time in the supine position showed a significant gender difference on the parasympathetic indicator. Parasympathetic indicator was higher in women. When the data were analyzed separately for each gender, men significantly improved the parasympathetic indicator throughout recovery.

The ANOVA for the effects of recovery time and posture revealed that there was a significant main effect of posture on the parasympathetic indicator, and a posture X gender interaction. Separate analyses for men and women showed that, in men, there was a significant effect of postoperative recovery time on the parasympathetic indicator; the parasympathetic indicator increased throughout the 12 weeks. In women, there was a significant effect of posture on the parasympathetic indicator and high frequency power; women decreased the parasympathetic indicator and high frequency power in the standing position relative to supine.

Table 5.2: Effect of Postoperative Recovery Time (5 Days to 12 Weeks) and Posture (Standing vs. Supine) on Heart Rate Variability Measures in Women (n=6) & Men (n=16)

Measure	Gender	5 Days Supine	5 Days Standing	6 Weeks Supine	6 Weeks Standing	12 Weeks Supine	12 Weeks Standing
Fractal Power (ms^2/Hz)	Women	50±40	44 ±48	345±495	196±183	204±134	152± 87
	Men	61±72	83±180	1065 ±3628	177±222	363±371	174±114
	Total	58±52	73±155	868±3093	182±208	320±329	168±106
High Frequency Power (ms^2/Hz)	Women	26±58	2±3	48±55	22±34	42±62	13±14 !
	Men	2±3	15± 57	17±21	60± 216	56±105	18±26
	Total	9±32	12±49	25±35	49±184	52±94	16±23
Low Frequency Power (ms^2/Hz)	Women	10±9	19± 21	155 ±227	19±25	78±68	44±42
	Men	13±16	18 ±37	88 ±103	35±42	223±565	67±81
	Total	13±14	18±33	107±144	31±38	183±484	61±73
PNS Indicator (high/total)	Women	.15 ±.2	.03± .0	.12 ±.1	.05±.1	.10±.1	.05± .0 !
	Men	.03±.0	.03±.1	.06±.1	.07±.1	.08±.1 •	.07±.1 •
	Total	.06±.1	.03±.0	.08±.1	.07±.1	.09±.1 #	.06±.1 !∞
SNS Indicator (low/high)	Women	13±21	14 ± 16	3±6	8±14	3 ±3	10±11
	Men	9 ±10	34±48	19±35	14±18	8±15	13±22
	Total	10±13	28±42	15±31	12±17	6±13	12±20
Total Harmonic Power (ms^2/Hz)	Women	38±61	21±23	234±257	61±61	165 ± 208	83±57
	Men	22±25	127±461	117±128	98±215	299±717	92±92
	Total	27±37	98±393	149±174	88±185	262±617	90±83
Total Power (ms^2/Hz)	Women	88 ± 96	65± 59	579±730	257±239	369±311	236±118
	Men	84±92	210±639	1177±3697	275±429	652±996	267±182
	Total	85±91	170±545	1014±3156	270±381	575±865	258±165

Values are Means ±SD
• Significant difference due to time from 5 days, $p < .05$.
∞ Significant posture x gender interaction, $p < .05$;
! Significant difference due to posture, $p < .05$.
Significant gender difference, $p < .05$.

SBR Sensitivity Day 5 (T1) to 12 Weeks Postoperatively (T3)

Baroreflex data are presented in Table 5.3.There was a main effect of postoperative recovery time on supine SBR slope, R-R interval and systolic blood pressure throughout the 12 weeks; SBR slope, R-R interval and systolic blood pressure increased significantly. Separate analysis for each gender revealed that men increased SBR slope; men and women increased R-R interval.

There were significant main effects of postoperative recovery time and posture on SBR slope; SBR slope increased over time and decreased in the standing posture compared with supine. There were main effects of postoperative recovery time and posture on R-R interval; R-R interval increased over time and decreased in the standing posture. There were main effects of postoperative recovery time and posture on systolic blood pressure and a posture x gender interaction; blood pressure increased over time and in the standing posture.

When the data were analyzed separately for men and women, there were significant main effects of postoperative recovery time and posture, and a time x posture interaction, on SBR in men; SBR increased over time and decreased in the standing posture. Similarly, in men, there were significant main effects of time and posture on R-R interval; R-R interval increased over time and decreased in the standing posture compared with supine. In women, there was a significant effect of posture on R-R interval that showed a decrease in the standing posture relative to supine. In men and woemn, systolic blood pressure increased in the standing posture compared with supine.

Table 5.3: Effect of Postoperative Recovery Time (5 Days to 12 Weeks) and Posture (Supine vs. Standing) on Baroreflex Measures in Women (n=6) and Men (n=16).

		5 Days	5 Days	6 Weeks	6 Weeks	12 Weeks	12 Weeks
Measure	Gender	Supine	Stand	Supine	Stand	Supine	Stand
R-R Interval (ms)	Women	719±114	690±114	756± 120	702±109	810± 85 *	739± 66 !
	Men	707±92	628±116	780±113	720±143	882±121*	770±104 *!
	Total	710±96	645±116	774±113	715±133	862±115*	761±95 *!
Systolic Blood Pressure (mmHg)	Women	99±22	125±30	117±39	147±36	133±31	152±31 !
	Men	109±20	121±16	110± 16	121±11	119±16	126±14 !
	Total	107± 21	122±20	112± 23	128±24	123±19 *	134±23 *!∞
Baroreflex Slope (ms/mmHg)	Women	3.7±3.3	2.5±2.0	4.6±2.8	3.5±1.6	4.8±2.7	3.4±2.0
	Men	2.8±1.8	1.9±1.6	4.8±2.4	2.3±.9	6.9±4.4 *	2.9±.9 *!o
	Total	3.0±2.2	2.1±1.7	4.8±2.5	2.6±1.2	6.3±4.0 *	3.0±1.3 *!

Values are Means ± SD

* Significant difference due to time, 5 days to 12 weeks, $p < .05$.

! Significant difference due to standing posture, $p < .05$.

o Significant time x posture interaction, $p < .05$.

∞ Significant posture x gender interaction, $p < .05$.

Discussion

The most important new finding in this study was the differential effect of CABG surgery on recovery of autonomic function in men and women throughout 12 weeks after surgery. A second finding was that there were significant effects of posture on indices of parasympathetic modulation of heart rate, as expected.

In our previous study (Study 2), we found that, compared with preoperatively, the indices of parasympathetic modulation of heart rate were significantly lower on Day 5 postoperatively in men. These findings suggested that cardiac parasympathetic nerves may have been damaged in men as a consequence of CABG surgery.

The primary purpose of this study was to measure autonomic modulation of heart rate and SBR sensitivity in men and women during 12 weeks recovery following CABG surgery. Men exhibited a significant increase in the indices of parasympathetic modulation of heart rate throughout the 12 week recovery period, probably due, in part, to improved coronary circulation following CABG surgery. Thus, cardiovascular adaptability to rapidly changing stimuli improved in men throughout 12 weeks recovery. These recovery results in men are contrary to the conclusions of others, that the attenuation of parasympathetic modulation of heart rate following CABG surgery was due to irreversible intraoperative damage to efferent cardiac autonomic nerves (Niemela *et al.*, 1992; Piha and Hamalainen, 1994;

Komatsu *et al.*, 1997). Men showed significant evidence of functional recovery following CABG surgery, compared with 5 days postoperatively.

CABG surgery disrupts the short-term cardiac control mechanisms that modulate beat-by-beat heart rate and blood pressure. Mechanical injury to the heart, SA node, and cardiac autonomic nerves can be caused by manipulation, stretching and compression; damage to the aortic baroreceptors may occur as a result of aortic clamping and vein grafting (Yang *et al.*, 1994; Komatsu *et al.*, 1997). SBR reflects both the sensitivity of arterial baroreceptors to detect and respond to changes in arterial blood pressure, and the ability of the efferent autonomic nervous system to effect beat-by-beat changes in heart rate. A decline in SBR sensitivity following CABG surgery may be due to (1) impaired afferent input from the aortic barorceptors, (2) altered efferent nerve activity in parasympathetic and sympathetic nerves, and (3) dysfunction of the SA node (Docherty, 1990). Central nervous system activity may alter the degree of parasympathetic and sympathetic output (Persson, 1996).

Impairment of efferent autonomic nerves, especially the vagus nerve, seems to be the most likely explanation for our results. Although intraoperative trauma to the vagus nerve to the heart could result in edema of the nerve and subsequent postoperative dysfunction, the nerves remain structurally intact throughout the surgical procedure. Thus, the autonomic dysfunction that was observed on Day 5 postoperatively would be expected to be temporary. The persistent absence of significant functional improvement in women throughout 12 weeks of recovery was unexpected, and suggests that the cardiac parasympathetic nerves require a longer time period for recovery. Thus, restoration of function would be expected to occur; the time required for this restoration may be longer than 12 weeks following surgery.

Cardiac reinervation or regeneration following transection of cardiac autonomic nerves during cardiac transplantation remains controversial. Fallen *et al.* (1988) found that functional reinervation of cardiac parasympathetic nerves, as quantified by spectral analysis of heart rate variability, occurred in only one of nine patients 33 months following heart transplant. Fitzpatrick *et al.* (1993) showed evidence of efferent vagal reinervation after heart transplant, by the presence of the vasovagal reflex response to supported head up tilt. Kaye *et al.* (1993) reported that partial reinervation of cardiac sympathetic nerves began approximately two years following heart transplant in humans. However, during CABG surgery, cardiac autonomic nerves are not transected; nerve injury is attributed to manipulation, stretching or compression of the nerve fibres.

Aortic baroreceptors may have been damaged during surgery. Both men and women received vein grafts that were sutured into the aortic arch, which may have caused temporary or permanent damage to aortic baroreceptors. This trauma could decrease baroreceptor sensitivity and, hence, reduce or delay afferent input via these receptors. Shi *et al.* (1993) and Shi *et al.* (1995) reported that aortic baroreceptors predominate over carotid baroreceptors in the modulation of heart rate in healthy young men. Our findings suggest that men and women may have experienced different trauma to aortic baroreceptors or to efferent cardiac autonomic nerves during CABG surgery (Niemela *et al.*, 1992; Komatsu *et al.*, 1997).

In addition, mechanical damage to the SA node could reduce the ability of the effector organ to respond to autonomic stimuli (Niemela *et al.*, 1992; Piha and Hamalainen, 1994; Komatsu *et al.*, 1997). Dysfunction of the SA node is a potential complication that occurs immediately following CABG surgery; consequently, temporary cardiac pacemaker wires are inserted during surgery and remain *in situ* for 3 to 4 days postoperatively, to provide emergency cardiac pacing in the event of SA node failure. In the present study, the normal pacing function of the SA node was confirmed by ECG prior to discontinuation of the temporary pacemaker, and prior to testing at discharge on Day 5. Subjects showed ECG evidence of normal sinus rhythm at each subsequent testing time, verifying that the SA node was the cardiac pacemaker.

Surgical trauma to efferent cardiac autonomic nerves could explain the lack of significant improvement in parasympathetic function throughout recovery in women, in spite of improved coronary circulation (Niemela *et al.*, 1992; Piha and Hamalainen, 1994; Komatsu *et al.*, 1997). However, the lack of postoperative decline in these measures in women is the more likely reason for our results during recovery. Komatsu *et al.* (1997) and Niemela *et al.* (1992) found that, compared with preoperatively, high frequency and low frequency power decreased 1 week postoperatively and remained low 4 and 6 weeks after surgery. The results were not related to aortic clamping time, nor to intraoperative myocardial damage as measured by serum enzymes. Niemela *et al.* attributed their findings to irreversible damage to cardiac autonomic nerves or to the SA node, but not to ischemic myocardial damage. Komatsu *et al.* also found that the ratio of low frequency to high frequency power did not decrease significantly postoperatively, consistent with our results. Piha and Hamalainen (1994) showed that although heart rate increased and parasympathetic reflexes decreased postoperatively, blood pressure responses, which are sympathetically-mediated via arterial baroreceptors, were unchanged. The authors concluded that mechanical damage to local cardiac autonomic pathways or the SA node, rather than alterations in baroreflex function, caused the attenuation in parasympathetic reflexes.

Our results in men of an increase in parasympathetic modulation throughout 12 weeks of recovery are in contrast to the findings of Niemela *et al.* (1992); our finding that there was no significant improvement in women may support their conclusion that the attenuation of parasympathetic activity following CABG surgery was irreversible. Alternatively, restoration of parasympathetic nerve function in women may require longer than 12 weeks. The lack of significant increase in parasympathetic indicator 12 weeks following surgery in women was unexpected, and could indicate important differences in the responses of men and women throughout the 12 week course of recovery following CABG surgery that have not been reported previously. The longer duration of our study versus the shorter periods of study of 4 weeks (Komatsu *et al.*) and 6 weeks (Niemela *et al.*) may have accounted for some of the discrepancies. Neither of these investigators reported the responses of women; nor did they compare two postures. Consequently, there are no available comparisons for women following CABG surgery.

There was no significant change in the sympathetic indicator throughout 12 weeks postoperatively, suggesting that the cardiac sympathetic nerves were not affected by CABG surgery. The apparently selective intraoperative damage to the parasympathetic division of the cardiac autonomic nervous system in women, and not to the sympathetic division, could be due to 1) the different structure of the nerve pathways or 2) the masking of the level of sympathetic activity by the use of β-adrenergic antagonist and calcium channel antagonist medications in some subjects throughout recovery.

Sympathetic preganglionic axons extend from neurons in the spinal cord to postganglionic neurons that are far from the target organ (Kandel *et* *al.*, 1991). Parasympathetic preganglionic axons extend from the parasympathetic nucleus to postganglionic neurons near the target organ, in this case, the heart and SA node; preganglionic axons are considerably longer than those of postganglionic neurons (Kandel *et al.*, 1991). Manipulation injury during CABG surgery may have affected the parasympathetic postganglionic neurons near the heart, thereby decreasing the ability of the nerve to activate the SA node. Alternatively, damage to the sympathetic nerve fibres may have been masked.

Postoperatively, from discharge to 12 weeks, more women (67%) than men (13%) resumed preoperative cardiovascular medications, including β-adrenergic antagonists and calcium channel antagonists; one women received digoxin throughout the study. Thus, the sympathetic indicator should have increased after surgery in men. The lack of increase in sympathetic indicator throughout recovery following surgery may reflect an actual decrease in sympathetic activity, and, thus, indicate sympathetic dysfunction.

Both women and men increased R-R interval and systolic blood pressure throughout 12 weeks recovery. Functional recovery of cardiac parasympathetic nerves, resulting in a shift in autonomic balance toward the parasympathetic nervous system modulation of heart rate, could account for these results in men. However, postoperative healing and improved hemoglobin level, which typically occur during the postoperative period, may have contributed to the findings. In contrast, women showed no significant change in either parasympathetic or sympathetic indicators, suggesting either that no impairment of autonomic modulation of heart rate had occurred as a consequence of surgery, or that functional recovery of efferent cardiac autonomic nerves had not occurred by 12 weeks after surgery. The increase in R-R interval and systolic blood pressure in women may be due to postoperative healing, including improved hemoglobin level and restoration of fluid balance.

The effects of posture were consistent with the attenuated responses of older subjects to orthostatic stress (Lipsitz *et al.*, 1990; Kamath *et al.*, 1991; Butler *et al.*, 1993; Fei *et al.*, 1995). Normally, the upright posture produces deactivation of afferent nerve impulses from arterial baroreceptors, resulting in an increase in efferent sympathetic activity and a concurrent withdrawal of parasympathetic activity, to the SA node (Kamath *et al.*, 1991; Persson, 1996). A decrease in parasympathetic influence on the SA node indicates a shift in the balance between parasympathetic and sympathetic efferent activity.

The women and men in our study responded differently to the standing position throughout recovery, although both groups showed some evidence of decreased parasympathetic modulation of heart rate. Our findings are consistent with our two previous studies and reported results in older healthy men and women to the upright posture (Lipsitz *et al.*, 1990).

The lack of significance in all indices of parasympathetic modulation in both men and women in response to standing may be due to the high variability in SBR sensitivity and the small sample of women. The significantly higher age of the women compared with the men may have accounted for the difference in SBR response, which decreases with increasing age. The combination of CABG surgery and attenuated responses in older women subjects may have contributed to our findings.

The increase in systolic blood pressure in the standing position was accompanied by a significant decrease in parasympathetic indicator and a significant decline in SBR slope. This suggests that there was a shift in autonomic balance toward decreased parasympathetic and increased sympathetic influence on heart rate and blood pressure. The decrease in R-R interval and increase in systolic blood pressure in the standing position reflect changes in autonomic balance that are consistent with typical responses to orthostatic stress in older individuals.

Summary and Conclusions

The 12 week recovery period following coronary revascularization showed significant evidence of autonomic recovery in men. Men exhibited an increase in the indices of parasympathetic heart rate modulation throughout the 12 weeks of recovery after CABG surgery. These findings suggest that functional recovery of parasympathetic nerves can occur within 12 weeks in men.

The results of the present study imply that the short-term ability of the cardiovascular system to adapt rapidly to changing stimuli may be attenuated in women and that the potential for sympathetically-mediated cardiac dysrhythmias remained a risk throughout recovery. Injury during CABG surgery to cardiac parasympathetic nerves, followed by prolonged functional recovery, probably accounted for these results. Given that the cardiac autonomic nerves were not transected during CABG surgery, restoration of function should occur postoperatively; the time frame for functional recovery of the parasympathetic nerves seems to be longer than 12 weeks following surgery in women.

However, in our previous study (Study 2), we found that, compared with preoperatively, the indices of parasympathetic modulation of heart rate were significantly lower on Day 5 postoperatively in men, but not women. These findings suggested that cardiac parasympathetic nerves may have been damaged in men as a consequence of CABG surgery.

In summary, in women, CABG surgery did not decrease the indices of parasympathetic modulation of heart rate, nor did the recovery period result in an increase. In contrast, in men, CABG surgery caused a decrease in these indices, but the recovery period showed a significant improvement. Although women had lower SBR than men preoperatively and postoperatively, there were no significant differences between them in the other measures. In conclusion, there is no evidence to suggest that CABG surgery affected parasympathetic modulation in women.

CHAPTER 6

Study 4

Autonomic Modulation of Heart Rate in Women and Men during Low Intensity Exercise 6 and 12 Weeks after Coronary Artery Bypass Graft Surgery

Heart rate variability and spontaneous baroreflex (SBR) sensitivity decrease following coronary artery bypass graft (CABG) surgery (Niemela *et al.*, 1992; Piha & Hamalainen, 1994; Yang *et al.*, 1994; Komatsu *et al.*, 1997) and during physiological perturbations, such as exercise (Pomeranz *et al.*, 1985; Lipsitz *et al.*, 1990; Kamath *et al.*, 1991; Yamamoto *et al.*, 1991; Butler *et al.*, 1993; Nakamura *et al.*, 1993; Fei *et al.*, 1995; Shi *et al.*, 1995). Decreased heart rate variability reflects decreased parasympathetic modulation of heart rate (Akselrod *et al.*, 1981; Goldberger, 1991). This reduces the ability of the cardiovascular system to adapt to rapidly changing stimuli, decreases the beat-by-beat heart rate response to changes in arterial pressure, and increases the potential for sympathetically-mediated heart rate and rhythm disturbances (Akselrod *et al.*, 1981; Huikuri *et al.*, 1995; Hainsworth, 1996; Smit *et al.*, 1996; Task Force of the European Society of Cardiology & the North American Society of Pacing & Electrophysiology [TFESCNASPE], 1996).

In our previous study of men and women following CABG surgery, we found gender differences in autonomic function throughout 12 weeks recovery after surgery (Study 3). Men, but not women, exhibited an increase in the indices of parasympathetic modulation of heart rate (i.e., the parasympathetic indicator and SBR sensitivity) throughout 12 weeks of recovery. Neither men nor women showed any significant change in the sympathetic indicator. However, we found that there were significant effects of posture (supine vs. standing) in both men and women on indices of parasympathetic modulation of heart rate that were similar to responses in older healthy individuals. Women decreased high frequency power and the parasympathetic indicator in the standing position compared with supine; men decreased the parasympathetic indicator and baroreflex sensitivity.

Reduced parasympathetic modulation of heart rate following CABG surgery may decrease cardiovascular responses to acute physical exercise, by decreasing the beat-by-beat heart rate response to changes in arterial blood pressure (Kamath *et al.*, 1991; Yamamoto *et al.*, 1991; Niemela *et al.*, 1992; Nakamura *et al.*, 1993; Yang *et al.*, 1994; Komatsu *et al.*, 1997). Moreover, the combination of diminished parasympathetic activity postoperatively, and enhanced sympathetic activity with the associated increase in plasma catecholamines during exercise, increases the risk of sympathetically-mediated cardiac electrical instability and life-threatening arrhythmias (Yamamoto *et al.*, 1991; Nakamura *et al.*, 1993; Huikuri *et al.*, 1995; TFESCNASPE, 1996). In addition, increased breathing frequency and tidal volume during exercise may cause a further reduction in the parasympathetic modulation of heart rate (Saul *et al.*, 1989; Brown *et al.*, 1993; Novak *et al.*, 1993). Thus, the measurement of beat-by-beat arterial blood pressure and spectral analysis of heart rate variability during low intensity steady-state exercise will greatly enhance the amount of information that can be gained regarding responses to exercise during early recovery 6 and 12 weeks following CABG surgery.

This study assessed 1) the effects of postoperative recovery time from 6 to 12 weeks following CABG surgery on the indices of parasympathetic modulation of heart rate (i.e., high frequency power, parasympathetic indicator and SBR sensitivity) in men and women, and 2) the effects of low intensity steady-state exercise on these measures. A secondary purpose was to determine the influence of tidal volume and breathing frequency on the study outcome measures. We hypothesized that the indices of parasympathetic modulation would increase from 6 to 12 weeks, and decrease from supine to exercise. Based on our previous findings, we predicted that women would show lower baroreflex sensitivity than men. We hypothesized that tidal volume and breathing frequency during exercise would influence baroreflex slope, high frequency power and parasympathetic indicator.

Methods

Subjects

Subjects were recruited preoperatively as described in Study 1. A sample of 22 subjects, 6 women and 16 men, completed testing at 6 and 12 weeks following CABG surgery, as described in Study 3.

The following information was obtained from the subjects prior to each testing session: activity profile (i.e., mode, intensity, frequency, and duration of activity), cardiovascular status, responses to physical activity, and medications which could affect the study variables.

Procedures

The procedures and measurements were the same as in the previous studies, with some exceptions. In the previous studies, subjects were tested in two postures: supine and standing. In the present study, subjects were tested in the supine position and during low intensity steady-state exercise in the Clinical Exercise Physiology Laboratory at Queen's University. Testing was conducted in a quiet, light-attenuated room; room temperature was similar for all tests. Cardiovascular data, as described previously, and ventilatory data were collected during the supine and exercise tests.

Steady-State Exercise. Approximately 15 minutes following a 20 minute supine test, subjects performed low intensity steady-state exercise, using an upright constant work rate cycle ergometer (Sensor-Medics, Model 800). Initially, the men and women performed 3 minutes of unloaded pedaling, followed by 10-15 minutes of pedaling at 20 watts at 60 cycles per minute. They exercised to a heart rate of 50% age-predicted maximum heart rate, corresponding to a rating of perceived exertion (RPE) 11 on the Borg 15 point (6-20) scale, for a period of 10 minutes, unless stopped for signs or symptoms of exercise intolerance, following standard criteria for cardiac patients (ACSM, 1995). During exercise testing, heart rate and rhythm were monitored continuously by ECG, and blood pressure was monitored continuously by a Finapres 2300 finger arterial blood pressure monitor (Datex-Ohmeda, Rexdale, Ont.). For safety reasons, a physician was present during the exercise testing component, and an emergency cart with standard drugs and resuscitation equipment was available in the testing laboratory. Cardiovascular were collected during steady-state conditions for a minimum of 512 cardiac cycles; ventilatory responses were measured throughout the exercise test (Hughson *et al.*, 1991).

Data Collection

The methods of collecting and analyzing the cardiovascular data was described in Study 1. In this study, in addition to cardiovascular data, ventilatory data were collected during supine rest and during exercise.

Ventilatory data. Breath-by-breath measurements of tidal volume, breathing frequency, oxygen uptake, and carbon dioxide output were collected using a computerized system (First Breath Inc., St. Agatha, Ont.), which incorporates a respiratory mass spectrometer (Perkin-Elmer, MGA-

1100) with a volume turbine (Alpha Technologies VMM-110). In the present study, tidal volume and breathing frequency were analyzed to determine their effects on heart rate variability and baroreflex sensitivity; peak oxygen uptake and the calculation of percent of predicted maximum oxygen uptake were used to verify the intensity of exercise performed.

Statistical Analysis

Repeated measures analysis of variance (ANOVA), with 1-between subjects factor (gender), and 1-within subjects factors (time: 6 weeks vs. 12 weeks), was done to determine if there were any significant effects of recovery time in the supine position between men and women. Subsequently, repeated measures ANOVA, with time (6 weeks vs. 12 weeks) as the within-subjects factor, was done separately for women and men to determine if there were any significant effects of time in the supine position from 6 to 12 weeks in each group.

ANOVA, with 1-between subjects factor (gender), and 2-within subjects factors (time [6 weeks vs. 12 weeks] and condition [supine vs. exercise]), was done to determine if there were any significant effects of recovery time and exercise between men and women. Subsequently, repeated measures ANOVA, with time (6 weeks vs. 12 weeks) and condition (supine vs. exercise) as the within-subjects factors, was done separately for women and men to determine if there were any significant effects of time from 6 to 12 weeks and exercise in each group.

Analysis of covariance (ANCOVA), with gender as the between-subjects fixed factor, and breathing frequency and tidal volume as covariates, was conducted in the supine position and during steady-state exercise at each testing time, to determine the influence of these factors on the selected heart rate variability measures (i.e., high frequency and low frequency power, parasympathetic indicator and sympathetic indicator) and baroreflex slope, R-R interval and systolic blood pressure. Differences were significant at $p < .05$.

Results

Sample Characteristics

Six and 12 weeks following CABG surgery, 6 women and 16 men from the preoperative sample of 38 subjects remained in the study. The women were significantly older, received fewer arterial grafts, and had lower BSA, than the men (Table 6.1). One man was stopped during exercise testing for ECG evidence of an unusual cardiac dysrhythmia, without symptoms; he was referred immediately to his cardiologist and surgeon, and experienced no untoward effects. Postoperative cardiovascular medications at 6 and 12 weeks for women included ACE inhibitor (1), calcium channel antagonist (1), β-adrenergic antagonist (1) and digoxin (1); for men, ACE inhibitor (1) and β-adrenergic antagonist (1).

Table 6.1. Sample Characteristics for Women and Men

Variable	Women	Men
Age (years)	64 ± 6	57 ± 8 #
Body Surface Area (m^2)	1.8 ± .1	2.0 ± .2 #
Ejection Fraction (%)	54 ± 11	58 ± 7
Total Grafts (number)	3 ± 2	3 ± 1
Arterial Grafts (number)	1 ± 0	2 ± 1#
Venous Grafts (number)	2 ± 2	1 ± 1

Significant Gender difference, $p < .05$

Baseline Measures 6 Weeks Following CABG Surgery

There were no significant differences between women and men in the heart rate variability measures in the supine position or during exercise at 6 weeks. Similarly, there were no significant differences between women and men in SBR sensitivity in the supine position or during exercise at 6 weeks. Women had significantly higher breathing frequency and lower tidal volume in the supine position, than men.

Six to Twelve Weeks Following CABG Surgery

Heart Rate Variability

The heart rate variability data are presented in Table 6.2. In the supine position, there were no main effects of time. When the data were analyzed separately for men and women, in men, there were significant effects of time in the supine position on high frequency power and total power; both increased from 6 to 12 weeks.

Analysis of the effects of time and condition showed that there were no main effects of time on heart rate variability measures. There was a significant time X gender interaction on parasympathetic indicator. There were significant main effects of exercise on fractal power, high frequency power, low frequency power, total harmonic power and total power; these measures decreased during exercise.

Separate analysis for the male and female groups showed that, in men, there was a main effect of time on fractal power, high frequency

Table 6.2: Effects of Time (6 to 12 Weeks Postoperatively) and Condition (Supine to Exercise) on Heart Rate Variability Measures for Women (n=6) and Men (n=13).

		6 Weeks		12 Weeks	
		Supine	Exercise	Supine	Exercise
Measure	Gender	Means±SD	Means±SD	Means±SD	Means±SD
Fractal Power (ms²/Hz)	Women	272±334	41±38	204±134	72±34
	Men	137±80	87±71	281±244	102±86 *!
	Total	180±198	73±65	257±215	92±74 !
High Frequency Power (ms²/Hz)	Women	45±50	8±11	42±62	10±13
	Men	17±24	5±6	32±32	20±22 *!
	Total	26±35	6±8	35±42	17±20 !
Low Frequency Power (ms²/Hz)	Women	149±217	19±31	78±68	8±6
	Men	75±93	24±23	90±107	48±52 !
	Total	98±142	22±25	86±94	35±47 !
PNS Indicator (high/total)	Women	.11±.06	.09.±09	.10 ±.05	.10±.08
	Men	.07±.08	.04±.05	.08±.11	.09±.10 *
	Total	.1±.1	.1±.1	.1±.1	.1±.1 ¤
SNS Indicator (low/high)	Women	3±.6	3±2	3±3	3±3
	Men	22±39	25±46	9±16	7±8
	Total	16±33	18±39	7±13	6±7
Total Harmonic Power (ms²/Hz)	Women	222±238	34±42	165±208	28±22
	Men	96±107	33±28	124±99	73±9 *!
	Total	136±164	33±31	137±137	59±61 !
Total Power (ms²/Hz)	Women	481±536	75±74	369±311	100±50
	Men	233±140	120±92	405±263*	177±0.4 *!
	Total	312±327	106±87	394±271	152±94 !

! Significant effect of condition, from supine to exercise, $p < .05$.
Significant gender difference, $p < .05$.
* Significant effect of time, $p < .05$.
¤ Significant time x gender interaction, $p < .05$.

power, parasympathetic indicator, total harmonic power and total power; these measures increased from 6 to 12 weeks. In men, there was a main effect of exercise on fractal power, high frequency power, low frequency power, total harmonic power and total power; these measures decreased during exercise compared with the supine position.

SBR Sensitivity

The baroreflex data are shown in Table 6.3. In the supine position, there was a significant main effect of time on R-R interval; R-R interval increased from 6 to 12 weeks. Separate analyses for each group showed that, in the supine position, men increased R-R interval, SBR slope and systolic blood pressure significantly from 6 to 12 weeks.

Analysis of the effects of time (6 to 12 weeks) and condition (exercise) showed that there was a main effect of condition on SBR slope; SBR slope declined during exercise. When the data were analyzed separately for women and men, SBR slope decreased from supine to exercise in both men and women.

There were also significant main effects of time and exercise on R-R interval; the R-R interval increased over time from 6 to 12 weeks, and decreased from supine to exercise. Separate analysis for each group showed that there was a significant main effect of time and exercise in men, and a significant main effect of exercise in women, on R-R interval. In men, the R-R interval increased from 6 to12 weeks and decreased from supine to exercise;

Table 6.3: Effects of Time (6 to 12 Weeks Postoperatively) and Condition (Supine to Exercise) on Baroreflex Measures.

		6 Weeks		12 Weeks	
		Supine	**Exercise**	**Supine**	**Exercise**
Measure	Gender	Means±SD	Means±SD	Means±SD	Means±SD
R-R Interval (ms)	Women	756±120	628±81	810±85	670±45 *
	Men	805±107	680±96	904±124*	763±97 *!
	Total	790±110	664±93	875±120*	733±94 *!
Systolic Blood Pressure (mmHg)	Women	117±39	167±52	133±25	172±21 !
	Men	109±16	152±16	119±18*	153±24 !o
	Total	111±25	157±32	124±21	159±25 !
Baroreflex Slope (ms/mmHg)	Women	4.6±2.8	2.4±1.1	4.8±2.7	2.6±0.8 !
	Men	4.5±2.4	4.3±4.6	5.8±2.4*	3.7±1.7 !
	Total	4.6±2.4	3.6±3.9	5.4±2.5	3.3±1.6 !

! Significant effect of condition, from supine to exercise, $p < .05$.
* Significant effect of time, $p < .05$.
o Significant time x condition interaction, $p < .05$.

in women, the R-R interval decreased from supine to exercise.

There was a significant main effect of exercise on systolic blood pressure; systolic blood pressure increased from supine to exercise. Separate analysis for each group showed that systolic blood pressure increased from supine to exercise in both women and men. Men also showed a significant time X condition interaction; blood pressure increased from 6 to 12 weeks, and increased from supine to exercise.

Breath-by-Breath Ventilation

There was a significant overall main effect of exercise on breathing frequency and tidal volume; both increased from supine to exercise (Table 6.4). There was also a significant gender difference in tidal volume; women had lower tidal volume than men. Women showed a significant increase in tidal volume from supine to exercise; men showed a significant increase in breathing frequency from supine to exercise.

There was a significant main effect of exercise on maximum oxygen uptake and percent of predicted maximum oxygen uptake; both increased in men and women from supine to exercise. The percent of predicted maximum oxygen uptake during exercise was significantly higher in women than men.

Table 6.4: Effects of Time (6 to 12 Weeks Postoperatively) and Condition (Supine to Exercise) on Ventilatory Measures for Women and Men.

		6 Weeks		12 Weeks	
		Supine	**Exercise**	**Supine**	**Exercise**
Measure	Gender	Means±SD	Means±SD	Means±SD	Means±SD
Breathing Rate (/min)	Women	18±3	21±3	17±3	20±3
	Men	13±3	20±5	14±1	20±4 !
	Total	14±3	20±5	15±2	20±4 !
Tidal Volume (ml)	Women	534±154	760±122	483±86	780±54 !
	Men	876±270	904±157	775±207	927±166
	Total	811±284	877±159	720±222	899±161 !#
Oxygen (O_2) Uptake (ml/min)	Women	327±39	704±45	327±38.7	708±79 !
	Men	383±79	774±292	452±230	832±113 !
	Total	372±75	760±262	427±211	807±117 !
% Predicted Max O_2 Uptake	Women	19±2	40±3	19±3	41±4 !
	Men	14±3	28±11	16±7	30±5
	Total	15±4	30±11	17±7	32±6! ∞

! Significant effect of exercise condition, $p < .05$.
Significant gender difference, $p < .05$.
∞ Significant condition x gender interaction, $p < .05$.

Influence of Tidal Volume and Breathing Frequency

Heart Rate Variability Measures. At 6 weeks, in the supine position, there were significant effects of tidal volume and gender on the sympathetic indicator, together accounting for 42% of the variance. There was also a significant gender effect on supine parasympathetic indicator, accounting for 40% of the variance. During exercise, there were significant effects of breathing frequency and tidal volume on high frequency power, together accounting for 31% of the variance.

At 12 weeks, in the supine position, there was a significant effect of tidal volume on the sympathetic indicator. During exercise, there was a significant effect of tidal volume on high frequency power, accounting for 30% of the variance, and on the parasympathetic indicator, accounting for 18% of the variance.

SBR Sensitivity. At 6 weeks, there were no significant effects of breathing frequency and tidal volume on SBR slope. At 12 weeks, during exercise, there was a significant effect of breathing frequency and tidal volume on SBR slope, together accounting for 51% of the variance.

Summary of the Influence of Breathing Frequency & Tidal Volume

In the supine position 6 weeks postoperatively, there were significant effects of gender and tidal volume on the sympathetic indicator; there was a significant effect of gender on the parasympathetic indicator. Twelve weeks postoperatively, there was a significant effect of tidal volume on the sympathetic indicator.

During low intensity steady-state exercise 6 weeks postoperatively, there were significant effects of breathing frequency and tidal volume on high frequency power. Twelve weeks postoperatively, there was a significant effect of tidal volume on high frequency power and the parasympathetic indicator; there was a significant effect of breathing frequency and tidal volume on SBR sensitivity.

Discussion

The major finding in this study was the differential effect of recovery time, from 6 to 12 weeks following CABG surgery, on heart rate variability measures in women and men. The effects of acute low intensity steady-state exercise on heart rate variability measures were different in men and women; exercise significantly decreased low frequency power and high frequency power in men. In contrast, the effects of acute low intensity steady-state exercise on baroreflex measures were similar in women and men, consistent with the hypothesis; exercise significantly decreased SBR slope and R-R interval, and increased systolic blood pressure in men and women.

The primary purpose of this study was to measure the effects of recovery time (6 to 12 weeks) following CABG surgery on the indices of parasympathetic modulation of heart rate in men and women. Baseline measurements at 6 weeks postoperatively showed that there were no significant differences between women and men in SBR slope or heart rate variability measures, consistent with the results of Arai *et al.* (1989) in healthy subjects. Our findings contrast with those in healthy age-matched middle aged and older subjects, in which women are reported to have higher high frequency power, lower low frequency power and lower sympathetic indicator than men (Ryan *et al.*, 1994; Liao *et al.*, 1995; Huikuri *et al.*, 1996; Dougherty, 1999). The significantly higher age of the women in the present study may account for the lack of significant differences between men and women. Increasing age decreases parasympathetic modulation of heart rate and SBR function, most likely due to reduced muscarinic receptor density and function (Docherty, 1990; Poller *et al.*, 1997; Brodde *et al.*, 1998; Brodde & Michel, 1999). Loss of muscarinic receptors in the SA node could attenuate the decrease in heart rate mediated by parasympathetic modulation, and decrease the beat-by-beat interaction between systolic blood pressure and heart rate (Brodde & Michel, 1999).

The major finding in this study was that men improved the heart rate variability indices of parasympathetic modulation of heart rate from 6 to 12 weeks recovery. The significantly higher age of the women compared with the men may have attenuated the functional recovery in women (Docherty, 1990; Poller *et al.*, 1997; Brodde *et al.*, 1998; Brodde & Michel, 1999).

Damage during surgery to aortic baroreceptors, the efferent cardiac autonomic nerves and the SA node could have the following effects: decrease the ability of the arterial baroreceptors in the aortic arch to detect changes in arterial blood pressure (Yang *et al.*, 1994; Shi *et al.*, 1995), decrease the efferent parasympathetic influence on the SA node, or cause dysfunction of the SA node (Docherty, 1990; Niemela *et al.*,1992; Komatsu *et al.*, 1997). Aortic baroreceptors may lose their sensitivity to changes in blood pressure, due to intraoperative crushing injury caused by aortic clamping, and by direct piercing injury due to vascular suturing. The efferent cardiac autonomic nerves, although not transected during CABG surgery, may lose functional ability due to compression or stretching injury during surgery. Intraoperative disruption of aortic baroreceptors and cardiac autonomic nerves may result in temporary dysfunction; consequently, restoration of autonomic and baroreflex function would be expected to occur during recovery. Dysfunction of the SA node reduces the ability of the SA node to respond to autonomic stimuli; this potential complication typically occurs immediately after surgery and is a risk for 3 to 4 days following CABG surgery (Niemela *et al.*, 1992; Piha and Hamalainen, 1994; Komatsu *et al.*, 1997). Temporary cardiac pacemaker wires that are inserted during surgery remain *in situ* to provide emergency cardiac pacing in the event of SA node failure, until normal SA node pacemaker function is verified by ECG.

In Study 2, we showed that, 5 days postoperatively, men significantly decreased the indices of parasympathetic modulation of heart rate, compared with preoperative levels. In contrast, women showed no significant changes in any of these measures. These findings suggested that the efferent cardiac autonomic nerves may have been damaged in men during CABG surgery, but that cardiac parasympathetic activity in women was not attenuated as a consequence of CABG surgery. In Study 3, we found that, throughout 12 weeks recovery following CABG surgery, men, but not women, exhibited a significant increase in the indices of parasympathetic modulation of heart rate, thereby reversing the effects of CABG surgery. Thus, in women, CABG surgery did not cause a significant decrease in the indices of parasympathetic modulation of heart rate, nor did the recovery period result in an increase. In contrast, in men, CABG surgery caused a decrease in these indices, but the recovery period showed a significant improvement. Our results suggest that CABG surgery disrupted the efferent cardiac parasympathetic nerves in men, consistent with other studies (Niemela *et al.*, 1992; Piha & Hamalainen, 1994; Yang *et al.*, 1994; Komatsu *et al.*, 1997).

In the present study, the men improved the parasympathetic modulation of heart rate from 6-12 weeks postoperatively, contradicting the conclusions of Niemela *et al.* (1992) that the impairment of parasympathetic function was irreversible. The duration of 4 and 6 weeks in previous studies of heart rate variability following CABG surgery may not have been long enough to show significant functional restoration. Our findings in men have not been reported previously.

The surgical trauma to cardiac autonomic nerves might disrupt the autonomic nervous system to the heart differently in men and women, and differently in any individual. The women in our study were significantly smaller than the men, as estimated by body surface area. Women tend to have smaller coronary arteries than men; this could present greater technical challenges during surgery and account for greater variation in damage to nerves in women compared with men. However, given that the women showed no significant decline in autonomic measures postoperatively, this does not explain the differential effects of CABG surgery in men and women.

Aortic baroreceptors are disrupted during surgery by aortic clamping and vein grafting in the region of the aortic arch; all subjects received vein grafts. This disruption may affect modulation of heart rate (Shi *et al.*, 1993; Shi *et al.*, 1995). Shi *et al.* (1995) showed that, during supine rest and steady-state exercise, aortic baroreceptors predominated over carotid baroreceptors in the modulation of heart rate. Piha & Hamalainen (1994) reported that, although the indices reflecting parasympathetic function were attenuated after CABG surgery, CABG surgery had no effect on beat-to-beat blood pressure. The authors concluded that the attenuation of heart rate was due to perioperative damage to efferent nerves or to the effector organ (i.e., the SA node), and not to baroreceptor dysfunction. These findings have not been confirmed by other investigators.

In summary, the increase in high frequency power, parasympathetic indicator and SBR sensitivity in men from 6 to 12 weeks postoperatively confirms that functional improvement of the efferent cardiac parasympathetic influence on heart rate had occurred. In women, the lack of significant improvement in the indices of both parasympathetic and sympathetic modulation may reflect continuing impairment of all autonomic activity 12 weeks following CABG surgery. However, given that, compared with preoperatively, there was no significant decline in women postoperatively, this interpretation is questionable. Lack of significant decrease in autonomic function as a consequence of CABG surgery in women could have been due to the low preoperative level of autonomic activity that prevented any reduction. Similarly, the low preoperative SBR may have precluded any decline postoperatively. The higher age of the women may account for the failure to improve these measures significantly during recovery, in spite of improved coronary circulation and postoperative healing 6 and 12 weeks after surgery. Smaller coronary arteries in women may have attenuated the expected improvement in coronary perfusion following surgery.

We also assessed the effects of low intensity steady-state exercise from 6 to 12 weeks, on the indices of parasympathetic modulation of heart rate in men and women. We found that the effects of exercise on SBR sensitivity, R-R interval and systolic blood pressure were similar in men and women. These results are consistent with findings in healthy subjects during low intensity exercise (Kamath *et al.*, 1991; Yamamoto *et al.*, 1991; Nakamura *et al.*, 1993; Fei *et al.*, 1995).

Central activation of the autonomic nervous system during exercise normally inhibits parasympathetic activity while stimulating sympathetic discharge, producing increases in heart rate, myocardial performance, and levels of catecholamines in plasma (Stone, 1983). However, the autonomic effects occur when exercise intensity exceeds 50% maximum oxygen consumption, coinciding with marked increases in plasma epinephrine and norepinephrine (Yamamoto *et al.*, 1991; Nakamura *et al.*, 1993).

In our study, acute low intensity steady-state exercise caused significant decreases in baroreflex slope, high frequency power and low frequency power in men, and a decrease in baroreflex slope in women. Men and women decreased R-R interval and increased systolic blood pressure during exercise. The parasympathetic and sympathetic indicators did not change significantly in men or women. These findings partially supported the hypothesis, and were consistent with the reports of Arai *et al.* (1989), Kamath *et al.* (1991) and Fei *et al.* (1995) in healthy young subjects. The lack of change in the parasympathetic and sympathetic indicators during exercise was consistent with the findings of Yamamoto *et al.* (1991) and Nakamura *et al.* (1993) for low intensity exercise in healthy young subjects. The latter investigators found that an increase in sympathetic activity accompanied by a withdrawal of parasympathetic activity occurred only when exercise intensity exceeded 50% maximum oxygen uptake. Our subjects achieved 30% (men) and 40% (women) of maximum oxygen uptake during exercise.

In contrast to our results that SBR sensitivity declined during exercise, Shi *et al.* (1995) found that baroreflex sensitivity was maintained during low intensity steady-state exercise; in particular, aortic baroreflex gain was maintained. In addition, the authors confirmed that aortic baroreceptors predominated over carotid baroreceptors in the reflex modulation of heart rate. In our subjects following CABG surgery, aortic baroreceptors may have been damaged during surgery, contributing to the discrepancy between our results in men and women and those of Shi *et al.* (1995) in healthy subjects.

A secondary purpose of this study was to determine the influence of tidal volume and breathing frequency on the indices of parasympathetic modulation of heart rate. The effect of tidal volume on supine sympathetic indicator at 6 and 12 weeks was contrary to expectations, given that the mean tidal volume for both groups in the present study was lower than the nominal tidal volumes used by Brown *et al.* (1993), and was within the normal range for resting supine adults. This effect suggests that the mechanical effort required by the subjects during inspiration in the supine position increased sympathetic activity. Following CABG surgery, the mechanics of ventilation are altered due to the sternal incision. This may have resulted in chest splinting, causing an increase in the work of breathing in the supine position.

During low intensity steady-state exercise 6 weeks postoperatively, there were significant effects of breathing frequency and tidal volume on high frequency power. Twelve weeks postoperatively, there was a significant effect of tidal volume on high frequency power and the parasympathetic indicator; there was a significant effect of breathing frequency and tidal volume on SBR sensitivity. Our findings during exercise are similar to those of others (Saul *et al.*, 1989; Brown *et al.*, 1993; Novak *et al.*, 1993). Brown *et al.* reported that R-R interval power declined at higher breathing frequencies. Novak *et al.* reported that the amplitude of R-R fluctuations was proportional to tidal volume, and that for a given tidal volume, the amplitude of R-R fluctuations increased as breathing frequency decreased. The breathing frequencies during exercise in our study were substantially higher than the low rate of 0.05 Hz, and lower than the high rate of 0.46 Hz, in the study by Novak *et al.*; the exercise tidal volumes in our study were lower than the nominal tidal volumes of Brown *et al.* (1993).

A decrease in R-R interval power implies a decline in parasympathetic influence on heart rate and may explain the significant effect of breathing frequency and tidal volume together on SBR slope during exercise. Our findings were consistent with expectations of a decrease in parasympathetic modulation of heart rate during exercise.

Summary and Conclusions

From 6 to 12 weeks after CABG surgery, men improved the indices of parasympathetic modulation of heart rate, as seen by increases in high frequency power, parasympathetic indicator and SBR sensitivity; total harmonic power and total power also increased. As expected, men increased R-R interval over the 6 weeks.

Acute low intensity steady-state exercise resulted in decreased low frequency power, high frequency power, SBR slope and R-R interval, and increased systolic blood pressure, in men; in women, exercise decreased SBR slope and R-R interval, and increased systolic blood pressure. The parasympathetic and sympathetic indicators did not change significantly. These results were similar to findings in healthy young subjects, and suggest that subjects following CABG surgery experienced appropriate cardiovascular responses to low intensity exercise 6 and 12 weeks postoperatively.

There were significant effects of breathing frequency and tidal volume on high frequency power during low intensity steady-state exercise 6 weeks postoperatively. Twelve weeks postoperatively, there was a significant effect of tidal volume on high frequency power and the parasympathetic indicator; there was a significant effect of breathing frequency and tidal volume on SBR sensitivity. There were no differences between men and women.

Aging in women and restoration of parasympathetic nerve function following surgical damage to cardiac autonomic nerves in men were the most likely reasons for our findings. Women were significantly older than men, which probably accounted for the differences in improvement of autonomic responses from 6 to 12 weeks between women and men. Aging decreases muscarinic receptor density and function, thereby reducing parasympathetic modulation of heart rate. Moreover, men showed evidence of partial recovery of autonomic function, as seen by the improvement in high frequency power and the parasympathetic indicator, but not in the sympathetic indicator. There was no evidence of improved parasympathetic or sympathetic modulation in women from 6 to 12 weeks.

Chapter 7

Conclusions

The results of these studies suggest that men and women responded differently to CABG surgery and during the course of recovery. Preoperatively, there were no significant differences between men and women in supine heart rate variability measures; SBR sensitivity was lower in women. Compared with preoperative findings, autonomic modulation of heart rate was significantly lower in men 5 days postoperatively. During the 12 week course of recovery, men improved the indices of parasympathetic modulation of heart rate. Women showed no significant decline postoperatively, nor improvement throughout recovery. SBR sensitivity decreased during low intensity exercise in men and women, as expected.

The improvement in men during recovery suggests that the observed postoperative dysfunction of efferent cardiac autonomic nerves was reversible by 12 weeks following CABG surgery. The absence of significant decline postoperatively in women may account for the lack of significant improvement throughout recovery, in spite of increased coronary perfusion and postoperative healing. Smaller coronary arteries in women and the higher age of the women may have blunted any improvement in coronary perfusion autonomic function. The small sample of women and large variability in the results may have contributed to the lack of statistical significance.

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APPENDIX A
Letter of Information & Consent Form

Name:______________________________

QUEEN'S UNIVERSITY
SCHOOL of PHYSICAL & HEALTH EDUCATION
LETTER OF INFORMATION AND INFORMED CONSENT
RESEARCH STUDY

Title of Study: **Autonomic control of heart rate during early recovery following coronary artery bypass graft surgery: comparison of men and women.**

Researcher: **Ann Brown, Registered Nurse, MSc., & Doctoral student, Queen's University.**

Supervisors: **Dr. Larry Wolfe, Exercise Physiologist, and Dr. Glorianne Ropchan, Heart Surgeon.**

WOMEN & MEN HAVING BYPASS SURGERY
are needed for a research study on heart rate & blood pressure before & after surgery.

Men and women may respond differently to rest, standing, and mild physical activity during early recovery after coronary bypass surgery. You are invited to participate in a research study conducted by Mrs. Ann Brown, a nurse, about heart rate, blood pressure, & breathing responses in men & women after coronary bypass surgery. This study, therefore, has two main objectives: (1) To compare heart rate and blood pressure regulation ***before and after*** surgery, and (2) To compare heart rate and blood pressure regulation of ***men and women***. Your participation will help us to learn more about the course of recovery after bypass surgery, in particular, about heart rate & blood pressure responses to rest, standing, & mild physical activity, during early recovery.

The study involves 2 in-hospital sessions of approximately 30 minutes, and 2 post-discharge sessions of 45 minutes to one hour. The 2 in-hospital sessions include 1 before surgery and 1 after surgery; the post-discharge sessions will be 6 weeks after surgery, and 12 weeks after surgery.

1. **In-hospital testing: 2 testing sessions @ Kingston General Hospital**

    1) **Pre-operative testing** (before surgery) will be done on the day of admission to hospital, in a quiet private room on Kidd 3, and will take approximately 30 minutes. Your heart rate and blood pressure will be recorded during a resting period of 20 minutes. Then, you will be asked to take 6 deep-breaths while still resting. Following this, you will be asked to stand at the side of the bed for approximately 10 minutes. Your blood pressure will be monitored by a small cuff which fits on your middle finger; your heart rate and rhythm will be monitored by an heart monitor similar to an electrocardiogram. Neither device should cause you any discomfort.

    2) **Post-operative testing** (after surgery) will be done in exactly the same way in the same quiet private room on Kidd 3, on the day before your expected discharge from hospital, and will take approximately 30 minutes. Your level of discomfort from your surgery will be assessed prior to the testing.

2. **Post-discharge testing: 2 testing sessions @ Queen's University**
Testing will be done **6 weeks and 12 weeks** after surgery, in the exercise physiology laboratory in the Physical Education Centre at Queen's University, under medical supervision. At each of these times, testing will take approximately 45 minutes to one hour. The same test as described above will be repeated. Afterwards, you will perform a low intensity exercise test on an exercise bicycle. Prior to the test, a small tube may be placed in a vein in your arm, for the purpose of blood sampling before and after the exercise test. We will monitor your heart and blood pressure before, continuously throughout the testing session, and for a short period after the test, using the same methods used in the previous tests. We will also monitor your breathing during the test, by means of a mouthpiece.

3. **Potential Risks and Discomforts during Low Intensity Exercise**
Normally, pulse rate, blood pressure, and breathing rate increase during exercise. There exists the ***unlikely*** possibility of certain other changes occurring during the exercise or testing sessions. These include abnormal blood pressure changes, heart beat irregularities, fainting or dizziness, chest or leg discomfort, and, in very rare instances, a heart attack. These are ***unlikely*** to occur with the level of exercise you will be instructed to do. We will stop any test or exercise session ***at your request*** or if we observe any signs or symptoms of distress. In accordance with standard protocol, emergency equipment and trained personnel will be available during exercise testing sessions.

4. **Benefits to be Expected**
Participation in this study may not benefit you directly in any way. The information from the tests will provide us with information about normal responses during the early recovery period following heart surgery. This should enable us to provide more specific and helpful information to other people undergoing this type of surgery in the future. It may be helpful to you to know your responses, which we will share with you and your physician.

5. **Responsibility of the Participant**
To promote your safety, it is important for you to follow instructions carefully. This involves the following:
1) DO NOT withold any information about how you feel during exercise or testing sessons, or any symptoms you have been experiencing at home
2) DO follow your written instructions regarding eating, drinking stimulant or alcoholic beverages, or exercise before your 6 and 12 week tests.

6. **Confidentiality**
All information obtained during the course of this study is strictly confidential and your anonymity will be protected. Information from your hospital record concerning your heart surgery and postoperative recovery period is necessary to ensure your safety and monitor your responses. The information obtained during your participation in this study will be used only for the purposes of this study. It will not be released or revealed to anyone except your physician without your written consent. The information may be used for scientific purposes and be published in a scientific journal, with your right to privacy retained. Information which could

identify you will remain confidential. All records will be stored in a locked file at Queen's University. Only the researchers will have access to these files.

7. **Inquiries**
Any questions about the study, the testing, or the researchers are welcome. If you have questions or concerns about the study, please consult Ann Brown (545-2668 or 389-6795), Dr. L. Wolfe, Supervisor (545-2666), Dr. Glorianne Ropchan (549-6345), or Dr. G. Reid, Director of the School of Physical and Health Education (545-2666). You are encouraged to discuss the study with your doctor.

8. **FREEDOM OF CONSENT**
Your participation in this study is voluntary. You are free not to participate, or to withdraw consent at any time, without affecting your usual care.

VOLUNTARY PARTICIPATION

I acknowledge that I have read this form in its entirety or it has been read to me, and I understand that I will participate in a study to examine my heart rate, blood pressure, and breathing responses after heart surgery. I understand that I will have one testing session before surgery, and one after surgery in hospital before discharge, which involve monitoring my heart rate and blood pressure during a rest period, during six deep breaths and when I stand up. I understand that I will have two (2) testing sessions after discharge, one at 6 weeks, and one at 12 weeks. These sessions will include monitoring my heart rate, blood pressure, and breathing at rest, standing, and during a low intensity exercise on a stationary bicycle, and may involve blood sampling from a vein in my arm. I accept the potential risks and my obligations as described in this form. I voluntarily consent to participate in this study, and understand that I may withdraw at any time without affecting my care.

For your information, you may keep a copy of this **LETTER OF INFORMATION AND INFORMED CONSENT form.**

SIGNATURES

Participant:________________________ Signature:________________________________

Witness:___________________________ Signature:_______________________________

Physician:_________________________ Signature:_______________________________

DATE:_____

APPENDIX B
Emergency Management

QUEEN'S UNIVERSITY
SCHOOL OF PHYSICAL & HEALTH EDUCATION
EMERGENCY MANAGEMENT *

Research Study:	**Autonomic control of heart rate during early recovery following coronary artery bypass graft surgery: comparison of men and women.**
Researcher:	**Ann Brown, RN, MSc., Doctoral student, Queen's University.**
Supervisor:	**Larry A. Wolfe, PhD, School of Physical & Health Education, Queen's University.**

* **ACSM's Guidelines for Exercise and Prescription, 1995, pp 253-262.**

1. All personnel should be trained in basic cardiopulmonary resuscitation (CPR) and preferably Advanced Cardiac Life Support (ACLS).

2. Telephone numbers for emergency assistance should be clearly posted on all telephones. Emergency communication devices must be readily available and working properly.

3. Emergency plans should be established and posted. Regular rehearsal of emergency plans and scenarios should be conducted and documented.

4. Regular drills should be conducted at least quarterly for all personnel.

If a problem occurs during exercise testing, the nearest physician available should be summoned immediately. The physician should make the decision whether or not to call for evacuation to the nearest hospital. If a physician is not available and there is question as to the status of the patient, then emergency transportation to the closest hospital should be summoned immediately.

See also (Attached)

Table B-1	Emergency Equipment and Drugs
Table B-2	Plan for Nonemergency Situations
Table B-3	Plan for Potentially Life-threatening Situations
Table B-4	Plan for Life-threatening Situations

APPENDIX C
ANOVA TABLES
Chapter 3

Ch. 3. ANOVA Table for **Fractal Power** with 1-between (gender) and 1-within subjects factor (condition: supine [1] vs. standing [2]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
FPR1	FEMALE	379.2849	392.8826	12
	MALE	546.1374	434.9153	23
	Total	488.9308	422.8332	35
FPS1	FEMALE	246.1290	175.7285	12
	MALE	451.3492	404.7789	23
	Total	380.9880	354.6500	35

Tests of Within-Subjects Effects
Measure: MEASURE_1

Source	Type III SS	df	Mean Square	F	Sig.
COND	204864.949	1	204864.949	2.426	.129
COND * GENDER	5804.237	1	5804.237	.069	.795
Error(COND)	2786771.403	33	84447.618		

Tests of Within-Subjects Contrasts

Source	COND	Type III SS	df	Mean Square	F	Sig.
COND	2 vs. 1	409729.898	1	409729.898	2.426	.129
COND * GENDER	2 vs. 1	11608.474	1	11608.474	.069	.795
Error(COND)	2 vs. 1	5573542.807	33	168895.237		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	5192360.516	1	5192360.516	48.839	.000
GENDER	272920.838	1	272920.838	2.567	.119
Error	3508388.373	33	106314.799		

Ch. 3. ANOVA Table for **Fractal Power** with 1-within subjects factor (condition: supine [1] vs. standing [2]) in Men & Women Separately.

Tests of Within-Subjects Effects
Measure: MEASURE_1

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	COND	11223.527	1	11223.527	.202	.662
	Error(COND)	611671.235	11	55606.476		
male	COND	103325.083	1	103325.083	1.448	.242
	Error(COND)	1569772.128	22	71353.279		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

gender	Source	COND	Type III SS	df	Mean Square	F	Sig.
female	COND	2 vs. 1	22447.054	1	22447.054	.202	.662
	Error(COND)	2 vs. 1	1223342.471	11	111212.952		
male	COND	2 vs. 1	206650.166	1	206650.166	1.448	.242
	Error(COND)	2 vs. 1	3139544.257	22	142706.557		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	860306.138	1	860306.138	30.523	.000
	Error	310036.099	11	28185.100		
male	Intercept	5721132.363	1	5721132.363	40.627	.000
	Error	3098083.386	22	140821.972		

Ch. 3. ANOVA Table for **High Frequency Power** with 1-between (gender) and 1-within subjects factor (condition: supine [1] vs. standing [2]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
HFR1	FEMALE	45.716692	45.713040	12
	MALE	207.042776	412.513703	23
	Total	151.730976	341.790577	35
HFS1	FEMALE	8.491973	7.591483	12
	MALE	44.696964	56.848621	23
	Total	32.283824	49.130494	35

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
COND	157037.680	1	157037.680	3.152	.085
COND * GENDER	61726.564	1	61726.564	1.239	.274
Error(COND)	1644052.810	33	49819.782		

Tests of Within-Subjects Contrasts

Source	COND	Type III SS	df	Mean Square	F	Sig.
COND	2 vs. 1	157037.680	1	157037.680	3.152	.085
COND * GENDER	2 vs. 1	61726.564	1	61726.564	1.239	.274
Error(COND)	2 vs. 1	1644052.810	33	49819.782		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	369068.884	1	369068.884	5.550	.025
GENDER	153844.471	1	153844.471	2.314	.138
Error	2194352.686	33	66495.536		

Ch. 3. ANOVA Table for **High Frequency Power** with 1-within subjects factor (condition: supine [1] vs. standing [2]) in Men & Women Separately.

Tests of Within-Subjects Effects

Measure: MEASURE_1

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	COND	8314.078	1	8314.078	8.204	.015
	Error(COND)	11147.292	11	1013.390		
male	COND	303095.871	1	303095.871	4.084	.056
	Error(COND)	1632905.519	22	74222.978		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

gender	Source	COND	Type III SS	df	Mean Square	F	Sig.
female	COND	2 vs. 1	16628.157	1	16628.157	8.204	.015
	Error(COND)	2 vs. 1	22294.583	11	2026.780		
male	COND	2 vs. 1	606191.743	1	606191.743	4.084	.056
	Error(COND)	2 vs. 1	3265811.037	22	148445.956		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	8815.738	1	8815.738	15.549	.002
	Error	6236.574	11	566.961		
male	Intercept	364394.156	1	364394.156	7.348	.013
	Error	1090939.769	22	49588.171		

Ch. 3. ANOVA Table for **Low Frequency Power** with 1-between (gender) and 1-within subjects factor (condition: supine [1] vs. standing [2]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
LFR1	FEMALE	102.851182	74.671165	12
	MALE	132.347896	145.745017	23
	Total	122.234737	125.500181	35
LFS1	FEMALE	64.441829	50.576690	12
	MALE	249.641792	337.600477	23
	Total	186.144662	287.281382	35

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
COND	24535.498	1	24535.498	.471	.497
COND * GENDER	95588.664	1	95588.664	1.836	.185
Error(COND)	1718191.401	33	52066.406		

Tests of Within-Subjects Contrasts

Source	COND	Type III SS	df	Mean Square	F	Sig.
COND	2 vs. 1	24535.498	1	24535.498	.471	.497
COND * GENDER	2 vs. 1	95588.664	1	95588.664	1.836	.185
Error(COND)	2 vs. 1	1718191.401	33	52066.406		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	1189605.276	1	1189605.276	29.165	.000
GENDER	181744.672	1	181744.672	4.456	.042
Error	1346025.448	33	40788.650		

Ch. 3. ANOVA Table for **Low Frequency Power** with 1-within subjects factor (condition: supine [1] vs. standing [2]) in Men & Women Separately.

Tests of Within-Subjects Effects

Measure: MEASURE_1

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	COND	8851.670	1	8851.670	5.924	.033
	Error(COND)	16435.138	11	1494.103		
male	COND	158215.369	1	158215.369	2.045	.167
	Error(COND)	1701756.263	22	77352.557		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

gender	Source	COND	Type III SS	df	Mean Square	F	Sig.
female	COND	2 vs. 1	17703.340	1	17703.340	5.924	.033
	Error(COND)	2 vs. 1	32870.275	11	2988.207		
male	COND	2 vs. 1	316430.738	1	316430.738	2.045	.167
	Error(COND)	2 vs. 1	3403512.526	22	154705.115		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	83960.854	1	83960.854	25.291	.000
	Error	36518.246	11	3319.841		
male	Intercept	839017.699	1	839017.699	29.000	.000
	Error	636494.478	22	28931.567		

Ch. 3. ANOVA Table for **Parasympathetic (PNS) Indicator** with 1-between (gender) and 1-within subjects factor (condition: supine [1] vs. standing [2]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
PNSR1	FEMALE	.118287	9.71625E-02	12
	MALE	.192036	.199923	23
	Total	.166751	.173719	35
PNSS1	FEMALE	2.59292E-02	2.13639E-02	12
	MALE	5.92783E-02	6.20898E-02	23
	Total	4.78443E-02	5.38527E-02	35

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
COND	.200	1	.200	14.891	.001
COND * GENDER	6.435E-03	1	6.435E-03	.480	.493
Error(COND)	.443	33	1.342E-02		

Tests of Within-Subjects Contrasts

Source	COND	Type III SS	df	Mean Square	F	Sig.
COND	2 vs. 1	.200	1	.200	14.891	.001
COND * GENDER	2 vs. 1	6.435E-03	1	6.435E-03	.480	.493
Error(COND)	2 vs. 1	.443	33	1.342E-02		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	.617	1	.617	32.300	.000
GENDER	4.522E-02	1	4.522E-02	2.368	.133
Error	.630	33	1.910E-02		

Ch. 3. ANOVA Table for **Parasympathetic (PNS) Indicator** with 1-within subjects factor (condition: supine [1] vs. standing [2]) in Men & Women Separately.

Tests of Within-Subjects Effects
Measure: MEASURE_1

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	COND	5.118E-02	1	5.118E-02	11.915	.005
	Error(COND)	4.725E-02	11	4.295E-03		
male	COND	.203	1	.203	11.273	.003
	Error(COND)	.396	22	1.798E-02		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

gender	Source	COND	Type III SS	df	Mean Square	F	Sig.
female	COND	2 vs. 1	.102	1	.102	11.915	.005
	Error(COND)	2 vs. 1	9.450E-02	11	8.591E-03		
male	COND	2 vs. 1	.405	1	.405	11.273	.003
	Error(COND)	2 vs. 1	.791	22	3.596E-02		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	6.239E-02	1	6.239E-02	22.278	.001
	Error	3.081E-02	11	2.801E-03		
male	Intercept	.363	1	.363	28.103	.000
	Error	.284	22	1.292E-02		

Ch. 3. ANOVA Table for **SDNN** with 1-between (gender) and 1-within subjects factor (condition: supine [1] vs. standing [2]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
SDNNR1	FEMALE	28.9340	11.4964	12
	MALE	42.0679	17.4935	23
	Total	37.5648	16.7565	35
SDNNS1	FEMALE	27.7281	9.2385	12
	MALE	40.4693	16.9658	23
	Total	36.1009	15.8591	35

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
COND	31.010	1	31.010	.283	.598
COND * GENDER	.608	1	.608	.006	.941
Error(COND)	3613.712	33	109.506		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	76398.555	1	76398.555	212.866	.000
GENDER	2639.806	1	2639.806	7.355	.011
Error	11843.848	33	358.904		

Ch. 3. ANOVA Table for **SDNN** with 1-within subjects factor (condition: supine [1] vs. standing [2]) in Men & Women Separately.

Tests of Within-Subjects Effects

Measure: MEASURE_1

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	COND	884.256	1	884.256	5.222	.048
	Error(COND)	1523.926	9	169.325		
male	COND	4638.543	1	4638.543	9.458	.006
	Error(COND)	10299.187	21	490.437		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

gender	Source	COND	Type III SS	df	Mean Square	F	Sig.
female	COND	2 vs. 1	1768.511	1	1768.511	5.222	.048
	Error(COND)	2 vs. 1	3047.851	9	338.650		
male	COND	2 vs. 1	9277.086	1	9277.086	9.458	.006
	Error(COND)	2 vs. 1	20598.374	21	980.875		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	5543.083	1	5543.083	67.081	.000
	Error	743.694	9	82.633		
male	Intercept	21658.534	1	21658.534	47.166	.000
	Error	9643.173	21	459.199		

Ch. 3. ANOVA Table for **Sympathetic (SNS) Indicator** with 1-between (gender) and 1-within subjects factor (condition: supine [1] vs. standing [2]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
SNSR1	FEMALE	4.193444	3.383415	12
	MALE	6.606403	19.611310	23
	Total	5.779103	15.934713	35
SNSS1	FEMALE	16.429479	17.209467	12
	MALE	46.878527	136.330987	23
	Total	36.438854	111.072851	35

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
COND	10870.878	1	10870.878	2.332	.136
COND * GENDER	3099.174	1	3099.174	.665	.421
Error(COND)	153848.898	33	4662.088		

Tests of Within-Subjects Contrasts

Source	COND	Type III SS	df	Mean Square	F	Sig.
COND	2 vs. 1	10870.878	1	10870.878	2.332	.136
COND * GENDER	2 vs. 1	3099.174	1	3099.174	.665	.421
Error(COND)	2 vs. 1	153848.898	33	4662.088		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	21654.069	1	21654.069	2.677	.111
GENDER	4257.937	1	4257.937	.526	.473
Error	266891.163	33	8087.611		

Ch. 3. ANOVA Table for **Sympathetic (SNS) Indicator** with 1-within subjects factor (condition: supine [1] vs. standing [2]) in Men & Women Separately.

Tests of Within-Subjects Effects
Measure: MEASURE_1

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	COND	898.323	1	898.323	6.698	.025
	Error(COND)	1475.301	11	134.118		
male	COND	18651.205	1	18651.205	2.693	.115
	Error(COND)	152373.597	22	6926.073		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

gender	Source	COND	Type III SS	df	Mean Square	F	Sig.
female	COND	2 vs. 1	1796.647	1	1796.647	6.698	.025
	Error(COND)	2 vs. 1	2950.603	11	268.237		
male	COND	2 vs. 1	37302.411	1	37302.411	2.693	.115
	Error(COND)	2 vs. 1	304747.194	22	13852.145		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	1275.915	1	1275.915	14.708	.003
	Error	954.222	11	86.747		
male	Intercept	16448.667	1	16448.667	2.731	.113
	Error	132491.359	22	6022.335		

Ch. 3. ANOVA Table for **Total Harmonic Power** with 1-between (gender) and 1-within subjects factor (condition: supine [1] vs. standing [2]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
THPR1	FEMALE	149.3795	84.8888	12
	MALE	341.7805	436.6884	23
	Total	275.8144	366.4821	35
THPS1	FEMALE	73.2002	53.6581	12
	MALE	301.0647	364.6898	23
	Total	222.9397	314.6933	35

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
COND	53877.056	1	53877.056	.501	.484
COND * GENDER	4958.783	1	4958.783	.046	.831
Error(COND)	3547158.390	33	107489.648		

Tests of Within-Subjects Contrasts

Source	COND	Type III SS	df	Mean Square	F	Sig.
COND	2 vs. 1	53877.056	1	53877.056	.501	.484
COND * GENDER	2 vs. 1	4958.783	1	4958.783	.046	.831
Error(COND)	2 vs. 1	3547158.390	33	107489.648		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	2953043.575	1	2953043.575	26.445	.000
GENDER	696399.311	1	696399.311	6.236	.018
Error	3685078.314	33	111669.040		

Ch. 3. ANOVA Table for **Total Harmonic Power** with 1-within subjects factor (condition: supine [1] vs. standing [2]) in Men & Women Separately.

Tests of Within-Subjects Effects
Measure: MEASURE_1

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	COND	34819.743	1	34819.743	11.345	.006
	Error(COND)	33761.965	11	3069.270		
male	COND	19064.425	1	19064.425	.119	.733
	Error(COND)	3513396.426	22	159699.838		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

gender	Source	COND	Type III SS	df	Mean Square	F	Sig.
female	COND	2 vs. 1	69639.485	1	69639.485	11.345	.006
	Error(COND)	2 vs. 1	67523.930	11	6138.539		
male	COND	2 vs. 1	38128.849	1	38128.849	.119	.733
	Error(COND)	2 vs. 1	7026792.851	22	319399.675		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	148625.256	1	148625.256	42.367	.000
	Error	38588.176	11	3508.016		
male	Intercept	2376187.030	1	2376187.030	28.979	.000
	Error	1803950.981	22	81997.772		

Ch. 3. ANOVA Table for **Total Power** with 1-between (gender) and 1-within subjects factor (condition: supine [1] vs. standing [2]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
TPR1	FEMALE	438.7586	324.5990	12
	MALE	900.4464	748.2360	23
	Total	742.1534	667.6726	35
TPS1	FEMALE	319.3290	196.3797	12
	MALE	768.1568	625.2005	23
	Total	614.2730	558.6756	35

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
COND	249829.446	1	249829.446	1.056	.312
COND * GENDER	652.061	1	652.061	.003	.958
Error(COND)	7804596.545	33	236502.926		

Tests of Within-Subjects Contrasts

Source	COND	Type III SS	df	Mean Square	F	Sig.
COND	2 vs. 1	249829.446	1	249829.446	1.056	.312
COND * GENDER	2 vs. 1	652.061	1	652.061	.003	.958
Error(COND)	2 vs. 1	7804596.545	33	236502.926		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	23218809.026	1	23218809.026	52.142	.000
GENDER	3268780.204	1	3268780.204	7.341	.011
Error	14694748.230	33	445295.401		

Ch. 3. ANOVA Table for **Total Power** with 1-within subjects factor (condition: supine [1] vs. standing [2]) in Men & Women Separately.

Tests of Within-Subjects Effects

Measure: MEASURE_1

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	COND	85580.608	1	85580.608	1.449	.254
	Error(COND)	649493.890	11	59044.899		
male	COND	201256.031	1	201256.031	.619	.440
	Error(COND)	7155102.655	22	325231.939		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

gender	Source	COND	Type III SS	df	Mean Square	F	Sig.
female	COND	2 vs. 1	171161.217	1	171161.217	1.449	.254
	Error(COND)	2 vs. 1	1298987.780	11	118089.798		
male	COND	2 vs. 1	402512.063	1	402512.063	.619	.440
	Error(COND)	2 vs. 1	14310205.310	22	650463.878		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	1724090.742	1	1724090.742	40.622	.000
	Error	466865.342	11	42442.304		
male	Intercept	16009359.890	1	16009359.890	51.189	.000
	Error	6880508.773	22	312750.399		

Ch. 3. ANOVA Table for **SBR Slope** with 1-between (gender) and 1-within subjects factor (condition: supine [1] vs. standing [2]).

Descriptive Statistics

	GENDER	Mean	SD	N
SLR1	FEMALE	5.6120	2.7979	11
	MALE	10.1630	4.9985	23
	Total	8.6906	4.8681	34
SLS1	FEMALE	3.8948	2.0213	11
	MALE	5.6392	2.8308	23
	Total	5.0748	2.6956	34

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
COND	144.916	1	144.916	19.826	.000
COND*GENDER	29.307	1	29.307	4.009	.054
Error(COND)	233.906	32	7.310		

Tests of Within-Subjects Contrasts

Source	COND	Type III SS	df	Mean Square	F	Sig.
COND	2 vs. 1	144.916	1	144.916	19.826	.000
COND * GENDER	2 vs. 1	29.307	1	29.307	4.009	.054
Error(COND)	2 vs. 1	233.906	32	7.310		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	2383.195	1	2383.195	124.777	.000
GENDER	147.453	1	147.453	7.720	.009
Error	611.187	32	19.100		

Ch. 3. ANOVA Table for **SBR Slope** with 1-within subjects factor (condition: supine [1] vs. standing [2]) in Men & Women Separately.

Tests of Within-Subjects Effects

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	COND	16.218	1	16.218	2.541	.142
	Error(COND)	63.829	10	6.383		
male	COND	235.344	1	235.344	30.443	.000
	Error(COND)	170.077	22	7.731		

Tests of Within-Subjects Contrasts

gender	Source	COND	Type III SS	df	Mean Square	F	Sig.
female	COND	2 vs. 1	32.436	1	32.436	2.541	.142
	Error(COND)	2 vs. 1	127.658	10	12.766		
male	COND	2 vs. 1	470.689	1	470.689	30.443	.000
	Error(COND)	2 vs. 1	340.154	22	15.462		

Tests of Between-Subjects Effects

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	248.542	1	248.542	89.878	.000
	Error	27.653	10	2.765		
male	Intercept	1435.821	1	1435.821	113.651	.000
	Error	277.940	22	12.634		

Ch. 3. ANOVA Table for **R-R Interval** with 1-between (gender) and 1-within subjects factor (condition: supine [1] vs. standing [2]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
RRIR1	FEMALE	991.1488	152.1085	12
	MALE	1023.6183	136.2345	23
	Total	1012.4859	140.4967	35
RRIS1	FEMALE	833.9278	131.2859	12
	MALE	906.0079	164.6638	23
	Total	881.2947	155.9674	35

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
COND	297812.976	1	297812.976	45.666	.000
COND * GENDER	6186.331	1	6186.331	.949	.337
Error(COND)	215210.675	33	6521.536		

Tests of Within-Subjects Contrasts

Source	COND	Type III SS	df	Mean Square	F	Sig.
COND	2 vs. 1	297812.976	1	297812.976	45.666	.000
COND * GENDER	2 vs. 1	6186.331	1	6186.331	.949	.337
Error(COND)	2 vs. 1	215210.675	33	6521.536		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	55585583.880	1	55585583.880	1486.824	.000
GENDER	43097.945	1	43097.945	1.153	.291
Error	1233720.101	33	37385.458		

Ch. 3. ANOVA Table for **R-R Interval** with 1-within subjects factor (condition: supine [1] vs. standing [2]) in Men & Women Separately.

Tests of Within-Subjects Effects

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	COND	148310.588	1	148310.588	12.443	.005
	Error(COND)	131113.473	11	11919.407		
male	COND	159070.363	1	159070.363	41.613	.000
	Error(COND)	84097.202	22	3822.600		

Tests of Within-Subjects Contrasts

gender	Source	COND	Type III SS	df	Mean Square	F	Sig.
female	COND	2 vs. 1	296621.176	1	296621.176	12.443	.005
	Error(COND)	2 vs. 1	262226.947	11	23838.813		
male	COND	2 vs. 1	318140.726	1	318140.726	41.613	.000
	Error(COND)	2 vs. 1	168194.403	22	7645.200		

Tests of Between-Subjects Effects

Transformed Variable: Average

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	9992713.204	1	9992713.204	702.387	.000
	Error	156494.673	11	14226.788		
male	Intercept	21409880.190	1	21409880.190	1023.138	.000
	Error	460365.378	22	20925.699		

Ch. 3. ANOVA Table for **Systolic Blood Pressure** with 1-between (gender) and 1-within subjects factor (condition: supine [1] vs. standing [2]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
SBPR1	FEMALE	116.0063	20.4617	11
	MALE	120.3438	17.6795	23
	Total	118.9405	18.4253	34
SBPS1	FEMALE	143.4826	17.7541	11
	MALE	127.8147	18.9465	23
	Total	132.8838	19.7531	34

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
COND	4544.011	1	4544.011	24.820	.000
COND * GENDER	1489.040	1	1489.040	8.133	.008
Error(COND)	5858.618	32	183.082		

Tests of Within-Subjects Contrasts

Source	COND	Type III SS	df	Mean Square	F	Sig.
COND	2 vs. 1	4544.011	1	4544.011	24.820	.000
COND * GENDER	2 vs. 1	1489.040	1	1489.040	8.133	.008
Error(COND)	2 vs. 1	5858.618	32	183.082		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	958817.592	1	958817.592	1887.664	.000
GENDER	477.640	1	477.640	.940	.339
Error	16254.039	32	507.939		

Ch. 3. ANOVA Table for **Systolic Blood Pressure** with 1-within subjects factor (condition: supine [1] vs. standing [2]) in Men & Women Separately.

Tests of Within-Subjects Effects

Measure: MEASURE_1

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	COND	4152.228	1	4152.228	19.520	.001
	Error(COND)	2127.168	10	212.717		
male	COND	641.875	1	641.875	3.784	.065
	Error(COND)	3731.450	22	169.611		

Within-Subjects Contrasts

Measure: MEASURE_1

gender	Source	COND	Type III SS	df	Mean Square	F	Sig.
female	COND	2 vs. 1	8304.456	1	8304.456	19.520	.001
	Error(COND)	2 vs. 1	4254.336	10	425.434		
male	COND	2 vs. 1	1283.749	1	1283.749	3.784	.065
	Error(COND)	2 vs. 1	7462.901	22	339.223		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	185169.858	1	185169.858	710.591	.000
	Error	2605.857	10	260.586		
male	Intercept	354100.248	1	354100.248	1410.972	.000
	Error	5521.162	22	250.962		

APPENDIX D
ANOVA TABLES
Chapter 4

Ch. 4. ANOVA Table: Fractal Power with 1- between (gender) and 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
FPR1	FEMALE	361.3408	414.8928	10
	MALE	571.0912	447.1209	21
	Total	503.4298	441.4219	31
FPS1	FEMALE	265.4504	186.2469	10
	MALE	480.9289	411.8953	21
	Total	411.4197	366.0546	31
FPR2	FEMALE	36.8727	35.3440	10
	MALE	65.1471	68.3494	21
	Total	56.0263	60.5781	31
FPS2	FEMALE	69.7468	98.6065	10
	MALE	77.7735	155.9525	21
	Total	75.1842	138.3678	31

Tests of Within-Subjects Effects
Measure: MEASURE_1

Source	SS	df	Mean Square	F	Sig.
TIME	3459608.426	1	3459608.426	33.653	.000
TIME * GENDER	256174.294	1	256174.294	2.492	.125
Error(TIME)	2981258.867	29	102802.030		
POSTURE	33455.960	1	33455.960	.715	.405
POSTURE * GENDER	357.027	1	357.027	.008	.931
Error(POSTURE)	1356225.029	29	46766.380		
TIME * POSTURE	90802.801	1	90802.801	1.765	.194
TIME * POSTURE * GENDER	1142.705	1	1142.705	.022	.883
Error(TIME*POSTURE)	1492007.319	29	51448.528		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

Source	TIME	POSTURE	SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		3459608.426	1	3459608.426	33.653	.000
TIME * GENDER	2 vs. 1		256174.294	1	256174.294	2.492	.125
Error(TIME)	2 vs. 1		2981258.867	29	102802.030		
POSTURE		2 vs. 1	33455.960	1	33455.960	.715	.405
POSTURE * GENDER		2 vs. 1	357.027	1	357.027	.008	.931
Error(POSTURE)		2 vs. 1	1356225.029	29	46766.380		
TIME*POSTURE	2 vs. 1	2 vs. 1	90802.801	1	90802.801	1.765	.194
T*P G	2 vs. 1	2 vs. 1	1142.705	1	1142.705	.022	.883
Error(T*P)	2 vs. 1	2 vs. 1	1492007.319	29	51448.528		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	6297525.928	1	6297525.928	44.521	.000
GENDER	360742.622	1	360742.622	2.550	.121
Error	4102029.585	29	141449.296		

ANOVA Table: Ch. 4. ANOVA Table: Fractal Power with 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	SS	df	Mean Square	F	Sig.
FEMALE	TIME	676446.624	1	676446.624	15.595	.003
	Error(TIME)	390387.295	9	43376.366		
	POSTURE	9927.664	1	9927.664	.149	.709
	Error(POSTURE)	600398.289	9	66710.921		
	TIME*POSTURE	41450.733	1	41450.733	.704	.423
	Error(T*P)	530059.826	9	58895.536		
MALE	TIME	4338925.307	1	4338925.307	33.494	.000
	Error(TIME)	2590871.572	20	129543.579		
	POSTURE	31562.035	1	31562.035	.835	.372
	Error(POSTURE)	755826.741	20	37791.337		
	TIME * POSTURE	55468.994	1	55468.994	1.153	.296
	Error(T*P)	961947.493	20	48097.375		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	TIME	POSTURE	SS	df	Mean Square	F	Sig.
FEMALE	TIME	2 vs. 1		676446.624	1	676446.624	15.595	.003
	Error(TIME)	2 vs. 1		390387.295	9	43376.366		
	POSTURE		2 vs. 1	9927.664	1	9927.664	.149	.709
	Error(POSTURE)		2 vs. 1	600398.289	9	66710.921		
	TIME*POSTURE	2 vs. 1	2 vs. 1	41450.733	1	41450.733	.704	.423
	Error(T*P)	2 vs. 1	2 vs. 1	530059.826	9	58895.536		
MALE	TIME	2 vs. 1		4338925.307	1	4338925.307	33.494	.000
	Error(TIME)	2 vs. 1		2590871.572	20	129543.579		
	POSTURE		2 vs. 1	31562.035	1	31562.035	.835	.372
	Error(POSTURE)		2 vs. 1	755826.741	20	37791.337		
	TIME*POSTURE	2 vs. 1	2 vs. 1	55468.994	1	55468.994	1.153	.296
	Error(T*P)	2 vs. 1	2 vs. 1	961947.493	20	48097.375		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	SS	df	Mean Square	F	Sig.
FEMALE	Intercept	1344728.159	1	1344728.159	27.548	.001
	Error	439321.833	9	48813.537		
MALE	Intercept	7496387.118	1	7496387.118	40.934	.000
	Error	3662707.752	20	183135.388		

Ch. 4. ANOVA Table: High Frequency Power with 1- between (gender) and 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
HFR1	FEMALE	35.637044	35.027276	10
	MALE	220.342099	429.816520	21
	Total	160.759823	362.261190	31
HFS1	FEMALE	9.136959	8.208135	10
	MALE	47.745859	58.669235	21
	Total	35.291375	51.493001	31
HFR2	FEMALE	16.292345	44.495514	10
	MALE	3.485907	4.774502	21
	Total	7.617016	25.420186	31
HFS2	FEMALE	11.450287	30.523913	10
	MALE	11.755070	49.797473	21
	Total	11.656753	43.962779	31

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	SS	df	Mean Square	F	Sig.
TIME	123348.454	1	123348.454	3.343	.078
TIME * GENDER	94176.536	1	94176.536	2.553	.121
Error(TIME)	1069893.685	29	36892.886		
POSTURE * GENDER	29950.391	1	29950.391	1.021	.321
Error(POSTURE)	850311.507	29	29321.086		
TIME * POSTURE	69462.140	1	69462.140	2.487	.126
TIME * POSTURE * GENDER	42926.352	1	42926.352	1.537	.225
Error(TIME*POSTURE)	810013.673	29	27931.506		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME	POSTURE	SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		123348.454	1	123348.454	3.343	.078
TIME * GENDER	2 vs. 1		94176.536	1	94176.536	2.553	.121
Error(TIME)	2 vs. 1		1069893.685	29	36892.886		
POSTURE		2 vs. 1	64839.945	1	64839.945	2.211	.148
POSTURE * GENDER		2 vs. 1	29950.391	1	29950.391	1.021	.321
Error(POSTURE)		2 vs. 1	850311.507	29	29321.086		
TIME*POSTURE	2 vs. 1	2 vs. 1	69462.140	1	69462.140	2.487	.126
T*P*G	2 vs. 1	2 vs. 1	42926.352	1	42926.352	1.537	.225
Error(TIME*POSTURE)	2 vs. 1	2 vs. 1	810013.673	29	27931.506		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	214447.376	1	214447.376	5.546	.026
GENDER	75264.382	1	75264.382	1.946	.174
Error	1121371.805	29	38667.993		

Ch. 4. ANOVA Table: High Frequency Power Power with 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	SS	df	Mean Square	F	Sig.
FEMALE	TIME	725.169	1	725.169	.803	.393
	Error(TIME)	8123.907	9	902.656		
	POSTURE	2455.825	1	2455.825	2.173	.175
	Error(POSTURE)	10171.358	9	1130.151		
	TIME * POSTURE	1172.675	1	1172.675	1.335	.278
	Error(TIME*POSTURE)	7907.116	9	878.568		
MALE	TIME	335640.879	1	335640.879	6.322	.021
	Error(TIME)	1061769.778	20	53088.489		
	POSTURE	141767.788	1	141767.788	3.375	.081
	Error(POSTURE)	840140.149	20	42007.007		
	TIME * POSTURE	171739.544	1	171739.544	4.282	.052
	Error(TIME*POSTURE)	802106.557	20	40105.328		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	TIME	POSTURE	SS	df	Mean Square	F	Sig.
FEMALE	TIME	2 vs. 1		725.169	1	725.169	.803	.393
	Error(TIME)	2 vs. 1		8123.907	9	902.656		
	POSTURE		2 vs. 1	2455.825	1	2455.825	2.173	.175
	Error(POSTURE)		2 vs. 1	10171.358	9	1130.151		
	TIME*POSTURE	2 vs. 1	2 vs. 1	1172.675	1	1172.675	1.335	.278
	Error(T*P)	2 vs. 1	2 vs. 1	7907.116	9	878.568		
MALE	TIME	2 vs. 1		335640.879	1	335640.879	6.322	.021
	Error(TIME)	2 vs. 1		1061769.778	20	53088.489		
	POSTURE		2 vs. 1	141767.788	1	141767.788	3.375	.081
	Error(POSTURE)		2 vs. 1	840140.149	20	42007.007		
	TIME*POSTURE	2 vs. 1	2 vs. 1	171739.544	1	171739.544	4.282	.052
	Error(T*P)	2 vs. 1	2 vs. 1	802106.557	20	40105.328		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Type III Sum of Squares	df	Mean Square	F	Sig.
FEMALE	Intercept	13146.656	1	13146.656	10.156	.011
	Error	11650.212	9	1294.468		
MALE	Intercept	421445.248	1	421445.248	7.596	.012
	Error	1109721.593	20	55486.080		

Ch. 4. ANOVA Table: **Low Frequency Power** with 1- between (gender) and 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
LFR1	FEMALE	97.565275	77.023338	10
	MALE	135.635818	151.660314	21
	Total	123.354997	132.064208	31
LFS1	FEMALE	69.341127	52.310084	10
	MALE	268.754504	347.785574	21
	Total	204.427608	300.727104	31
LFR2	FEMALE	10.596054	13.484098	10
	MALE	15.778451	17.312803	21
	Total	14.106710	16.137934	31
LFS2	FEMALE	17.469479	18.423069	10
	MALE	18.025850	33.497589	21
	Total	17.846375	29.153932	31

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	SS	df	Mean Square	F	Sig.
TIME	439502.491	1	439502.491	20.158	.000
TIME * GENDER	90953.398	1	90953.398	4.172	.050
Error(TIME)	632283.055	29	21802.864		
POSTURE	22015.287	1	22015.287	.751	.393
POSTURE * GENDER	41593.816	1	41593.816	1.420	.243
Error(POSTURE)	849559.336	29	29295.150		
TIME * POSTURE	15534.250	1	15534.250	.533	.471
TIME * POSTURE * GENDER	46649.913	1	46649.913	1.601	.216
Error(TIME*POSTURE)	844973.120	29	29137.004		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME	POSTURE	SS	df	Mean Square	F	Sig.
	TIME	2 vs. 1	439502.491	1	439502.491	20.158	.000
TIME * GENDER	2 vs. 1		90953.398	1	90953.398	4.172	.050
Error(TIME)	2 vs. 1		632283.055	29	21802.864		
POSTURE		2 vs. 1	22015.287	1	22015.287	.751	.393
POSTURE * GENDER		2 vs. 1	41593.816	1	41593.816	1.420	.243
Error(POSTURE)		2 vs. 1	849559.336	29	29295.150		
TIME*POSTURE	2 vs. 1	2 vs. 1	15534.250	1	15534.250	.533	.471
T*P*G	2 vs. 1	2 vs. 1	46649.913	1	46649.913	1.601	.216
Error(T*P)	2 vs. 1	2 vs. 1	844973.120	29	29137.004		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	678943.361	1	678943.361	29.677	.000
GENDER	100185.709	1	100185.709	4.379	.045
Error	663445.584	29	22877.434		

Ch. 4. ANOVA Table: Low Frequency Power with 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	SS	df	Mean Square	F	Sig.
FEMALE	TIME	48191.967	1	48191.967	11.627	.008
	Error(TIME)	37305.087	9	4145.010		
	POSTURE	1139.633	1	1139.633	1.636	.233
	Error(POSTURE)	6268.292	9	696.477		
	TIME*POSTURE	3079.599	1	3079.599	2.958	.120
	Error(T*P)	9368.828	9	1040.981		
MALE	TIME	721003.496	1	721003.496	24.236	.000
	Error(TIME)	594977.967	20	29748.898		
	POSTURE	96200.879	1	96200.879	2.282	.147
	Error(POSTURE)	843291.044	20	42164.552		
	TIME*POSTURE	89918.294	1	89918.294	2.152	.158
	Error(T*P)	835604.292	20	41780.215		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	TIME	POSTURE	SS	df	MS	F	Sig.
FEMALE	TIME	2 vs. 1		48191.967	1	48191.967	11.627	.008
	Error(TIME)	2 vs. 1		37305.087	9	4145.010		
	POSTURE		2 vs. 1	1139.633	1	1139.633	1.636	.233
	Error(POSTURE)		2 vs. 1	6268.292	9	696.477		
	TIME*POSTURE	2 vs. 1	2 vs. 1	3079.599	1	3079.599	2.958	.120
	Error(T*P)	2 vs. 1	2 vs. 1	9368.828	9	1040.981		
MALE	TIME	2 vs. 1		721003.496	1	721003.496	24.236	.000
	Error(TIME)	2 vs. 1		594977.967	20	29748.898		
	POSTURE		2 vs. 1	96200.879	1	96200.879	2.282	.147
	Error(POSTURE)		2 vs. 1	843291.044	20	42164.552		
	TIME*POSTURE	2 vs. 1	2 vs. 1	89918.294	1	89918.294	2.152	.158
	Error(T*P)	2 vs. 1	2 vs. 1	835604.292	20	41780.215		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	SS	df	Mean Square	F	Sig.
FEMALE	Intercept	95035.139	1	95035.139	28.731	.000
	Error	29769.322	9	3307.702		
MALE	Intercept	1008076.267	1	1008076.267	31.817	.000
	Error	633676.261	20	31683.813		

Ch. 4: ANOVA Table: **Parasympathetic Indicator** with 1- between (gender) and 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
PNSR1	FEMALE	.107760	.109905	10
	MALE	.196633	.205863	21
	Total	.167964	.183467	31
PNSS1	FEMALE	2.50990E-02	2.32848E-02	10
	MALE	5.88652E-02	6.48863E-02	21
	Total	4.79729E-02	5.68061E-02	31
PNSR2	FEMALE	.155298	.168844	10
	MALE	4.09248E-02	4.45619E-02	21
	Total	7.78194E-02	.113270	31
PNSS2	FEMALE	4.39750E-02	5.22883E-02	10
	MALE	2.09252E-02	3.20895E-02	21
	Total	2.83606E-02	4.03321E-02	31

Tests of Within-Subjects Effects
Measure: MEASURE_1

Source	SS	df	Mean Square	F	Sig.
TIME	2.742E-02	1	2.742E-02	1.799	.190
TIME * GENDER	.115	1	.115	7.518	.010
Error(TIME)	.442	29	1.524E-02		
POSTURE	.210	1	.210	20.331	.000
POSTURE * GENDER	2.221E-03	1	2.221E-03	.216	.646
Error(POSTURE)	.299	29	1.031E-02		
TIME * POSTURE	1.345E-02	1	1.345E-02	1.400	.246
TIME * POSTURE * GENDER	3.631E-02	1	3.631E-02	3.782	.062
Error(TIME*POSTURE)	.278	29	9.603E-03		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

Source	TIME	POSTURE	SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		2.742E-02	1	2.742E-02	1.799	.190
TIME * GENDER	2 vs. 1		.115	1	.115	7.518	.010
Error(TIME)	2 vs. 1		.442	29	1.524E-02		
POSTURE		2 vs. 1	.210	1	.210	20.331	.000
POSTURE * GENDER		2 vs. 1	2.221E-03	1	2.221E-03	.216	.646
Error(POSTURE)		2 vs. 1	.299	29	1.031E-02		
TIME*POSTURE	2 vs. 1	2 vs. 1	1.345E-02	1	1.345E-02	1.400	.246
T*P*G	2 vs. 1	2 vs. 1	3.631E-02	1	3.631E-02	3.782	.062
Error(T*P)	2 vs. 1	2 vs. 1	.278	29	9.603E-03		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	.714	1	.714	56.347	.000
GENDER	3.701E-04	1	3.701E-04	.029	.866
Error	.368	29	1.268E-02		

Ch. 4. ANOVA Table: Parsympathetic Indicator with 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	SS	df	Mean Square	F	Sig.
FEMALE	TIME	1.103E-02	1	1.103E-02	.805	.393
	Error(TIME)	.123	9	1.370E-02		
	POSTURE	9.407E-02	1	9.407E-02	9.458	.013
	Error(POSTURE)	8.952E-02	9	9.946E-03		
	TIME * POSTURE	2.054E-03	1	2.054E-03	.224	.647
	Error(TIME*POSTURE)	8.255E-02	9	9.172E-03		
MALE	TIME	.197	1	.197	12.360	.002
	Error(TIME)	.319	20	1.593E-02		
	POSTURE	.131	1	.131	12.483	.002
	Error(POSTURE)	.209	20	1.047E-02		
	TIME * POSTURE	7.281E-02	1	7.281E-02	7.433	.013
	Error(TIME*POSTURE)	.196	20	9.797E-03		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	TIME	POSTURE	SS	df	Mean Square	F	Sig.
FEMALE	TIME	2 vs. 1		1.103E-02	1	1.103E-02	.805	.393
	Error(TIME)	2 vs. 1		.123	9	1.370E-02		
	POSTURE		2 vs. 1	9.407E-02	1	9.407E-02	9.458	.013
	Error(POSTURE)		2 vs. 1	8.952E-02	9	9.946E-03		
	TIME*POSTURE	2 vs. 1	2 vs. 1	2.054E-03	1	2.054E-03	.224	.647
	Error(T*P)	2 vs. 1	2 vs. 1	8.255E-02	9	9.172E-03		
MALE	TIME	2 vs. 1		.197	1	.197	12.360	.002
	Error(TIME)	2 vs. 1		.319	20	1.593E-02		
	POSTURE		2 vs. 1	.131	1	.131	12.483	.002
	Error(POSTURE)		2 vs. 1	.209	20	1.047E-02		
	TIME*POSTURE	2 vs. 1	2 vs. 1	7.281E-02	1	7.281E-02	7.433	.013
	Error(T*P)	2 vs. 1	2 vs. 1	.196	20	9.797E-03		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Type III Sum of Squares	df	MS	F	Sig.
FEMALE	Intercept	.276	1	.276	24.961	.001
	Error	9.944E-02	9	1.105E-02		
MALE	Intercept	.529	1	.529	39.423	.000
	Error	.268	20	1.341E-02		

Ch. 4. ANOVA Table: SDNN with 1- between (gender) and 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
RRISDR1	FEMALE	30.1930	14.2704	10
	MALE	42.2439	18.2595	21
	Total	38.3565	17.7809	31
RRISDS1	FEMALE	28.3743	9.1877	10
	MALE	41.6583	17.1705	21
	Total	37.3731	16.1778	31
RRISDR2	FEMALE	15.8505	12.2454	10
	MALE	15.2920	7.0493	21
	Total	15.4722	8.8422	31
RRISDS2	FEMALE	16.8945	11.4432	10
	MALE	21.5789	33.6518	21
	Total	20.0678	28.2702	31

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	SS	df	Mean Square	F	Sig.
TIME	8988.742	1	8988.742	36.812	.000
TIME * GENDER	761.792	1	761.792	3.120	.088
Error(TIME)	7081.252	29	244.181		
POSTURE	41.104	1	41.104	.138	.713
POSTURE * GENDER	71.027	1	71.027	.239	.629
Error(POSTURE)	8629.795	29	297.579		
TIME * POSTURE	160.506	1	160.506	.746	.395
TIME * POSTURE * GENDER	27.229	1	27.229	.126	.725
Error(TIME*POSTURE)	6242.595	29	215.262		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME	POSTURE	SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		8988.742	1	8988.742	36.812	.000
TIME * GENDER	2 vs. 1		761.792	1	761.792	3.120	.088
Error(TIME)	2 vs. 1		7081.252	29	244.181		
POSTURE		2 vs. 1	41.104	1	41.104	.138	.713
POSTURE * GENDER		2 vs. 1	71.027	1	71.027	.239	.629
Error(POSTURE)		2 vs. 1	8629.795	29	297.579		
TIME*POSTURE	2 vs. 1	2 vs. 1	160.506	1	160.506	.746	.395
T*P*G	2 vs. 1	2 vs. 1	27.229	1	27.229	.126	.725
Error(T*P)	2 vs. 1	2 vs. 1	6242.595	29	215.262		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	76176.219	1	76176.219	114.022	.000
GENDER	1469.908	1	1469.908	2.200	.149
Error	19374.460	29	668.085		

Ch. 4. ANOVA Table: High Frequency Power with 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	SS	df	Mean Square	F	Sig.
FEMALE	TIME	1666.977	1	1666.977	20.243	.001
	Error(TIME)	741.131	9	82.348		
	POSTURE	1.501	1	1.501	.008	.930
	Error(POSTURE)	1674.759	9	186.084		
	TIME * POSTURE	20.488	1	20.488	.182	.680
	Error(TIME*POSTURE)	1012.716	9	112.524		
MALE	TIME	11612.675	1	11612.675	36.632	.000
	Error(TIME)	6340.121	20	317.006		
	POSTURE	170.651	1	170.651	.491	.492
	Error(POSTURE)	6955.036	20	347.752		
	TIME * POSTURE	247.965	1	247.965	.948	.342
	Error(TIME*POSTURE)	5229.879	20	261.494		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	TIME	POSTURE	SS	df	Mean Square	F	Sig.
FEMALE	TIME	2 vs. 1		1666.977	1	1666.977	20.243	.001
	Error(TIME)	2 vs. 1		741.131	9	82.348		
	POSTURE		2 vs. 1	1.501	1	1.501	.008	.930
	Error(POSTURE)		2 vs. 1	1674.759	9	186.084		
	TIME*POSTURE	2 vs. 1	2 vs. 1	20.488	1	20.488	.182	.680
	Error(T*P)	2 vs. 1	2 vs. 1	1012.716	9	112.524		
MALE	TIME	2 vs. 1		11612.675	1	11612.675	36.632	.000
	Error(TIME)	2 vs. 1		6340.121	20	317.006		
	POSTURE		2 vs. 1	170.651	1	170.651	.491	.492
	Error(POSTURE)		2 vs. 1	6955.036	20	347.752		
	TIME*POSTURE	2 vs. 1	2 vs. 1	247.965	1	247.965	.948	.342
	Error(T*P)	2 vs. 1	2 vs. 1	5229.879	20	261.494		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Type III Sum of Squares	df	Mean Square	F	Sig.
FEMALE	Intercept	20844.828	1	20844.828	110.878	.000
	Error	1691.976	9	187.997		
MALE	Intercept	76577.357	1	76577.357	86.614	.000
	Error	17682.484	20	884.124		

Ch. 4. ANOVA Table: Sympathetic (SNS) Indicator with 1- between (gender) and 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
SNSR1	FEMALE	4.478490	3.472930	10
	MALE	7.091305	21.048582	20
	Total	6.220367	17.192496	30
SNSS1	FEMALE	18.401919	18.198052	10
	MALE	53.306933	145.557837	20
	Total	41.671928	119.432208	30
SNSR2	FEMALE	15.012658	25.899087	10
	MALE	8.157498	9.208743	20
	Total	10.442551	16.568947	30
SNSS2	FEMALE	15.019655	17.292657	10
	MALE	31.667783	43.757904	20
	Total	26.118407	37.563458	30

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	SS	df	Mean Square	F	Sig.
TIME	300.208	1	300.208	.060	.809
TIME * GENDER	1281.113	1	1281.113	.254	.618
Error(TIME)	141008.917	28	5036.033		
POSTURE	11663.972	1	11663.972	4.350	.046
POSTURE * GENDER	5188.560	1	5188.560	1.935	.175
Error(POSTURE)	75073.196	28	2681.186		
TIME * POSTURE	2235.257	1	2235.257	.620	.438
TIME * POSTURE * GENDER	128.742	1	128.742	.036	.851
Error(TIME*POSTURE)	100882.409	28	3602.943		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME	POSTURE	SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		300.208	1	300.208	.060	.809
TIME * GENDER	2 vs. 1		1281.113	1	1281.113	.254	.618
Error(TIME)	2 vs. 1		141008.917	28	5036.033		
POSTURE		2 vs. 1	11663.972	1	11663.972	4.350	.046
POSTURE * GENDER		2 vs. 1	5188.560	1	5188.560	1.935	.175
Error(POSTURE)		2 vs. 1	75073.196	28	2681.186		
TIME*POSTURE	2 vs. 1	2 vs. 1	2235.257	1	2235.257	.620	.438
T*P*G	2 vs. 1	2 vs. 1	128.742	1	128.742	.036	.851
Error(T*P)	2 vs. 1	2 vs. 1	100882.409	28	3602.943		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	39084.514	1	39084.514	7.609	.010
GENDER	3730.519	1	3730.519	.726	.401
Error	143816.695	28	5136.311		

Ch. 4. ANOVA Table: Sympathetic (SNS) Indicator with 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	SS	df	Mean Square	F	Sig.
FEMALE	TIME	127.874	1	127.874	.316	.588
	Error(TIME)	3639.041	9	404.338		
	POSTURE	485.142	1	485.142	1.722	.222
	Error(POSTURE)	2534.933	9	281.659		
	TIME*POSTURE	484.168	1	484.168	1.288	.286
	Error(T*P)	3384.152	9	376.017		
MALE	TIME	2116.233	1	2116.233	.293	.595
	Error(TIME)	137369.876	19	7229.993		
	POSTURE	24308.514	1	24308.514	6.367	.021
	Error(POSTURE)	72538.263	19	3817.803		
	TIME * POSTURE	2577.663	1	2577.663	.502	.487
	Error(TIME*POSTURE)	97498.257	19	5131.487		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	TIME	POSTURE	SS	df	Mean Square	F	Sig.
FEMALE	TIME	2 vs. 1		127.874	1	127.874	.316	.588
	Error(TIME)	2 vs. 1		3639.041	9	404.338		
	POSTURE		2 vs. 1	485.142	1	485.142	1.722	.222
	Error(POSTURE)		2 vs. 1	2534.933	9	281.659		
	TIME*POSTURE	2 vs. 1	2 vs. 1	484.168	1	484.168	1.288	.286
	Error(T*P)	2 vs. 1	2 vs. 1	3384.152	9	376.017		
MALE	TIME	2 vs. 1		2116.233	1	2116.233	.293	.595
	Error(TIME)	2 vs. 1		137369.876	19	7229.993		
	POSTURE		2 vs. 1	24308.514	1	24308.514	6.367	.021
	Error(POSTURE)		2 vs. 1	72538.263	19	3817.803		
	TIME*POSTURE	2 vs. 1	2 vs. 1	2577.663	1	2577.663	.502	.487
	Error(T*P)	2 vs. 1	2 vs. 1	97498.257	19	5131.487		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Type III Sum of Squares	df	Mean Square	F	Sig.
FEMALE	Intercept	6999.390	1	6999.390	27.884	.001
	Error	2259.135	9	251.015		
MALE	Intercept	50223.769	1	50223.769	6.741	.018
	Error	141557.560	19	7450.398		

Ch. 4. ANOVA Table: Total Harmonic Power with 1- between (gender) and 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture (supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
THPR1	FEMALE	133.7468	87.5667	10
	MALE	358.6166	453.0607	21
	Total	286.0780	388.0222	31
THPS1	FEMALE	78.8212	55.3641	10
	MALE	323.7803	374.2514	21
	Total	244.7612	328.3979	31
THPR2	FEMALE	28.6251	48.4396	10
	MALE	25.3578	25.0117	21
	Total	26.4118	33.5170	31
THPS2	FEMALE	37.4928	60.6057	10
	MALE	100.7475	402.4073	21
	Total	80.3428	331.6019	31

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	SS	df	Mean Square	F	Sig.
TIME	836351.790	1	836351.790	11.342	.002
TIME * GENDER	284465.569	1	284465.569	3.858	.059
Error(TIME)	2138432.212	29	73739.042		
POSTURE	51.314	1	51.314	.000	.982
POSTURE * GENDER	12704.190	1	12704.190	.124	.728
Error(POSTURE)	2976726.595	29	102645.745		
TIME * POSTURE	51285.285	1	51285.285	.682	.416
T*P*G	3651.275	1	3651.275	.049	.827
Error(TIME*POSTURE)	2181456.510	29	75222.638		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME	POSTURE	SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		836351.790	1	836351.790	11.342	.002
TIME*GENDER	2 vs. 1		284465.569	1	284465.569	3.858	.059
Error(TIME)	2 vs. 1		2138432.212	29	73739.042		
POSTURE		2 vs. 1	51.314	1	51.314 .000	.982	
POSTURE*GENDER		2 vs. 1	12704.190	1	12704.190	.124	.728
Error(POSTURE)		2 vs. 1	2976726.595	29	102645.745		
TIME*POSTURE	2 vs. 1	2 vs. 1	51285.285	1	51285.285	.682	.416
T*P*G	2 vs. 1	2 vs. 1	3651.275	1	3651.275	.049	.827
Error(T*P)	2 vs. 1	2 vs. 1	2181456.510	29	75222.638		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	2001737.376	1	2001737.376	19.274	.000
GENDER	475388.153	1	475388.153	4.577	.041
Error	3011864.670	29	103857.402		

Ch. 4. ANOVA Table: Total Harmonic Power with 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	SS	df	Mean Square	F	Sig.
FEMALE	TIME	53619.019	1	53619.019	11.107	.009
	Error(TIME)	43446.082	9	4827.342		
	POSTURE	5303.331	1	5303.331	2.962	.119
	Error(POSTURE)	16112.314	9	1790.257		
	TIME * POSTURE	10173.982	1	10173.982	2.756	.131
	Error(TIME*POSTURE)	33228.697	9	3692.077		
MALE	TIME	1624666.969	1	1624666.969	15.510	.001
	Error(TIME)	2094986.131	20	104749.307		
	POSTURE	8634.037	1	8634.037	.058	.812
	Error(POSTURE)	2960614.282	20	148030.714		
	TIME * POSTURE	63786.306	1	63786.306	.594	.450
	Error(TIME*POSTURE)	2148227.813	20	107411.391		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	TIME	POSTURE	SS	df	Mean Square	F	Sig.
FEMALE	TIME	2 vs. 1		53619.019	1	53619.019	11.107	.009
	Error(TIME)	2 vs. 1		43446.082	9	4827.342		
	POSTURE		2 vs. 1	5303.331	1	5303.331	2.962	.119
	Error(POSTURE)		2 vs. 1	16112.314	9	1790.257		
	TIME*POSTURE	2 vs. 1	2 vs. 1	10173.982	1	10173.982	2.756	.131
	Error(T*P)	2 vs. 1	2 vs. 1	33228.697	9	3692.077		
MALE	TIME	2 vs. 1		1624666.969	1	1624666.969	15.510	.001
	Error(TIME)	2 vs. 1		2094986.131	20	104749.307		
	POSTURE		2 vs. 1	8634.037	1	8634.037	.058	.812
	Error(POSTURE)		2 vs. 1	2960614.282	20	148030.714		
	TIME*POSTURE	2 vs. 1	2 vs. 1	63786.306	1	63786.306	.594	.450
	Error(T*P E)	2 vs. 1	2 vs. 1	2148227.813	20	107411.391		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Type III Sum of Squares	df	Mean Square	F	Sig.
FEMALE	Intercept	194164.623	1	194164.623	30.136	.000
	Error	57985.895	9	6442.877		
MALE	Intercept	3431798.862	1	3431798.862	23.236	.000
	Error	2953878.775	20	147693.939		

Ch. 4. ANOVA Table: Total Power with 1- between (gender) and 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
TPR1	FEMALE	495.0876	434.0829	10
	MALE	943.4295	770.3723	21
	Total	798.8031	705.3842	31
TPS1	FEMALE	344.2716	203.5582	10
	MALE	821.9514	628.4886	21
	Total	667.8611	572.0899	31
TPR2	FEMALE	65.4978	79.3396	10
	MALE	90.5049	86.7863	21
	Total	82.4381	83.9695	31
TPS2	FEMALE	107.2396	156.4632	10
	MALE	178.4128	556.8894	21
	Total	155.4537	463.9381	31

Tests of Within-Subjects Effects
Measure: MEASURE_1

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
TIME	7924006.069	1	7924006.069	36.447	.000
TIME * GENDER	1166239.965	1	1166239.965	5.364	.028
Error(TIME)	6304928.878	29	217411.341		
POSTURE	34459.411	1	34459.411	.179	.675
POSTURE * GENDER	9654.696	1	9654.696	.050	.824
Error(POSTURE)	5573600.795	29	192193.131		
TIME * POSTURE	273607.731	1	273607.731	1.456	.237
T*P*G	479.590	1	479.590	.003	.960
Error(T*P)	5449699.434	29	187920.670		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

Source	TIME	POSTURE	SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		7924006.069	1	7924006.069	36.447	.000
TIME * GENDER	2 vs. 1		1166239.965	1	1166239.965	5.364	.028
Error(TIME)	2 vs. 1		6304928.878	29	217411.341		
POSTURE		2 vs. 1	34459.411	1	34459.411	.179	.675
POSTURE * GENDER		2 vs. 1	9654.696	1	9654.696	.050	.824
Error(POSTURE)		2 vs. 1	5573600.795	29	192193.131		
TIME * POSTURE	2 vs. 1	2 vs. 1	273607.731	1	273607.731	1.456	.237
T*P*G	2 vs. 1	2 vs. 1	479.590	1	479.590	.003	.960
Error(TIME*POSTURE)	2 vs. 1	2 vs. 1	5449699.434	29	187920.670		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	15717016.882	1	15717016.882	40.915	.000
GENDER	1769583.538	1	1769583.538	4.607	.040
Error	11140105.994	29	384141.586		

Ch. 4. ANOVA Table: Total Power with 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	SS	df	Mean Square	F	Sig.
FEMALE	TIME	1110961.454	1	1110961.454	18.928	.002
	Error(TIME)	528252.475	9	58694.719		
	POSTURE	29743.014	1	29743.014	.430	.528
	Error(POSTURE)	621940.204	9	69104.467		
	TIME*POSTURE	92696.312	1	92696.312	1.504	.251
	Error(T*P)	554607.723	9	61623.080		
MALE	TIME	11756862.299	1	11756862.299	40.705	.000
	Error(TIME)	5776676.403	20	288833.820		
	POSTURE	5916.538	1	5916.538	.024	.879
	Error(POSTURE)	4951660.591	20	247583.030		
	TIME*POSTURE	230173.092	1	230173.092	.940	.344
	Error(T*P)	4895091.711	20	244754.586		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	TIME	POSTURE	SS	df	Mean Square	F	Sig.
FEMALE	TIME	2 vs. 1		1110961.454	1	1110961.454	18.928	.002
	Error(TIME)	2 vs. 1		528252.475	9	58694.719		
	POSTURE		2 vs. 1	29743.014	1	29743.014	.430	.528
	Error(POSTURE)		2 vs. 1	621940.204	9	69104.467		
	TIME*POSTURE	2 vs. 1	2 vs. 1	92696.312	1	92696.312	1.504	.251
	Error(T*P)	2 vs. 1	2 vs. 1	554607.723	9	61623.080		
MALE	TIME	2 vs. 1		11756862.299	1	11756862.299	40.705	.000
	Error(TIME)	2 vs. 1		5776676.403	20	288833.820		
	POSTURE		2 vs. 1	5916.538	1	5916.538	.024	.879
	Error(POSTURE)		2 vs. 1	4951660.591	20	247583.030		
	TIME*POSTURE	2 vs. 1	2 vs. 1	230173.092	1	230173.092	.940	.344
	Error(T*P)	2 vs. 1	2 vs. 1	4895091.711	20	244754.586		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Type III Sum of Squares	df	Mean Square	F	Sig.
FEMALE	Intercept	2560849.022	1	2560849.022	35.958	.000
	Error	640954.317	9	71217.146		
MALE	Intercept	21726447.706	1	21726447.706	41.387	.000
	Error	10499151.677	20	524957.584		

ANOVA Table: **SBR Slope** with 1- between (gender) and 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	SD	N
SLR1	FEMALE	5.6943	2.9351	10
	MALE	9.8753	5.2828	20
	Total	8.4816	4.9976	30
SLS1	FEMALE	3.8016	2.1055	10
	MALE	5.1150	2.6436	20
	Total	4.6772	2.5202	30
SLR2	FEMALE	3.8004	3.9181	10
	MALE	2.5377	1.5915	20
	Total	2.9586	2.6058	30
SLS2	FEMALE	3.5813	3.0714	10
	MALE	1.7525	1.4555	20
	Total	2.3621	2.2549	30

Tests of Within-Subjects Effects
Measure: MEASURE_1

Source	SS	df	Mean Square	F	Sig.
TIME	273.674	1	273.674	23.488	.000
TIME * GENDER	122.860	1	122.860	10.544	.003
Error(TIME)	326.244	28	11.652		
POSTURE	97.728	1	97.728	16.883	.000
POSTURE * GENDER	19.649	1	19.649	3.394	.076
Error(POSTURE)	162.078	28	5.789		
TIME * POSTURE	53.179	1	53.179	12.901	.001
TIME * POSTURE * GENDER	8.828	1	8.828	2.142	.154
Error(TIME*POSTURE)	115.416	28	4.122		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

Source	TIME	POSTURE	SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		273.674	1	273.674	23.488	.000
TIME * GENDER	2 vs. 1		122.860	1	122.860	10.544	.003
Error(TIME)	2 vs. 1		326.244	28	11.652		
POSTURE		2 vs. 1	97.728	1	97.728	16.883	.000
POSTURE * GENDER		2 vs. 1	19.649	1	19.649	3.394	.076
Error(POSTURE)		2 vs. 1	162.078	28	5.789		
TIME*POSTURE	2 vs. 1	2 vs. 1	53.179	1	53.179	12.901	.001
T*P*G	2 vs. 1	2 vs. 1	8.828	1	8.828	2.142	.154
Error(TIME*POSTURE)	2 vs. 1	2 vs. 1	115.416	28	4.122		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	2179.012	1	2179.012	124.983	.000
GENDER	9.623	1	9.623	.552	.464
Error	488.166	28	17.435		

Ch. 4. ANOVA Table: **SBR Slope** with 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]) in Men & women Separately.

Descriptive Statistics

GENDER		Mean	SD	N
FEMALE	SLR1	5.6943	2.9351	10
	SLS1	3.8016	2.1055	10
	SLR2	3.8004	3.9181	10
	SLS2	3.5813	3.0714	10
MALE	SLR1	9.8753	5.2828	20
	SLS1	5.1150	2.6436	20
	SLR2	2.5377	1.5915	20
	SLS2	1.7525	1.4555	20

Tests of Within-Subjects Effects

GENDER	Source	SS	df	MS	F	Sig.
FEMALE	TIME	11.175	1	11.2	1.025	.338
	Error(TIME)	98.124	9	10.9		
	POSTURE	11.151	1	11.2	1.849	.207
	Error(POSTURE)	54.290	9	6.0		
	TIME* POSTURE	7.002	1	7.0	1.551	.245
	Error(TIME*POSTURE)	40.645	9	4.5		
MALE	TIME	572.451	1	572.5	47.679	.000
	Error(TIME)	228.121	19	12.0		
	POSTURE	153.764	1	153.8	27.104	.000
	Error(POSTURE)	107.788	19	5.7		
	TIME* POSTURE	79.006	1	79.0	20.076	.000
	Error(TIME*POSTURE)	74.771	19	3.9		

Tests of Within-Subjects Contrasts

GENDER	Source	TIME	POSTURE	SS	df	MS	F	Sig.
FEMALE	TIME	2 vs. 1		11.18	1	11.18	1.025	.338
	Error(TIME)	2 vs. 1		98.12	9	10.90		
	POSTURE		2 vs. 1	11.15	1	11.15	1.849	.207
	Error(POSTURE)		2 vs. 1	54.29	9	6.03		
	TIME **POSTURE	2 vs. 1	2 vs. 1	7.00	1	7.00	1.551	.245
	Error(TIME*POSTURE)	2 vs. 1	2 vs. 1	40.65	9	4.52		
MALE	TIME	2 vs. 1		572.45	1	572.45	47.679	.000
	Error(TIME)	2 vs. 1		228.12	19	12.01		
	POSTURE		2 vs. 1	153.76	1	153.76	27.104	.000
	Error(POSTURE)		2 vs. 1	107.79	19	5.67		
	TIME * POSTURE	2 vs. 1	2 vs. 1	79.01	1	79.01	20.076	.000
	Error(TIME*POSTURE)	2 vs. 1	2 vs. 1	74.771	19	3.935		

Tests of Between-Subjects Effects

GENDER	Source	SS	df	Mean Square	F	Sig.
FEMALE	Intercept	712.133	1	712.133	43.469	.000
	Error	147.442	9	16.382		
MALE	Intercept	1858.688	1	1858.688	103.647	.000
	Error	340.725	19	17.933		

Ch. 4. ANOVA Table: **R-R Interval** with 1-between and 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
RRIR1	FEMALE	995.7913	145.7819	10
	MALE	1038.8484	126.6994	21
	Total	1024.9590	132.2730	31
RRIS1	FEMALE	851.9292	128.3714	10
	MALE	919.5779	161.6188	21
	Total	897.7558	152.9408	31
RRIR2	FEMALE	672.8134	104.5985	10
	MALE	719.3164	90.6686	21
	Total	704.3154	96.1826	31
RRIS2	FEMALE	641.2972	107.3093	10
	MALE	630.7644	110.1669	21
	Total	634.1621	107.5676	31

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	SS	df	Mean Square	F	Sig.
TIME	2208492.324	1	2208492.324	93.455	.000
TIME * GENDER	9459.162	1	9459.162	.400	.532
Error(TIME)	685319.149	29	23631.695		
POSTURE	248685.341	1	248685.341	74.896	.000
POSTURE * GENDER	1782.661	1	1782.661	.537	.470
Error(POSTURE)	96291.512	29	3320.397		
TIME * POSTURE	34662.566	1	34662.566	15.947	.000
TIME * POSTURE * GENDER	11284.191	1	11284.191	5.191	.030
Error(TIME*POSTURE)	63034.573	29	2173.606		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME	POSTURE	SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		2208492.324	1	2208492.324	93.455	.000
TIME * GENDER	2 vs. 1		9459.162	1	9459.162	.400	.532
Error(TIME)	2 vs. 1		685319.149	29	23631.695		
POSTURE		2 vs. 1	248685.341	1	248685.341	74.896	.000
POSTURE * GENDER		2 vs. 1	1782.661	1	1782.661	.537	.470
Error(POSTURE)		2 vs. 1	96291.512	29	3320.397		
TIME * POSTURE	2 vs. 1	2 vs. 1	34662.566	1	34662.566	15.947	.000
T*P*G	2 vs. 1	2 vs. 1	11284.191	1	11284.191	5.191	.030
Error(TIME*POSTURE)	2 vs. 1	2 vs. 1	63034.573	29	2173.606		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	70900871.616	1	70900871.616	2169.681	.000
GENDER	36434.695	1	36434.695	1.115	.300
Error	947662.626	29	32678.022		

Ch. 4. ANOVA Table: **R-R Interval** with 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]) in Men & Women Separately.

Descriptive Statistics

GENDER		Mean	Std. Deviation	N
FEMALE	RRIR1	995.7913	145.7819	10
	RRIS1	851.9292	128.3714	10
	RRIR2	672.8134	104.5985	10
	RRIS2	641.2972	107.3093	10
MALE	RRIR1	1038.8484	126.6994	21
	RRIS1	919.5779	161.6188	21
	RRIR2	719.3164	90.6686	21
	RRIS2	630.7644	110.1669	21

Tests of Within-Subjects Effects

Measure: MEASURE_1

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	TIME	711848.811	1	711848.811	37.796	.000
	Error(TIME)	169506.970	9	18834.108		
	POSTURE	76893.871	1	76893.871	19.022	.002
	Error(POSTURE)	36380.471	9	4042.275		
	TIME*POSTURE	31554.024	1	31554.024	13.616	.005
	Error(T*P)	20857.288	9	2317.476		
MALE	TIME	1942942.302	1	1942942.302	75.335	.000
	Error(TIME)	515812.179	20	25790.609		
	POSTURE	226748.274	1	226748.274	75.695	.000
	Error(POSTURE)	59911.041	20	2995.552		
	TIME*POSTURE	4954.023	1	4954.023	2.349	.141
	Error(T*P)	42177.285	20	2108.864		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

GENDER	Source	TIME	POSTURE	Type III SS	df	Mean Square	F	Sig.
FEMALE	TIME	2 vs. 1		711848.811	1	711848.811	37.796	.000
	Error(TIME)	2 vs. 1		169506.970	9	18834.108		
	POSTURE		2 vs. 1	76893.871	1	76893.871	19.022	.002
	Error(POSTURE)		2 vs. 1	36380.471	9	4042.275		
	TIME*POSTURE	2 vs. 1	2 vs. 1	31554.024	1	31554.024	13.616	.005
	Error(T*P)	2 vs. 1	2 vs. 1	20857.288	9	2317.476		
MALE	TIME	2 vs. 1		1942942.302	1	1942942.302	75.335	.000
	Error(TIME)	2 vs. 1		515812.179	20	25790.609		
	POSTURE		2 vs. 1	226748.274	1	226748.274	75.695	.000
	Error(POSTURE)		2 vs. 1	59911.041	20	2995.552		
	TIME*POSTURE	2 vs. 1	2 vs. 1	4954.023	1	4954.023	2.349	.141
	Error(T*P)	2 vs. 1	2 vs. 1	42177.285	20	2108.864		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Intercept	24992940.632	1	24992940.632	714.209	.000
	Error	314944.757	9	34993.862		
MALE	Intercept	57467649.456	1	57467649.456	1816.533	.000
	Error	632717.869	20	31635.893		

Ch. 4. ANOVA Table: **Systolic Blood Pressure** with 1-between and 2-within-subjects factors (Time [preoperatively vs. postoperatively] and Posture [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
SBPR1	FEMALE	117.3785	21.0282	10
	MALE	120.2947	18.6143	20
	Total	119.3226	19.1363	30
SBPS1	FEMALE	144.0799	18.5976	10
	MALE	129.1548	18.9620	20
	Total	134.1298	19.8524	30
SBPR2	FEMALE	95.7768	19.6750	10
	MALE	114.1093	29.1897	20
	Total	107.9984	27.4887	30
SBPS2	FEMALE	118.6334	26.8649	10
	MALE	123.0449	18.0567	20
	Total	121.5744	21.0255	30

Tests of Within-Subjects Effects
Measure: MEASURE_1

Source	SS	df	Mean Square	F	Sig.
TIME	5869.438	1	5869.438	9.476	.005
TIME * GENDER	2012.929	1	2012.929	3.250	.082
Error(TIME)	17343.899	28	619.425		
POSTURE	7560.868	1	7560.868	16.421	.000
POSTURE * GENDER	1681.406	1	1681.406	3.652	.066
Error(POSTURE)	12892.641	28	460.451		
TIME * POSTURE	23.679	1	23.679	.087	.770
TIME * POSTURE * GENDER	25.615	1	25.615	.094	.761
Error(TIME*POSTURE)	7601.997	28	271.500		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

Source	TIME	POSTURE	SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		5869.438	1	5869.438	9.476	.005
TIME * GENDER	2 vs. 1		2012.929	1	2012.929	3.250	.082
Error(TIME)	2 vs. 1		17343.899	28	619.425		
POSTURE		2 vs. 1	7560.868	1	7560.868	16.421	.000
POSTURE * GENDER		2 vs. 1	1681.406	1	1681.406	3.652	.066
Error(POSTURE)		2 vs. 1	12892.641	28	460.451		
TIME * POSTURE	2 vs. 1	2 vs. 1	23.679	1	23.679	.087	.770
T*P*G	2 vs. 1	2 vs. 1	25.615	1	25.615	.094	.761
Error(TIME*POSTURE)	2 vs. 1	2 vs. 1	7601.997	28	271.500		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	1543921.226	1	1543921.226	2875.856	.000
GENDER	192.067	1	192.067	.358	.555
Error	15031.977	28	536.856		

Ch. 4. ANOVA Table: **Systolic Blood Pressure** with 2-within-subjects factors (Time (preoperatively vs. postoperatively) and Posture [supine vs. standing]) in Men & women Separately.

Descriptive Statistics

GENDER		Mean	Std. Deviation	N
FEMALE	SBPR1	117.3785	21.0282	10
	SBPS1	144.0799	18.5976	10
	SBPR2	95.7768	19.6750	10
	SBPS2	118.6334	26.8649	10
MALE	SBPR1	120.2947	18.6143	20
	SBPS1	129.1548	18.9620	20
	SBPR2	114.1093	29.1897	20
	SBPS2	123.0449	18.0567	20

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	TIME	5533.833	1	5533.833	7.736	.021
	Error(TIME)	6438.117	9	715.346		
	POSTURE	6139.988	1	6139.988	14.469	.004
	Error(POSTURE)	3819.172	9	424.352		
	TIME * POSTURE	36.956	1	36.956	.127	.729
	Error(TIME*POSTURE)	2612.842	9	290.316		
MALE	TIME	755.884	1	755.884	1.317	.265
	Error(TIME)	10905.782	19	573.989		
	POSTURE	1583.435	1	1583.435	3.316	.084
	Error(POSTURE)	9073.470	19	477.551		
	TIME*POSTURE	2.850E-02	1	2.850E-02	.000	.992
	Error(T*P)	4989.154	19	262.587		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	TIME	POSTURE	Type III SS	df	Mean Square	F	Sig.
FEMALE	TIME	2 vs. 1		5533.833	1	5533.833	7.736	.021
	Error(TIME)	2 vs. 1		6438.117	9	715.346		
	POSTURE		2 vs. 1	6139.988	1	6139.988	14.469	.004
	Error(POSTURE)		2 vs. 1	3819.172	9	424.352		
	TIME*POSTURE	2 vs. 1	2 vs. 1	36.956	1	36.956	.127	.729
	Error(T*P)	2 vs. 1	2 vs. 1	2612.842	9	290.316		
MALE	TIME	2 vs. 1		755.884	1	755.884	1.317	.265
	Error(TIME)	2 vs. 1		10905.782	19	573.989		
	POSTURE		2 vs. 1	1583.435	1	1583.435	3.316	.084
	Error(POSTURE)		2 vs. 1	9073.470	19	477.551		
	TIME*POSTURE	2 vs. 1	2 vs. 1	2.850E-02	1	2.850E-02	.000	.992
	Error(T*P)	2 vs. 1	2 vs. 1	4989.154	19	262.587		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Intercept	566127.311	1	566127.311	1212.598	.000
	Error	4201.844	9	466.872		
MALE	Intercept	1183915.318	1	1183915.318	2077.019	.000
	Error	10830.132	19	570.007		

Ch. 4 ANOVA Table for **Fractal Power** with 1-between (gender) and 2-within subjects factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing]) in subjects > 55 years.

Descriptive Statistics

	gender	Mean	Std. Deviation	N
FPR1	female	235.9329	279.1015	7
	male	667.0772	478.0084	10
	Total	489.5472	453.4055	17
FPS1	female	275.6938	182.1521	7
	male	601.4883	517.9976	10
	Total	467.3376	436.6796	17
FPR2	female	34.1889	38.5908	7
	male	51.3628	65.6132	10
	Total	44.2912	55.2810	17
FPS2	female	69.5539	118.3945	7
	male	106.8183	226.9570	10
	Total	91.4741	185.9783	17

Tests of Within-Subjects Effects
Measure: MEASURE_1

Source	Type III SS	df	Mean Square	F	Sig.
TIME	2372936.919	1	2372936.919	20.694	.000
TIME * GENDER	508021.898	1	508021.898	4.430	.053
Error(TIME)	1720027.683	15	114668.512		
COND	4348.244	1	4348.244	.110	.745
COND * GENDER	7482.951	1	7482.951	.189	.670
Error(COND)	593218.791	15	39547.919		
TIME * COND	14007.101	1	14007.101	.270	.611
TIME*COND*GENDER	16198.075	1	16198.075	.312	.585
Error(TIME*COND)	778846.828	15	51923.122		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		2372936.919	1	2372936.919	20.694	.000
TIME * GENDER	2 vs. 1		508021.898	1	508021.898	4.430	.053
Error(TIME)	2 vs. 1		1720027.683	15	114668.512		
COND		2 vs. 1	4348.244	1	4348.244	.110	.745
COND * GENDER		2 vs. 1	7482.951	1	7482.951	.189	.670
Error(COND)		2 vs. 1	593218.791	15	39547.919		
TIME * COND	2 vs. 1	2 vs. 1	56028.406	1	56028.406	.270	.611
TIME*COND*GENDER	2 vs. 1	2 vs. 1	64792.298	1	64792.298	.312	.585
Error(TIME*COND)	2 vs. 1	2 vs. 1	3115387.311	15	207692.487		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	1073223.024	1	1073223.024	24.382	.000
GENDER	169423.888	1	169423.888	3.849	.069
Error	660265.158	15	44017.677		

Ch. 4 ANOVA Table for **Fractal Power** with 2-within subjects factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing]) separately in men & women > 55 years.

Descriptive Statistics

GENDER		Mean	Std. Deviation	N
FEMALE	FPR1	235.9329	279.1015	7
	FPS1	275.6938	182.1521	7
	FPR2	34.1889	38.5908	7
	FPS2	69.5539	118.3945	7
MALE	FPR1	667.0772	478.0084	10
	FPS1	601.4883	517.9976	10
	FPR2	51.3628	65.6132	10
	FPS2	106.8183	226.9570	10

Tests of Within-Subjects Effects

Measure: MEASURE_1

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	TIME	291146.237	1	291146.237	10.967	.016
	Error(TIME)	159291.119	6	26548.520		
	COND	9876.813	1	9876.813	.242	.640
	Error(COND)	244760.059	6	40793.343		
	TIME * COND	33.816	1	33.816	.001	.976
	Error(TIME*COND)	201334.250	6	33555.708		
MALE	TIME	3082383.939	1	3082383.939	17.775	.002
	Error(TIME)	1560736.564	9	173415.174		
	COND	256.718	1	256.718	.007	.937
	Error(COND)	348458.732	9	38717.637		
	TIME * COND	36629.405	1	36629.405	.571	.469
	Error(TIME*COND)	577512.578	9	64168.064		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

GENDER	Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
FEMALE	TIME	2 vs. 1		291146.237	1	291146.237	10.967	.016
	Error(TIME)	2 vs. 1		159291.119	6	26548.520		
	COND		2 vs. 1	9876.813	1	9876.813	.242	.640
	Error(COND)		2 vs. 1	244760.059	6	40793.343		
	TIME * COND	2 vs. 1	2 vs. 1	135.265	1	135.265	.001	.976
	Error(T*C)	2 vs. 1	2 vs. 1	805336.999	6	134222.833		
MALE	TIME	2 vs. 1		3082383.939	1	3082383.939	17.775	.002
	Error(TIME)	2 vs. 1		1560736.564	9	173415.174		
	COND		2 vs. 1	256.718	1	256.718	.007	.937
	Error(COND)		2 vs. 1	348458.732	9	38717.637		
	TIME * COND	2 vs. 1	2 vs. 1	146517.620	1	146517.620	.571	.469
	Error(T*C)	2 vs. 1	2 vs. 1	2310050.313	9	256672.257		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Intercept	165672.322	1	165672.322	25.800	.002
	Error	38529.004	6	6421.501		
MALE	Intercept	1272253.647	1	1272253.647	18.417	.002
	Error	621736.154	9	69081.795		

Ch. 4 ANOVA Table for **High Frequency Power** with 1-between (gender) and 2-within subjects factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing]) in subjects > 55 years.

Descriptive Statistics

	gender	Mean	Std. Deviation	N
HFR1	female	27.951860	19.170964	7
	male	245.112025	575.305456	10
	Total	155.693134	445.475496	17
HFS1	female	9.640303	8.067701	7
	male	64.493172	69.667701	10
	Total	41.906696	59.404416	17
HFR2	female	22.728076	52.991699	7
	male	2.137573	3.427334	10
	Total	10.616015	34.187164	17
HFS2	female	15.551847	36.494740	7
	male	23.883859	72.085670	10
	Total	20.453031	58.653723	17

Tests of Within-Subjects Effects
Measure: MEASURE_1

Source	Type III SS	df	Mean Square	F	Sig.
TIME	82383.978	1	82383.978	1.460	.246
TIME * GENDER	83187.073	1	83187.073	1.474	.243
Error(TIME)	846519.201	15	56434.613		
COND	34988.408	1	34988.408	.747	.401
COND * GENDER	18314.779	1	18314.779	.391	.541
Error(COND)	702521.769	15	46834.785		
TIME * COND	46923.110	1	46923.110	1.060	.319
TIME*COND*GENDER	37644.395	1	37644.395	.851	.371
Error(TIME*COND)	663814.702	15	44254.313		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		82383.978	1	82383.978	1.460	.246
TIME * GENDER	2 vs. 1		83187.073	1	83187.073	1.474	.243
Error(TIME)	2 vs. 1		846519.201	15	56434.613		
COND		2 vs. 1	34988.408	1	34988.408	.747	.401
COND * GENDER		2 vs. 1	18314.779	1	18314.779	.391	.541
Error(COND)		2 vs. 1	702521.769	15	46834.785		
TIME * COND	2 vs. 1	2 vs. 1	187692.440	1	187692.440	1.060	.319
TIME*COND*GENDER	2 vs. 1	2 vs. 1	150577.578	1	150577.578	.851	.371
Error(TIME*COND)	2 vs. 1	2 vs. 1	2655258.806	15	177017.254		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	43577.880	1	43577.880	2.958	.106
GENDER	17364.226	1	17364.226	1.179	.295
Error	220980.587	15	14732.039		

Ch. 4 ANOVA Table for **High Frequency Power** with 2-within subjects factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing]) separately in men & women > 55 years.

Descriptive Statistics

gender		Mean	Std. Deviation	N
female	HFR1	27.951860	19.170964	7
	HFS1	9.640303	8.067701	7
	HFR2	22.728076	52.991699	7
	HFS2	15.551847	36.494740	7
male	HFR1	245.112025	575.305456	10
	HFS1	64.493172	69.667701	10
	HFR2	2.137573	3.427334	10
	HFS2	23.883859	72.085670	10

Tests of Within-Subjects Effects

Measure: MEASURE_1

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	TIME	.828	1	.828	.001	.972
	Error(TIME)	3751.346	6	625.224		
	COND	1136.848	1	1136.848	.781	.411
	Error(COND)	8738.402	6	1456.400		
	TIME * COND	216.992	1	216.992	.222	.654
	Error(TIME*COND)	5871.085	6	978.514		
male	TIME	201049.379	1	201049.379	2.147	.177
	Error(TIME)	842767.855	9	93640.873		
	COND	63101.231	1	63101.231	.819	.389
	Error(COND)	693783.367	9	77087.041		
	TIME * COND	102379.124	1	102379.124	1.400	.267
	Error(TIME*COND)	657943.617	9	73104.846		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

gender	Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
female	TIME	2 vs. 1		.828	1	.828	.001	.972
	Error(TIME)	2 vs. 1		3751.346	6	625.224		
	COND		2 vs. 1	1136.848	1	1136.848	.781	.411
	Error(COND)		2 vs. 1	8738.402	6	1456.400		
	TIME * COND	2 vs. 1	2 vs. 1	867.969	1	867.969	.222	.654
	Error(T*C)	2 vs. 1	2 vs. 1	23484.338	6	3914.056		
male	TIME	2 vs. 1		201049.379	1	201049.379	2.147	.177
	Error(TIME)	2 vs. 1		842767.855	9	93640.873		
	COND		2 vs. 1	63101.231	1	63101.231	.819	.389
	Error(COND)		2 vs. 1	693783.367	9	77087.041		
	TIME * COND	2 vs. 1	2 vs. 1	409516.495	1	409516.495	1.400	.267
	Error(T*C)	2 vs. 1	2 vs. 1	2631774.468	9	292419.385		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	2518.501	1	2518.501	6.661	.042
	Error	2268.692	6	378.115		
male	Intercept	70403.271	1	70403.271	2.897	.123
	Error	218711.896	9	24301.322		

Ch. 4 ANOVA Table for **Low Frequency Power** with 1-between (gender) and 2-within subjects factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing]) in subjects > 55 years.

Descriptive Statistics

	gender	Mean	Std. Deviation	N
LFR1	female	112.952223	87.591694	7
	male	108.323232	102.695964	10
	Total	110.229287	93.888301	17
LFS1	female	78.773209	61.048414	7
	male	266.107738	446.396447	10
	Total	188.969991	350.026354	17
LFR2	female	5.581073	6.604543	7
	male	8.995292	13.022197	10
	Total	7.589437	10.711902	17
LFS2	female	20.556483	21.698580	7
	male	20.422778	45.122208	10
	Total	20.477833	36.356883	17

Tests of Within-Subjects Effects
Measure: MEASURE_1

Source	Type III SS	df	Mean Square	F	Sig.
TIME	268381.186	1	268381.186	9.986	.006
TIME * GENDER	33140.202	1	33140.202	1.233	.284
Error(TIME)	403154.355	15	26876.957		
COND	23164.355	1	23164.355	.633	.439
COND * GENDER	36544.567	1	36544.567	.998	.334
Error(COND)	549276.549	15	36618.437		
TIME * COND	9726.237	1	9726.237	.263	.616
TIME*COND*GENDER	39348.981	1	39348.981	1.062	.319
Error(TIME*COND)	555775.410	15	37051.694		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		268381.186	1	268381.186	9.986	.006
TIME * GENDER	2 vs. 1		33140.202	1	33140.202	1.233	.284
Error(TIME)	2 vs. 1		403154.355	15	26876.957		
COND		2 vs. 1	23164.355	1	23164.355	.633	.439
COND * GENDER		2 vs. 1	36544.567	1	36544.567	.998	.334
Error(COND)		2 vs. 1	549276.549	15	36618.437		
TIME * COND	2 vs. 1	2 vs. 1	38904.948	1	38904.948	.263	.616
TIME*COND*GENDER	2 vs. 1	2 vs. 1	157395.926	1	157395.926	1.062	.319
Error(TIME*COND)	2 vs. 1	2 vs. 1	2223101.639	15	148206.776		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	99473.563	1	99473.563	12.659	.003
GENDER	8902.047	1	8902.047	1.133	.304
Error	117868.054	15	7857.870		

Ch. 4 ANOVA Table for **Low Frequency Power** with 2-within subjects factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing]) separately in men & women > 55 years.

Descriptive Statistics

gender		Mean	Std. Deviation	N
female	LFR1	112.952223	87.591694	7
	LFS1	78.773209	61.048414	7
	LFR2	5.581073	6.604543	7
	LFS2	20.556483	21.698580	7
male	LFR1	108.323232	102.695964	10
	LFS1	266.107738	446.396447	10
	LFR2	8.995292	13.022197	10
	LFS2	20.422778	45.122208	10

Tests of Within-Subjects Effects
Measure: MEASURE_1

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	TIME	47983.853	1	47983.853	8.754	.025
	Error(TIME)	32886.659	6	5481.110		
	COND	645.362	1	645.362	.781	.411
	Error(COND)	4960.294	6	826.716		
	TIME * COND	4228.275	1	4228.275	3.137	.127
	Error(TIME*COND)	8086.827	6	1347.805		
male	TIME	297584.753	1	297584.753	7.233	.025
	Error(TIME)	370267.696	9	41140.855		
	COND	71581.746	1	71581.746	1.184	.305
	Error(COND)	544316.254	9	60479.584		
	TIME * COND	53550.943	1	53550.943	.880	.373
	Error(TIME*COND)	547688.582	9	60854.287		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

gender	Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
female	TIME	2 vs. 1		47983.853	1	47983.853	8.754	.025
	Error(TIME)	2 vs. 1		32886.659	6	5481.110		
	COND		2 vs. 1	645.362	1	645.362	.781	.411
	Error(COND)		2 vs. 1	4960.294	6	826.716		
	TIME * COND	2 vs. 1	2 vs. 1	16913.102	1	16913.102	3.137	.127
	Error(T*C)	2 vs. 1	2 vs. 1	32347.310	6	5391.218		
male	TIME	2 vs. 1		297584.753	1	297584.753	7.233	.025
	Error(TIME)	2 vs. 1		370267.696	9	41140.855		
	COND		2 vs. 1	71581.746	1	71581.746	1.184	.305
	Error(COND)		2 vs. 1	544316.254	9	60479.584		
	TIME * COND	2 vs. 1	2 vs. 1	214203.773	1	214203.773	.880	.373
	Error(T*C)	2 vs. 1	2 vs. 1	2190754.329	9	243417.148		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	20765.623	1	20765.623	19.507	.004
	Error	6387.048	6	1064.508		
male	Intercept	101933.779	1	101933.779	8.229	.019
	Error	111481.006	9	12386.778		

Ch. 4 ANOVA Table for **Parasympathetic (PNS) Indicator** with 1-between (gender) and 2-within subjects factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing]) in subjects > 55 years.

Descriptive Statistics

	gender	Mean	Std. Deviation	N
PNSR1	female	.116867	.128714	7
	male	.138062	.205330	10
	Total	.129335	.173331	17
PNSS1	female	2.71700E-02	2.73871E-02	7
	male	8.85440E-02	7.87568E-02	10
	Total	6.32724E-02	6.88450E-02	17
PNSR2	female	.199919	.181553	7
	male	3.60410E-02	2.91254E-02	10
	Total	.103520	.140532	17
PNSS2	female	5.32914E-02	6.10036E-02	7
	male	3.44830E-02	4.24129E-02	10
	Total	4.22276E-02	4.99843E-02	17

Tests of Within-Subjects Effects
Measure: MEASURE_1

Source	Type III SS	df	Mean Square	F	Sig.
TIME	2.265E-03	1	2.265E-03	.119	.735
TIME * GENDER	7.243E-02	1	7.243E-02	3.804	.070
Error(TIME)	.286	15	1.904E-02		
COND	8.503E-02	1	8.503E-02	8.927	.009
COND * GENDER	3.533E-02	1	3.533E-02	3.709	.073
Error(COND)	.143	15	9.525E-03		
TIME * COND	8.283E-05	1	8.283E-05	.009	.924
TIME*COND*GENDER	1.133E-02	1	1.133E-02	1.295	.273
Error(TIME*COND)	.131	15	8.748E-03		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		2.265E-03	1	2.265E-03	.119	.735
TIME * GENDER	2 vs. 1		7.243E-02	1	7.243E-02	3.804	.070
Error(TIME)	2 vs. 1		.286	15	1.904E-02		
COND		2 vs. 1	8.503E-02	1	8.503E-02	8.927	.009
COND * GENDER		2 vs. 1	3.533E-02	1	3.533E-02	3.709	.073
Error(COND)		2 vs. 1	.143	15	9.525E-03		
TIME * COND	2 vs. 1	2 vs. 1	3.313E-04	1	3.313E-04	.009	.924
TIME*COND*GENDER	2 vs. 1	2 vs. 1	4.530E-02	1	4.530E-02	1.295	.273
Error(TIME*COND)	2 vs. 1	2 vs. 1	.525	15	3.499E-02		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	.124	1	.124	33.326	.000
GENDER	2.580E-03	1	2.580E-03	.693	.418
Error	5.585E-02	15	3.723E-03		

Ch. 4 ANOVA Table for **PNS Indicator** with 2-within subjects factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing]) separately in men & women > 55 years.

Descriptive Statistics

gender		Mean	Std. Deviation	N
female	PNSR1	.116867	.128714	7
	PNSS1	2.71700E-02	2.73871E-02	7
	PNSR2	.199919	.181553	7
	PNSS2	5.32914E-02	6.10036E-02	7
male	PNSR1	.138062	.205330	10
	PNSS1	8.85440E-02	7.87568E-02	10
	PNSR2	3.60410E-02	2.91254E-02	10
	PNSS2	3.44830E-02	4.24129E-02	10

Tests of Within-Subjects Effects

Measure: MEASURE_1

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	TIME	2.086E-02	1	2.086E-02	1.174	.320
	Error(TIME)	.107	6	1.776E-02		
	COND	9.774E-02	1	9.774E-02	7.851	.031
	Error(COND)	7.469E-02	6	1.245E-02		
	TIME * COND	5.672E-03	1	5.672E-03	.455	.525
	Error(TIME*COND)	7.486E-02	6	1.248E-02		
male	TIME	6.090E-02	1	6.090E-02	3.062	.114
	Error(TIME)	.179	9	1.989E-02		
	COND	6.522E-03	1	6.522E-03	.861	.378
	Error(COND)	6.818E-02	9	7.575E-03		
	TIME * COND	5.750E-03	1	5.750E-03	.918	.363
	Error(TIME*COND)	5.637E-02	9	6.263E-03		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

gender	Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
female	TIME	2 vs. 1		2.086E-02	1	2.086E-02	1.174	.320
	Error(TIME)	2 vs. 1		.107	6	1.776E-02		
	COND		2 vs. 1	9.774E-02	1	9.774E-02	7.851	.031
	Error(COND)		2 vs. 1	7.469E-02	6	1.245E-02		
	TIME * COND	2 vs. 1	2 vs. 1	2.269E-02	1	2.269E-02	.455	.525
	Error(T*C)	2 vs. 1	2 vs. 1	.299	6	4.991E-02		
male	TIME	2 vs. 1		6.090E-02	1	6.090E-02	3.062	.114
	Error(TIME)	2 vs. 1		.179	9	1.989E-02		
	COND		2 vs. 1	6.522E-03	1	6.522E-03	.861	.378
	Error(COND)		2 vs. 1	6.818E-02	9	7.575E-03		
	TIME * COND	2 vs. 1	2 vs. 1	2.300E-02	1	2.300E-02	.918	.363
	Error(T*C)	2 vs. 1	2 vs. 1	.225	9	2.505E-02		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	6.904E-02	1	6.904E-02	24.407	.003
	Error	1.697E-02	6	2.829E-03		
male	Intercept	5.518E-02	1	5.518E-02	12.773	.006
	Error	3.888E-02	9	4.320E-03		

Ch. 4 ANOVA Table for **SDNN** with 1-between (gender) and 2-within subjects factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing]) in subjects > 55 years.

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
SDNNR1	FEMALE	27.4233	11.6654	7
	MALE	43.3490	22.3271	10
	Total	36.7914	19.9176	17
SDNNS1	FEMALE	28.2450	6.2249	7
	MALE	44.0411	20.3152	10
	Total	37.5368	17.6322	17
SDNNR2	FEMALE	17.2211	14.5511	7
	MALE	13.5334	6.3410	10
	Total	15.0518	10.2722	17
SDNNS2	FEMALE	14.5090	12.4851	7
	MALE	28.1960	49.0218	10
	Total	22.5602	38.1894	17

Tests of Within-Subjects Effects
Measure: MEASURE_1

Source	Type III SS	df	Mean Square	F	Sig.
TIME	4986.493	1	4986.493	14.127	.002
TIME * GENDER	485.748	1	485.748	1.376	.259
Error(TIME)	5294.689	15	352.979		
COND	186.617	1	186.617	.402	.536
COND * GENDER	306.140	1	306.140	.659	.430
Error(COND)	6970.379	15	464.692		
TIME * COND	112.132	1	112.132	.322	.579
TIME*COND*GENDER	315.411	1	315.411	.905	.356
Error(TIME*COND)	5225.454	15	348.364		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		4986.493	1	4986.493	14.127	.002
TIME * GENDER	2 vs. 1		485.748	1	485.748	1.376	.259
Error(TIME)	2 vs. 1		5294.689	15	352.979		
COND		2 vs. 1	186.617	1	186.617	.402	.536
COND * GENDER		2 vs. 1	306.140	1	306.140	.659	.430
Error(COND)		2 vs. 1	6970.379	15	464.692		
TIME * COND	2 vs. 1	2 vs. 1	448.529	1	448.529	.322	.579
TIME*COND*GENDER	2 vs. 1	2 vs. 1	1261.645	1	1261.645	.905	.356
Error(TIME*COND)	2 vs. 1	2 vs. 1	20901.816	15	1393.454		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	12064.706	1	12064.706	45.370	.000
GENDER	447.961	1	447.961	1.685	.214
Error	3988.778	15	265.919		

Ch. 4 ANOVA Table for **SDNN** with 2-within subjects factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing]) separately in men & women > 55 years.

Descriptive Statistics

gender		Mean	Std. Deviation	N
female	SDNNR1	27.4233	11.6654	7
	SDNNS1	28.2450	6.2249	7
	SDNNR2	17.2211	14.5511	7
	SDNNS2	14.5090	12.4851	7
male	SDNNR1	43.3490	22.3271	10
	SDNNS1	44.0411	20.3152	10
	SDNNR2	13.5334	6.3410	10
	SDNNS2	28.1960	49.0218	10

Tests of Within-Subjects Effects
Measure: MEASURE_1

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	TIME	1002.818	1	1002.818	14.249	.009
	Error(TIME)	422.257	6	70.376		
	COND	6.254	1	6.254	.039	.849
	Error(COND)	953.259	6	158.877		
	TIME * COND	21.852	1	21.852	.255	.631
	Error(TIME*COND)	513.490	6	85.582		
male	TIME	5212.267	1	5212.267	9.628	.013
	Error(TIME)	4872.433	9	541.381		
	COND	589.413	1	589.413	.882	.372
	Error(COND)	6017.120	9	668.569		
	TIME * COND	487.942	1	487.942	.932	.360
	Error(TIME*COND)	4711.964	9	523.552		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

gender	Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
female	TIME	2 vs. 1		1002.818	1	1002.818	14.249	.009
	Error(TIME)	2 vs. 1		422.257	6	70.376		
	COND		2 vs. 1	6.254	1	6.254	.039	.849
	Error(COND)		2 vs. 1	953.259	6	158.877		
	TIME*COND	2 vs. 1	2 vs. 1	87.409	1	87.409	.255	.631
	Error(T*C)	2 vs. 1	2 vs. 1	2053.960	6	342.327		
male	TIME	2 vs. 1		5212.267	1	5212.267	9.628	.013
	Error(TIME)	2 vs. 1		4872.433	9	541.381		
COND			2 vs. 1	589.413	1	589.413	.882	.372
	Error(COND)		2 vs. 1	6017.120	9	668.569		
TIME * COND		2 vs. 1	2 vs. 1	1951.769	1	1951.769	.932	.360
	Error(T*C)	2 vs. 1	2 vs. 1	18847.856	9	2094.206		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	3341.836	1	3341.836	58.729	.000
	Error	341.414	6	56.902		
male	Intercept	10419.901	1	10419.901	25.711	.001
	Error	3647.364	9	405.263		

Ch. 4 ANOVA Table for **Sympathetic (SNS) Indicator** with 1-between (gender) and 2-within subjects factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing]) in subjects > 55 years.

Descriptive Statistics

	gender	Mean	Std. Deviation	N
SNSR1	female	5.466320	3.700412	7
	male	2.700182	3.121126	10
	Total	3.839180	3.547335	17
SNSS1	female	19.393479	20.974994	7
	male	9.629333	22.457630	10
	Total	13.649864	21.753418	17
SNSR2	female	3.607743	7.119301	7
	male	4.802352	5.861904	10
	Total	4.310454	6.221134	17
SNSS2	female	18.474409	19.840234	7
	male	12.791437	17.854710	10
	Total	15.131484	18.309679	17

Tests of Within-Subjects Effects
Measure: MEASURE_1

Source	Type III SS	df	Mean Square	F	Sig.
TIME	6.365	1	6.365	.025	.877
TIME * GENDER	66.575	1	66.575	.259	.618
Error(TIME)	3854.963	15	256.998		
COND	1966.943	1	1966.943	9.064	.009
COND * GENDER	198.195	1	198.195	.913	.354
Error(COND)	3255.182	15	217.012		
TIME * COND	4.115	1	4.115	.021	.886
TIME*COND*GENDER	1.493E-02	1	1.493E-02	.000	.993
Error(TIME*COND)	2918.965	15	194.598		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		6.365	1	6.365	.025	.877
TIME * GENDER	2 vs. 1		66.575	1	66.575	.259	.618
Error(TIME)	2 vs. 1		3854.963	15	256.998		
COND		2 vs. 1	1966.943	1	1966.943	9.064	.009
COND * GENDER		2 vs. 1	198.195	1	198.195	.913	.354
Error(COND)		2 vs. 1	3255.182	15	217.012		
TIME * COND	2 vs. 1	2 vs. 1	16.461	1	16.461	.021	.886
TIME*COND*GENDER	2 vs. 1	2 vs. 1	5.972E-02	1	5.972E-02	.000	.993
Error(TIME*COND)	2 vs. 1	2 vs. 1	11675.858	15	778.391		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	1520.510	1	1520.510	28.836	.000
GENDER	74.538	1	74.538	1.414	.253
Error	790.955	15	52.730		

Ch. 4 ANOVA Table for **SNS Indicator** with 2-within subjects factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing]) separately in men & women > 55 years.

Descriptive Statistics

gender		Mean	Std. Deviation	N
female	SNSR1	5.466320	3.700412	7
	SNSS1	19.393479	20.974994	7
	SNSR2	3.607743	7.119301	7
	SNSS2	18.474409	19.840234	7
male	SNSR1	2.700182	3.121126	10
	SNSS1	9.629333	22.457630	10
	SNSR2	4.802352	5.861904	10
	SNSS2	12.791437	17.854710	10

Tests of Within-Subjects Effects

Measure: MEASURE_1

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	TIME	13.502	1	13.502	.036	.856
	Error(TIME)	2259.518	6	376.586		
	COND	1450.898	1	1450.898	12.914	.011
	Error(COND)	674.099	6	112.350		
	TIME * COND	1.545	1	1.545	.007	.938
	Error(TIME*COND)	1424.949	6	237.492		
male	TIME	69.281	1	69.281	.391	.547
	Error(TIME)	1595.446	9	177.272		
	COND	556.384	1	556.384	1.940	.197
	Error(COND)	2581.083	9	286.787		
	TIME * COND	2.809	1	2.809	.017	.899
	Error(TIME*COND)	1494.015	9	166.002		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

gender	Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
female	TIME	2 vs. 1		13.502	1	13.502	.036	.856
	Error(TIME)	2 vs. 1		2259.518	6	376.586		
	COND		2 vs. 1	1450.898	1	1450.898	12.914	.011
	Error(COND)		2 vs. 1	674.099	6	112.350		
	TIME *COND	2 vs. 1	2 vs. 1	6.179	1	6.179	.007	.938
	Error(T*C)	2 vs. 1	2 vs. 1	5699.797	6	949.966		
male	TIME	2 vs. 1		69.281	1	69.281	.391	.547
	Error(TIME)	2 vs. 1		1595.446	9	177.272		
	COND		2 vs. 1	556.384	1	556.384	1.940	.197
	Error(COND)		2 vs. 1	2581.083	9	286.787		
	TIME * COND	2 vs. 1	2 vs. 1	11.235	1	11.235	.017	.899
	Error(T*C)	2 vs. 1	2 vs. 1	5976.061	9	664.007		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	964.052	1	964.052	22.481	.003
	Error	257.303	6	42.884		
male	Intercept	559.628	1	559.628	9.438	.013
	Error	533.652	9	59.295		

Ch. 4 ANOVA Table for **Total Harmonic Power** with 1-between (gender) and 2-within subjects factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing]) in subjects > 55 years.

Descriptive Statistics

	gender	Mean	Std. Deviation	N
THPR1	female	141.6611	94.2738	7
	male	356.4632	612.5590	10
	Total	268.0153	475.6817	17
THPS1	female	88.8373	63.9406	7
	male	345.4974	471.6298	10
	Total	239.8138	378.9533	17
THPR2	female	30.5275	58.2180	7
	male	16.9117	16.8917	10
	Total	22.5182	38.4605	17
THPS2	female	45.4610	72.3114	7
	male	192.6105	584.3340	10
	Total	132.0196	446.7626	17

Tests of Within-Subjects Effects
Measure: MEASURE_1

Source	Type III SS	df	Mean Square	F	Sig.
TIME	430851.946	1	430851.946	4.045	.063
TIME * GENDER	117554.315	1	117554.315	1.104	.310
Error(TIME)	1597883.073	15	106525.538		
COND	16562.246	1	16562.246	.093	.764
COND * GENDER	42263.756	1	42263.756	.238	.633
Error(COND)	2660789.701	15	177385.980		
TIME * COND	66634.376	1	66634.376	.520	.482
TIME*COND*GENDER	14554.785	1	14554.785	.114	.741
Error(TIME*COND)	1922024.511	15	128134.967		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		430851.946	1	430851.946	4.045	.063
TIME * GENDER	2 vs. 1		117554.315	1	117554.315	1.104	.310
Error(TIME)	2 vs. 1		1597883.073	15	106525.538		
COND		2 vs. 1	16562.246	1	16562.246	.093	.764
COND * GENDER		2 vs. 1	42263.756	1	42263.756	.238	.633
Error(COND)		2 vs. 1	2660789.701	15	177385.980		
TIME * COND	2 vs. 1	2 vs. 1	266537.506	1	266537.506	.520	.482
TIME*COND*GENDER	2 vs. 1	2 vs. 1	58219.140	1	58219.140	.114	.741
Error(TIME*COND)	2 vs. 1	2 vs. 1	7688098.043	15	512539.870		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	381770.314	1	381770.314	9.531	.008
GENDER	94196.307	1	94196.307	2.352	.146
Error	600855.234	15	40057.016		

Ch. 4 ANOVA Table for **Total Harmonic Power** with 2-within subjects factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing]) separately in men & women > 55 years.

Descriptive Statistics

GENDER		Mean	Std. Deviation	N
FEMALE	THPR1	141.6611	94.2738	7
	THPS1	88.8373	63.9406	7
	THPR2	30.5275	58.2180	7
	THPS2	45.4610	72.3114	7
MALE	THPR1	356.4632	612.5590	10
	THPS1	345.4974	471.6298	10
	THPR2	16.9117	16.8917	10
	THPS2	192.6105	584.3340	10

Tests of Within-Subjects Effects

Measure: MEASURE_1

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	TIME	41778.267	1	41778.267	6.553	.043
	Error(TIME)	38253.920	6	6375.653		
	COND	2512.442	1	2512.442	1.220	.312
	Error(COND)	12356.059	6	2059.343		
	TIME * COND	8034.354	1	8034.354	1.549	.260
	Error(TIME*COND)	31116.046	6	5186.008		
MALE	TIME	606238.649	1	606238.649	3.498	.094
	Error(TIME)	1559629.153	9	173292.128		
	COND	67842.370	1	67842.370	.231	.643
	Error(COND)	2648433.642	9	294270.405		
	TIME * COND	87109.190	1	87109.190	.415	.536
	Error(TIME*COND)	1890908.464	9	210100.940		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

GENDER	Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
FEMALE	TIME	2 vs. 1		41778.267	1	41778.267	6.553	.043
	Error(TIME)	2 vs. 1		38253.920	6	6375.653		
	COND		2 vs. 1	2512.442	1	2512.442	1.220	.312
	Error(COND)		2 vs. 1	12356.059	6	2059.343		
	TIME * COND	2 vs. 1	2 vs. 1	32137.417	1	32137.417	1.549	.260
	Error(T*C)	2 vs. 1	2 vs. 1	124464.185	6	20744.031		
MALE	TIME	2 vs. 1		606238.649	1	606238.649	3.498	.094
	Error(TIME)	2 vs. 1		1559629.153	9	173292.128		
	COND		2 vs. 1	67842.370	1	67842.370	.231	.643
	Error(COND)		2 vs. 1	2648433.642	9	294270.405		
	TIME * COND	2 vs. 1	2 vs. 1	348436.759	1	348436.759	.415	.536
	Error(T*C)	2 vs. 1	2 vs. 1	7563633.858	9	840403.762		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Intercept	41096.242	1	41096.242	20.617	.004
	Error	11959.826	6	1993.304		
MALE	Intercept	519250.550	1	519250.550	7.936	.020
	Error	588895.408	9	65432.823		

Ch. 4 ANOVA Table for **Total Power** with 1-between (gender) and 2-within subjects factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing]) in subjects > 55 years.

Descriptive Statistics

	gender	Mean	Std. Deviation	N
TPR1	female	377.5941	304.3913	7
	male	1052.3560	984.8788	10
	Total	774.5128	835.1864	17
TPS1	female	364.5310	197.6446	7
	male	983.1942	747.8621	10
	Total	728.4506	654.0291	17
TPR2	female	64.7164	93.9521	7
	male	68.2745	76.0158	10
	Total	66.8094	81.0168	17
TPS2	female	115.0149	189.7485	7
	male	299.2015	809.9677	10
	Total	223.3600	625.5071	17

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	Type III SS	df	Mean Square	F	Sig.
TIME	5121310.268	1	5121310.268	18.730	.001
TIME * GENDER	1258485.881	1	1258485.881	4.603	.049
Error(TIME)	4101402.088	15	273426.806		
COND	40766.040	1	40766.040	.146	.708
COND * GENDER	15963.781	1	15963.781	.057	.814
Error(COND)	4193040.193	15	279536.013		
TIME * COND	135981.235	1	135981.235	.463	.507
TIME*COND*GENDER	57687.992	1	57687.992	.196	.664
Error(TIME*COND)	4407676.827	15	293845.122		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		5121310.268	1	5121310.268	18.730	.001
TIME * GENDER	2 vs. 1		1258485.881	1	1258485.881	4.603	.049
Error(TIME)	2 vs. 1		4101402.088	15	273426.806		
COND		2 vs. 1	40766.040	1	40766.040	.146	.708
COND * GENDER		2 vs. 1	15963.781	1	15963.781	.057	.814
Error(COND)		2 vs. 1	4193040.193	15	279536.013		
TIME * COND	2 vs. 1	2 vs. 1	543924.939	1	543924.939	.463	.507
TIME*COND*GENDER	2 vs. 1	2 vs. 1	230751.967	1	230751.967	.196	.664
Error(TIME*COND)	2 vs. 1	2 vs. 1	17630707.308	15	1175380.487		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	2844996.884	1	2844996.884	21.134	.000
GENDER	564597.346	1	564597.346	4.194	.058
Error	2019291.331	15	134619.422		

Ch. 4 ANOVA Table for **Total Power** with 2-within subjects factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing]) separately in men & women > 55 years.

Descriptive Statistics

GENDER	Mean	Std. Deviation	N	
FEMALE	TPR1	377.5941	304.3913	7
	TPS1	364.5310	197.6446	7
	TPR2	64.7164	93.9521	7
	TPS2	115.0149	189.7485	7
MALE	TPR1	1052.3560	984.8788	10
	TPS1	983.1942	747.8621	10
	TPR2	68.2745	76.0158	10
	TPS2	299.2015	809.9677	10

Tests of Within-Subjects Effects

Measure: MEASURE_1

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	TIME	553501.794	1	553501.794	11.634	.014
	Error(TIME)	285459.798	6	47576.633		
	COND	2426.340	1	2426.340	.063	.810
	Error(COND)	229392.708	6	38232.118		
	TIME * COND	7025.692	1	7025.692	.191	.677
	Error(TIME*COND)	220132.250	6	36688.708		
MALE	TIME	6956178.475	1	6956178.475	16.406	.003
	Error(TIME)	3815942.290	9	423993.588		
	COND	65420.011	1	65420.011	.149	.709
	Error(COND)	3963647.485	9	440405.276		
	TIME * COND	225133.073	1	225133.073	.484	.504
	Error(TIME*COND)	4187544.577	9	465282.731		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

GENDER	Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
FEMALE	TIME	2 vs. 1		553501.794	1	553501.794	11.634	.014
	Error(TIME)	2 vs. 1		285459.798	6	47576.633		
	COND		2 vs. 1	2426.340	1	2426.340	.063	.810
	Error(COND)		2 vs. 1	229392.708	6	38232.118		
TIME * COND		2 vs. 1	2 vs. 1	28102.767	1	28102.767	.191	.677
	Error(T*C)	2 vs. 1	2 vs. 1	880529.002	6	146754.834		
MALE	TIME	2 vs. 1		6956178.475	1	6956178.475	16.406	.003
	Error(TIME)	2 vs. 1		3815942.290	9	423993.588		
COND			2 vs. 1	65420.011	1	65420.011	.149	.709
	Error(COND)		2 vs. 1	3963647.485	9	440405.276		
TIME * COND		2 vs. 1	2 vs. 1	900532.291	1	900532.291	.484	.504
	Error(T*C)	2 vs. 1	2 vs. 1	16750178.307	9	1861130.923		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Intercept	371795.955	1	371795.955	27.514	.002
	Error	81077.190	6	13512.865		
MALE	Intercept	3609084.486	1	3609084.486	16.759	.003
	Error	1938214.141	9	215357.127		

CH 4. ANOVA Table for **SBR Slope** with 1-between (gender) and 2-within factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing] in subjects > 55 years.

Descriptive Statistics

	gender	Mean	SD	N	gender	Mean	SD	N
SLR1	female	6.0162	3.0779	8	male	10.2193	5.8305	10
SLS1	female	3.2812	1.9653	8	male	5.6580	2.5073	10
SLR2	female	4.2139	4.3267	8	male	2.5962	1.8232	10
SLS2	female	3.2706	3.0301	8	male	2.1171	1.7832	10

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	Type III SS	df	Mean Square	F	Sig.
TIME	187.113	1	187.113	12.749	.003
TIME * GENDER	97.159	1	97.159	6.620	.020
Error(TIME)	234.833	16	14.677		
COND	84.463	1	84.463	17.282	.001
COND * GENDER	2.062	1	2.062	.422	.525
Error(COND)	78.198	16	4.887		
TIME * COND	38.338	1	38.338	8.346	.011
TIME*COND*GENDER	5.830	1	5.830	1.269	.277
Error(TIME*COND)	73.494	16	4.593		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		187.113	1	187.113	12.749	.003
TIME*GENDER	2 vs. 1		97.159	1	97.159	6.620	.020
Error(TIME)	2 vs. 1		234.833	16	14.677		
COND		2 vs. 1	84.463	1	84.463	17.282	.001
COND*GENDER		2 vs. 1	2.062	1	2.062	.422	.525
Error(COND)		2 vs. 1	78.198	16	4.887		
TIME*COND	2 vs. 1	2 vs. 1	153.354	1	153.354	8.346	.011
TIME*COND*GENDER	2 vs. 1	2 vs. 1	23.319	1	23.319	1.269	.277
Error(TIME*COND)	2 vs. 1	2 vs. 1	293.976	16	18.373		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	387.971	1	387.971	76.824	.000
GENDER	4.030	1	4.030	.798	.385
Error	80.802	16	5.050		

CH 4. ANOVA Table for **SBR Slope** with 2-within factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing] separately in men & women > 55 years.

Descriptive Statistics

gender		Mean	SD	N
female	SLR1	6.0162	3.0779	8
	SLS1	3.2812	1.9653	8
	SLR2	4.2139	4.3267	8
	SLS2	3.2706	3.0301	8
male	SLR1	10.2193	5.8305	10
	SLS1	5.6580	2.5073	10
	SLR2	2.5962	1.8232	10
	SLS2	2.1171	1.7832	10

Tests of Within-Subjects Effects

Measure: MEASURE_1

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	TIME	6.574	1	6.574	.474	.513
	Error(TIME)	97.147	7	13.878		
	COND	27.060	1	27.060	7.049	.033
	Error(COND)	26.873	7	3.839		
	TIME * COND	6.421	1	6.421	1.409	.274
	Error(TIME*COND)	31.901	7	4.557		
male	TIME	311.589	1	311.589	20.367	.001
	Error(TIME)	137.686	9	15.298		
	COND	63.516	1	63.516	11.138	.009
	Error(COND)	51.325	9	5.703		
	TIME * COND	41.663	1	41.663	9.015	.015
	Error(TIME*COND)	41.593	9	4.621		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

gender	Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
female	TIME	2 vs. 1		6.574	1	6.574	.474	.513
	Error(TIME)	2 vs. 1		97.147	7	13.878		
	COND		2 vs. 1	27.060	1	27.060	7.049	.033
	Error(COND)		2 vs. 1	26.873	7	3.839		
	TIME * COND	2 vs. 1	2 vs. 1	25.683	1	25.683	1.409	.274
	Error(TIME*COND)	2 vs. 1	2 vs. 1	127.604	7	18.229		
male	TIME	2 vs. 1		311.589	1	311.589	20.367	.001
	Error(TIME)	2 vs. 1		137.686	9	15.298		
	COND		2 vs. 1	63.516	1	63.516	11.138	.009
	Error(COND)		2 vs. 1	51.325	9	5.703		
	TIME * COND	2 vs. 1	2 vs. 1	166.653	1	166.653	9.015	.015
	Error(TIME*COND)	2 vs. 1	2 vs. 1	166.371	9	18.486		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	140.815	1	140.815	29.702	.001
	Error	33.186	7	4.741		
male	Intercept	264.982	1	264.982	50.085	.000
	Error	47.616	9	5.291		

CH 4. ANOVA Table for **Systolic Blood Pressure** with 1-between (gender) and 2-within factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing] in subjects > 55 years.

Descriptive Statistics

	gender	Mean	SD	N	gender	Mean	SD	N
SBPR1	female	117.8343	23.8181	8	male	128.0736	20.1214	10
SBPS1	female	140.5789	19.2664	8	male	137.7942	19.7278	10
SBPR2	female	92.4374	20.5794	8	male	116.0159	36.7281	10
SBPS2	female	113.9615	28.2390	8	male	120.6175	18.5230	10

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	Type III SS	df	Mean Square	F	Sig.
TIME	7334.826	1	7334.826	9.683	.007
TIME * GENDER	576.580	1	576.580	.761	.396
Error(TIME)	12120.120	16	757.507		
COND	3814.333	1	3814.333	5.696	.030
COND * GENDER	996.440	1	996.440	1.488	.240
Error(COND)	10715.328	16	669.708		
TIME * COND	44.655	1	44.655	.104	.751
TIME*COND*GENDER	16.887	1	16.887	.039	.845
Error(TIME*COND)	6864.053	16	429.003		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		7334.826	1	7334.826	9.683	.007
TIME * GENDER	2 vs. 1		576.580	1	576.580	.761	.396
Error(TIME)	2 vs. 1		12120.120	16	757.507		
COND		2 vs. 1	3814.333	1	3814.333	5.696	.030
COND * GENDER		2 vs. 1	996.440	1	996.440	1.488	.240
Error(COND)		2 vs. 1	10715.328	16	669.708		
TIME * COND	2 vs. 1	2 vs. 1	178.619	1	178.619	.104	.751
TIME*COND*GENDER	2 vs. 1	2 vs. 1	67.548	1	67.548	.039	.845
Error(TIME*COND)	2 vs. 1	2 vs. 1	27456.213	16	1716.013		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	259915.230	1	259915.230	2134.918	.000
GENDER	394.577	1	394.577	3.241	.091
Error	1947.918	16	121.745		

CH 4. ANOVA Table for **Systolic Blood Pressure** with 2-within factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing] separately in men & women > 55 years.

Descriptive Statistics

gender		Mean	Std. Deviation	N
female	SBPR1	117.8343	23.8181	8
	SBPS1	140.5789	19.2664	8
	SBPR2	92.4374	20.5794	8
	SBPS2	113.9615	28.2390	8
male	SBPR1	128.0736	20.1214	10
	SBPS1	137.7942	19.7278	10
	SBPR2	116.0159	36.7281	10
	SBPS2	120.6175	18.5230	10

Tests of Within-Subjects Effects

Measure: MEASURE_1

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	TIME	5410.964	1	5410.964	6.132	.042
	Error(TIME)	6176.883	7	882.412		
	COND	3919.444	1	3919.444	7.961	.026
	Error(COND)	3446.167	7	492.310		
	TIME * COND	2.979	1	2.979 .008	.930	
	Error(TIME*COND)	2516.333	7	359.476		
male	TIME	2136.625	1	2136.625	3.236	.106
	Error(TIME)	5943.237	9	660.360		
	COND	512.814	1	512.814	.635	.446
	Error(COND)	7269.161	9	807.685		
	TIME * COND	65.510	1	65.510 .136	.721	
	Error(TIME*COND)	4347.720	9	483.080		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

gender	Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
female	TIME	2 vs. 1		5410.964	1	5410.964	6.132	.042
	Error(TIME)	2 vs. 1		6176.883	7	882.412		
	COND		2 vs. 1	3919.444	1	3919.444	7.961	.026
	Error(COND)		2 vs. 1	3446.167	7	492.310		
	TIME * COND	2 vs. 1	2 vs. 1	11.917	1	11.917	.008	.930
	Error(TIME*COND)	2 vs. 1	2 vs. 1	10065.333	7	1437.905		
male	TIME	2 vs. 1		2136.625	1	2136.625	3.236	.106
	Error(TIME)	2 vs. 1		5943.237	9	660.360		
	COND		2 vs. 1	512.814	1	512.814	.635	.446
	Error(COND)		2 vs. 1	7269.161	9	807.685		
	TIME * COND	2 vs. 1	2 vs. 1	262.042	1	262.042	.136	.721
	Error(TIME*COND)	2 vs. 1	2 vs. 1	17390.880	9	1932.320		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	108025.098	1	108025.098	1016.105	.000
	Error	744.190	7	106.313		
male	Intercept	157817.160	1	157817.160	1179.964	.000
	Error	1203.727	9	133.747		

CH 4. ANOVA Table for **R-R Interval** with 1-between (gender) and 2-within factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing] in subjects > 55 years.

Descriptive Statistics

	gender	Mean	Std. Deviation	N
RRIR1	female	942.3665	120.8218	7
	male	1084.3451	128.8202	10
	Total	1025.8833	141.4087	17
RRIS1	female	842.8563	137.7277	7
	male	989.9715	165.7831	10
	Total	929.3947	167.7587	17
RRIR2	female	680.7979	122.4177	7
	male	748.2625	89.7042	10
	Total	720.4830	106.3836	17
RRIS2	female	655.8067	119.6844	7
	male	678.6136	114.1655	10
	Total	669.2225	113.3004	17

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	Type III SS	df	Mean Square	F	Sig.
TIME	1236678.402	1	1236678.402	46.103	.000
TIME * GENDER	40692.966	1	40692.966	1.517	.237
Error(TIME)	402366.917	15	26824.461		
COND	85694.403	1	85694.403	36.800	.000
COND * GENDER	1607.851	1	1607.851	.690	.419
Error(COND)	34929.695	15	2328.646		
TIME * COND	10138.983	1	10138.983	9.536	.007
TIME*COND*GENDER	2552.391	1	2552.391	2.400	.142
Error(TIME*COND)	15949.146	15	1063.276		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
TIME	2 vs. 1		1236678.402	1	1236678.402	46.103	.000
TIME * GENDER	2 vs. 1		40692.966	1	40692.966	1.517	.237
Error(TIME)	2 vs. 1		402366.917	15	26824.461		
COND		2 vs. 1	85694.403	1	85694.403	36.800	.000
COND * GENDER		2 vs. 1	1607.851	1	1607.851	.690	.419
Error(COND)		2 vs. 1	34929.695	15	2328.646		
TIME * COND	2 vs. 1	2 vs. 1	40555.931	1	40555.931	9.536	.007
TIME*COND*GENDER	2 vs. 1	2 vs. 1	10209.564	1	10209.564	2.400	.142
Error(TIME*COND)	2 vs. 1	2 vs. 1	63796.583	15	4253.106		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	11288631.228	1	11288631.228	1326.900	.000
GENDER	37037.746	1	37037.746	4.354	.054
Error	127612.838	15	8507.523		

CH 4. ANOVA Table for **R-R Interval** with 2-within factors (time [preoperatively vs. postoperatively] and condition [supine vs. standing] separately in men & women > 55 years.

Descriptive Statistics

gender		Mean	Std. Deviation	N
female	RRIR1	942.3665	120.8218	7
	RRIS1	842.8563	137.7277	7
	RRIR2	680.7979	122.4177	7
	RRIS2	655.8067	119.6844	7
male	RRIR1	1084.3451	128.8202	10
	RRIS1	989.9715	165.7831	10
	RRIR2	748.2625	89.7042	10
	RRIS2	678.6136	114.1655	10

Tests of Within-Subjects Effects
Measure: MEASURE_1

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	TIME	352202.022	1	352202.022	17.105	.006
	Error(TIME)	123543.260	6	20590.543		
	COND	27126.042	1	27126.042	38.879	.001
	Error(COND)	4186.172	6	697.695		
	TIME * COND	9717.874	1	9717.874	8.805	.025
	Error(TIME*COND)	6622.435	6	1103.739		
male	TIME	1047948.058	1	1047948.058	33.826	.000
	Error(TIME)	278823.657	9	30980.406		
	COND	67258.391	1	67258.391	19.690	.002
	Error(COND)	30743.523	9	3415.947		
	TIME * COND	1528.277	1	1528.277	1.475	.256
	Error(TIME*COND)	9326.710	9	1036.301		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

gender	Source	TIME	COND	Type III SS	df	Mean Square	F	Sig.
female	TIME	2 vs. 1		352202.022	1	352202.022	17.105	.006
	Error(TIME)	2 vs. 1		123543.260	6	20590.543		
	COND		2 vs. 1	27126.042	1	27126.042	38.879	.001
	Error(COND)		2 vs. 1	4186.172	6	697.695		
	TIME * COND	2 vs. 1	2 vs. 1	38871.496	1	38871.496	8.805	.025
	Error(TIME*COND)	2 vs. 1	2 vs. 1	26489.742	6	4414.957		
male	TIME	2 vs. 1		1047948.058	1	1047948.058	33.826	.000
	Error(TIME)	2 vs. 1		278823.657	9	30980.406		
	COND		2 vs. 1	67258.391	1	67258.391	19.690	.002
	Error(COND)		2 vs. 1	30743.523	9	3415.947		
	TIME * COND	2 vs. 1	2 vs. 1	6113.106	1	6113.106	1.475	.256
	Error(TIME*COND)	2 vs. 1	2 vs. 1	37306.841	9	4145.205		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

gender	Source	Type III SS	df	Mean Square	F	Sig.
female	Intercept	4263790.181	1	4263790.181	421.268	.000
	Error	60727.976	6	10121.329		
male	Intercept	7661469.210	1	7661469.210	1030.924	.000
	Error	66884.862	9	7431.651		

APPENDIX E
ANOVA TABLES
Chapter 5

Ch 5: ANOVA Table: **Fractal Power** with 1-between (gender) and 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
FPR2	FEMALE	49.8127	40.5319	6
	MALE	60.8355	72.1544	16
	Total	57.8293	64.3052	22
FPS2	FEMALE	43.8001	47.5440	6
	MALE	83.4593	179.6401	16
	Total	72.6432	154.6461	22
FPR3	FEMALE	344.5437	494.5087	6
	MALE	1064.5222	3628.1952	16
	Total	868.1645	3093.3237	22
FPS3	FEMALE	195.6044	182.6867	6
	MALE	176.9419	222.0083	16
	Total	182.0316	207.9042	22
FPR4	FEMALE	204.3061	133.7117	6
	MALE	363.2993	371.2596	16
	Total	319.9375	328.5761	22
FPS4	FEMALE	152.4488	87.0529	6
	MALE	174.4978	113.8745	16
	Total	168.4844	105.6777	22

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Time	2618968.102	2	1309484.051	.771	.469
T * GENDER	517093.247	2	258546.623	.152	.859
Error(T)	67943092.035	40	1698577.301		
Condition	1155658.195	1	1155658.195	.683	.418
C * GENDER	521689.034	1	521689.034	.308	.585
Error(C)	33850811.859	20	1692540.593		
T * C	1315394.087	2	657697.043	.384	.684
T * C * GENDER	711396.908	2	355698.454	.208	.813
Error(T*C)	68551191.538	40	1713779.788		

Tests of Within-Subjects Contrasts

Source	Time	Condition	Type III SS	df	Mean Square	F	Sig.
Time	2 vs.1		2599662.071	1	2599662.071	1.044	.319
	3 vs. 1		470379.920	1	470379.920	12.903	.002
T * GENDER	2 vs.1		461808.686	1	461808.686	.185	.671
	3 vs. 1		18538.687	1	18538.687	.509	.484
Error(T)	2 vs.1		49797077.718	20	2489853.886		
	3 vs. 1		729100.012	20	36455.001		
Condition		2 vs. 1	770438.797	1	770438.797	.683	.418
C * GENDER		2 vs. 1	347792.690	1	347792.690	.308	.585
Error(C)		2 vs. 1	22567207.906	20	1128360.395		
T * C	2 vs.1	2 vs. 1	4839641.525	1	4839641.525	.478	.497
	3 vs.1	2 vs. 1	288819.594	1	288819.594	2.178	.156
T*C*GENDER	2 vs.1	2 vs. 1	2568936.716	1	2568936.716	.254	.620
	3 vs.1	2 vs. 1	119637.424	1	119637.424	.902	.353
Error(T*C)	2 vs.1	2 vs. 1	202568751.39	20	10128437.570		
	3 vs.1	2 vs. 1	2651578.338	20	132578.917		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	1029310.848	1	1029310.848	3.835	.064
GENDER	105522.918	1	105522.918	.393	.538
Error	5368627.688	20	268431.384		

Ch 5: ANOVA Table for **Fractal Power** with 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Time	302270.504	2	151135.252	3.157	.087
	Error(T)	478749.034	10	47874.903		
	Condition	42770.056	1	42770.056	1.202	.323
	Error(C)	177918.513	5	35583.703		
	T * C	31954.687	2	15977.343	.388	.688
	Error(T*C)	411675.670	10	41167.567		
MALE	T	4943391.130	2	2471695.565	1.099	.346
	Error(T)	67464343.001	30	2248811.433		
	C	2961083.106	1	2961083.106	1.319	.269
	Error(C)	33672893.346	15	2244859.556		
	T * C	3630570.992	2	1815285.496	.799	.459
	Error(T*C)	68139515.868	30	2271317.196		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	Time	Cond	Type III SS	df	Mean Square	F	Sig.
FEMALE	Time	2 vs. 1		299090.576	1	299090.576	4.586	.085
		3 vs. 1		103865.542	1	103865.542	18.694	.008
	Error(T)	2 vs. 1		326114.844	5	65222.969		
		3 vs. 1		27780.590	5	5556.118		
	C		2 vs. 1	28513.370	1	28513.370	1.202	.323
	Error(C)		2 vs. 1	118612.342	5	23722.468		
	T * C	2 vs. 1	2 vs. 1	122568.232	1	122568.232	.516	.505
		3 vs. 1	2 vs. 1	12610.425	1	12610.425	.720	.435
	Error(T*C)	2 vs. 1	2 vs. 1	1188436.908	5	237687.382		
		3 vs. 1	2 vs. 1	87607.748	5	17521.550		
MALE	T	2 vs. 1		4815121.518	1	4815121.518	1.460	.246
		3 vs. 1		619376.002	1	619376.002	13.247	.002
	Error(T)	2 vs. 1		49470962.874	15	3298064.192		
		3 vs. 1		701319.422	15	46754.628		
	C		2 vs. 1	1974055.404	1	1974055.404	1.319	.269
	Error(C)		2 vs. 1	22448595.564	15	1496573.038		
	T * C	2 vs. 1	2 vs. 1	13255544.823	1	13255544.823	.987	.336
		3 vs. 1	2 vs. 1	715210.067	1	715210.067	4.184	.059
	Error(T*C)	2 vs. 1	2 vs. 1	201380314.48	15	13425354.299		
		3 vs. 1	2 vs. 1	2563970.590	15	170931.373		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Intercept	163520.254	1	163520.254	10.482	.023
	Error	78004.169	5	15600.834		
MALE	Intercept	1644474.559	1	1644474.559	4.662	.047
	Error	5290623.519	15	352708.235		

Ch 5: ANOVA Table for **High Frequency Power** with 1-between (gender) and 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
HFR2	FEMALE	25.476370	57.529397	6
	MALE	2.183538	3.002161	16
	Total	8.536129	30.119500	22
HFS2	FEMALE	2.245635	3.083537	6
	MALE	15.423583	56.985112	16
	Total	11.829597	48.557706	22
HFR3	FEMALE	47.525515	54.905240	6
	MALE	17.125015	21.332624	16
	Total	25.416060	35.140514	22
HFS3	FEMALE	21.698318	34.253757	6
	MALE	59.909022	215.831093	16
	Total	49.487921	184.000992	22
HFR4	FEMALE	42.289355	62.063771	6
	MALE	56.267133	104.692001	16
	Total	52.455012	93.736801	22
HFS4	FEMALE	12.817773	13.782949	6
	MALE	17.643642	25.837536	16
	Total	16.327496	22.954558	22

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Time	12718.283	2	6359.142	.821	.447
T * GENDER	929.779	2	464.889	.060	.942
Error(T)	309700.430	40	7742.511		
Cond	2717.636	1	2717.636	.310	.584
C * GENDER	6692.785	1	6692.785	.764	.393
Error(C)	175305.653	20	8765.283		
T * C	8244.444	2	4122.222	.538	.588
T* C * GENDER	6662.937	2	3331.469	.435	.650
Error(T*C)	306447.632	40	7661.191		

Tests of Within-Subjects Contrasts

Source	Time	Cond	Type III SS	df	Mean Square	F	Sig.
T	2 vs. 1		11112.667	1	11112.667	1.086	.310
	3 vs. 1		7640.522	1	7640.522	2.523	.128
T * GENDER	2 vs. 1		350.519	1	350.519	.034	.855
	3 vs. 1		912.307	1	912.307	.301	.589
Error(T)	2 vs. 1		204577.490	20	10228.874		
	3 vs. 1		60574.712	20	3028.736		
C		2 vs. 1	1811.757	1	1811.757	.310	.584
C * GENDER		2 vs. 1	4461.857	1	4461.857	.764	.393
Error(C)		2 vs. 1	116870.435	20	5843.522		
T * C	2 vs. 1	2 vs. 1	3168.732	1	3168.732	.078	.783
	3 vs. 1	2 vs. 1	14732.157	1	14732.157	.996	.330
T*C*GENDER	2 vs. 1	2 vs. 1	4507.666	1	4507.666	.111	.742
	3 vs. 1	2 vs. 1	9082.603	1	9082.603	.614	.442
Error(T*C)	2 vs. 1	2 vs. 1	810772.449	20	40538.622		
	3 vs. 1	2 vs. 1	295730.042	20	14786.502		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	12459.091	1	12459.091	7.662	.012
GENDER	32.996	1	32.996 .020	.888	
Error	32521.279	20	1626.064		

Ch. 5: ANOVA Table for **High Frequency Power** with 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Tests of Within-Subjects Effects

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Time	2671.628	2	1335.814	.605	.565
	Error(T)	22067.988	10	2206.799		
	Cond	6166.884	1	6166.884	7.018	.045
	Error(C)	4393.497	5	878.699		
	T * C	58.971	2	29.486	.023	.977
	Error(T*C)	12629.056	10	1262.906		
MALE	T	17897.105	2	8948.553	.933	.404
	Error(T)	287632.443	30	9587.748		
	C	807.412	1	807.412	.071	.794
	Error(C)	170912.156	15	11394.144		
	T * C	27172.941	2	13586.470	1.387	.265
	Error(T*C)	293818.576	30	9793.953		

Tests of Within-Subjects Contrasts

GENDER	Source	Time	Cond	Type III SS	df	Mean Square	F	Sig.
FEMALE	T	2 vs. 1		2583.603	1	2583.603	.820	.407
		3 vs. 1		1124.917	1	1124.917	.421	.545
	Error(T)	2 vs. 1		15758.026	5	3151.605		
		3 vs. 1		13364.200	5	2672.840		
	C		2 vs. 1	4111.256	1	4111.256	7.018	.045
	Error(C)		2 vs. 1	2928.998	5	585.800		
	T * C	2 vs. 1	2 vs. 1	40.450	1	40.450	.009	.928
		3 vs. 1	2 vs. 1	233.689	1	233.689	.033	.862
	Error(T*C)	2 vs. 1	2 vs. 1	22415.003	5	4483.001		
		3 vs. 1	2 vs. 1	34977.666	5	6995.533		
MALE	T	2 vs. 1		14126.233	1	14126.233	1.122	.306
		3 vs. 1		12680.406	1	12680.406	4.029	.063
	Error(T)	2 vs. 1		188819.463	15	12587.964		
		3 vs. 1		47210.512	15	3147.367		
	C		2 vs. 1	538.275	1	538.275	.071	.794
	Error(C)		2 vs. 1	113941.437	15	7596.096		
	T * C	2 vs. 1	2 vs. 1	13965.531	1	13965.531	.266	.614
		3 vs. 1	2 vs. 1	43037.222	1	43037.222	2.476	.136
	Error(T*C)	2 vs. 1	2 vs. 1	788357.446	15	52557.163		
		3 vs. 1	2 vs. 1	260752.376	15	17383.492		

Tests of Between-Subjects Effects

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Intercept	3853.351	1	3853.351	6.197	.055
	Error	3109.015	5	621.803		
MALE	Intercept	12626.557	1	12626.557	6.439	.023
	Error	29412.264	15	1960.818		

Ch. 5: ANOVA Table for **Low Frequency Power** with 1-between (gender) and 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
LFR2	FEMALE	10.182468	8.978690	6
	MALE	13.382568	15.648590	16
	Total	12.509814	14.008410	22
LFS2	FEMALE	18.756387	21.071410	6
	MALE	18.335097	36.514080	16
	Total	18.449994	32.528352	22
LFR3	FEMALE	155.303508	227.222302	6
	MALE	88.261633	103.295490	16
	Total	106.545781	144.389042	22
LFS3	FEMALE	18.754570	24.717427	6
	MALE	35.105318	41.547475	16
	Total	30.646023	37.868350	22
LFR4	FEMALE	77.517853	67.684820	6
	MALE	223.063076	565.384490	16
	Total	183.368924	483.550224	22
LFS4	FEMALE	43.722030	42.078522	6
	MALE	66.899514	81.446444	16
	Total	60.578382	72.604599	22

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
T	139554.254	2	69777.127	1.604	.214
T * GENDER	57119.157	2	28559.579	.656	.524
Error(T)	1740462.859	40	43511.571		
C	97496.127	1	97496.127	2.162	.157
C * GENDER	1319.609	1	1319.609	.029	.866
Error(C)	901949.502	20	45097.475		
T * C	60152.489	2	30076.245	.645	.530
T*C*GENDER	46552.335	2	23276.167	.499	.611
Error(T*C)	1865247.908	40	46631.198		

Tests of Within-Subjects Contrasts

Source	Time	Cond	Type III SS	df	Mean Square	F	Sig.
T	2 vs. 1		61155.630	1	61155.630	10.312	.004
	3 vs. 1		134053.598	1	134053.598	2.271	.147
T * GENDER	2 vs. 1		3118.946	1	3118.946	.526	.477
	3 vs. 1		30040.775	1	30040.775	.509	.484
Error(T)	2 vs. 1		118609.821	20	5930.491		
	3 vs. 1		1180664.751	20	59033.238		
C		2 vs. 1	64997.418	1	64997.418	2.162	.157
C * GENDER		2 vs. 1	879.739	1	879.739	.029	.866
Error(C)		2 vs. 1	601299.668	20	30064.983		
T * C	2 vs. 1	2 vs. 1	180231.814	1	180231.814	8.416	.009
	3 vs. 1	2 vs. 1	180682.839	1	180682.839	.719	.406
T*C*GENDER	2 vs. 1	2 vs. 1	33039.004	1	33039.004	1.543	.229
	3 vs. 1	2 vs. 1	61530.307	1	61530.307	.245	.626
Error(T*C)	2 vs. 1	2 vs. 1	428314.986	20	21415.749		
	3 vs. 1	2 vs. 1	5024128.771	20	251206.439		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	71733.080	1	71733.080	9.651	.006
GENDER	1769.109	1	1769.109	.238	.631
Error	148656.404	20	7432.820		

Ch. 5: ANOVA Table for **Low Frequency Power** with 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	T	32368.831	2	16184.415	2.072	.177
	Error(T)	78108.753	10	7810.875		
	C	26169.806	1	26169.806	2.793	.156
	Error(C)	46855.855	5	9371.171		
	T * C	33414.041	2	16707.021	2.032	.182
	Error(T*C)	82216.160	10	8221.616		
MALE	T	274251.038	2	137125.519	2.475	.101
	Error(T)	1662354.106	30	55411.804		
	C	111376.035	1	111376.035	1.954	.183
	Error(C)	855093.647	15	57006.243		
	T * C	106521.401	2	53260.700	.896	.419
	Error(T*C)	1783031.747	30	59434.392		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	Time	Cond	Type III SS	df	Mean Square	F	Sig.
FEMALE	Time	2 vs. 1		31589.383	1	31589.383	2.299	.190
		3 vs. 1		12779.220	1	12779.220	13.009	.015
	Error(T)	2 vs. 1		68697.714	5	13739.543		
		3 vs. 1		4911.841	5	982.368		
	Cond		2 vs. 1	17446.537	1	17446.537	2.793	.156
	Error(C)		2 vs. 1	31237.237	5	6247.447		
	T * C	2 vs. 1	2 vs. 1	126363.861	1	126363.861	2.857	.152
		3 vs. 1	2 vs. 1	10771.170	1	10771.170	1.091	.344
	Error(T*C)	2 vs. 1	2 vs. 1	221154.228	5	44230.846		
		3 vs. 1	2 vs. 1	49367.219	5	9873.444		
MALE	T	2 vs. 1		33598.367	1	33598.367	10.097	.006
		3 vs. 1		266761.764	1	266761.764	3.403	.085
	Error(T)	2 vs. 1		49912.106	15	3327.474		
		3 vs. 1		1175752.910	15	78383.527		
	C		2 vs. 1	74250.690	1	74250.690	1.954	.183
	Error(C)		2 vs. 1	570062.431	15	38004.162		
	T * C	2 vs. 1	2 vs. 1	54026.204	1	54026.204	3.912	.067
		3 vs. 1	2 vs. 1	415334.315	1	415334.315	1.252	.281
	Error(T*C)	2 vs. 1	2 vs. 1	207160.758	15	13810.717		
		3 vs. 1	2 vs. 1	4974761.552	15	331650.770		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Intercept	17521.586	1	17521.586	5.946	.059
	Error	14734.358	5	2946.872		
MALE	Intercept	88029.785	1	88029.785	9.860	.007
	Error	133922.045	15	8928.136		

Ch. 5: ANOVA Table for **Parasympathetic (PNS) Indicator** with 1-between (gender) and 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
PNSR2	FEMALE	.145017	.197582	6
	MALE	2.98444E-02	2.23046E-02	16
	Total	6.12550E-02	.111385	22
PNSS2	FEMALE	3.42533E-02	1.79630E-02	6
	MALE	3.40019E-02	5.37122E-02	16
	Total	3.40705E-02	4.62337E-02	22
PNSR3	FEMALE	.116980	6.42321E-02	6
	MALE	5.97356E-02	6.97835E-02	16
	Total	7.53477E-02	7.17051E-02	22
PNSS3	FEMALE	5.26383E-02	5.21416E-02	6
	MALE	6.99313E-02	.118467	16
	Total	6.52150E-02	.103605	22
PNSR4	FEMALE	9.62250E-02	5.22065E-02	6
	MALE	8.27988E-02	7.15276E-02	16
	Total	8.64605E-02	6.58848E-02	22
PNSS4	FEMALE	5.41467E-02	4.79553E-02	6
	MALE	6.57250E-02	8.30060E-02	16
	Total	6.25673E-02	7.41407E-02	22

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Time	4.557E-03	2	2.279E-03	.372	.692
T * GENDER	1.458E-02	2	7.290E-03	1.190	.315
Error(T)	.245	40	6.124E-03		
Cond	3.517E-02	1	3.517E-02	4.570	.045
C * GENDER	3.345E-02	1	3.345E-02	4.346	.050
Error(C)	.154	20	7.696E-03		
T * C	3.657E-03	2	1.829E-03	.333	.719
T*C*GENDER	8.850E-03	2	4.425E-03	.806	.454
Error(T*C)	.220	40	5.493E-03		

Tests of Within-Subjects Contrasts

Source	Time	Cond	Type III SS	df	Mean Square	F	Sig.
T	2 vs. 1		3.442E-03	1	3.442E-03	.367	.552
	3 vs. 1		3.394E-03	1	3.394E-03	.600	.448
T * GENDER	2 vs. 1		6.214E-03	1	6.214E-03	.662	.425
	3 vs. 1		1.407E-02	1	1.407E-02	2.487	.130
Error(T)	2 vs. 1		.188	20	9.380E-03		
	3 vs. 1		.113	20	5.659E-03		
C		2 vs. 1	2.345E-02	1	2.345E-02	4.570	.045
C * GENDER		2 vs. 1	2.230E-02	1	2.230E-02	4.346	.050
Error(C)		2 vs. 1	.103	20	5.131E-03		
T * C	2 vs. 1	2 vs. 1	1.201E-02	1	1.201E-02	.480	.496
	3 vs. 1	2 vs. 1	9.826E-03	1	9.826E-03	.435	.517
T*C*GENDER	2 vs. 1	2 vs. 1	7.116E-03	1	7.116E-03	.285	.600
	3 vs. 1	2 vs. 1	3.528E-02	1	3.528E-02	1.561	.226
Error(T*C)	2 vs. 1	2 vs. 1	.500	20	2.501E-02		
	3 vs. 1	2 vs. 1	.452	20	2.261E-02		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	8.579E-02	1	8.579E-02	67.763	.000
GENDER	2.996E-03	1	2.996E-03	2.367	.140
Error	2.532E-02	20	1.266E-03		

Ch. 5: ANOVA Table for Parasympathetic Indicator with 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Time	1.299E-03	2	6.494E-04	.048	.954
	Error(T)	.137	10	1.366E-02		
	Cond	4.717E-02	1	4.717E-02	10.347	.024
	Error(C)	2.279E-02	5	4.559E-03		
	T * C	7.368E-03	2	3.684E-03	.519	.610
	Error(T*C)	7.103E-02	10	7.103E-03		
MALE	T	3.162E-02	2	1.581E-02	4.377	.021
	Error(T)	.108	30	3.612E-03		
	C	1.974E-05	1	1.974E-05	.002	.963
	Error(C)	.131	15	8.742E-03		
	T * C	3.282E-03	2	1.641E-03	.331	.721
	Error(T*C)	.149	30	4.957E-03		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	Time	Cond	Type III SS	df	Mean Square	F	Sig.
FEMALE	Time	2 vs. 1		1.397E-04	1	1.397E-04	.006	.940
		3 vs. 1		1.253E-03	1	1.253E-03	.067	.806
	Error(T)	2 vs. 1		.110	5	2.201E-02		
		3 vs. 1		9.380E-02	5	1.876E-02		
	Cond		2 vs. 1	3.145E-02	1	3.145E-02	10.347	.024
	Error(C)		2 vs. 1	1.520E-02	5	3.039E-03		
	T * C	2 vs. 1	2 vs. 1	1.293E-02	1	1.293E-02	.319	.597
		3 vs. 1	2 vs. 1	2.831E-02	1	2.831E-02	.681	.447
	Error(T*C)	2 vs. 1	2 vs. 1	.203	5	4.052E-02		
		3 vs. 1	2 vs. 1	.208	5	4.159E-02		
MALE	T	2 vs. 1		1.733E-02	1	1.733E-02	3.353	.087
		3 vs. 1		2.868E-02	1	2.868E-02	22.210	.000
	Error(T)	2 vs. 1		7.753E-02	15	5.169E-03		
		3 vs. 1		1.937E-02	15	1.291E-03		
	C		2 vs. 1	1.316E-05	1	1.316E-05	.002	.963
	Error(C)		2 vs. 1	8.742E-02	15	5.828E-03		
	T * C	2 vs. 1	2 vs. 1	5.833E-04	1	5.833E-04	.029	.866
		3 vs. 1	2 vs. 1	7.212E-03	1	7.212E-03	.443	.516
	Error(T*C)	2 vs. 1	2 vs. 1	.298	15	1.984E-02		
		3 vs. 1	2 vs. 1	.244	15	1.628E-02		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Intercept	4.154E-02	1	4.154E-02	48.423	.001
	Error	4.290E-03	5	8.579E-04		
MALE	Intercept	5.200E-02	1	5.200E-02	37.084	.000
	Error	2.103E-02	15	1.402E-03		

Ch. 5: ANOVA Table for SDNN with 1-between (gender) and 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
RRISDR2	FEMALE	20.3575	14.2606	6
	MALE	14.1298	6.4852	16
	Total	15.8283	9.3017	22
RRISDS2	FEMALE	12.3921	6.3731	6
	MALE	22.7809	38.7256	16
	Total	19.9476	33.2159	22
RRISDR3	FEMALE	31.1701	26.8470	6
	MALE	39.0499	53.1931	16
	Total	36.9008	46.9637	22
RRISDS3	FEMALE	24.8467	12.9687	6
	MALE	26.0613	12.2231	16
	Total	25.7300	12.1272	22
RRISDR4	FEMALE	29.8194	15.1822	6
	MALE	33.9446	15.7650	16
	Total	32.8195	15.3604	22
RRISDS4	FEMALE	23.5064	6.1155	6
	MALE	28.4173	9.6951	16
	Total	27.0780	9.0030	22

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
T	3488.738	2	1744.369	2.353	.108
T * GENDER	34.987	2	17.493	.024	.977
Error(T)	29658.954	40	741.474		
C	675.064	1	675.064	1.142	.298
C * GENDER	83.844	1	83.844	.142	.710
Error(C)	11820.216	20	591.011		
T * C	445.559	2	222.779	.425	.656
T*C*GENDER	616.849	2	308.425	.589	.560
Error(T*C)	20952.147	40	523.804		

Tests of Within-Subjects Contrasts

Source	Time	Cond	Type III SS	df	Mean Square	F	Sig.
T	2 vs. 1		2889.713	1	2889.713	2.832	.108
	3 vs. 1		2311.107	1	2311.107	6.284	.021
T * GENDER	2 vs. 1		26.550	1	26.550	.026	.873
	3 vs. 1		25.927	1	25.927	.070	.793
Error(T)	2 vs. 1		20410.568	20	1020.528		
	3 vs. 1		7355.459	20	367.773		
C		2 vs. 1	450.042	1	450.042	1.142	.298
C * GENDER		2 vs. 1	55.896	1	55.896	.142	.710
Error(C)		2 vs. 1	7880.144	20	394.007		
T * C	2 vs. 1	2 vs. 1	1745.078	1	1745.078	.622	.439
	3 vs. 1	2 vs. 1	684.663	1	684.663	.604	.446
T* C*GENDER	2 vs. 1	2 vs. 1	2365.251	1	2365.251	.843	.369
	3 vs. 1	2 vs. 1	1093.596	1	1093.596	.966	.338
Error(T*C)	2 vs. 1	2 vs. 1	56094.168	20	2804.708		
	3 vs. 1	2 vs. 1	22653.402	20	1132.670		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	11385.159	1	11385.159	77.979	.000
GENDER	60.231	1	60.231	.413	.528
Error	2920.075	20	146.004		

Ch. 5: ANOVA Table for **SDNN** with 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Time	971.978	2	485.989	2.343	.146
	Error(T)	2074.086	10	207.409		
	Cond	424.436	1	424.436	6.648	.050
	Error(C)	319.219	5	63.844		
	T * C	5.426	2	2.713	.019	.981
	Error(T*C)	1432.363	10	143.236		
MALE	T	3868.221	2	1934.110	2.103	.140
	Error(T)	27584.868	30	919.496		
	C	259.501	1	259.501	.338	.569
	Error(C)	11500.998	15	766.733		
	T * C	1933.277	2	966.639	1.486	.243
	Error(T*C)	19519.784	30	650.659		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	Time	Cond	Type III SS	df	Mean Square	F	Sig.
FEMALE	Time	2 vs. 1		812.038	1	812.038	2.726	.160
		3 vs. 1		635.066	1	635.066	7.788	.038
	Error(T)	2 vs. 1		1489.283	5	297.857		
		3 vs. 1		407.718	5	81.544		
	C		2 vs. 1	282.958	1	282.958	6.648	.050
	Error(C)		2 vs. 1	212.813	5	42.563		
	T * C	2 vs. 1	2 vs. 1	16.175	1	16.175	.020	.894
		3 vs. 1	2 vs. 1	16.383	1	16.383	.030	.869
	Error(T*C)	2 vs. 1	2 vs. 1	4114.005	5	822.801		
		3 vs. 1	2 vs. 1	2718.097	5	543.619		
MALE	T	2 vs. 1		3181.047	1	3181.047	2.522	.133
		3 vs. 1		2591.051	1	2591.051	5.594	.032
	Error(T)	2 vs. 1		18921.285	15	1261.419		
		3 vs. 1		6947.741	15	463.183		
	C		2 vs. 1	173.001	1	173.001	.338	.569
	Error(C)		2 vs. 1	7667.332	15	511.155		
	T * C	2 vs. 1	2 vs. 1	7492.470	1	7492.470	2.162	.162
		3 vs. 1	2 vs. 1	3216.454	1	3216.454	2.420	.141
	Error(T*C)	2 vs. 1	2 vs. 1	51980.163	15	3465.344		
		3 vs. 1	2 vs. 1	19935.305	15	1329.020		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Intercept	3365.038	1	3365.038	31.761	.002
	Error	529.745	5	105.949		
MALE	Intercept	12009.780	1	12009.780	75.365	.000
	Error	2390.330	15	159.355		

Ch. 5: ANOVA Table for SNS Indicator with 1-between (gender) and 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
SNSR2	FEMALE	12.887318	20.756584	6
	MALE	9.163345	9.912879	16
	Total	10.178974	13.253340	22
SNSS2	FEMALE	14.094723	15.697129	6
	MALE	33.624729	48.319256	16
	Total	28.298364	42.492374	22
SNSR3	FEMALE	3.421148	5.581283	6
	MALE	19.159583	35.315653	16
	Total	14.867283	30.817859	22
SNSS3	FEMALE	7.618167	13.580284	6
	MALE	13.897909	17.954642	16
	Total	12.185252	16.803824	22
SNSR4	FEMALE	3.183327	2.749740	6
	MALE	7.582214	14.516477	16
	Total	6.382518	12.503646	22
SNSS4	FEMALE	9.594118	11.138624	6
	MALE	12.645016	22.270113	16
	Total	11.812953	19.640010	22

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Time	1551.892	2	775.946	1.950	.156
T * GENDER	233.204	2	116.602	.293	.748
Error(T)	15913.283	40	397.832		
Posture	946.620	1	946.620	2.275	.147
P * GENDER	112.680	1	112.680	.271	.609
Error(P)	8321.990	20	416.099		
T * P	780.646	2	390.323	.626	.540
T * P * GENDER	1266.298	2	633.149	1.016	.371
Error(T*P)	24937.950	40	623.449		

Tests of Within-Subjects Contrasts

Source	Time	Posture	Type III SS	df	Mean Square	F	Sig.
T	2 vs. 1		1438.077	1	1438.077	1.217	.283
	3 vs. 1		2949.158	1	2949.158	2.955	.101
T * GENDER	2 vs. 1		84.198	1	84.198	.071	.792
	3 vs. 1		152.350	1	152.350	.153	.700
Error(T)	2 vs. 1		23624.800	20	1181.240		
	3 vs. 1		19963.742	20	998.187		
P		2 vs. 1	315.540	1	315.540	2.275	.147
P * GENDER		2 vs. 1	37.560	1	37.560	.271	.609
Error(P)		2 vs. 1	2773.997	20	138.700		
T * P	2 vs. 1	2 vs. 1	1559.295	1	1559.295	.796	.383
	3 vs. 1	2 vs. 1	439.644	1	439.644	.417	.526
T * P * GENDER	2 vs. 1	2 vs. 1	2334.805	1	2334.805	1.191	.288
	3 vs. 1	2 vs. 1	1320.560	1	1320.560	1.253	.276
Error(T*P)	2 vs. 1	2 vs. 1	39196.572	20	1959.829		
	3 vs. 1	2 vs. 1	21079.500	20	1053.975		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	5229.398	1	5229.398	11.801	.003
GENDER	496.905	1	496.905	1.121	.302
Error	8862.657	20	443.133		

Ch. 5: ANOVA Table for **SNS Indicator** with 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	T	458.962	2	229.481	1.042	.388
	Error(T)	2202.238	10	220.224		
	P	139.599	1	139.599	.983	.367
	Error(P)	709.960	5	141.992		
	T * P	40.914	2	20.457	.116	.891
	Error(T*P)	1757.106	10	175.711		
MALE	T	2048.777	2	1024.389	2.241	.124
	Error(T)	13711.045	30	457.035		
	P	1569.785	1	1569.785	3.093	.099
	Error(P)	7612.030	15	507.469		
	T * P	3643.626	2	1821.813	2.358	.112
	Error(T*P)	23180.844	30	772.695		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	Time	Posture	Type III SS	df	Mean Square	F	Sig.
FEMALE	Time	2 vs. 1		762.512	1	762.512	1.138	.335
		3 vs. 1		605.312	1	605.312	1.326	.302
	Error(T)	2 vs. 1		3351.217	5	670.243		
		3 vs. 1		2282.381	5	456.476		
	Posture		2 vs. 1	46.533	1	46.533	.983	.367
	Error(P)		2 vs. 1	236.653	5	47.331		
	T * P	2 vs. 1	2 vs. 1	26.813	1	26.813	.078	.791
		3 vs. 1	2 vs. 1	81.226	1	81.226	.158	.707
	Error(T*P)	2 vs. 1	2 vs. 1	1713.974	5	342.795		
		3 vs. 1	2 vs. 1	2565.751	5	513.150		
MALE	T	2 vs. 1		757.474	1	757.474	.560	.466
		3 vs. 1		4071.933	1	4071.933	3.454	.083
	Error(T)	2 vs. 1		20273.583	15	1351.572		
		3 vs. 1		17681.362	15	1178.757		
	P		2 vs. 1	523.262	1	523.262	3.093	.099
	Error(P)		2 vs. 1	2537.343	15	169.156		
	T * P	2 vs. 1	2 vs. 1	7067.681	1	7067.681	2.828	.113
		3 vs. 1	2 vs. 1	3010.440	1	3010.440	2.439	.139
	Error(T*P)	2 vs. 1	2 vs. 1	37482.598	15	2498.840		
		3 vs. 1	2 vs. 1	18513.749	15	1234.250		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Intercept	860.173	1	860.173	28.489	.003
	Error	150.966	5	30.193		
MALE	Intercept	8204.429	1	8204.429	14.127	.002
	Error	8711.691	15	580.779		

Ch. 5: ANOVA Table for **Total Harmonic Power** with 1-between (gender) and 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
THPR2	FEMALE	38.3289	60.9970	6
	MALE	22.9846	24.5857	16
	Total	27.1694	36.9668	22
THPS2	FEMALE	21.1562	22.5053	6
	MALE	126.5715	461.2547	16
	Total	97.8219	392.9353	22
THPR3	FEMALE	234.1557	256.5920	6
	MALE	116.6624	128.1645	16
	Total	148.7060	174.0044	22
THPS3	FEMALE	61.2590	61.0942	6
	MALE	97.8187	215.2218	16
	Total	87.8479	185.0742	22
THPR4	FEMALE	164.5483	207.9270	6
	MALE	299.0704	716.8130	16
	Total	262.3825	617.3077	22
THPS4	FEMALE	83.4288	57.1491	6
	MALE	92.3255	91.9762	16
	Total	89.8991	82.6841	22

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Time	212700.444	2	106350.222	1.062	.355
T * GENDER	59943.667	2	29971.834	.299	.743
Error(T)	4006277.359	40	100156.934		
Cond	112435.470	1	112435.470	1.023	.324
C * GENDER	16186.793	1	16186.793	.147	.705
Error(C)	2197829.412	20	109891.471		
T * C	164868.582	2	82434.291	.815	.450
T*C*GENDER	101842.962	2	50921.481	.504	.608
Error(T*C)	4044256.984	40	101106.425		

Tests of Within-Subjects Contrasts

Source	Time	Cond	Type III SS	df	Mean Square	F	Sig.
T	2 vs. 1		98741.907	1	98741.907	2.091	.164
	3 vs. 1		202020.383	1	202020.383	1.480	.238
T * GENDER	2 vs. 1		31901.006	1	31901.006	.675	.421
	3 vs. 1		3104.703	1	3104.703	.023	.882
Error(T)	2 vs. 1		944563.281	20	47228.164		
	3 vs. 1		2730013.631	20	136500.682		
C		2 vs. 1	74956.980	1	74956.980	1.023	.324
C * GENDER		2 vs. 1	10791.196	1	10791.196	.147	.705
Error(C)		2 vs. 1	1465219.608	20	73260.980		
T * C	2 vs. 1	2 vs. 1	337614.455	1	337614.455	1.311	.266
	3 vs. 1	2 vs. 1	611277.780	1	611277.780	1.225	.282
T* C*GENDER	2 vs. 1	2 vs. 1	4836.919	1	4836.919	.019	.892
	3 vs. 1	2 vs. 1	264896.927	1	264896.927	.531	.475
Error(T*C)	2 vs. 1	2 vs. 1	5152222.175	20	257611.109		
	3 vs. 1	2 vs. 1	9982811.270	20	499140.563		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	223637.158	1	223637.158	11.523	.003
GENDER	2821.017	1	2821.017	.145	.707
Error	388156.826	20	19407.841		

Ch. 5: ANOVA Table for **Total Harmonic Power** with 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	T	93442.310	2	46721.155	2.514	.130
	Error(T)	185860.167	10	18586.017		
	C	73543.411	1	73543.411	4.890	.078
	Error(C)	75201.559	5	15040.312		
	T * C	36762.246	2	18381.123	1.654	.240
	Error(T*C)	111148.363	10	11114.836		
MALE	T	250668.046	2	125334.023	.984	.385
	Error(T)	3820417.193	30	127347.240		
	C	39691.719	1	39691:719	.280	.604
	Error(C)	2122627.853	15	141508.524		
	T * C	390938.507	2	195469.254	1.491	.241
	Error(T*C)	3933108.621	30	131103.621		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	T	C	Type III SS	df	Mean Square	F	Sig.
FEMALE	T	2 vs. 1		83494.136	1	83494.136	4.517	.087
		3 vs. 1		53293.844	1	53293.844	3.425	.123
	Error(T)	2 vs. 1		92415.307	5	18483.061		
		3 vs. 1		77794.345	5	15558.869		
	C		2 vs. 1	49028.941	1	49028.941	4.890	.078
	Error(C)		2 vs. 1	50134.373	5	10026.875		
	T * C	2 vs. 1	2 vs. 1	145499.922	1	145499.922	4.042	.101
		3 vs. 1	2 vs. 1	24535.188	1	24535.188	.634	.462
	Error(T*C)	2 vs. 1	2 vs. 1	179991.596	5	35998.319		
		3 vs. 1	2 vs. 1	193528.368	5	38705.674		
MALE	T	2 vs. 1		16860.978	1	16860.978	.297	.594
		3 vs. 1		233945.740	1	233945.740	1.323	.268
	Error(T)	2 vs. 1		852147.974	15	56809.865		
		3 vs. 1		2652219.286	15	176814.619		
	C		2 vs. 1	26461.146	1	26461.146	.280	.604
	Error(C)		2 vs. 1	1415085.235	15	94339.016		
	T * C	2 vs. 1	2 vs. 1	239827.725	1	239827.725	.724	.408
		3 vs. 1	2 vs. 1	1540893.131	1	1540893.131	2.361	.145
	Error(T*C)	2 vs. 1	2 vs. 1	4972230.579	15	331482.039		
		3 vs. 1	2 vs. 1	9789282.901	15	652618.860		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Intercept	60576.780	1	60576.780	7.926	.037
	Error	38213.921	5	7642.784		
MALE	Intercept	253635.240	1	253635.240	10.872	.005
	Error	349942.905	15	23329.527		

Ch.5: ANOVA Table **Total Power** with 1-between (gender) and 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
TPR2	FEMALE	88.1416	95.7877	6
	MALE	83.8202	92.1868	16
	Total	84.9988	90.8777	22
TPS2	FEMALE	64.9564	59.0014	6
	MALE	209.8888	639.3040	16
	Total	170.3618	545.0955	22
TPR3	FEMALE	578.6994	729.7472	6
	MALE	1177.2129	3696.6188	16
	Total	1013.9820	3156.2534	22
TPS3	FEMALE	256.8634	238.5253	6
	MALE	274.7606	428.6677	16
	Total	269.8795	380.6141	22
TPR4	FEMALE	368.8544	311.2852	6
	MALE	652.0921	995.9244	16
	Total	574.8454	864.9949	22
TPS4	FEMALE	235.8776	117.6091	6
	MALE	266.8233	182.4884	16
	Total	258.3835	165.1649	22

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
T	3731924.389	2	1865962.194	.942	.398
T * GENDER	252984.825	2	126492.412	.064	.938
Error(T)	79263303.030	40	1981582.576		
C	1955239.371	1	1955239.371	1.011	.327
C * GENDER	339915.159	1	339915.159	.176	.680
Error(C)	38687921.994	20	1934396.100		
T * C	1924132.474	2	962066.237	.487	.618
T*C*GENDER	583088.247	2	291544.123	.148	.863
Error(T*C)	79035733.655	40	1975893.341		

Tests of Within-Subjects Contrasts

Source	T	C	Type III SS	df	Mean Square	F	Sig.
T	2 vs. 1		3696310.380	1	3696310.380	1.359	.257
	3 vs. 1		1265001.921	1	1265001.921	4.711	.042
T * GENDER	2 vs. 1		246965.886	1	246965.886	.091	.766
	3 vs. 1		32866.240	1	32866.240	.122	.730
Error(T)	2 vs. 1		54398420.650	20	2719921.033		
	3 vs. 1		5370641.109	20	268532.055		
C		2 vs. 1	1303492.914	1	1303492.914	1.011	.327
C * GENDER		2 vs. 1	226610.106	1	226610.106	.176	.680
Error(C)		2 vs. 1	25791947.996	20	1289597.400		
T * C	2 vs. 1	2 vs. 1	7686042.104	1	7686042.104	.708	.410
	3 vs. 1	2 vs. 1	1683495.899	1	1683495.899	1.665	.212
T*C*GENDER	2 vs. 1	2 vs. 1	2324554.604	1	2324554.604	.214	.649
	3 vs. 1	2 vs. 1	703588.574	1	703588.574	.696	.414
Error(T*C)	2 vs. 1	2 vs. 1	217120534.6	20	10856026.734		
	3 vs. 1	2 vs. 1	20220804.58	20	1011040.229		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	2197634.474	1	2197634.474	7.337	.014
GENDER	139088.522	1	139088.522	.464	.503
Error	5990655.747	20	299532.787		

Ch.5: ANOVA Table **Total Power** with 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Tests of Within-Subjects Effects

Measure: MEASURE_1

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	T	723014.310	2	361507.155	3.329	.078
	Error(T)	1085873.823	10	108587.382		
	C	228482.188	1	228482.188	2.836	.153
	Error(C)	402871.403	5	80574.281		
	T * C	136914.265	2	68457.133	.836	.461
	Error(T*C)	818588.013	10	81858.801		
MALE	T	5377628.731	2	2688814.366	1.032	.369
	Error(T)	78177429.208	30	2605914.307		
	C	3598497.470	1	3598497.470	1.410	.254
	Error(C)	38285050.591	15	2552336.706		
	T * C	4231466.614	2	2115733.307	.811	.454
	Error(T*C)	78217145.643	30	2607238.188		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

GENDER	Source	Time	Cond	Type III SS	df	Mean Square	F	Sig.
FEMALE	T	2 vs. 1		698637.305	1	698637.305	4.589	.085
		3 vs. 1		305959.839	1	305959.839	11.696	.019
	Error(T)	2 vs. 1		761154.169	5	152230.834		
		3 vs. 1		130795.068	5	26159.014		
	C		2 vs. 1	152321.459	1	152321.459	2.836	.153
	Error(C)		2 vs. 1	268580.935	5	53716.187		
	T * C	2 vs. 1	2 vs. 1	535153.671	1	535153.671	1.302	.306
		3 vs. 1	2 vs. 1	72325.109	1	72325.109	.766	.421
	Error(T*C)	2 vs. 1	2 vs. 1	2055813.185	5	411162.637		
		3 vs. 1	2 vs. 1	471807.199	5	94361.440		
MALE	T	2 vs. 1		5366307.007	1	5366307.007	1.501	.239
		3 vs. 1		1563532.058	1	1563532.058	4.476	.052
	Error(T)	2 vs. 1		53637266.481	15	3575817.765		
		3 vs. 1		5239846.042	15	349323.069		
	C		2 vs. 1	2398998.313	1	2398998.313	1.410	.254
	Error(C)		2 vs. 1	25523367.060	15	1701557.804		
	T * C	2 vs. 1	2 vs. 1	16925684.176	1	16925684.176	1.181	.294
		3 vs. 1	2 vs. 1	4183454.577	1	4183454.577	3.177	.095
	Error(T*C)	2 vs. 1	2 vs. 1	215064721.51	15	14337648.100		
		3 vs. 1	2 vs. 1	19748997.385	15	1316599.826		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Intercept	423150.098	1	423150.098	10.101	.025
	Error	209454.559	5	41890.912		
MALE	Intercept	3155591.897	1	3155591.897	8.188	.012
	Error	5781201.188	15	385413.413		

Ch. 5: ANOVA Table: **SBR Slope** with 1-between (gender) and 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	SD	N
SLR2	FEMALE	3.6923	3.2867	6
	MALE	2.5941	1.6988	15
	Total	2.9079	2.2314	21
SLS2	FEMALE	2.4823	2.0999	6
	MALE	1.9330	1.6395	15
	Total	2.0899	1.7460	21
SLR3	FEMALE	4.6432	2.7873	6
	MALE	4.4879	2.1598	15
	Total	4.5323	2.2832	21
SLS3	FEMALE	3.4767	1.5809	6
	MALE	2.3115	.8929	15
	Total	2.6444	1.2140	21
SLR4	FEMALE	4.7543	2.6858	6
	MALE	6.0946	3.2124	15
	Total	5.7116	3.0679	21
SLS4	FEMALE	3.3963	1.9840	6
	MALE	2.8614	.8840	15
	Total	3.0142	1.2619	21

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
T	45.425	2	22.712	6.622	.003
T * GENDER	7.602	2	3.801	1.108	.341
Error(T)	130.335	38	3.430		
P	68.673	1	68.673	21.323	.000
P * GENDER	3.899	1	3.899	1.211	.285
Error(P)	61.190	19	3.221		
T * P	7.945	2	3.973	1.610	.213
T*P*GENDER6	.468	2	3.234	1.311	.282
Error(T*P)	93.771	38	2.468		

Tests of Within-Subjects Contrasts

Source	Time	Posture	Type III SS	df	MS	F	Sig.
T	2 vs. 1		38.119	1	38.119	3.935	.062
	3 vs. 1		87.904	1	87.904	12.114	.003
T * GENDER	2 vs. 1		.229	1	.229	.024	.879
	3 vs. 1		12.893	1	12.893	1.777	.198
Error(T)	2 vs. 1		184.074	19	9.688		
	3 vs. 1		137.873	19	7.256		
P		2 vs. 1	22.891	1	22.891	21.323	.000
P * GENDER		2 vs. 1	1.300	1	1.300	1.211	.285
Error(P)		2 vs. 1	20.397	19	1.074		
T * P	2 vs. 1	2 vs. 1	4.642	1	4.642	2.030	.170
	3 vs. 1	2 vs. 1	15.855	1	15.855	2.188	.156
T*P*GENDER	2 vs. 1	2 vs. 1	5.207	1	5.207	2.277	.148
	3 vs. 1	2 vs. 1	12.593	1	12.593	1.738	.203
Error(T*P)	2 vs. 1	2 vs. 1	43.445	19	2.287		
	3 vs. 1	2 vs. 1	137.701	19	7.247		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	434.676	1	434.676	119.248	.000
GENDER	1.113	1	1.113	.305	.587
Error	69.258	19	3.645		

Ch. 5: ANOVA Table **SBR Slope** with 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	Type III SS	df	MS	F	Sig.
FEMALE	T	7.690	2	3.845	.551	.593
	Error(T)	69.775	10	6.977		
	P	13.946	1	13.946	3.668	.114
	Error(P)	19.009	5	3.802		
	T * P	6.048E-02	2	3.024E-02	.015	.985
	Error(T*P)	20.257	10	2.026		
MALE	T	73.572	2	36.786	17.008	.000
	Error(T)	60.560	28	2.163		
	P	92.134	1	92.134	30.580	.000
	Error(P)	42.181	14	3.013		
	T * P	25.073	2	12.536	4.775	.016
	Error(T*P)	73.514	28	2.626		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	T	P	Type III SS	df	Mean Square	F	Sig.
FEMALE	T	2 vs. 1		11.353	1	11.353	.484	.518
		3 vs. 1		11.713	1	11.713	.670	.450
	Error(T)	2 vs. 1		117.364	5	23.473		
		3 vs. 1		87.358	5	17.472		
	P		2 vs. 1	4.649	1	4.649	3.668	.114
	Error(P)		2 vs. 1	6.336	5	1.267		
	T * P	2 vs. 1	2 vs. 1	5.689E-03	1	5.689E-03	.003	.960
		3 vs. 1	2 vs. 1	6.570E-02	1	6.570E-02	.011	.922
	Error(T*P)	2 vs. 1	2 vs. 1	10.101	5	2.020		
		3 vs. 1	2 vs. 1	30.705	5	6.141		
MALE	T	2 vs. 1		38.726	1	38.726	8.127	.013
		3 vs. 1		147.111	1	147.111	40.771	.000
	Error(T)	2 vs. 1		66.710	14	4.765		
		3 vs. 1		50.515	14	3.608		
	P		2 vs. 1	30.711	1	30.711	30.580	.000
	Error(P)		2 vs. 1	14.060	14	1.004		
	T * P	2 vs. 1	2 vs. 1	17.221	1	17.221	7.231	.018
		3 vs. 1	2 vs. 1	49.620	1	49.620	6.493	.023
	Error(T*P)	2 vs. 1	2 vs. 1	33.344	14	2.382		
		3 vs. 1	2 vs. 1	106.996	14	7.643		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Intercept	167.926	1	167.926	33.989	.002
	Error	24.703	5	4.941		
MALE	Intercept	342.816	1	342.816	107.720	.000
	Error	44.555	14	3.182		

Ch. 5: ANOVA Table for **R-R Interval** with 1-between (gender) and 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
RRIR2	FEMALE	718.2845	113.9232	6
	MALE	707.0671	92.0780	16
	Total	710.1264	95.7718	22
RRIS2	FEMALE	690.4040	113.4618	6
	MALE	627.5657	115.5626	16
	Total	644.7034	115.8651	22
RRIR3	FEMALE	756.4160	119.9770	6
	MALE	780.2980	113.3421	16
	Total	773.7847	112.7910	22
RRIS3	FEMALE	702.1425	108.9922	6
	MALE	720.4673	143.2773	16
	Total	715.4696	132.5191	22
RRIR4	FEMALE	810.3287	85.4121	6
	MALE	881.9955	121.2410	16
	Total	862.4500	115.3419	22
RRIS4	FEMALE	738.7489	65.5361	6
	MALE	769.7215	104.0021	16
	Total	761.2744	94.5938	22

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
T	228543.355	2	114271.678	14.973	.000
T * GENDER	35192.924	2	17596.462	2.306	.113
Error(T)	305271.525	40	7631.788		
C	119491.294	1	119491.294	21.702	.000
C * GENDER	6966.511	1	6966.511	1.265	.274
Error(C)	110118.242	20	5505.912		
T * C	7824.106	2	3912.053	1.117	.337
T*C*GENDER	2527.901	2	1263.950	.361	.699
Error(T*C)	140093.508	40	3502.338		

Tests of Within-Subjects Contrasts

Source	Time	Cond	Type III SS	df	Mean Square	F	Sig.
T	2 vs. 1		50898.602	1	50898.602	6.118	.022
	3 vs. 1		228307.485	1	228307.485	29.580	.000
T * GENDER	2 vs. 1		14745.812	1	14745.812	1.773	.198
	3 vs. 1		34059.472	1	34059.472	4.413	.049
Error(T)	2 vs. 1		166384.170	20	8319.209		
	3 vs. 1		154367.124	20	7718.356		
C		2 vs. 1	79660.863	1	79660.863	21.702	.000
C * GENDER		2 vs. 1	4644.341	1	4644.341	1.265	.274
Error(C)		2 vs. 1	73412.161	20	3670.608		
T * C	2 vs. 1	2 vs. 1	197.178	1	197.178	.012	.914
	3 vs. 1	2 vs. 1	25518.272	1	25518.272	1.769	.199
T*C*GENDER	2 vs. 1	2 vs. 1	9259.047	1	9259.047	.567	.460
	3 vs. 1	2 vs. 1	520.993	1	520.993	.036	.851
Error(T*C)	2 vs. 1	2 vs. 1	326361.554	20	16318.078		
	3 vs. 1	2 vs. 1	288562.239	20	14428.112		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	9608634.681	1	9608634.681	1183.873	.000
GENDER	607.430	1	607.430	.075	.787
Error	162325.485	20	8116.274		

Ch. 5: ANOVA Table **R-R Interval** with 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	T	30389.826	2	15194.913	2.949	.098
	Error(T)	51517.646	10	5151.765		
	C	23634.126	1	23634.126	17.537	.009
	Error(C)	6738.198	5	1347.640		
	T * C	2905.724	2	1452.862	2.564	.126
	Error(T*C)	5666.182	10	566.618		
MALE	T	402476.977	2	201238.489	23.791	.000
	Error(T)	253753.878	30	8458.463		
	C	168814.974	1	168814.974	24.494	.000
	Error(C)	103380.043	15	6892.003		
	T * C	11230.081	2	5615.041	1.253	.300
	Error(T*C)	134427.326	30	4480.911		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	T	C	Type III SS	df	Mean Square	F	Sig.
FEMALE	T	2 vs. 1		3730.512	1	3730.512	1.997	.217
		3 vs. 1		29563.644	1	29563.644	4.975	.076
	Error(T)	2 vs. 1		9338.993	5	1867.799		
		3 vs. 1		29709.708	5	5941.942		
	C		2 vs. 1	15756.084	1	15756.084	17.537	.009
	Error(C)		2 vs. 1	4492.132	5	898.426		
	T * C	2 vs. 1	2 vs. 1	4179.512	1	4179.512	1.836	.233
		3 vs. 1	2 vs. 1	11457.767	1	11457.767	5.275	.070
	Error(T*C)	2 vs. 1	2 vs. 1	11380.857	5	2276.171		
		3 vs. 1	2 vs. 1	10860.926	5	2172.185		
MALE	T	2 vs. 1		110400.060	1	110400.060	10.545	.005
		3 vs. 1		402169.702	1	402169.702	48.393	.000
	Error(T)	2 vs. 1		157045.178	15	10469.679		
		3 vs. 1		124657.415	15	8310.494		
	C		2 vs. 1	112543.316	1	112543.316	24.494	.000
	Error(C)		2 vs. 1	68920.029	15	4594.669		
	T * C	2 vs. 1	2 vs. 1	6191.048	1	6191.048	.295	.595
		3 vs. 1	2 vs. 1	17184.608	1	17184.608	.928	.351
	Error(T*C)	2 vs. 1	2 vs. 1	314980.697	15	20998.713		
		3 vs. 1	2 vs. 1	277701.313	15	18513.421		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Intercept	3250653.718	1	3250653.718	382.943	.000
	Error	42443.055	5	8488.611		
MALE	Intercept	8948533.955	1	8948533.955	1119.664	.000
	Error	119882.430	15	7992.162		

Ch. 5: ANOVA Table for **Systolic Blood Pressure** with 1-between (gender) and 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
SBPR2	FEMALE	98.8975	22.8346	6
	MALE	107.5911	19.5222	15
	Total	105.1072	20.3305	21
SBPS2	FEMALE	124.9460	29.7794	6
	MALE	121.2726	16.1015	15
	Total	122.3221	20.1513	21
SBPR3	FEMALE	116.5518	38.8507	6
	MALE	110.6767	16.2893	15
	Total	112.3553	23.8847	21
SBPS3	FEMALE	147.0665	36.0576	6
	MALE	120.8901	11.4414	15
	Total	128.3691	23.7382	21
SBPR4	FEMALE	133.0640	24.6899	6
	MALE	119.7785	16.2383	15
	Total	123.5744	19.3597	21
SBPS4	FEMALE	152.3117	30.9673	6
	MALE	126.3557	13.8223	15
	Total	133.7717	22.7563	21

Tests of Within-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
T	6666.961	2	3333.481	6.976	.003
T * GENDER	2417.920	2	1208.960	2.530	.093
Error(T)	18157.261	38	477.823		
P	8068.621	1	8068.621	28.322	.000
P * GENDER	1468.284	1	1468.284	5.154	.035
Error(P)	5412.885	19	284.889		
T * P	297.468	2	148.734	.554	.579
T*P*GENDER	86.625	2	43.312	.161	.852
Error(T*P)	10207.924	38	268.630		

Tests of Within-Subjects Contrasts

Source	T	P	Type III SS	df	Mean Square	F	Sig.
T	2 vs. 1		3866.536	1	3866.536	4.787	.041
	3 vs. 1		13306.877	1	13306.877	14.402	.001
T * GENDER	2 vs. 1		2944.941	1	2944.941	3.646	.071
	3 vs. 1		4198.042	1	4198.042	4.543	.046
Error(T)	2 vs. 1		15346.770	19	807.725		
	3 vs. 1		17555.799	19	923.989		
P		2 vs. 1	2689.540	1	2689.540	28.322	.000
P * GENDER		2 vs. 1	489.428	1	489.428	5.154	.035
Error(P)		2 vs. 1	1804.295	19	94.963		
T * P	2 vs. 1	2 vs. 1	2.134	1	2.134	.002	.962
	3 vs. 1	2 vs. 1	414.329	1	414.329	.855	.367
T*P*GENDER	2 vs. 1	2 vs. 1	134.900	1	134.900	.149	.704
	3 vs. 1	2 vs. 1	.197	1	.197	.000	.984
Error(T*P)	2 vs. 1	2 vs. 1	17232.120	19	906.954		
	3 vs. 1	2 vs. 1	9206.622	19	484.559		

Tests of Between-Subjects Effects

Source	Type III SS	df	Mean Square	F	Sig.
Intercept	521102.658	1	521102.658	1852.658	.000
GENDER	1045.731	1	1045.731	3.718	.069
Error	5344.186	19	281.273		

Ch. 5: ANOVA Table for **Systolic Blood Pressure** with 2-within factors (time [Day 5, 6 weeks, 12 weeks postoperatively] & condition [supine vs. standing]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	T	5841.626	2	2920.813	2.608	.123
	Error(T)	11201.070	10	1120.107		
	P	5747.282	1	5747.282	14.040	.013
	Error(P)	2046.704	5	409.341		
	T * P	193.143	2	96.572	.134	.877
	Error(T*P)	7231.241	10	723.124		
MALE	T	1294.475	2	647.238	2.605	.092
	Error(T)	6956.191	28	248.435		
	P	2321.377	1	2321.377	9.655	.008
	Error(P)	3366.182	14	240.442		
	T * P	189.304	2	94.652	.890	.422
	Error(T*P)	2976.683	28	106.310		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	T	P	Type III SS	df	Mean Square	F	Sig.
FEMALE	T	2 vs. 1		4746.112	1	4746.112	1.916	.225
		3 vs. 1		11358.623	1	11358.623	8.427	.034
	Error(T)	2 vs. 1		12387.644	5	2477.529		
		3 vs. 1		6739.801	5	1347.960		
	P		2 vs. 1	1915.761	1	1915.761	14.040	.013
	Error(P)		2 vs. 1	682.235	5	136.447		
	T * P	2 vs. 1	2 vs. 1	59.840	1	59.840	.023	.886
		3 vs. 1	2 vs. 1	138.754	1	138.754	.140	.723
	Error(T*P)	2 vs. 1	2 vs. 1	13234.810	5	2646.962		
		3 vs. 1	2 vs. 1	4946.368	5	989.274		
MALE	T	2 vs. 1		54.805	1	54.805	.259	.619
		3 vs. 1		2237.052	1	2237.052	2.896	.111
	Error(T)	2 vs. 1		2959.126	14	211.366		
		3 vs. 1		10815.997	14	772.571		
	P		2 vs. 1	773.792	1	773.792	9.655	.008
	Error(P)		2 vs. 1	1122.061	14	80.147		
	T * P	2 vs. 1	2 vs. 1	90.210	1	90.210	.316	.583
		3 vs. 1	2 vs. 1	378.537	1	378.537	1.244	.283
	Error(T*P)	2 vs. 1	2 vs. 1	3997.309	14	285.522		
		3 vs. 1	2 vs. 1	4260.254	14	304.304		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Type III SS	df	Mean Square	F	Sig.
FEMALE	Intercept	199092.600	1	199092.600	353.310	.000
	Error	2817.531	5	563.506		
MALE	Intercept	416028.180	1	416028.180	2305.180	.000
	Error	2526.655	14	180.475		

APPENDIX F
ANOVA TABLES
Chapter 6

Ch 6: ANOVA Table: Fractal Power with 1-between (gender) and 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
FPR3	FEMALE	272.2188	334.1836	6
	MALE	137.2860	79.5851	13
	Total	179.8964	198.4863	19
FPE3	FEMALE	41.2686	38.0268	6
	MALE	87.0817	70.6347	13
	Total	72.6144	64.8578	19
FPR4	FEMALE	204.3061	133.7117	6
	MALE	280.5391	244.2812	13
	Total	256.4655	214.6484	19
FPE4	FEMALE	71.5111	33.9281	6
	MALE	101.6610	86.0573	13
	Total	92.1400	73.9210	19

Tests of Within-Subjects Effects

Source	Sum of Squares	df	Mean Square	F	Sig.
TIME	14818.922	1	14818.922	.863	.366
TIME * GENDER	39227.090	1	39227.090	2.284	.149
Error(TIME)	291952.142	17	17173.655		
COND	360693.215	1	360693.215	20.302	.000
COND * GENDER	18611.280	1	18611.280	1.048	.320
Error(COND)	302026.263	17	17766.251		
TIME * COND	955.891	1	955.891	.038	.847
TIME * COND * GENDER	52805.459	1	52805.459	2.123	.163
Error(TIME*COND)	422881.595	17	24875.388		

Tests of Within-Subjects Contrasts

Source	TIME (T)	COND (C)	Sum of Squares	df	Mean Square	F	Sig.
TIME	T4 vs. T3		14818.922	1	14818.922	.863	.366
T * GENDER	T4 vs. T3		39227.090	1	39227.090	2.284	.149
Error(TIME)	T4 vs. T3		291952.142	17	17173.655		
COND		Ex vs. Su	360693.215	1	360693.215	20.302	.000
C * GENDER		Ex vs. Su	18611.280	1	18611.280	1.048	.320
Error(COND)		Ex vs. Su	302026.263	17	17766.251		
T * C	T4 vs. T3	Ex vs. Su	3823.566	1	3823.566	.038	.847
T * C * G	T4 vs. T3	Ex vs. Su	211221.837	1	211221.837	2.123	.163
Error(T*C)	T4 vs. T3	Ex vs. Su	1691526.380	17	99501.552		

Tests of Between-Subjects Effects

Source	Sum of Squares	df	Mean Square	F	Sig.
Intercept	366936.294	1	366936.294	42.671	.000
GENDER	76.465	1	76.465	.009	.926
Error	146184.912	17	8599.112		

Ch. 6: ANOVA Table Fractal Power with 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise])

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	TIME (T)	2128.567	1	2128.567	.089	.777
	Error(TIME)	119190.433	5	23838.087		
	COND (C)	198465.901	1	198465.901	5.848	.060
	Error(COND)	169687.955	5	33937.591		
	T * C	14451.699	1	14451.699	.643	.459
	Error(T * C)	112304.602	5	22460.920		
MALE	TIME	80960.957	1	80960.957	5.624	.035
	Error(TIME)	172761.709	12	14396.809		
	COND	170555.998	1	170555.998	15.465	.002
	Error(COND)	132338.308	12	11028.192		
	T * C	53810.125	1	53810.125	2.079	.175
	Error(T * C)	310576.993	12	25881.416		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	TIME (T)	COND (C)	Sum of Squares	df	MS	F	Sig.
FEMALE	TIME	T4 vs. T3		2128.567	1	2128.567	.089	.777
	Error(T)	T4 vs. T3		119190.433	5	23838.087		
	COND		Ex vs. Su	198465.901	1	198465.901	5.848	.060
	Error(C)		Ex vs. Su	169687.955	5	33937.591		
	T * C	T4 vs. T3	Ex vs. Su	57806.795	1	57806.795	.643	.459
	Error(T*C)							
		T4 vs. T3	Ex vs. Su	449218.407	5	89843.681		
MALE	TIME	T4 vs. T3		80960.957	1	80960.957	5.624	.035
	Error(T)	T4 vs. T3		172761.709	12	14396.809		
	COND		Ex vs. Su	170555.998	1	170555.998	15.465	.002
	Error(C)		Ex vs. Su	132338.308	12	11028.192		
	T * C	T4 vs. T3	Ex vs. Su	215240.499	1	215240.499	2.079	.175
	Error(T * C)							
		T4 vs. T3	Ex vs. Su	1242307.973	12	103525.664		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	Intercept	130229.957	1	130229.957	10.033	.025
	Error	64897.612	5	12979.522		
MALE	Intercept	298938.627	1	298938.627	44.131	.000
	Error	81287.300	12	6773.942		

Ch. 6: ANOVA Table: High Frequency Power with 1-between (gender) and 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
HFR3	FEMALE	44.685412	50.202652	6
	MALE	16.831676	23.480489	13
	Total	25.627593	35.278668	19
HFE3	FEMALE	8.030902	10.624763	6
	MALE	4.509197	6.142266	13
	Total	5.621314	7.703074	19
HFR4	FEMALE	42.289355	62.063771	6
	MALE	32.161514	31.681698	13
	Total	35.359779	41.982409	19
HFE4	FEMALE	10.386673	12.957043	6
	MALE	20.299141	21.743525	13
	Total	17.168888	19.601823	19

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	Sum of Squares	df	Mean Square	F	Sig.
TIME	991.354	1	991.354	3.213	.091
TIME * GENDER	996.501	1	996.501	3.230	.090
Error(TIME)	5245.162	17	308.539		
COND	8827.431	1	8827.431	10.479	.005
COND * GENDER	2020.718	1	2020.718	2.399	.140
Error(COND)	14320.422	17	842.378		
TIME * COND	27.879	1	27.879	.078	.783
T * C * G	18.904	1	18.904	.053	.821
Error(TIME*COND)	6066.013	17	356.824		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME	COND	Sum of Squares	df	Mean Square	F	Sig.
TIME	T4 vs T3		991.354	1	991.354	3.213	.091
T * G	T4 vs T3		996.501	1	996.501	3.230	.090
Error(T)	T4 vs T3		5245.162	17	308.539		
COND		Ex vs. Su	8827.431	1	8827.431	10.479	.005
C * G		Ex vs. Su	2020.718	1	2020.718	2.399	.140
Error(C)		Ex vs. Su	14320.422	17	842.378		
T * C	T4 vs T3	Ex vs. Su	111.516	1	111.516	.078	.783
T * C * G	T4 vs T3	Ex vs. Su	75.614	1	75.614	.053	.821
Error(T*C)	T4 vs T3	Ex vs. Su	24264.051	17	1427.297		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Sum of Squares	df	Mean Square	F	Sig.
Intercept	8238.864	1	8238.864	17.281	.001
GENDER	256.061	1	256.061	.537	.474
Error	8105.051	17	476.768		

Ch. 6: ANOVA Source Table: High Frequency Power with 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Descriptive Statistics

GENDER		Mean	Std. Deviation	N
FEMALE	HFR3	44.685412	50.202652	6
	HFE3	8.030902	10.624763	6
	HFR4	42.289355	62.063771	6
	HFE4	10.386673	12.957043	6
MALE	HFR3	16.831676	23.480489	13
	HFE3	4.509197	6.142266	13
	HFR4	32.161514	31.681698	13
	HFE4	20.299141	21.743525	13

Tests of Within-Subjects Effects

Measure: MEASURE_1

GENDER	Source	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	TIME	2.434E-03	1	2.434E-03	.000	.998
	Error(TIME)	2405.426	5	481.085		
	COND	7050.133	1	7050.133	3.091	.139
	Error(COND)	11402.821	5	2280.564		
	TIME * COND	33.870	1	33.870	.050	.832
	Error(TIME*COND)	3378.410	5	675.682		
MALE	TIME	3147.433	1	3147.433	13.300	.003
	Error(TIME)	2839.736	12	236.645		
	COND	1900.948	1	1900.948	7.819	.016
	Error(COND)	2917.601	12	243.133		
	TIME * COND	.688	1	.688	.003	.957
	Error(TIME*COND)	2687.603	12	223.967		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

GENDER	Source	TIME (T)	COND (C)	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	TIME	T4 vs. T3		2.434E-03	1	2.434E-03	.000	.998
	Error(T)	T4 vs. T3		2405.426	5	481.085		
	COND		Ex vs. Su	7050.133	1	7050.133	3.091	.139
	Error(C)		Ex vs. Su	11402.821	5	2280.564		
	T * C	T4 vs. T3	Ex vs. Su	135.479	1	135.479	.050	.832
	Error(T * C)							
		T4 vs. T3	Ex vs. Su	13513.639	5	2702.728		
MALE	TIME	T4 vs. T3		3147.433	1	3147.433	13.300	.003
	Error(T)	T4 vs. T3		2839.736	12	236.645		
	COND		Ex vs. Su	1900.948	1	1900.948	7.819	.016
	Error(C)		Ex vs. Su	2917.601	12	243.133		
	T * C	T4 vs. T3	Ex vs. Su	2.752	1	2.752	.003	.957
	Error(T * C)							
		T4 vs. T3	Ex vs. Su	10750.412	12	895.868		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

GENDER	Source	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	Intercept	4165.330	1	4165.330	5.181	.072
	Error	4019.571	5	803.914		
MALE	Intercept	4425.416	1	4425.416	12.998	.004
	Error	4085.480	12	340.457		

Ch. 6: ANOVA Source Table: Low Frequency Power with 1-between (gender) and 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
LFR3	FEMALE	148.753810	216.948798	6
	MALE	74.890447	92.621325	13
	Total	98.215719	141.554054	19
LFE3	FEMALE	18.567485	30.675756	6
	MALE	24.088451	23.345093	13
	Total	22.344988	25.133050	19
LFR4	FEMALE	77.517853	67.684820	6
	MALE	89.928577	106.677741	13
	Total	86.009401	94.310415	19
LFE4	FEMALE	8.420087	6.201648	6
	MALE	47.498652	52.365934	13
	Total	35.158053	46.766490	19

Tests of Within-Subjects Effects
Measure: MEASURE_1

Source	Sum of Squares	df	Mean Square	F	Sig.
TIME (T)	1891.927	1	1891.927	.424	.524
T * GENDER (G)	14737.518	1	14737.518	3.305	.087
Error(T)	75816.164	17	4459.774		
COND (C)	87817.344	1	87817.344	10.965	.004
C * G	11543.038	1	11543.038	1.441	.246
Error(C)	136146.968	17	8008.645		
T * C	4951.747	1	4951.747	.850	.369
T * C * G	2852.160	1	2852.160	.490	.494
Error(T*C)	99018.199	17	5824.600		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

Source	TIME (T)	COND (C)	Sum of Squares	df	Mean Square	F	Sig.
TIME	T4 vs. T3		1891.927	1	1891.927	.424	.524
T * G	T4 vs. T3		14737.518	1	14737.518	3.305	.087
Error(T)	T4 vs. T3		75816.164	17	4459.774		
COND		Ex vs. Su	87817.344	1	87817.344	10.965	.004
C * G		Ex vs. Su	11543.038	1	11543.038	1.441	.246
Error(C)		Ex vs. Su	136146.968	17	8008.645		
T * C	T4 vs. T3	Ex vs. Su	19806.988	1	19806.988	.850	.369
T * C * G	T4 vs. T3	Ex vs. Su	11408.641	1	11408.641	.490	.494
Error(T*C)	T4 vs. T3	Ex vs. Su	396072.797	17	23298.400		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

Source	Sum of Squares	df	Mean Square	F	Sig.
Intercept	61520.490	1	61520.490	18.101	.001
GENDER	72.875	1	72.875	.021	.885
Error	57777.119	17	3398.654		

Ch. 6: ANOVA Source Table: Low Frequency Power with 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	TIME (T)	9934.876	1	9934.876	.946	.375
	Error(T)	52496.079	5	10499.216		
	COND (C)	59571.224	1	59571.224	4.124	.098
	Error(C)	72221.106	5	14444.221		
	T * C	5597.718	1	5597.718	.805	.411
	Error(T*C)	34787.746	5	6957.549		
MALE	TIME	4804.391	1	4804.391	2.472	.142
	Error(T)	23320.085	12	1943.340		
	COND	28249.621	1	28249.621	5.303	.040
	Error(C)	63925.862	12	5327.155		
	T * C	227.798	1	227.798	.043	.840
	Error(T*C)	64230.454	12	5352.538		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	TIME	COND	SS	df	Mean Square	F	Sig.
FEMALE	TIME	T4 vs. T3		9934.876	1	9934.876	.946	.375
	Error(T)	T4 vs. T3		52496.079	5	10499.216		
	COND		Ex vs. Su	59571.224	1	59571.224	4.124	.098
	Error(C)		Ex vs. Su	72221.106	5	14444.221		
	T * C	T4 vs. T3	Ex vs. Su	22390.872	1	22390.872	.805	.411
	Error(T*C)							
		T4 vs. T3	Ex vs. Su	139150.983	5	27830.197		
MALE	TIME	T4 vs. T3		4804.391	1	4804.391	2.472	.142
	Error(T)	T4 vs. T3		23320.085	12	1943.340		
	COND		Ex vs. Su	28249.621	1	28249.621	5.303	.040
	Error(C)		Ex vs. Su	63925.862	12	5327.155		
	T * C	T4 vs. T3	Ex vs. Su	911.191	1	911.191	.043	.840
	Error(T*C)							
		T4 vs. T3	Ex vs. Su	256921.814	12	21410.151		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	Intercept	24052.590	1	24052.590	4.642	.084
	Error	25908.115	5	5181.623		
MALE	Intercept	45408.884	1	45408.884	17.098	.001
	Error	31869.004	12	2655.750		

Ch. 6: ANOVA Source Table: Parasympathetic Indicator with 1-between (gender) and 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
PNSR3	FEMALE	.116980	6.42321E-02	6
	MALE	6.66492E-02	7.54240E-02	13
	Total	8.25432E-02	7.42718E-02	19
PNSE3	FEMALE	8.58133E-02	8.98876E-02	6
	MALE	3.72262E-02	4.86898E-02	13
	Total	5.25695E-02	6.60549E-02	19
PNSR4	FEMALE	9.62250E-02	5.22065E-02	6
	MALE	8.56723E-02	7.88962E-02	13
	Total	8.90047E-02	7.02298E-02	19
PNSE4	FEMALE	9.97117E-02	8.26927E-02	6
	MALE	.114738	.106369	13
	Total	.109993	9.74362E-02	19

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	Sum of Squares	df	Mean Square	F	Sig.
TIME (T)	8.254E-03	1	8.254E-03	3.813	.068
TIME * GENDER (G)	1.097E-02	1	1.097E-02	5.068	.038
Error(TIME)	3.680E-02	17	2.165E-03		
COND (C)	8.068E-04	1	8.068E-04	.244	.628
COND * GENDER	7.662E-04	1	7.662E-04	.232	.636
Error(COND)	5.621E-02	17	3.306E-03		
TIME * COND	8.904E-03	1	8.904E-03	1.550	.230
T * C * G	5.831E-04	1	5.831E-04	.101	.754
Error(TIME*COND)	9.766E-02	17	5.745E-03		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME	COND	Sum of Squares	df	Mean Square	F	Sig.
TIME	T4 vs. T3		8.254E-03	1	8.254E-03	3.813	.068
TIME * G	T4 vs. T3		1.097E-02	1	1.097E-02	5.068	.038
Error(TIME)	T4 vs. T3		3.680E-02	17	2.165E-03		
COND		Ex vs. Su	8.068E-04	1	8.068E-04	.244	.628
COND * G		Ex vs. Su	7.662E-04	1	7.662E-04	.232	.636
Error(COND)		Ex vs. Su	5.621E-02	17	3.306E-03		
TIME * COND	T4 vs. T3	Ex vs. Su	3.561E-02	1	3.561E-02	1.550	.230
T * C * G	T4 vs. T3	Ex vs. Su	2.332E-03	1	2.332E-03	.101	.754
Error(T*C)	T4 vs. T3	Ex vs. Su	.391	17	2.298E-02		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Sum of Squares	df	Mean Square	F	Sig.
Intercept	.127	1	.127	38.265	.000
GENDER	2.289E-03	1	2.289E-03	.691	.417
Error	5.634E-02	17	3.314E-03		

Ch. 6: ANOVA Source Table: Parasympathetic Indicator with 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Tests of Within-Subjects Effects

Measure: MEASURE_1

GENDER	Source	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	TIME	7.052E-05	1	7.052E-05	.047	.837
	Error(T)	7.511E-03	5	1.502E-03		
	COND	1.149E-03	1	1.149E-03	.276	.622
	Error(C)	2.085E-02	5	4.169E-03		
	T * C	1.801E-03	1	1.801E-03	.932	.379
	Error(T*C)	9.665E-03	5	1.933E-03		
MALE	TIME	3.029E-02	1	3.029E-02	12.408	.004
	Error(T)	2.929E-02	12	2.441E-03		
	COND	4.158E-07	1	4.158E-07	.000	.991
	Error(C)	3.536E-02	12	2.947E-03		
	T * C	1.112E-02	1	1.112E-02	1.516	.242
	Error(T*C)	8.800E-02	12	7.333E-03		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

GENDER	Source	TIME	COND	SS	df	MS	F	Sig.
FEMALE	TIME	T4 vs. T3		7.052E-05	1	7.052E-05	.047	.837
	Error(T)	T4 vs. T3		7.511E-03	5	1.502E-03		
	COND		Ex vs. Su	1.149E-03	1	1.149E-03	.276	.622
	Error(C)		Ex vs. Su	2.085E-02	5	4.169E-03		
	T * C	T4 vs. T3	Ex vs. Su	7.205E-03	1	7.205E-03	.932	.379
	Error(T*C)	T4 vs. T3	Ex vs. Su	3.866E-02	5	7.732E-03		
MALE	TIME	T4 vs. T3		3.029E-02	1	3.029E-02	12.408	.004
	Error(T)	T4 vs. T3		2.929E-02	12	2.441E-03		
	COND		Ex vs. Su	4.158E-07	1	4.158E-07	.000	.991
	Error(C)		Ex vs. Su	3.536E-02	12	2.947E-03		
	T * C	T4 vs. T3	Ex vs. Su	4.447E-02	1	4.447E-02	1.516	.242
	Error(T*C)	T4 vs. T3	Ex vs. Su	.352	12	2.933E-02		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

GENDER	Source	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	Intercept	5.962E-02	1	5.962E-02	16.836	.009
	Error	1.771E-02	5	3.541E-03		
MALE	Intercept	7.523E-02	1	7.523E-02	23.368	.000
	Error	3.863E-02	12	3.219E-03		

Ch. 6: ANOVA Source Table: SDNN with 1-between (gender) and 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
RRISDR3	FEMALE	31.1701	26.8470	6
	MALE	26.4978	10.6895	14
	Total	27.8995	16.5131	20
RRISDE3	FEMALE	13.1310	5.9704	6
	MALE	19.1333	9.2546	14
	Total	17.3326	8.7147	20
RRISDR4	FEMALE	29.8194	15.1822	6
	MALE	31.9157	10.8056	14
	Total	31.2868	11.8962	20
RRISDE4	FEMALE	18.6244	6.7255	6
	MALE	19.9471	5.2915	14
	Total	19.5503	5.6079	20

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	Sum of Squares	df	Mean Square	F	Sig.
TIME	113.009	1	113.009	1.230	.282
T * GENDER	4.583	1	4.583	.050	.826
Error(T)	1653.574	18	91.865		
COND	2476.729	1	2476.729	24.714	.000
C * GENDER	102.931	1	102.931	1.027	.324
Error(C)	1803.909	18	100.217		
T * C	5.268	1	5.268	.064	.803
T * C * G	137.615	1	137.615	1.666	.213
Error(T*C)	1486.427	18	82.579		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME	COND	SS	df	Mean Square	F	Sig.
TIME	T4 vs. T3		113.009	1	113.009	1.230	.282
T * GENDER	T4 vs. T3		4.583	1	4.583	.050	.826
Error(T)	T4 vs. T3		1653.574	18	91.865		
COND		Ex vs. Su	2476.729	1	2476.729	24.714	.000
C * GENDER		Ex vs. Su	102.931	1	102.931	1.027	.324
Error(C)		Ex vs. Su	1803.909	18	100.217		
T * C	T4 vs. T3	Ex vs. Su	21.073	1	21.073	.064	.803
T * C * G	T4 vs. T3	Ex vs. Su	550.459	1	550.459	1.666	.213
Error(T*C)	T4 vs. T3	Ex vs. Su	5945.709	18	330.317		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Sum of Squares	df	Mean Square	F	Sig.
Intercept	9500.086	1	9500.086	145.608	.000
GENDER	5.920	1	5.920	.091	.767
Error	1174.393	18	65.244		

Ch. 6: ANOVA Source Table: SDNN with 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Tests of Within-Subjects Effects

Measure: MEASURE_1

GENDER	Source	SS	df	MS	F	Sig.
FEMALE	TIME	25.742	1	25.742	.163	.703
	Error(T)	788.035	5	157.607		
	COND	1281.956	1	1281.956	5.179	.072
	Error(C)	1237.730	5	247.546		
	T * C	70.262	1	70.262	.483	.518
	Error(T*C)	727.951	5	145.590		
MALE	TIME	135.921	1	135.921	2.041	.177
	Error(T)	865.539	13	66.580		
	COND	1308.203	1	1308.203	30.038	.000
	Error(C)	566.179	13	43.552		
	T * C	74.193	1	74.193	1.272	.280
	Error(T*C)	758.476	13	58.344		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

GENDER	Source	TIME	COND	SS	df	Mean Square	F	Sig.
FEMALE	TIME	T4 vs. T3		25.742	1	25.742	.163	.703
	Error(T)	T4 vs. T3		788.035	5	157.607		
	C		Ex vs. Su	1281.956	1	1281.956	5.179	.072
	Error(C)		Ex vs. Su	1237.730	5	247.546		
	T * C	T4 vs. T3	Ex vs. Su	281.049	1	281.049	.483	.518
	Error(T*C)	T4 vs. T3	Ex vs. Su	2911.806	5	582.361		
MALE	T	T4 vs. T3		135.921	1	135.921	2.041	.177
	Error(T)	T4 vs. T3		865.539	13	66.580		
	C		Ex vs. Su	1308.203	1	1308.203	30.038	.000
	Error(C)		Ex vs. Su	566.179	13	43.552		
	T * C	T4 vs. T3	Ex vs. Su	296.773	1	296.773	1.272	.280
	Error(T*C)	T4 vs. T3	Ex vs. Su	3033.903	13	233.377		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

GENDER	Source	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	Intercept	3225.607	1	3225.607	26.802	.004
	Error	601.742	5	120.348		
MALE	Intercept	8316.927	1	8316.927	188.806	.000
	Error	572.651	13	44.050		

Ch. 6: ANOVA Source Table: Sympathetic Indicator with 1-between (gender) and 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
SNSR3	FEMALE	3.421148	5.581283	6
	MALE	22.080972	38.810743	13
	Total	16.188396	33.049161	19
SNSE3	FEMALE	2.886630	1.865741	6
	MALE	24.886411	45.618088	13
	Total	17.939112	38.712926	19
SNSR4	FEMALE	3.183327	2.749740	6
	MALE	8.676228	15.986648	13
	Total	6.941628	13.392668	19
SNSE4	FEMALE	2.711873	3.368003	6
	MALE	6.864675	8.247617	13
	Total	5.553264	7.241063	19

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	Sum of Squares	df	Mean Square	F	Sig.
TIME (T)	1040.403	1	1040.403	1.750	.203
TIME * GENDER (G)	987.174	1	987.174	1.661	.215
Error(TIME)	10105.358	17	594.433		
COND (C)	1.499E-04	1	1.499E-04	.000	1.000
COND * GENDER	4.105	1	4.105	.007	.934
Error(COND)	10015.119	17	589.125		
TIME * COND	21.284	1	21.284	.090	.768
TIME * COND * GENDER	22.479	1	22.479	.095	.762
Error(TIME*COND)	4038.685	17	237.570		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME	COND	Sum of Squares	df	Mean Square	F	Sig.
TIME	T4 vs. T3		1040.403	1	1040.403	1.750	.203
TIME * GENDER	T4 vs. T3		987.174	1	987.174	1.661	.215
Error(TIME)	T4 vs. T3		10105.358	17	594.433		
COND		Ex vs. Su	1.499E-04	1	1.499E-04	.000	1.000
COND * GENDER		Ex vs. Su	4.105	1	4.105	.007	.934
Error(COND)		Ex vs. Su	10015.119	17	589.125		
TIME * COND	T4 vs. T3	Ex vs. Su	85.136	1	85.136	.090	.768
T * C * G	T4 vs. T3	Ex vs. Su	89.917	1	89.917	.095	.762
Error(T*C)	T4 vs. T3	Ex vs. Su	16154.740	17	950.279		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Sum of Squares	df	Mean Square	F	Sig.
Intercept	1432.165	1	1432.165	4.227	.055
GENDER	649.305	1	649.305	1.916	.184
Error	5759.769	17	338.810		

Ch. 6: ANOVA Source Table: Sympathetic Indicator with 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	SS	df	Mean Square	F	Sig.
FEMALE	TIME	.255	1	.255	.034	.861
	Error(TIME)	37.438	5	7.488		
	COND	1.518	1	1.518	.068	.805
	Error(COND)	112.250	5	22.450		
	TIME * COND	5.966E-03	1	5.966E-03	.002	.965
	Error(TIME*COND)	13.812	5	2.762		
MALE	TIME	3209.777	1	3209.777	3.826	.074
	Error(TIME)	10067.920	12	838.993		
	COND	3.210	1	3.210	.004	.951
	Error(COND)	9902.869	12	825.239		
	TIME * COND	69.279	1	69.279	.207	.658
	Error(TIME*COND)	4024.873	12	335.406		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	TIME	COND	SS	df	Mean Square	F	Sig.
FEMALE	TIME	T4 vs. T3		.255	1	.255	.034	.861
	Error(T)	T4 vs. T3		37.438	5	7.488		
	COND		Ex vs. Su	1.518	1	1.518	.068	.805
	Error(C)		Ex vs. Su	112.250	5	22.450		
	T * C	T4 vs. T3	Ex vs. Su	2.386E-02	1	2.386E-02	.002	.965
	Error(T*C)	T4 vs. T3	Ex vs. Su	55.247	5	11.049		
MALE	TIME	T4 vs. T3		3209.777	1	3209.777	3.826	.074
	Error(T)	T4 vs. T3		10067.920	12	838.993		
	COND		Ex vs. Su	3.210	1	3.210	.004	.951
	Error(C)		Ex vs. Su	9902.869	12	825.239		
	T * C	T4 vs. T3	Ex vs. Su	277.116	1	277.116	.207	.658
	Error(T*C)	T4 vs. T3	Ex vs. Su	16099.494	12	1341.624		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	Intercept	55.842	1	55.842	10.720	.022
	Error	26.045	5	5.209		
MALE	Intercept	3174.670	1	3174.670	6.644	.024
	Error	5733.724	12	477.810		

Ch. 6: ANOVA Source Table: Total Harmonic Power with 1-between (gender) and 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
THPR3	FEMALE	222.2617	238.4248	6
	MALE	96.0485	106.4246	13
	Total	135.9053	164.2394	19
THPE3	FEMALE	34.0674	41.4570	6
	MALE	32.7024	27.6792	13
	Total	33.1334	31.4419	19
THPR4	FEMALE	164.5483	207.9270	6
	MALE	124.3986	98.4729	13
	Total	137.0774	137.2647	19
THPE4	FEMALE	28.0768	21.9806	6
	MALE	73.2865	68.9008	13
	Total	59.0097	61.3616	19

Tests of Within-Subjects Effects
Measure: MEASURE_1

Source	Sum of Squares	df	Mean Square	F	Sig.
TIME	28.074	1	28.074	.005	.947
TIME * GENDER	18055.870	1	18055.870	2.939	.105
Error(TIME)	104425.623	17	6142.684		
COND	197904.386	1	197904.386	15.544	.001
COND * GENDER	45350.068	1	45350.068	3.562	.076
Error(COND)	216436.179	17	12731.540		
TIME * COND	4198.121	1	4198.121	.493	.492
T * C * G	1600.401	1	1600.401	.188	.670
Error(T*C)	144657.625	17	8509.272		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

Source	TIME(T)	COND (C)	SS	df	MS	F	Sig.
TIME	T4 vs. T3		28.074	1	28.074	.005	.947
T * G	T4 vs. T3		18055.870	1	18055.870	2.939	.105
Error(T)	T4 vs. T3		104425.623	17	6142.684		
COND		Ex vs. Su	197904.386	1	197904.386	15.544	.001
C * G		Ex vs. Su	45350.068	1	45350.068	3.562	.076
Error(C)		Ex vs. Su	216436.179	17	12731.540		
T * C	T4 vs. T3	Ex vs. Su	16792.483	1	16792.483	.493	.492
T * C * G	T4 vs. T3	Ex vs. Su	6401.604	1	6401.604	.188	.670
Error(T*C)	T4 vs. T3	Ex vs. Su	578630.501	17	34037.088		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

Source	Sum of Squares	df	Mean Square	F	Sig.
Intercept	154262.944	1	154262.944	28.792	.000
GENDER	3851.446	1	3851.446	.719	.408
Error	91082.161	17	5357.774		

Ch. 6: ANOVA Source Table: Total Harmonic Power with 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Tests of Within-Subjects Effects

Measure: MEASURE_1

GENDER	Source	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	TIME	6087.309	1	6087.309	.363	.573
	Error(T)	83844.475	5	16768.895		
	COND	158111.850	1	158111.850	5.067	.074
	Error(C)	156020.948	5	31204.190		
	T * C	4012.874	1	4012.874	.282	.618
	Error(T*C)	71101.548	5	14220.310		
MALE	TIME	15443.742	1	15443.742	9.005	.011
	Error(T)	20581.148	12	1715.096		
	COND	42577.210	1	42577.210	8.457	.013
	Error(C)	60415.231	12	5034.603		
	T * C	486.431	1	486.431	.079	.783
	Error(T*C)	73556.077	12	6129.673		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

GENDER	Source	TIME	COND	SS	df	Mean Square	F	Sig.
FEMALE	TIME	T4 vs. T3		6087.309	1	6087.309	.363	.573
	Error(T)	T4 vs. T3		83844.475	5	16768.895		
	COND		Ex vs. Su	158111.850	1	158111.850	5.067	.074
	Error(C)		Ex vs. Su	156020.948	5	31204.190		
	T * C	T4 vs. T3	Ex vs. Su	16051.498	1	16051.498	.282	.618
	Error(T*C)							
		T4 vs. T3	Ex vs. Su	284406.194	5	56881.239		
MALE	TIME	T4 vs. T3		15443.742	1	15443.742	9.005	.011
	Error(T)	T4 vs. T3		20581.148	12	1715.096		
	COND		Ex vs. Su	42577.210	1	42577.210	8.457	.013
	Error(C)		Ex vs. Su	60415.231	12	5034.603		
	T * C	T4 vs. T3	Ex vs. Su	1945.726	1	1945.726	.079	.783
	Error(T*C)							
		T4 vs. T3	Ex vs. Su	294224.308	12	24518.692		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

GENDER	Source	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	Intercept	75584.987	1	75584.987	7.542	.040
	Error	50110.555	5	10022.111		
MALE	Intercept	86580.312	1	86580.312	25.358	.000
	Error	40971.606	12	3414.301		

Ch. 6: ANOVA Source Table: Total Power with 1-between (gender) and 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
TPR3	FEMALE	480.9373	535.6944	6
	MALE	233.3345	140.2775	13
	Total	311.5248	326.8246	19
TPE3	FEMALE	75.3360	74.2432	6
	MALE	119.7843	91.5199	13
	Total	105.7480	86.9807	19
TPR4	FEMALE	368.8544	311.2852	6
	MALE	404.9377	262.6934	13
	Total	393.5430	270.5890	19
TPE4	FEMALE	99.5879	50.0154	6
	MALE	176.6583	100.3936	13
	Total	152.3203	93.6420	19

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	Sum of Squares	df	Mean Square	F	Sig.
TIME	20301.920	1	20301.920	.705	.413
TIME * GENDER	102683.714	1	102683.714	3.563	.076
Error(TIME)	489896.548	17	28817.444		
COND	1060875.241	1	1060875.241	23.555	.000
COND * GENDER	113833.255	1	113833.255	2.527	.130
Error(COND)	765655.860	17	45038.580		
TIME * COND	479.083	1	479.083	.018	.896
T * C * G	64691.930	1	64691.930	2.394	.140
Error(TIME*COND)	459441.988	17	27025.999		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME	COND	Sum of Squares	df	Mean Square	F	Sig.
TIME	T4 vs. T3		20301.920	1	20301.920	.705	.413
T * G	T4 vs. T3		102683.714	1	102683.714	3.563	.076
Error(T)	T4 vs. T3		489896.548	17	28817.444		
COND		Ex vs. Su	1060875.241	1	1060875.241	23.555	.000
C * G		Ex vs. Su	113833.255	1	113833.255	2.527	.130
Error(C)		Ex vs. Su	765655.860	17	45038.580		
T * C	T4 vs. T3	Ex vs. Su	1916.333	1	1916.333	.018	.896
T * C * G	T4 vs. T3	Ex vs. Su	258767.721	1	258767.721	2.394	.140
Error(T*C)	T4 vs. T3	Ex vs. Su	1837767.952	17	108103.997		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Sum of Squares	df	Mean Square	F	Sig.
Intercept	985100.801	1	985100.801	43.780	.000
GENDER	2078.325	1	2078.325	.092	.765
Error	382523.175	17	22501.363		

Ch. 6: ANOVA Source Table: Total Power with 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Tests of Within-Subjects Effects
Measure: MEASURE_1

GENDER	Source	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	TIME	11571.408	1	11571.408	.176	.692
	Error(TIME)	327858.336	5	65571.667		
	COND	683169.693	1	683169.693	6.043	.057
	Error(COND)	565294.009	5	113058.802		
	TIME * COND	27880.765	1	27880.765	.521	.503
	Error(TIME*COND)	267356.140	5	53471.228		
MALE	TIME	169655.868	1	169655.868	12.564	.004
	Error(TIME)	162038.212	12	13503.184		
	COND	379754.117	1	379754.117	22.744	.000
	Error(COND)	200361.851	12	16696.821		
	TIME * COND	42779.114	1	42779.114	2.672	.128
	Error(TIME*COND)	192085.848	12	16007.154		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

GENDER	Source	TIME	COND	SS	df	Mean Square	F	Sig.
FEMALE	TIME	T4 vs. T3		11571.408	1	11571.408	.176	.692
	Error(T)	T4 vs. T3		327858.336	5	65571.667		
	COND		Ex vs. Su	683169.693	1	683169.693	6.043	.057
	Error(C)		Ex vs. Su	565294.009	5	113058.802		
	T * C	T4 vs. T3	Ex vs. Su	111523.061	1	111523.061	.521	.503
	Error(T*C)							
		T4 vs. T3	Ex vs. Su	1069424.559	5	213884.912		
MALE	TIME	T4 vs. T3		169655.868	1	169655.868	12.564	.004
	Error(T)	T4 vs. T3		162038.212	12	13503.184		
	COND		Ex vs. Su	379754.117	1	379754.117	22.744	.000
	Error(C)		Ex vs. Su	200361.851	12	16696.821		
	T * C	T4 vs. T3	Ex vs. Su	171116.454	1	171116.454	2.672	.128
	Error(T*C)							
		T4 vs. T3	Ex vs. Su	768343.393	12	64028.616		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

GENDER	Source	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	Intercept	393765.734	1	393765.734	9.858	.026
	Error	199723.548	5	39944.710		
MALE	Intercept	709874.525	1	709874.525	46.600	.000
	Error	182799.626	12.	15233.302		

Ch 6: ANOVA Source Table: **SBR Slope** with 1-between (gender) and 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Descriptive Statistics

	GENDER	Mean	SD	N
SLR3	FEMALE	4.6432	2.7873	6
	MALE	4.5320	2.3739	12
	Total	4.5690	2.4361	18
SLE3	FEMALE	2.3850	1.0850	6
	MALE	4.2617	4.6485	12
	Total	3.6361	3.8932	18
SLR4	FEMALE	4.7543	2.6858	6
	MALE	5.7527	2.4140	12
	Total	5.4199	2.4753	18
SLE4	FEMALE	2.5528	.8448	6
	MALE	3.6521	1.7361	12
	Total	3.2856	1.5635	18

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	SS	df	MS	F	Sig.
TIME (T)	.792	1	.792	.224	.643
T * GENDER	.110	1	.110	.031	.862
Error(T)	56.638	16	3.540		
COND (C)	46.657	1	46.657	18.446	.001
C * GENDER	4.363	1	4.363	1.725	.208
Error(C)	40.470	16	2.529		
T * C	3.146	1	3.146	.837	.374
T * C * GENDER	3.561	1	3.561	.948	.345
Error(T*C)	60.108	16	3.757		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME (T)	COND (C)	SS	df	MS	F	Sig.
TIME	T4 vs. T3		.792	1	.792	.224	.643
T * GENDER	T4 vs. T3		.110	1	.110	.031	.862
Error(TIME)	T4 vs. T3		56.638	16	3.540		
COND		Ex vs. Su	46.657	1	46.657	18.446	.001
COND * GENDER		Ex vs. Su	4.363	1	4.363	1.725	.208
Error(COND)		Ex vs. Su	40.470	16	2.529		
T * C	T4 vs. T3	Ex vs. Su	12.582	1	12.582	.837	.374
T * C* GENDER	T4 vs. T3	Ex vs. Su	14.244	1	14.244	.948	.345
Error(T*C)	T4 vs. T3	Ex vs. Su	240.43	16	15.027		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	264.609	1	264.609	52.253	.000
GENDER	3.731	1	3.731	.737	.403
Error	81.023	16	5.064		

Ch. 6: ANOVA Source Table: **SBR Slope** with 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Tests of Within-Subjects Effects

GENDER	Source	SS	df	Mean Square	F	Sig.
FEMALE	TIME (T)	.117	1	.117	.077	.792
	Error(T)	7.567	5	1.513		
	COND (C)	29.833	1	29.833	9.249	.029
	Error(C)	16.129	5	3.226		
	T * C	4.829E-03	1	4.829E-03	.007	.936
	Error(T*C)	3.359	5	.672		
MALE	TIME	1.120	1	1.120	.251	.626
	Error(T)	49.071	11	4.461		
	COND	16.863	1	16.863	7.620	.019
	Error(C)	24.342	11	2.213		
	T * C	10.050	1	10.050	1.948	.190
	Error(T*C)	56.749	11	5.159		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

GENDER	Source	TIME (T)	COND (C)	SS	df	MS	F	Sig.
FEMALE	TIME (T)	T4 vs. T3		.117	1	.117	.077	.792
	Error(T)	T4 vs. T3		7.567	5	1.513		
	COND (C)		Ex vs. Su	29.833	1	29.833	9.249	.029
	Error(C)		Ex vs. Su	16.129	5	3.226		
	T * C	T4 vs. T3	Ex vs. Su	.01932	1	.01932	.007	.936
	Error(T*C)	T4 vs. T3	Ex vs. Su	13.437	5	2.687		
MALE	TIME	T4 vs. T3		1.120	1	1.120	.251	.626
	Error(T)	T4 vs. T3		49.071	11	4.461		
	COND		Ex vs. Su	16.863	1	16.863	7.620	.019
	Error(C)		Ex vs. Su	24.342	11	2.213		
	T * C	T4 vs. T3	Ex vs. Su	40.200	1	40.200	1.948	.190
	Error(T*C)	T4 vs. T3	Ex vs. Su	226.995	11	20.636		

Tests of Between-Subjects Effects

GENDER	Source	SS	df	Mean Square	F	Sig.
FEMALE	Intercept	77.062	1	77.062	26.891	.004
	Error	14.329	5	2.866		
MALE	Intercept	248.386	1	248.386	40.967	.000
	Error	66.695	11	6.063		

Ch. 6: ANOVA Source Table: **R-R Interval** with 1-between (gender) and 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
RRIR3	FEMALE	756.4160	119.9770	6
	MALE	805.2727	106.8878	13
	Total	789.8443	110.2703	19
RRIE3	FEMALE	628.2448	81.4382	6
	MALE	679.7091	96.0073	13
	Total	663.4572	92.6891	19
RRIR4	FEMALE	810.3287	85.4121	6
	MALE	904.0948	124.1292	13
	Total	874.4844	119.5981	19
RRIE4	FEMALE	670.3298	44.9162	6
	MALE	762.5089	96.8067	13
	Total	733.3997	93.5201	19

Tests of Within-Subjects Effects
Measure: MEASURE_1

Source	Sum of Squares	df	Mean Square	F	Sig.
TIME (T)	79100.803	1	79100.803	18.415	.000
TIME * GENDER (G)	7524.414	1	7524.414	1.752	.203
Error(TIME)	73020.926	17	4295.349		
COND	294108.388	1	294108.388	154.050	.000
COND * GENDER	1.069	1	1.069	.001	.981
Error(COND)	32455.920	17	1909.172		
TIME * COND	796.042	1	796.042	.712	.410
TIME * COND * GENDER	18.056	1	18.056 .016	.900	
Error(TIME*COND)	18995.426	17	1117.378		

Tests of Within-Subjects Contrasts
Measure: MEASURE_1

Source	TIME(T)	COND (C)	Sum of Squares	df	Mean Square	F	Sig.
TIME	T4 vs. T3		79100.803	1	79100.803	18.415	.000
T * G	T4 vs. T3		7524.414	1	7524.414	1.752	.203
Error(T)	T4 vs. T3		73020.926	17	4295.349		
COND		Ex vs. Su	294108.388	1	294108.388	154.05	.000
C * G		Ex vs. Su	1.069	1	1.069 .001	.981	
Error(C)		Ex vs. Su	32455.920	17	1909.172		
T * C	T4 vs. T3	Ex vs. Su	3184.169	1	3184.169	.712	.410
T * C * G	T4 vs. T3	Ex vs. Su	72.225	1	72.225	.016	.900
Error(T*C)	T4 vs. T3	Ex vs. Su	75981.706	17	4469.512		

Tests of Between-Subjects Effects
Measure: MEASURE_1
Transformed Variable: Average

Source	Sum of Squares	df	Mean Square	F	Sig.
Intercept	9288964.268	1	9288964.268	1103.726	.000
GENDER	21026.220	1	21026.220	2.498	.132
Error	143072.141	17	8416.008		

Ch. 6: ANOVA Source Table: **R-R Interval** with 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Tests of Within-Subjects Effects

GENDER	Source	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	TIME (T)	13823.340	1	13823.340	3.637	.115
	Error(TIME)	19005.989	5	3801.198		
	COND	107872.811	1	107872.811	41.022	.001
	Error(COND)	13148.151	5	2629.630		
	TIME * COND	209.847	1	209.847	.281	.619
	Error(TIME*COND)	3730.202	5	746.040		
MALE	TIME	107206.023	1	107206.023	23.817	.000
	Error(TIME)	54014.937	12	4501.245		
	COND	231948.884	1	231948.884	144.159	.000
	Error(COND)	19307.769	12	1608.981		
	TIME * COND	834.320	1	834.320	.656	.434
	Error(TIME*COND)	15265.224	12	1272.102		

Tests of Within-Subjects Contrasts

GENDER	Source	TIME (T)	COND (C)	SS	df	MS	F	Sig.
FEMALE	TIME	T4 vs. T3		13823.340	1	13823.340	3.637	.115
	Error(T)	T4 vs. T3		19005.989	5	3801.198		
	COND		Ex vs. Su	107872.811	1	107872.811	41.022	.001
	Error(C)		Ex vs. Su	13148.151	5	2629.630		
	T * C	T4 vs. T3	Ex vs. Su	839.389	1	839.389	.281	.619
	Error(T*C)							
		T4 vs. T3	Ex vs. Su	14920.809	5	2984.162		
MALE	TIME	T4 vs. T3		107206.023	1	107206.023	23.817	.000
	Error(T)	T4 vs. T3		54014.937	12	4501.245		
	COND		Ex vs. Su	231948.884	1	231948.884	144.159	.000
	Error(C)		Ex vs. Su	19307.769	12	1608.981		
	T * C	T4 vs. T3	Ex vs. Su	3337.281	1	3337.281	.656	.434
	Error(T*C)							
		T4 vs. T3	Ex vs. Su	61060.897	12	5088.408		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

GENDER	Source	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	Intercept	3078770.441	1	3078770.441	531.682	.000
	Error	28953.111	5	5790.622		
MALE	Intercept	8070148.984	1	8070148.984	848.603	.000
	Error	114119.030	12	9509.919		

Ch. 6: ANOVA Source Table: **Systolic Blood Pressure** with 1-between (gender) and 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Descriptive Statistics

	GENDER	Mean	Std. Deviation	N
SBPR3	FEMALE	116.5518	38.8507	6
	MALE	108.7994	16.1590	12
	Total	111.3836	25.0406	18
SBPE3	FEMALE	166.5953	51.5254	6
	MALE	151.9456	15.7826	12
	Total	156.8288	31.5042	18
SBPR4	FEMALE	133.0640	24.6899	6
	MALE	119.1774	18.0511	12
	Total	123.8063	20.8687	18
SBPE4	FEMALE	172.1908	21.2714	6
	MALE	152.8733	24.4101	12
	Total	159.3124	24.6259	18

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source	Sum of Squares	df	Mean Square	F	Sig.
TIME (T)	1116.451	1	1116.451	1.671	.215
TIME * GENDER (G)	116.683	1	116.683	.175	.682
Error(TIME)	10692.054	16	668.253		
COND (C)	27560.095	1	27560.095	87.832	.000
COND * GENDER	151.988	1	151.988	.484	.496
Error(COND)	5020.499	16	313.781		
TIME * COND	414.815	1	414.815	1.219	.286
T * C * G	2.150	1	2.150	.006	.938
Error(T*C)	5445.648	16	340.353		

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source	TIME	COND	Sum of Squares	df	Mean Square	F	Sig.
TIME	T4 vs. T3		1116.451	1	1116.451	1.671	.215
T * G	T4 vs. T3		116.683	1	116.683	.175	.682
Error(T)	T4 vs. T3		10692.054	16	668.253		
COND		Ex vs. Su	27560.095	1	27560.095	87.832	.000
C * G		Ex vs. Su	151.988	1	151.988	.484	.496
Error(C)		Ex vs. Su	5020.499	16	313.781		
T * C	T4 vs. T3	Ex vs. Su	1659.259	1	1659.259	1.219	.286
T * C * G	T4 vs. T3	Ex vs. Su	8.601	1	8.601	.006	.938
Error(T*C)	T4 vs. T3	Ex vs. Su	21782.591	16	1361.412		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Sum of Squares	df	Mean Square	F	Sig.
Intercept	314271.052	1	314271.052	970.525	.000
GENDER	773.016	1	773.016	2.387	.142
Error	5181.049	16	323.816		

Ch. 6: ANOVA Source Table: **Systolic Blood Pressure** with 2-within factors (time [6 weeks vs. 12 weeks postoperatively] & condition [supine vs. exercise]).

Tests of Within-Subjects Effects

GENDER	Source	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	TIME	733.123	1	733.123	.546	.493
	Error(TIME)	6713.596	5	1342.719		
	COND	11927.023	1	11927.023	16.279	.010
	Error(COND)	3663.224	5	732.645		
	TIME * COND	178.760	1	178.760	.182	.687
	Error(TIME*COND)	4910.882	5	982.176		
MALE	TIME	383.454	1	383.454	1.060	.325
	Error(TIME)	3978.459	11	361.678		
	COND	17714.079	1	17714.079	143.563	.000
	Error(COND)	1357.275	11	123.389		
	TIME * COND	267.926	1	267.926	5.511	.039
	Error(TIME*COND)	534.766	11	48.615		

Tests of Within-Subjects Contrasts

GENDER	Source	TIME (T)	COND (C)	SS	df	MS	F	Sig.
FEMALE	TIME	T4 vs T3		733.123	1	733.123	.546	.493
	Error(T)	T4 vs T3		6713.596	5	1342.719		
	COND		Ex vs. Su	11927.023	1	11927.023	16.279	.010
	Error(C)		Ex vs. Su	3663.224	5	732.645		
	T * C	T4 vs T3	Ex vs. Su	715.042	1	715.042	.182	.687
	Error(T*C)							
		T4 vs T3	Ex vs. Su	19643.528	5	3928.706		
MALE	TIME	T4 vs T3		383.454	1	383.454	1.060	.325
	Error(T)	T4 vs T3		3978.459	11	361.678		
	COND		Ex vs. Su	17714.079	1	17714.079	143.563	.000
	Error (C)		Ex vs. Su	1357.275	11	123.389		
	T * C	T4 vs T3	Ex vs. Su	1071.706	1	1071.706	5.511	.039
	Error(T*C)							
		T4 vs T3	Ex vs. Su	2139.063	11	194.460		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

GENDER	Source	Sum of Squares	df	Mean Square	F	Sig.
FEMALE	Intercept	129831.343	1	129831.343	239.457	.000
	Error	2710.948	5	542.190		
MALE	Intercept	212903.417	1	212903.417	948.114	.000
	Error	2470.102	11	224.555		