Case Study

Improvements in Heart Rate Variability and Reduction in Dysautonomia Following Chiropractic Care: A Case Study and Selective Review of Literature

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Abstract

Objective: To review the outcomes of chiropractic care and its effect on heart rate variability and associated autonomic function in a 38-year-old male.

Clinical Feature: A 38-year-old male patient presented for chiropractic evaluation with a chief complaint of intermittent low back pain. Dysautonomia was noted using multiple instruments, including thermography and heart rate variability.

Intervention and Outcomes: Diversified technique was used to evaluate and adjust the patient to reduce subluxations. Dietary and exercise coaching was rendered. Re-assessments indicate continued improvement in autonomic function over the course of thirteen months of chiropractic care and a total of 61 pounds lost and 9. 5 percent decrease in fat mass.

Conclusion: This paper reviews the results of a patient undergoing chiropractic care with symptoms of low back pain and objective measures of autonomic dysfunction. The patient's compliance with chiropractic care and supervised wellness coaching led to significant improvement in autonomic function and reduction in overall weight and fat mass. Further research is suggested to ascertain the autonomic response to the chiropractic adjustment and concomitant lifestyle modifications as a key area for improved health.

Key Words: *Chiropractic, adjustment, vertebral subluxation, diversified technique, sympathetic nervous system, parasympathetic nervous system, autonomic nervous system, heart rate variability*

Introduction

Autonomic Dysfunction

The autonomic nervous system is understood to have two branches, the sympathetic nervous system and the parasympathetic nervous system.[1] The sympathetic nervous system is the principle pathway by which the body responds to an increased stress demand. The sympathetic nervous system is largely facilitated through sympathetic chain ganglia located in the thoracic and lumbar areas. The parasympathetic nervous system is understood to work conversely and principally regulates bodily functions such as digestion and reproduction. The vagus nerve is largely associated with parasympathetic function throughout the body. Increased vagal tone should predominate function and is marker of health.[2]

Both branches of the autonomic nervous system play a critical role in the overall picture of health, as both are critically necessary in their own respect and must work in tandem for optimum health to be achieved. It is important that these two branches compliment one another while remaining dynamic and changing as to achieve a state of equilibrium in the body. The external and internal environments of one's body is ever changing. Autonomic dysfunction, in which typically the sympathetic system is hyperactive and the parasympathetic system is hypoactive, occurs when the hyperactive sympathetic nervous system predominates the function of the

body. It is demonstrated that increased energy demands on the body are required while the sympathetic nervous system is hyperactive.[1] These increased energy demands, cumulatively, become excessive and cannot be met, leading to a state of disease in the body and precipitates numerous pathological processes.[1] Autonomic dysfunction is associated with various pathological processes. It is demonstrated to be a final common pathway to increased morbidity and mortality.[1] Heart rate variability may be used to assess the overall health of the autonomic nervous system and indicates the resulting dysfunction.

Heart Rate Variability

Heart rate variability is most accurately described as the change in intervals between successive heartbeats.[3] The heart is dually innervated by the sympathetic and parasympathetic systems. The parasympathetic system exerts the most immediate control of the function of the heart by acting as an inhibitory mechanism to the sympathetic system. By up-regulating or down-regulating the inhibitory control of the sympathetic nervous system, quick changes in the heart rate may be observed.

When the sympathetic nervous system predominates, a quickened heart rate may be observed. This response is normal and critical to meet increased energy and oxygen demands to the body when responding to environmental changes; however, as previously stated, if the body's control of this system is not adequate, then increased energy demands and stress on the body is constant and eventually cannot be met.[1] A state of increased parasympathetic control with resultant inhibition on the sympathetic nervous system results in a longer interval between heartbeats and a decreased energy demands.

Measures of heart rate variability have been indexed through much research using multiple indices, most notably time and frequency domains. The consensus is that lower values of these indices of vagal function are associated with death and morbidity. Several morbidities of note that have been discovered to be associated with decreased heart rate variability are cardiovascular disease, hypertension, diabetes mellitus type II, and depressive and anxiety disorders.[4-6]

Epidemiology of Heart Disease and Heart Rate Variability

Cardiovascular disease is the first leading cause of death in the United States and it has maintained this ranking since 1921.[7] According to the Centers for Disease Control and Prevention, in 2006, cardiovascular disease was responsible for 31.7% of all deaths.[7] The *International Journal of Cardiology* recognizes cardiovascular disease as the leading cause of death worldwide.[1] The direct health care burden of heart disease in the United States is estimated to be $23.4 billion.[8] With a growing and aging population, current trends suggest that an incremental increase in health care expenditure is expected, adding to the already overwhelming health care burden.

Autonomic dysfunction has been found to lead to cardiovascular disease due to the increased sympathetic response and increased energy demands.[1] Autonomic dysfunction is characterized most commonly by a hyperactive sympathetic nervous system, which increases energy demands. This condition of dysfunction, over time, leads to an inability for the energy demands to be met and overworking of the heart and other body systems that leads to cardiovascular disease.[1]

Inhibited parasympathetic and increased sympathetic function is suggested as an independent risk factor for all-cause mortality and additionally is a common factor in all of the major risk factors for cardiovascular disease.[1]

Epidemiology of Hypertension and Heart Rate Variability

Hypertension is recognized as the leading risk factor for cardiovascular disease and costs $131 billion annually in direct and indirect health care expenditures.[9] It has also been found that nearly one-third of U.S. adults have hypertension, with less than half having it under control. The prevalence of hypertension was observed to remain unchanged over a 10-year period, from 1998 to 2008, as it remained approximately 30%.[10-11]

One hallmark study in respect to cardiovascular disease was the Framingham Heart Study. The findings of this study indicate that autonomic dysfunction is present in the early stages of hypertension, indicating its significance in the pathogenesis of hypertension.[6] It was demonstrated that the baseline heart rate variability values in subjects with normal blood pressure readings who developed hypertension at follow up, were reduced in comparison to those who maintained normal blood pressure readings at follow-up.

In conclusion, heart rate variability is reduced in men and women with systemic hypertension. Among men and women with normal blood pressure readings, a lower heart rate variability, as assessed at baseline evaluation, was related to the subsequent development of hypertension at follow-up.[6]

Epidemiology of Diabetes and Heart Rate Variability

Diabetes is a serious, costly, and potentially preventable public health problem in the United States that has seen a rapid increase in incidence and prevalence since the mid 1990's.[12] New research provides comprehensive estimates that suggest the U.S. national economic burden of pre-diabetes and diabetes reached $218 billion in 2007.[13] For each American, regardless of diabetes status, this burden represents $700 annually.

Nearly 17.5 million people were diagnosed with Type I and type II diabetes in 2007, 16.5 million being diabetes mellitus type II. It is estimated that another 6.3 million people have diabetes and are undiagnosed. Nearly 57 million adults have pre-diabetes.[13] These statistics underscore the urgency of better understanding what measures can be made to better understand prevention and treatment options.

Autonomic dysfunction was revealed through heart rate variability in type II diabetic patients. It was concluded that patients with type II diabetes have increased sympathetic and decreased parasympathetic cardiac activity.[5] It was also found that autonomic dysfunction is correlated to components of

metabolic syndrome which is widely recognized as a complex of interrelated risk factors for cardiovascular disease and diabetes.[14]

Decreased parasympathetic activity in combination with increased sympathetic activation leads to a shift of cardiac sympathetic and parasympathetic balance in diabetic patients and leads to decreased autonomic function.[5]

Epidemiology of Depression and Heart Rate Variability

Major depressive disorder was estimated to affect 18.1 million people in the U.S. in 2002 and have a lifetime prevalence of 16.2% and an annual prevalence of 6.2%.[15] It was concluded that the prevalence of mild, moderate, or severe depression among the workforce was 47.7%. The estimated annual cost of clinical depression was 83.1 billion in 2000 and resulted in 27.2 lost workdays per individual each year. Some studies suggest that depression affects up to 8.3% of older adolescents and is associated with an increased risk of suicide.[16] Better management of depression is warranted as it may offer direction for improving care and better management of direct and indirect costs.

Research suggests that depression, panic disorder, hostility, and other altered emotional states are associated with decreased heart rate variability, which may also increase the risk for coronary artery disease as discussed previously (heart rate variability in depressive and anxiety disorder). It is proposed that decreased parasympathetic innervation exposes the heart to unopposed sympathetic stimulation by the sympathetic nerves. This leads to decreased heart rate variability, which has been noted in depressed individuals.[4]

Exercise

High intensity interval training exercise, as outlined by Munk et al,[17] markedly improved all indices of heart rate variability. The significant increase in heart rate variability seen with high intensity exercise indicates a shift towards increased parasympathetic and decreased sympathetic nervous system activity. Further study by Rennie et al[18] investigated the effects of exercise training on heart rate variability and found that it is a useful therapeutic intervention to improve the nervous system function. The Journal of Cardiology reports the beneficial effects of exercise and physical activity on heart rate variability and autonomic function.[1]

Nutrition

Much attention has been gained to the significance of nutrition on the overall health of the body. The finding that malnutrition leads to changes in cardiac autonomic modulation further promotes the significance of a healthy diet that supports health and not disease.[19] For these reasons, addressing one's nutritional status is paramount in restoring health and vitality to the body.

Barreto et al[19] reports that malnutrition presents "changes in cardiac autonomic modulation, characterized by reductions in both sympathetic and parasympathetic activity, as well as increased heart rate and decreased blood pressure."[19(p6)] The Journal of Cardiology states that "dietary changes including the consumption of fruits and vegetables, moderate alcohol consumption, and intake of omega-3 fatty acids and vitamin D through fish or nut consumption"[1(p129)] are effective approaches to increase heart rate variability. This research represents a body of evidence that supports the positive effects of proper nutrition.

Case Report

History

A 38-year-old male patient presented to the office with chief complaints of bilateral lower back pain and right heel pain that began 2 weeks prior to the patient presenting to the office. The pain was described as a dull ache and a rated intensity of 7 on a scale of 0 to 10 with zero being complete absence of symptoms and 10 being very severe or unbearable. The patient stated that the pain has been intermittent over of the past two weeks. The patient stated that some relief is obtained when Tylenol and ibuprofen is used, ice is applied, and analgesic topical pain relief gel is applied. The patient states that he has spinal fusions at levels T12-L2.

Physical Examination

Upon chiropractic examination and Diversified technique analysis, static palpation revealed hypomobile intersegmental motion and end point tenderness mild hypertonicity bilaterally in the mid cervical region and mild to moderate hypertonicity bilaterally in the lower back. Subluxations were found at the following vertebral levels as determined by motion palpation and radiograph findings (Figure 1): C1, C2, T6, L3, L4, and left posterior and inferior ilium. Radiographs also reveals L5 grade 2 spondylolisthesis and degenerative disc disease at levels L3-L5.

Range of motion was demonstrated to be significantly reduced in cervical flexion, extension, and both left and right lateral flexion as outlined in Figure 2. Lumbosacral flexion and extension and left and right lateral flexion were significantly decreased. These optimal ranges of motion used as reference are those outlined by the American Medical Assocation.[20] Orthopedic testing revealed a positive Valsalva, Soto-Hall, Kemp's bilaterally, and positive straight leg raiser on the right.

Diversified technique is an example of a "segmental model" as described by Cooperstein.[21] The segmental model describes subluxation in terms of alterations in specific intervertebral motion segments. In segmental approaches, segmental relationship may be evaluated by motion palpation.[22]

Thermal scanning was performed from spinal levels S1-C1, which can be seen in Figure 3. Paraspinal thermography scanning has been previously shown to be both a valid and reliable objective outcome assessment for vertebral subluxation and autonomic system dysfunction.[23] The patient's thermal scan showed moderate skin temperature changes on the right at spinal levels at L5 and S1. Mild skin temperature differences were noted on the left at spinal levels C5, C6, T1, and T6.

Heart rate variability was measured using a pulse wave profiler. The heart rate variability and domain frequency is

measured, giving insight to the function of the autonomic nervous system.[3] The patients initial score was a 55.28, with the score being from 0-100. An autonomic activity diagram was extrapolated using the pulse wave profiler. The patient was given an autonomic activity index of 60.55 and an autonomic balance index of 45.50.

The pulse wave profiler shows the actual heart rate over the entire data collection period. The variability over that length of time is measured and recorded as a number.[3] The pulse wave profiler uses a frequency domain analysis to show parasympathetic and sympathetic responses in the autonomic nervous system.

Intervention and Outcomes

Following the new patient exam, the doctor utilized a Diversified technique to address the multiple areas of subluxation as noted on the physical exam and x-ray. The patient regularly received diversified adjustments in the upper cervical, mid-thoracic, lower lumbar, and left ilium. Diversified technique is a generic term used to encompass multiple techniques used to address subluxations that most often describes a high-velocity, low-amplitude (HVLA) force. Diversified technique is an example of a "segmental model" as described by Cooperstein.[22]

The segmental model describes subluxation in terms of alterations in specific intervertebral motion segments. In segmental approaches, segmental relationship may be evaluated by motion palpation.[22] The broad philosophy used by Diversified practitioners is that adjusting subluxations removes nervous system interference allowing the body to heal itself. This philosophy is substantiated by Korr's work which describes multiple models of vertebral subluxation which include, the subluxation degeneration model which is a progressive process that is associated with abnormal spinal mechanics. The neurological consequences of spinal degeneration are shown to lead to autonomic dysfunction.[22] Subluxations are typically identified using a combination of patient history, static palpation, motion palpation, x-rays, and thermography.

It was recommended for the patient to follow a two times per week for six weeks adjustment schedule and would be reassessed at the conclusion of care. The adjustment schedule was reduced to one time per week following the first reassessment. In conjunction with chiropractic care, the patient was provided structured supervision on dietary modifications and high intensity workouts that were executed over the following six weeks and continued through the remainder of care.

The dietary modifications consisted of the consumption of vegetables, increase intake of healthy fats such as Omega-3 fatty acids, reduced or eliminated alcohol consumption, and intake of vitamin D. *The Journal of Cardiology* has suggested all of these measures as effective approaches to increase heart rate variability.[1] The high intensity workouts are best described as high-intensity interval training, or HIIT workouts. This type of workout is generally short, lasting no longer than 20-30 minutes. The objective is to raise one's heart rate significantly during 2-5 minute bursts of specific exercises that may implement light weights or body weight. This high intensity part of the workout is followed by a short interval of rest that allows the patient to reduce their heart rate slightly, but not all of the way before repeating another set of the previous exercise or moving to another exercise. The *American Journal of Epidemiology* reports that vigorous exercise improves one's heart rate variability.[18]

The patient's heart rate variability index was re-assessed using the pulse wave profiler and it was demonstrated to have increased indicating a shift towards greater parasympathetic control. The pulse wave profile score increased from the initial 55.28 to 71.97 (Figure 4) Autonomic activity index increased from 60.55 to 76.42 and autonomic balance index increased from 45.50 to 63.70 (Figure 5).

Cervical and lumbar ranges of motion findings were demonstrated to have increased significantly as shown in Figure 1.The rolling thermal scan showed changes demonstrating a dynamic and adaptive response to the environment (Figure 3).[23] The surface electromyography showed change in pattern and an overall reduction in total energy expenditure, as shown in Figure 6.The patient's weight was reassessed at intervals following initial onset of care and showed a total loss of 61 pounds and a resultant 9.5% reduction in fat mass following 16 months of care (Figure 7).

Discussion

The effects of chiropractic care on autonomic dysfunction can be analyzed through heart rate variability. This helps determine one's overall ability to adapt to the environment.[24] It does this by looking at multiple indices that include the timing of your pulse which indicates the level of balance that exists within the autonomic nervous system.[3] In a state of autonomic dysfunction, the sympathetic and parasympathetic nervous system are not acting in harmony and one predominates the function of the body.[1]

In a state of autonomic dis-ease it is most commonly found that the body's sympathetic system predominates function and leads to increased heart rate and a resulting increase in energy expenditure.[1] It is important to note that this process is benign and in fact normal when this process in mediated by inhibition of the parasympathetic nervous system.

When external and/or internal stimuli are present that require excess energy demand, the sympathetic response of the nervous system is normal function of the body. However, the sympathetic branch should not remain chronically elevated for extended lengths of time.[1] This increased response of the nervous system has been found to be due to work stress, malnutrition, and subluxation in the body.[1]

Review of Literature on Chiropractic Care and Autonomic Dysfunction

Welch and Boone[25] investigated the response of the autonomic nervous system based on the area of the spine adjusted. It was proposed that a chiropractic adjustment in the cervical spine would induce a greater parasympathetic response and that a thoracic adjustment would induce a sympathetic response. Forty patients were used in this study. Autonomic dysfunction

was assessed by evaluating blood pressure, pulse rate, and heart rate variability pre- and post- adjustment. The results of the study demonstrated that cervical adjustments may result in a parasympathetic response and thoracic adjustments may result in sympathetic response.[25]

Ruffini et al[26] investigated the influence of osteopathic manipulative treatment on cardiac autonomic function in healthy subjects, compared with sham therapy and a control group. Sixty-six healthy subjects, both male and female, were included in the study. Heart rate variability was continuously measured before, during, and after the intervention for a total of twenty-five minutes. The study showed a positive modification of autonomic nervous system activity through influencing the parasympathetic function of healthy subjects compared to a sham intervention and a control group.[26]

Zhang et al[27] investigated chiropractic care in a multiclinic setting to determine the effect of chiropractic care on the sympathetic and parasympathetic nervous system activities using heart rate variability analysis. Chiropractors were provided heart rate variability analysis devices to perform analysis before and after adjustments. At each site 10 subjects were monitored, with 8 subjects being monitored before and after a single chiropractic adjustment and 2 subjects followed for 4 weeks with heart rate variability analysis recorded two times per week. 157 subjects were recruited to serve as a control group and their heart rate variability was noted. The chiropractic care group showed a statistically significant improvement in heart rate variability on the single-visit and the 4-week visit groups, but not in the control group.[27]

Roy et al[28] examined heart rate variability in the presence of the absence of pain in the lower back, while receiving one chiropractic adjustment at L5 using either diversified technique or an activator. Fifty-one participants were assigned to a control group, sham group, or treatment group. It was concluded that adjusting the lumbar vertebrae appears to affect the lumbar parasympathetic nervous system as noted by heart rate variability.[28]

Budgell and Polus[29] measured the effects of a thoracic manipulation on heart rate variability in a cohort of young healthy adults. Heart rate variability was measured before and after a sham intervention and thoracic manipulation intervention on 28 healthy young adults. The positive changes in heart rate variability following the thoracic manipulation were not noted in the sham intervention. It was suggested that high-velocity and low-amplitude manipulation of the thoracic spine influences the autonomic nervous system in a way that is not otherwise duplicated in a sham intervention.[29]

Budgell[30] reviewed the reflex effect of subluxation and its effect on the autonomic nervous system to substantiate the collective experiences of the chiropractic profession. These collective experiences found that aberrant stimulation at a particular level of the spine may manifest as a dysfunction of the parasympathetic nervous system at that corresponding level and produce dysfunction within organs innervated by that particular level. It was concluded that recent neuroscience research supports a neurophysiological rationale that supports the concept that dysfunction at a particular spinal level may result in altered visceral function.[30]

Girsberger et al[31] examined the affects cranioscral therapy on autonomic dysfunction as observed through heart rate variability. It was proposed that discomforts in a preclinical range are due to imbalanced autonomic nervous system activity. Heart rate variability measurements were taken before and after intervention on 31 patients who reported subjective discomfort. It was concluded that craniosacral therapy had favorable effect on autonomic nervous system activity.[31]

Win et al[32] studies the effects upper and lower cervical spinal manipulative therapy on blood pressure and heart rate variability in volunteers and patients with neck pain. This reports provides evidence that upper cervical adjustments may provide an increase in parasympathetic function and lower cervical adjustments may provide an increase in sympathetic activity. Dominance of parasympathetic activity was found in patients with neck pain that received both upper and lower cervical adjustments.

Proposed Mechanism of Subluxation Correction

Multiple models of subluxation support the effects of subluxation on the autonomic nervous system and thus the mechanism by which autonomic dysfunction results, as demonstrated through heart rate variability. These models include the Subluxation Degeneration Model, Dysafferentation Model, and the Neurodystophic model, as one model of subluxation is not mutually exclusive to the other but rather provides different mechanisms of pathophysiology that lead to the resulting autonomic dysfunction.

The Subluxation Degeneration Model is described as a progressive process associated with alterations in spinal mechanics. The degenerative changes in the spine lead to multiple incidences of neurological dysfunction. Disc thinning, osteophytes, and degenerative changes between the vertebral bodies characterize progressive degeneration. The neurological consequence of spinal degeneration is autonomic dysfunction, as described in multiple incidences. The phenomenon can occur following cervical injury and the stimulation of the sympathetic nerves has been implicated in the pathogenesis.[22]

The dysafferentation model describes a phenomenon in which a lack of proper sensory input to the central nervous system leads to misdirected neurophysiological reactions to external and internal stimuli. These repercussions in turn work as a cascade of dysponesis throughout the body. The intervertebral spinal segments are rich in proprioceptive structures that allow the body to assess the nature of internal and external stimuli. Biomechanical dysfunction may result in an alteration in this normal proprioceptive input. If afferent input is compromised then efferent output, such as parasympathetic and sympathetic output, may be qualitatively and quantitatively altered, as in the case of heart rate variability indices.[22]

The neurodystrophic model suggests that neural dysfunction is stressful to the body and that lowered tissue resistance leads to immune responses that can alter the function of involved nerves. The neural dysfunction initiates an acute immune response and an inflammatory response occurs. It is proposed

that this neural dysfunction, if left in a state of dysfunction, can create a chronic inflammatory response, which initiates a sympathetic response. This stressful condition leads to altered immune function and resulting autonomic dysfunction.[22]

This response to chiropractic care and dietary and exercise implementation as described above have all been documented as independent therapeutic responses to increased heart rate variability.[1, 19] More evidence should be compiled through case studies, case series, and randomized control trials to effectively demonstrate the reproducibility of these interventions so they can be utilized to help others with autonomic dysfunction and associated sequela.

Allopathic and Complementary and Alternative Management of Autonomic Dysfunction

As reviewed above, there are several clinical diagnoses that have been linked to autonomic dysfunction. The following section serves to briefly review the management of each condition.

Coronary Heart Disease and Hypertension

High blood pressure is considered one of the most common risk factors for cardiovascular disease and stroke.[10] The current research suggests that the prevalence of coronary artery disease is increasing, as are the major risk factors.[33] One such major risk factor being hypertension. Accordingly it is not uncommon for heart disease and hypertension to be co-morbid conditions that exist separate of one another, but closely related. Thus, the treatment for one condition, regularly coincides with the other.[33]

Current trends in hypertension management emphasize a multi-drug therapy. Combinations of hypertensive medications such as beta blockers, angiotensin II-receptor blocker, angiotensin converting enzyme inhibitor (ACE inhibitor), and anti-diuretics are among the most commonly used drugs. These drugs, along with complimentary actions may minimize the adverse effects and reduce adverse outcomes by reducing blood pressure. "Beta blockers are effective in hypertension treatment and reduce incidence of death and re-infarction in patients who have had a myocardial infarction.

Along with diuretics, Beta-blockers became the standard of care for hypertensive coronary artery disease patients."[33(p2806)] These medications are aimed at reducing one's blood pressure in order to improve blood pressure control and subsequent organ protection.[33] As outlined by the Joint National Committee (JNC) on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure, the target systolic blood pressure reading is desired to be less than 140 mm Hg and diastolic blood pressure less than 90 mm Hg. Measures of management are outlined in order to achieve the blood pressure readings as outlined by the JNC. Blood pressure screening, measurements, and control through medication are the key points of the allopathic model.[33]

The American Heart Association recognizes many antihypertensive medications and lifestyle changes are proven to reduce blood pressure and accordingly performed a study to summarize the blood pressure lowering efficacy of "alternative approaches."[34] The alternative approaches were divided into broad categories to include diet, behavioral therapies, non-invasive procedures or devices, and exercise based regimens.

The American Heart Association published research outlining the efficacy of dietary management, which included the reduction of sodium in the diet. Given the 90% lifetime risk of developing hypertension among middle aged adults with normal blood pressure, these dietary recommendations were made for the general public. The conclusions of the American Heart Association, recognizes the effectiveness of using aerobic and/or dynamic resistance exercise for the adjuvant treatment of high blood pressure. Biofeedback techniques such as, isometric handgrip, and device guided breathing are also likely effective treatments.

The Department of Pharmacological Sciences acknowledges the many side effects of conventional antihypertensive therapies and accordingly has made concerted efforts to review the efficacy of herbal remedies to hypertension in the past several decades.[35] The hypertensive effects of the some of these plants have been approved and others disapproved. Currently, more scientific research is warranted to further verify the effectiveness and safety profile of such herbal remedies.[35]

The current allopathic model utilizes invasive procedures such as coronary-stent placement, coronary artery bypass surgery, and balloon angioplasty in the treatment of coronary artery disease. These measures are commonly only necessitated if the lumen of the coronary vessel is reduced to less than 50% of the original size or symptoms of myocardial ischemia are present.[36-37] These measures are preceded by less invasive measures and used when measures discussed above prove to be ineffective in treating the effects of hypertension and subsequent coronary artery disease.

Diabetes Mellitus Type II

Type II diabetes is a growing health concern that has been shown to shorten one's life expectancy by up to 15 years. Interventions to delay or prevent diabetes has the potential to improve the health of a population and reduce the burden of health care costs.[38] The current allopathic model seeks to reduce impaired glucose tolerance through oral medication. Allopathic medicine and complementary and alternative medicine also recognize the benefits of lifestyle modification in preventing what is fundamentally a lifestyle issue.[38] The British Medical Journal recently quantified the effectiveness of pharmacological and lifestyle interventions to prevent or delay the onset of diabetes mellitus type II in people with impaired glucose tolerance.

Evidence showed clinical effectiveness for both lifestyle interventions such as diet and exercise as well pharmacological interventions. The biggest limiting factor in both interventions appeared to be compliance with each respected intervention. Further research is warranted to assess the long-term side effects of pharmacological intervention and strategies to implement to increase compliance with lifestyle interventions.[38]

Another area of interest in regards to decreasing impaired glucose tolerance is the use of herbs and supplements. "In response to the increasing use of complementary and alternative medicine among the general public, the American Diabetes Association issued a Position Statement in 2001 on 'Unproven Therapies' that encouraged health care providers to ask their patients about alternative therapies and practices, evaluate each therapy's effectiveness, be cognizant of any potential harm to patients, and acknowledge circumstances in which new and innovative diagnostic or therapeutic measure might be provided to patients."[39(p1277)]

It was concluded by Yeh et al[39] that there still remains insufficient evidence to draw definitive conclusions about the efficacy of individual herbs and supplements for diabetes, although they are thought to be generally regarded as safe.[39]

Depression

The current approach to managing depression includes psychosocial and pharmacological treatment. In general, it has been found that psychosocial interventions are effective at post-treatment and follow-up in reducing depressive symptoms/disorders.[40] The most common pharmacological drugs used to treat depression are selective serotonin reuptake inhibitors (SSRIs) and tricyclic antidepressants (TCAs). Some evidence suggests that selective serotonin reuptake inhibitors are effective and likely play an increased role in the management of depression.[40]

Limitations

A case study represents a small sample size, which does not allow for evidence supporting reproducibility in results among a broader scope of patients. A limited sample size also does not allow for a control group for comparison. Further limitations of this study include the fact that the patient was working on improvements in his dietary and exercise habits while receiving chiropractic care. The multiple variables that are being addressed makes it particularly difficult to isolate the specific agent(s) of change and the mechanism by which they work together.

Conclusion

Heart rate variability is demonstrated to be a valid and reliable indicator of overall health and indicates that a decreased heart rate variability is consistent with poor health and autonomic function. Improved autonomic function, as assessed by a decreased heart rate variability is noted following chiropractic adjustments and wellness coaching. Evidence supports that chiropractic care should be utilized for individuals who demonstrate autonomic dysfunction.

Further research in the form of additional case studies and randomized control trials demonstrating the effects of chiropractic care and dietary and exercise modifications on heart rate variability are needed to help document the connection between vertebral subluxation, autonomic dysfunction, and all cause morbidity and mortality. The direct link to vertebral subluxation and autonomic dysfunction should be further explored in the form of a randomized control that uses heart rate variability changes among a large number of patients in an attempt to eliminate sample size fallacy.

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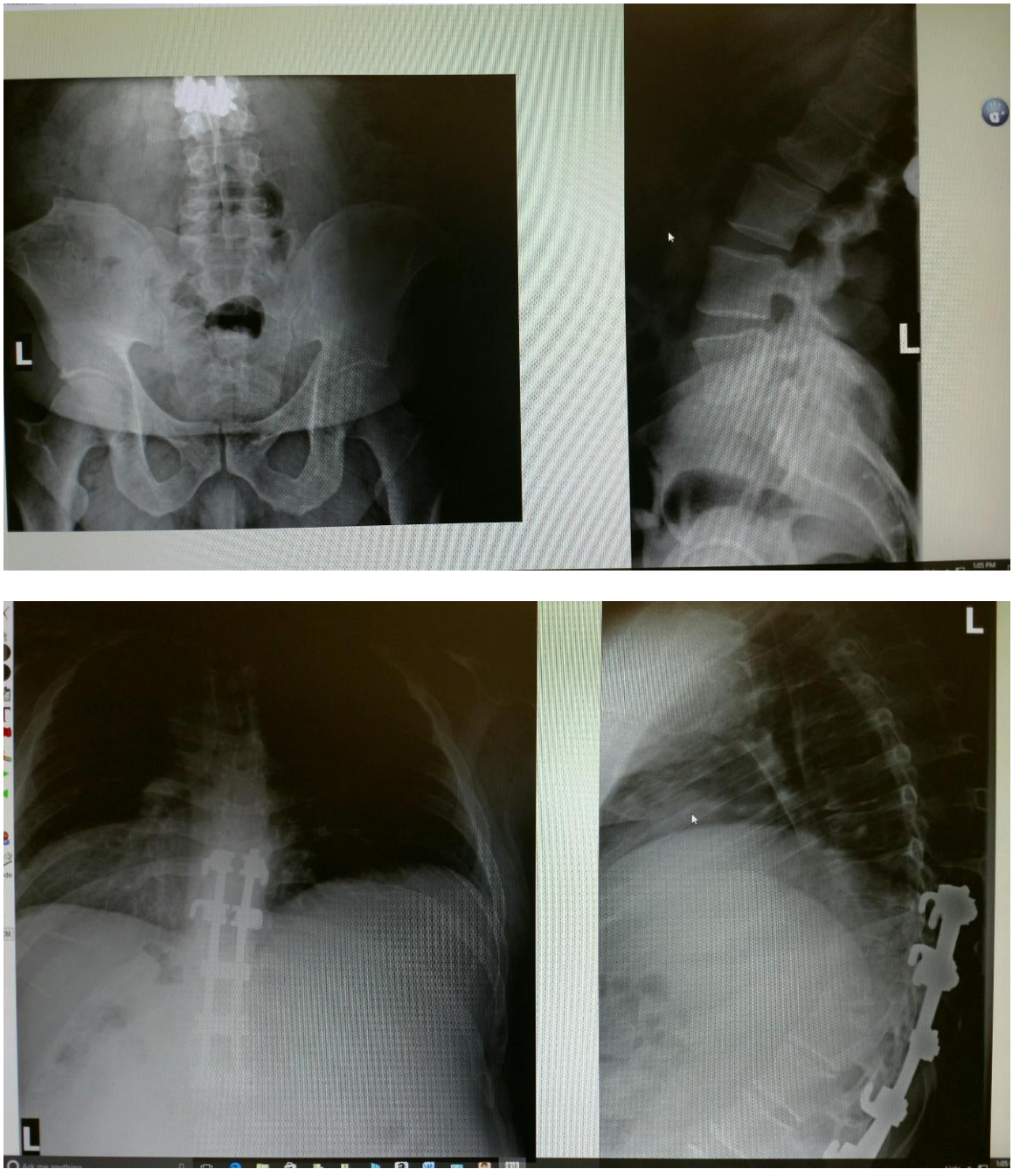
Appendix

Figure 1. Radiographs reveal L5 grade 2 spondylolisthesis and degenerative disc disease at levels L3-L5. The patient has spinal fusions at levels T12-L2. Upon physical exam, the following listings were noted: C1, C2, T6, L3, L4, and left posterior and inferior ilium, confirmed by x-ray.



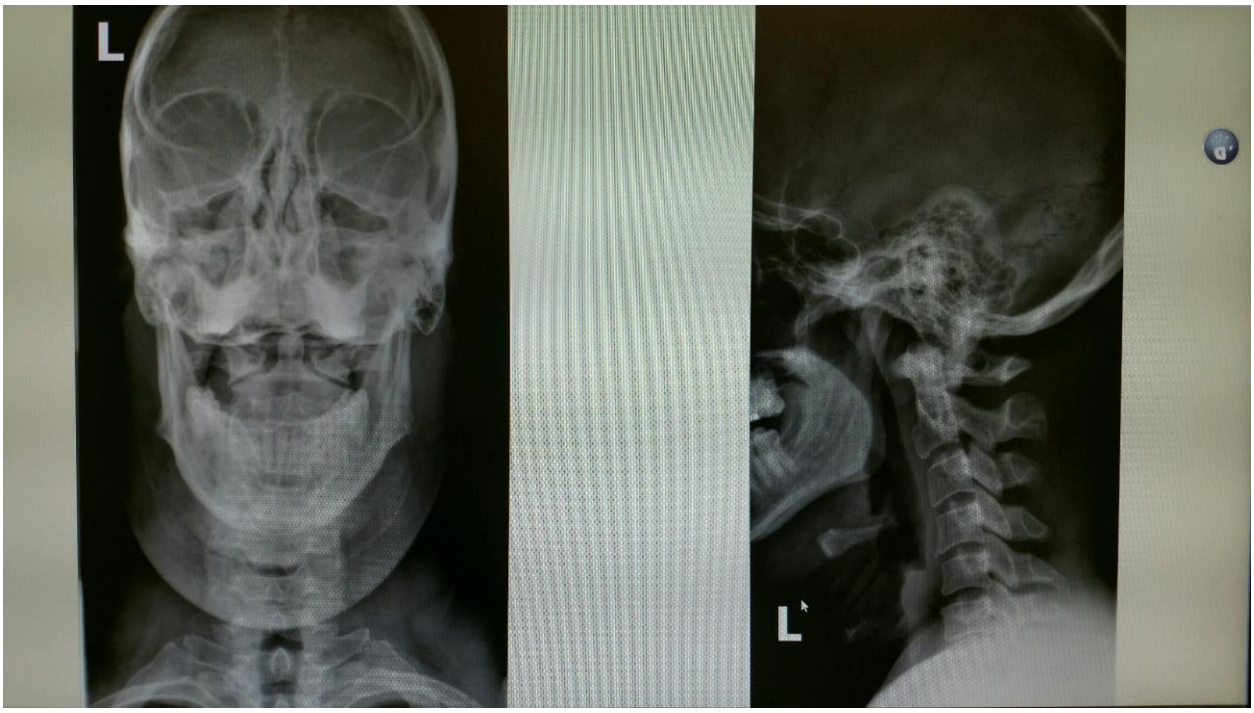

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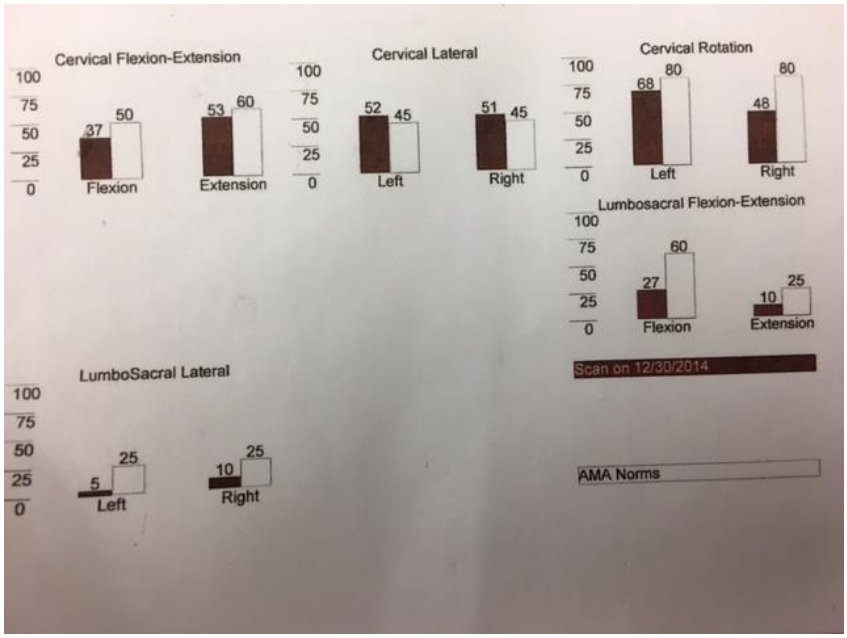
Figure 2. Pre and Post ROM Graph

Pre:



Post ROM

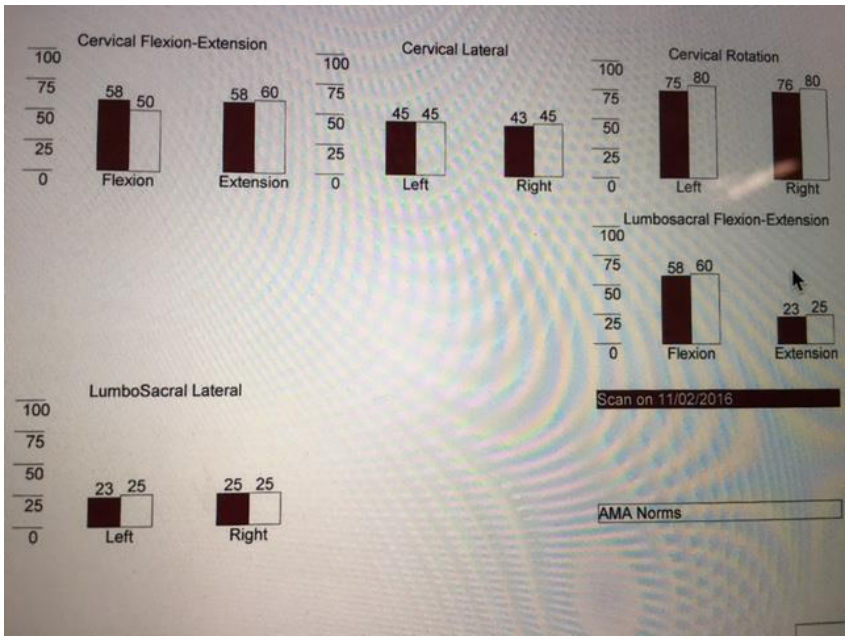
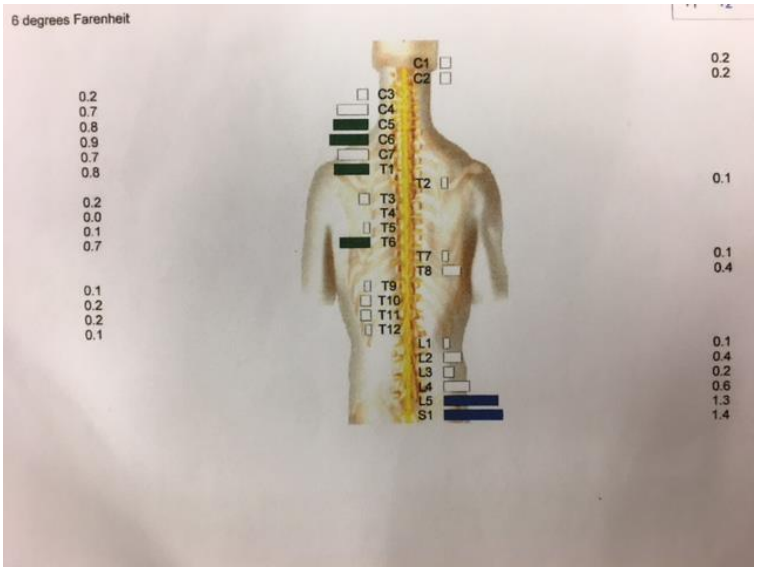


Figure 3. Pre and Post Rolling Thermal Scan

Pre:



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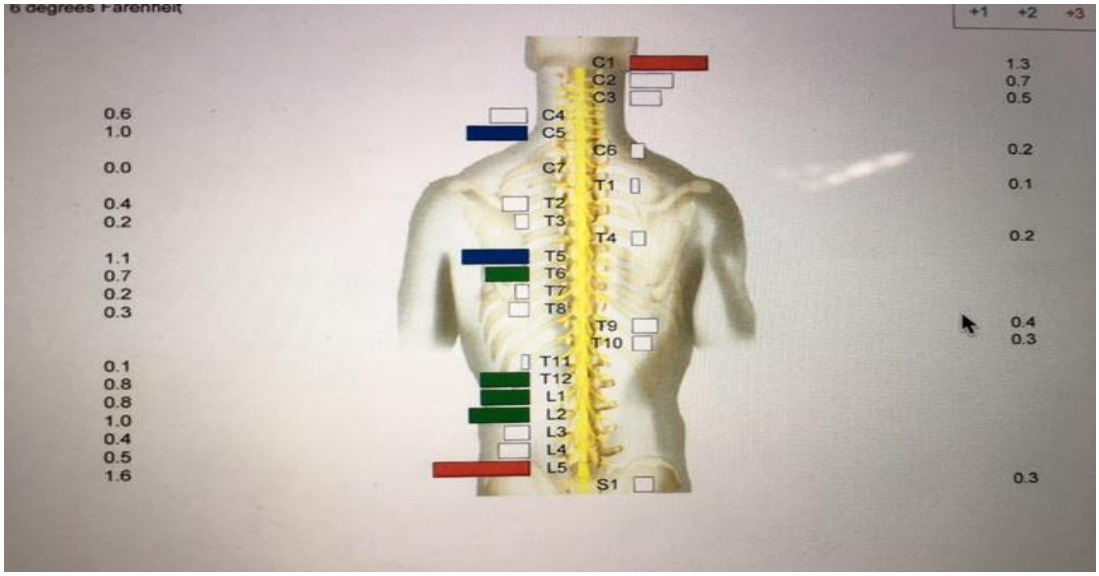
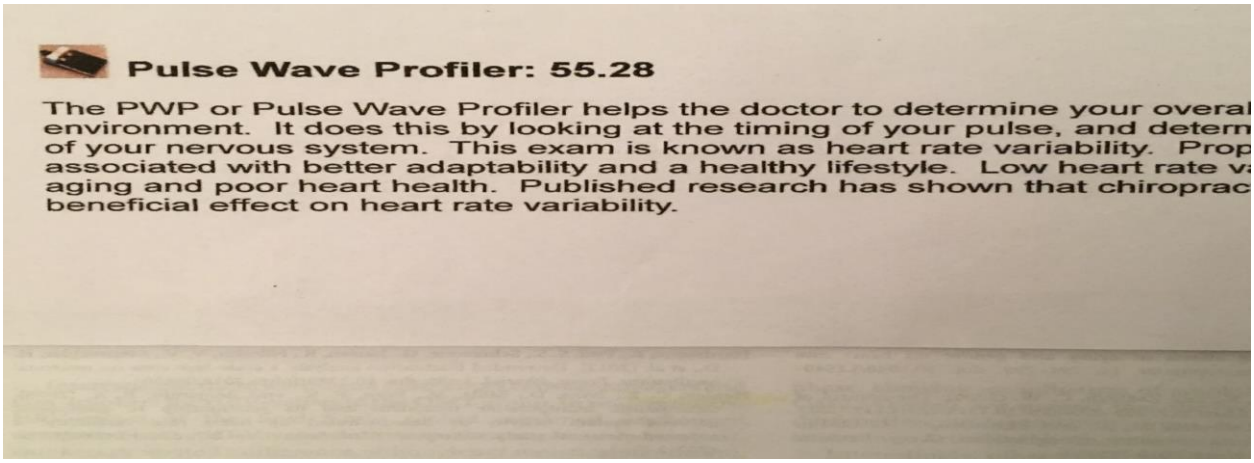


Figure 4. Pre and Post Pulse Wave Profiler

Pre:



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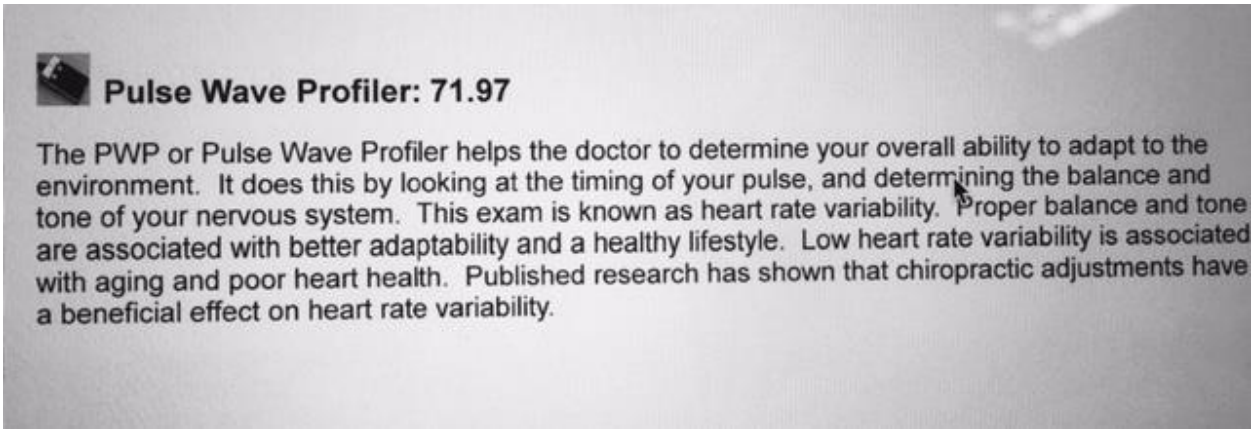
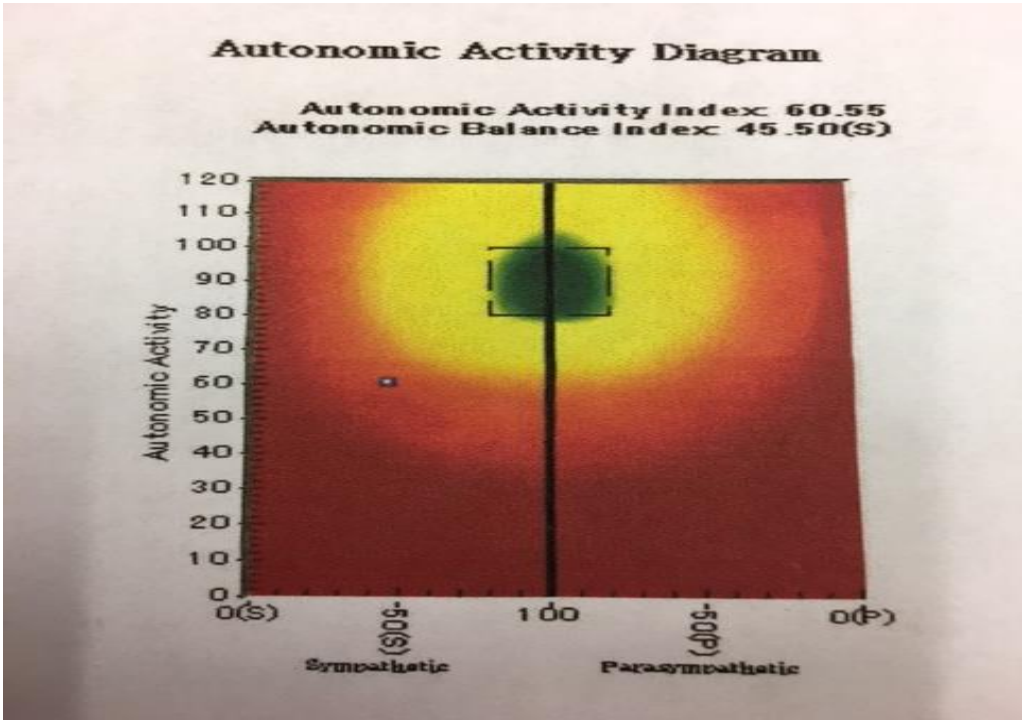


Figure 5. Pre and Post Autonomic Activity

Pre:



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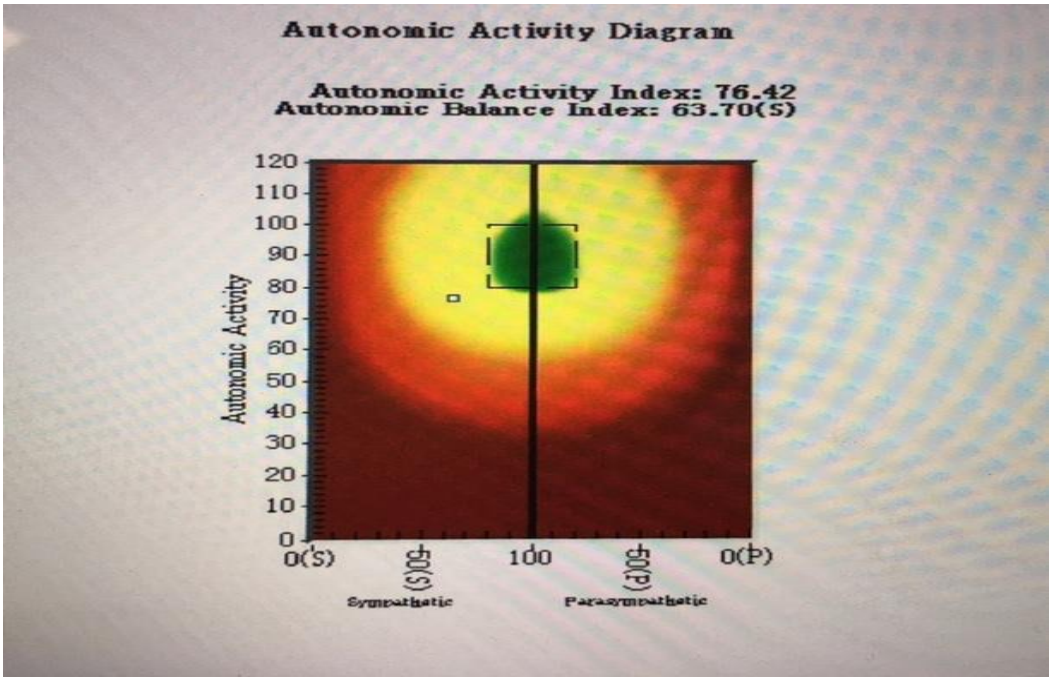
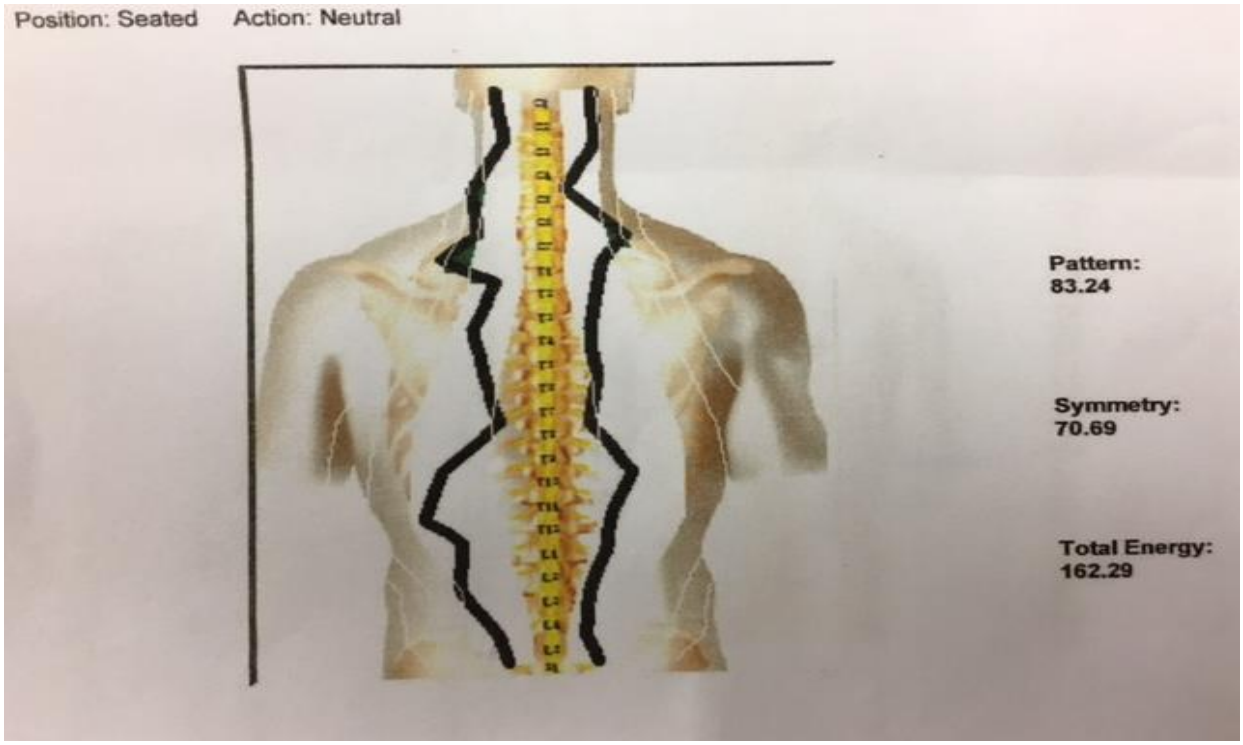


Figure 6. Pre and Post Static EMG Scan

Pre:



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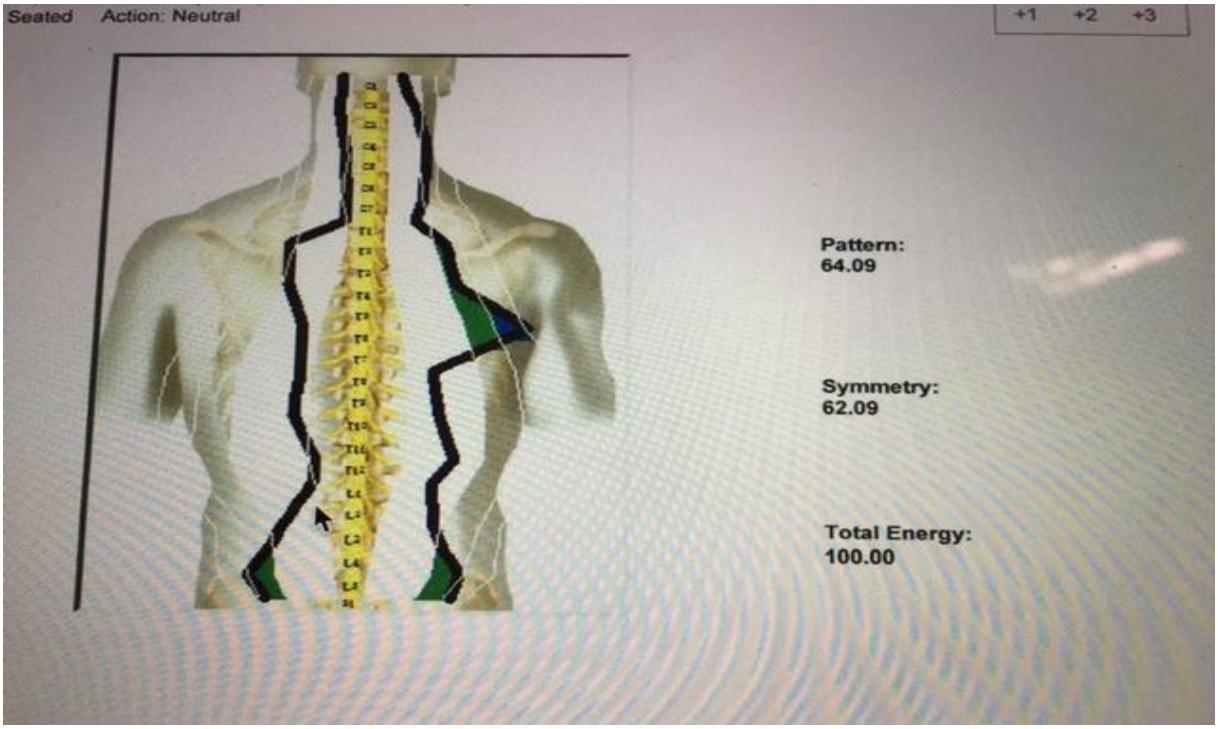
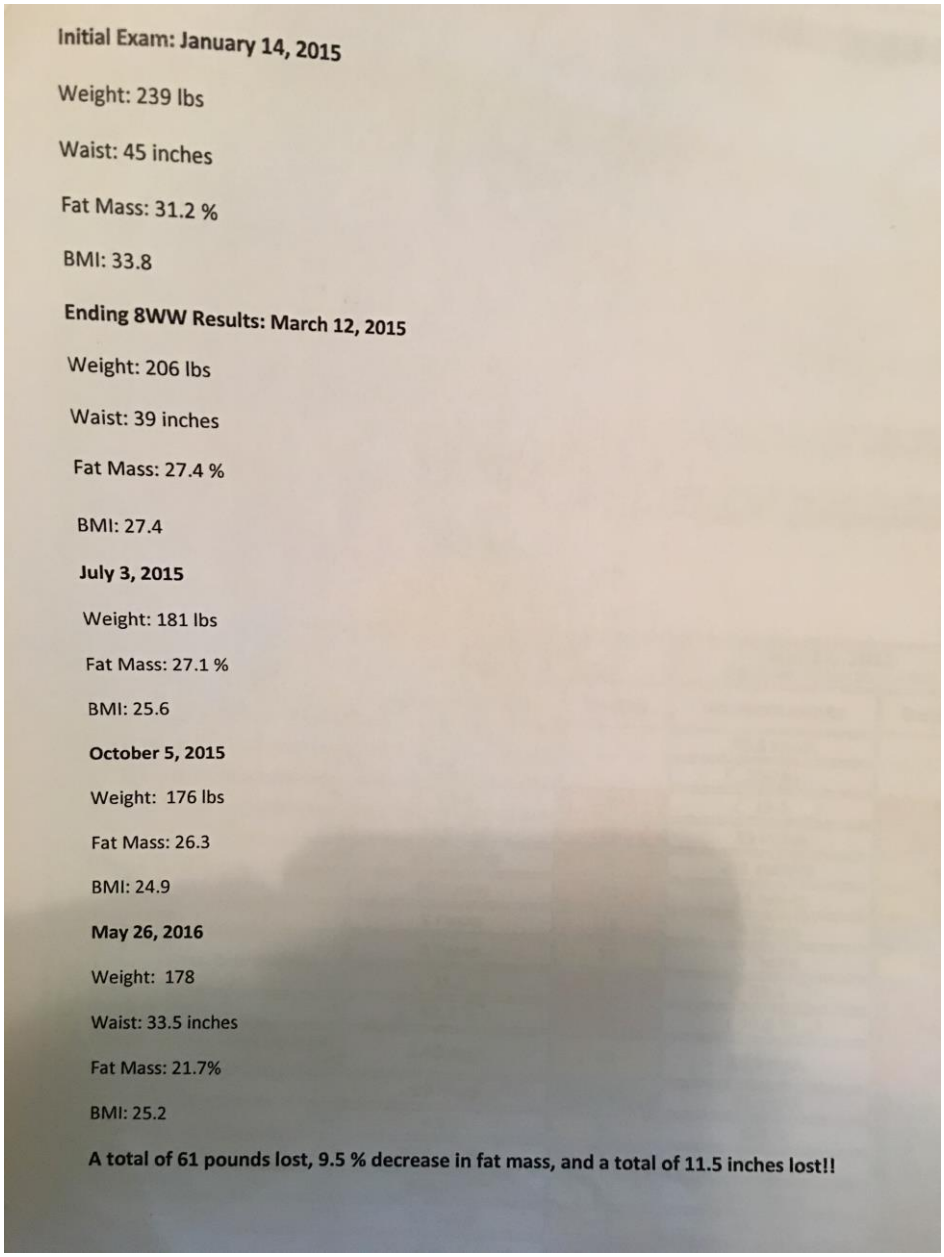


Figure 7.


Initial Exam: January 14, 2015
Weight: 239 lbs
Waist: 45 inches
Fat Mass: 31.2 %
BMI: 33.8
Ending 8WW Results: March 12, 2015
Weight: 206 lbs
Waist: 39 inches
Fat Mass: 27.4 %
BMI: 27.4
July 3, 2015
Weight: 181 lbs
Fat Mass: 27.1 %
BMI: 25.6
October 5, 2015
Weight: 176 lbs
Fat Mass: 26.3
BMI: 24.9
May 26, 2016
Weight: 178
Waist: 33.5 inches
Fat Mass: 21.7%
BMI: 25.2
A total of 61 pounds lost, 9.5 % decrease in fat mass, and a total of 11.5 inches lost!!