

Case Study

Resolution of Obstructive Sleep Apnea in a Patient Undergoing Corrective Chiropractic Care: A Case Study

David Jockers, D.C., M.S., C.S.C.S.¹
Holly Waite, D.C.²

1. Private Practice of
Chiropractic, Kennesaw, GA
2. Private Practice of
Chiropractic, Greenville, SC

Abstract

Objective: The purpose of this case study is to present the report of corrective chiropractic management for a patient suffering from obstructive sleep apnea (OSA).

Clinical Features: A 34-year-old male patient presented to the chiropractor with OSA which he had been diagnosed with for 5 years and had symptoms many years prior to being diagnosed. The patient was unable to breathe at night while sleeping without the use of a continuous positive airway pressure (CPAP) machine. The patient also suffered from daytime drowsiness, lack of energy, and loud snoring.

Intervention and Outcomes: The patient was initially evaluated for vertebral subluxations, which were corrected by chiropractic adjustments utilizing Diversified Technique, Full Spine Technique, and Pettibon Technique. Dietary modifications were also implemented. These interventions make up the Maximized Living protocol. After being under corrective chiropractic care and dietary modification for 3 months, the patient experienced an increase in energy, decreased daytime drowsiness, and improvement in other health conditions. He was also able to sleep throughout the night without the use of the CPAP machine.

Conclusions: Corrective chiropractic care and dietary modification in this case study resulted in resolution of OSA and overall improvement in health. Further research is needed.

Keywords: Chiropractic, obstructive sleep apnea, continuous positive airway pressure, subluxation, Maximized Living, Pettibon, Diversified technique

Introduction

Obstructive sleep apnea (OSA) is a sleep disorder that causes abnormal pauses in breathing in an individual, causing them to repeatedly stop breathing while they sleep.¹ This interruption in sleep is most likely caused by an obstruction of the upper airway which may be due to decreased muscle tone of the tongue and possibly the airway dilator muscles.² OSA is categorized as one of three apneas: Obstructive, Central or Mixed.³ In Greek, the word “apnea” means “breathless” or “loss of breath.”⁴ Furthermore, an apnea is classified as the total cessation of airflow for 10 seconds or more, and it has also been reported that it is abnormal to have greater than 30 apneas per night’s sleep.^{3,5}

Typical symptoms of OSA include, but are not limited to, excessive daytime sleepiness, unrefreshing sleep, difficulty concentrating, and fatigue.⁶ Additionally, Yang and colleagues conducted a study that showed a significant association between sleep apnea and decreased quality of life.⁷ In 1997 the prevalence of OSA in the United States was between 3-7% with some subgroups being at a higher risk. Subgroups or some risk factors include obesity, male gender, age, family history, menopause, craniofacial abnormalities, cigarette smoking, alcohol use, and others.³ According to one study, obesity is one of the major risk factors of OSA.¹ Moreover, Rajagopalan reports that obese, middle-aged men are predominantly at risk for OSA.⁸ Young and colleagues report that many individuals have sleep apnea and are unaware

of it. Their study shows that around 93% of women and 82% of men have OSA but have not been clinically diagnosed.⁹ In addition, Punjabi also points out that the extent of sleep apnea in the United States did not exist until around 15 years ago due to the change in lifestyle of Americans.³

It should be noted that there has been a link established between OSA and an increasing health risk of neurologic, psychometric, endocrine, and cardiovascular damage.⁸ Furthermore, Knecht and colleagues conducted a clinical study of patients that had suffered from heart failure.¹⁰ It was found that there is a link between heart failure patients having cognitive impairment, which also correlated to sleep apnea patients being more likely to have cognitive deficits.

The study concluded that heart failure patients have an increased risk of comorbid sleep apnea.¹⁰ Furthermore, Rajagopalan informs, "It has been well known that nocturnal increase in sympathetic activity and elevated blood pressure create left ventricular pressure overload, which leads to left ventricular hypertrophy and impaired ventricular relaxation."⁸ In addition to this, Thakre stresses that OSA is a major link between the pathophysiology of many diseases such as hypertension, ischemic heart disease, arrhythmias, stroke, and diabetes.² One of the reasons for these increased risks is due to sleep deprivation, which increases the sympathetic nervous system activity, which creates the pathophysiology for these conditions.¹¹

While the prevalence and gravity of OSA is continuing to increase, there are few options as how to manage it. Currently, as Ho and Brass note, the following are the most common treatment options for OSA: changes in lifestyle, continuous positive airway pressure (CPAP) machine, surgery, and dental appliances.¹ The most common method of treatment for moderate to severe OSA is a CPAP machine.¹² A CPAP machine is a device that utilizes continuous pressurized air flow that maintains an open airway during sleep.¹ This paper will expand on the focus of lifestyle changes on OSA by discussing the effects of corrective chiropractic care and dietary modifications for the resolution of OSA.

Case Report

Patient History

The patient was a 34-year-old male who presented to the health center for the treatment of OSA. The patient's symptoms included daytime drowsiness, lack of energy, loud snoring, and difficulty breathing while he slept at night. The patient had been diagnosed five years prior with obstructive sleep apnea by his medical doctor, but the patient had experienced symptoms of obstructive sleep apnea for many years prior to being diagnosed.

The patient's medical doctor prescribed a CPAP machine that the patient had been using for three years every night so that he would continue to breathe while he slept. The patient noted that the CPAP machine did help temporarily and after using it the first night he felt more energized and better rested.

Furthermore, during the time the patient had been diagnosed

with OSA, his oxygen levels ranged between 70-80%. After beginning the use of the CPAP machine, the patient's oxygen levels increased to 96%.

The patient also presented with depression, acid reflux, severe anxiety, and obesity. In addition, the patient had past issues with anemia and indigestion. The patient was regularly taking Zoloft for depression and anxiety and Prilosec for acid reflux. The patient also noted that he had been overweight for many years (approximately 300 pounds) and that he had poor eating habits. Furthermore, the patient stated that he had been to a chiropractor previously, and that his reason for coming to the clinic was for change. The patient's surgeries consisted of a cyst removal in 2001. No other part of the patient's history was remarkable, including birth process and childhood.

Chiropractic Examination

The chiropractor evaluated the patient for vertebral subluxations and performed the following assessments as part of the chiropractic examination: inspection, palpation, postural analysis, cervical and lumbar ranges of motion (ROM), surface electromyography (SEMG), and x-ray imaging.

Both inspection and palpation were analyzed on the patient during the initial chiropractic examination. The chiropractor found and noted tender musculature, slight edema, and motion abnormalities that revealed vertebral subluxations.

Postural analysis was performed and deviations were recorded. The patient's postural abnormalities were left head tilt and right high shoulder. When performing cervical ROM, it was noted that the patient had decreased extension on the left side and decreased left rotation. All lumbar ROMs were within normal limits.

SEMG was also assessed during the chiropractic examination. The Insight Millennium Subluxation Station was used to perform the SEMG while the patient was seated. SEMG measures the patient's paraspinal muscle tone and compares it to normative data. Research illustrates that it is a reliable tool for quantitative assessment of paraspinal muscle activity.¹³

This tool (sEMG) shows changes in paraspinal myoelectric activity that are correlated with vertebral subluxation. Even more, this assessment tool has been implemented since 1949 to evaluate muscular activity.¹³ When looking at the patient's results, the bar graph is analyzed by assessing the amplitude. Amplitude is the degree of severity of the hypertonicity of muscle tone, and it is measured in microvolts (FIGURE 1).

Initial examination findings of patient's SEMG amplitude graph shows the following results: mild hypertonicity at T1 on the right and T12 bilaterally compared to normal, moderate hypertonicity at C3, C5, and T1 on the left compared to normal, and severe hypertonicity at C3 on the right and C7 on the left compared to normal (Figure 1).

Hart demonstrates the importance of the use of radiography in the scope of chiropractic by conducting a study that looked at how vertebral misalignments are detected on radiographs.¹⁴ In this case, pre-and-post lateral cervical radiographs were taken

to analyze and monitor the cervical curve. The cervical curve was measured using Jackson's line analysis. Jackson's line is obtained by drawing vertical lines on the posterior aspect of the vertebral bodies of C2-C7 and then finding the angle that is formed by these converging lines creating Jackson's angle.¹⁵ Jackson's angle measured 6 degrees on the initial lateral cervical radiograph.

Forward head placement (FHP) was also a major assessment measurement. FHP was measured on the lateral cervical radiographs and measured on the z-axis from the sella turcica to the C4 vertebral body. The normal measurement is 0mm for FHP.¹⁵ FHP measured 28 mm on the initial lateral cervical radiograph (Figure 2).

After thorough analysis of the radiographs, it was found that there was narrowed disc space between the C5 and C6 vertebrae. Also, the radiographic analysis showed several areas of subluxation. Chiropractors use subluxation listings to describe the abnormal or misaligned position of the vertebrae. Hart mentions that listing subluxations requires the use of radiography.¹⁴ When using listings, an "A" represents anterior movement of the vertebrae, and a "P" represents posterior movement of the vertebrae.

Furthermore, right or left movement of the spinous process is represented by an "R" or "L." Finally, superior or inferior movement of the vertebrae is noted by an "S" or "I," respectively, and thus, creates an open wedge if it moves superior or a closed wedge if it moves inferior. After radiographic analysis the chiropractor found the following subluxations: C1 ASR, C2 PL, T2 PL, and sacrum P-R (Figure 2).

Based on the radiographic analysis, the chiropractor categorized the patient as Phase II Spinal Degeneration, meaning there was a loss of cervical curve, loss of disc space, and, therefore, damage to the spine and nervous system. Shaikewitz reports that Spinal Degeneration Phases are influenced by factors such as age and occupation. He more specifically points out that Phase II Degeneration is a transition category between the other phases and usually occurs between the ages of 25-64.¹⁶

Interventions

Following the chiropractic examination, a personal care plan was created and recommended to the patient. The patient started chiropractic care with 3 visits per week for 3 months. After the 3-month reassessment, the patient continued care at a frequency of once per week. The vertebral subluxations were corrected by chiropractic adjustments utilizing Diversified Technique, Full Spine Technique, and Pettibon Technique.

The Pettibon Technique is a corrective care technique that addresses the curvatures of the spine. The technique does so by having the patient engage in pre-and-post adjustment exercises. Before the adjustment, the patient performed cervical traction. Cervical traction is designed with a rope attached to the wall at an adjustable height for the patient.

The rope is attached to a foam head piece that goes behind the

neck and has a bar in the front that is placed on the forehead or under the chin and is held on to by the patient. The patient then tractions down in a squat-like-position. The purpose of the cervical traction is to bring oxygen, blood flow and nutrients to the cervical area, to increase disc space, and to re-establish the proper cervical curve. Cervical traction also facilitates in hydrating the discs and pumping toxins out of the area. Furthermore, cervical traction allows the anterior muscles of the cervical spine to stretch. The patient performed 25-60 repetitions before every adjustment.

The other Pettibon exercise the patient performed prior to the adjustment was wobble chair exercises. The wobble chair is a chair designed by Pettibon to specifically facilitate 360 degrees of rotation, 40 degrees of flexion to each side, and 35 degrees each to the front and the back.¹⁷ Similar to the objective of the cervical traction, the wobble chair increases oxygen and nutrient supply to the discs, vertebrae, and surrounding tissues. It also facilitates in hydrating the disc and pumping the toxins out of the area.

The patient performed 5 minutes of wobble chair exercises before every adjustment. The patient was analyzed and adjusted according to palpation findings and x-ray listings per Full Spine, Diversified, and Pettibon protocol. The subluxations were addressed with a specific, high-speed, low-force adjustment. Following the adjustment, the patient concluded with the Pettibon exercises and wore head weights on a vibration plate for 5 minutes.

The purpose of the head weights on a vibration plate is to establish proper muscular proprioception and alignment and to decrease forward head posture.^{18,19} After being adjusted 3 times a week for 3 months, as well as performing rehabilitative exercises, a reassessment was performed on the patient that included a follow-up SEMG scan and a follow-up lateral cervical radiograph, and appropriate modifications were made to the patient's care plan.

Nutritional Recommendations

The patient followed the nutritional recommendations to eliminate sugars and include healthy fats, naturally raised meat sources, and whole carbohydrates. These recommendations are part of Maximized Living and are designed to reduce inflammation, balance hormones, reset leptin receptors, and reduce toxins.²⁰

Outcomes

The patient received 3 months of corrective chiropractic care at a frequency of 3 times per week in the office. After the 3 month reassessment the patient's visit frequency was reduced to maintenance care of once per week. The reduction in visit frequency was due to the patient having an increase in energy, no longer snoring, and no longer having daytime drowsiness. Furthermore, the reduction in visit frequency was also due to the patient's cervical curve increase, forward head placement reduction, decreased paraspinal hypertonicity, and discontinued use of the CPAP machine. The patient is able to sleep through the night and breathe well without the assistance of the CPAP machine now. At this point, his tested oxygen levels, without the use of the CPAP machine, were at 99%

post chiropractic care. The patient also noted that his life dramatically increased in quality after receiving chiropractic care, and he no longer experienced anxiety or acid reflux. After receiving chiropractic care, the patient discontinued use of Zoloft and Prilosec after no longer experiencing associated symptoms. After 18 months of chiropractic corrective care and following the nutritional recommendation, the patient lost 115 pounds and has been able to maintain a weight of 180 pounds down from 295.

After 3 months, the reassessment examination findings of the patient's SEMG amplitude graph showed the following results: mild hypertonicity at C5 bilaterally compared to normal [FIGURE 1].

In addition, post-management lateral cervical radiographs were taken 3 months following the pre-management radiographs. Jackson's angle on the post-management radiograph increased from 6 degrees to 22 degrees, and FHP measured 14 mm on the follow-up lateral cervical x-rays.

Discussion

Obstructive sleep apnea has become much more prevalent in the United States and around the world within the last 15 years.³ This is particularly concerning since there are such serious health risks associated with this condition, and the effects it has on a person's life because of chronic fatigue and increased stress to the body. In addition, studies show that OSA increases the number of traffic accidents as well as sick leave and work disability.^{21,22}

Currently, the common treatment options include the following: changes in lifestyle, CPAP machine use, surgery, and dental appliances.¹ Tulmac and colleagues support the evidence of the positive effects of a CPAP machine use in their study with OSA patients. They concluded that OSA may lead to endothelial dysfunction because of pathological changes and that these changes may be improved by one night's use of a CPAP machine.²³

Another study performed by Kim and colleagues looked at the use of a CPAP machine in surgical patients with one lung ventilation. They concluded that the CPAP machine was effective in improving arterial oxygen within the lung. Therefore, evidence suggests that the CPAP machine is useful in assisting OSA patients and other pulmonary conditions.²⁴ However, another study performed by Brostrom and colleagues looked at the side effects of the CPAP machine and noted that there are a considerable amount of side effects, and as such, compliance of the CPAP machine decreases as patients experience problems with it.²⁵ While many people see positive results from the use of a CPAP machine, there is still little known or researched about the side effects or other alternative choices. Therefore, this case report is an example of how two components of a lifestyle change, corrective chiropractic care and dietary modifications, resulted in the resolution of OSA.

Chiropractic Care

Currently, there is little to no research on the effectiveness

of corrective chiropractic care and OSA. There is, however, some research on upper cervical kyphosis and its correlation with OSA. Two studies analyzed upper cervical/occiput curve angles on patients to find the correlation with OSA and found an increase in flexion in the upper cervical curve at atlas/occiput.^{26,27}

This case report, therefore, is among the first studies conducted looking at corrective chiropractic care and its effects of the entire cervical spine in patients with OSA. The patient in this case study had been suffering from symptoms of sleep apnea for years and eventually was diagnosed with OSA for 5 years, 3 of those years using a CPAP machine. One of the main management objectives was the correction of subluxations. Chiropractors analyze the nervous system for the presence of subluxations. Research has shown that subluxations contribute to the dysfunction of the autonomic nervous system. Research also shows that subluxations influence visceral physiology, and that there is improvement of visceral problems from chiropractic adjustments.²⁸ Therefore, it is imperative for the chiropractor to reduce a patient's subluxations who suffers from a condition such as OSA.

The foundation of chiropractic is the removal of vertebral subluxations in order to allow the nervous system to function optimally and to create normal physiologic function. Subluxation is defined as "a complex of functional and/or structural and/or pathological articular changes that compromise neural integrity, and may influence organ system function and general health."²⁹

Within the chiropractic profession, there are several different models of subluxation. The patient presented in this case is an example of the neurodystrophic model. "The 'neurodystrophic model' suggests that neural dysfunction is stressful to the body tissues and that 'lowered tissue resistance' can modulate specific and nonspecific immune responses and may alter the trophic function of the involved nerves."³⁰ Even more, this model is based on the existence of increased sympathetic activity that negatively affects organ and tissue responses to hormones, infectious agents, and blood components.³⁰

Expanding on the idea that this model largely affects organs and tissues, it can be deduced that the patient's OSA was resolved, as well as other health conditions, when vertebral subluxations were reduced, and sympathetic activity was normalized; thus, creating optimally functioning organs and tissues.

Another key management objective was the correction of the cervical curve. As previously mentioned, the patient's lateral cervical curve was analyzed using Jackson's angle. Pre-management measurement of Jackson's angle was 6 degrees compared to 22 degrees 3 months later on the follow up x-ray. Therefore, there was a significant increase in the cervical curve of this patient using corrective chiropractic care. A study conducted by Morningstar and colleagues reports that the implementation of the Pettibon protocol resulted in an improvement in cervical lordosis.¹⁸

In addition, Harrison and colleagues conducted a study that looked at the correlation between sagittal spinal curves and a

person's health. They found that there is "...a positive association between sagittal plane curves/posture and health disorders. Thus, the evidence indicates that altered sagittal plane curves and posture are associated with a variety of health disorders."¹⁹ As such, the research shows a connection between the curves in our spine and the state of one's health.

Furthermore, the patient's FHP on the initial lateral cervical x-ray measured 28 mm and later measured 14 mm at the 3 month follow-up lateral cervical x-ray. Three months of corrective chiropractic care with this patient shows a large decrease in FHP by 50%. Morningstar and colleagues conclude that the Pettibon protocol resulted in a decrease in FHP after only one session.¹⁸

Additionally, studies show that an increase in FHP contribute to a host of health conditions including decreased vital lung capacity. Researchers also suggest that many of these problems can be reduced by improving posture.³¹ In fact, in one study, the researchers concluded that there was a significant increase in vital lung capacity after decreasing FHP and chiropractic adjustments.³¹ Consequently, posture is largely affected by addressing spinal curves with corrective chiropractic care.

Corrective care was accomplished by use of the Pettibon technique. Pettibon is interested in looking at the whole body and its structure. The Pettibon System's mission and promise to chiropractic states, "To provide health care that enables the human spine to maintain its optimal structure for normal function." The Pettibon rehabilitation process includes the use of exercise and weights, and it uses x-rays for diagnosis and comparative progress.³² The Pettibon technique is classified as a postural model. In this approach, Kent describes that subluxation is created by postural distortion, which is a "global" subluxation. Through this approach, radiographs and postural analysis are used to assess the patient. The main focus of the analysis is proper curve structure and alignment.³⁰

Nutrition Recommendations

The nutritional recommendations the patient followed facilitated healing, supplied proper nutrients, and supported elimination of toxins. The patient focused on eating whole foods with the elimination of processed foods. These recommendations to maximize quality nutrients make up essential #3 of the Maximized Living protocol. They are designed to balance and heal the body with foods that we were designed to consume.²⁰

These principles are supported by a research study in which ethnic groups living in Europe who started adopting dietary habits of processed foods had less nutrient intake and were more likely to develop degenerative diseases. Even more, Gilbert and Khokhar conclude that degenerative diseases begin to develop when ethnic groups eat foods that are not their traditional foods, specifically from the Western diet.³³

Maximized Living

The patient in this case study experienced what is known as Maximized Living care. Maximized Living is a health care system that focuses on chiropractic wellness care. Maximized Living was founded by Dr. Ben Lerner and Dr. Greg Loman.³⁴

The first component, or essential, of Maximized Living is Maximized Mind which consists of decreasing stress and increasing discipline, peace of mind, and a positive attitude. This decreases stress hormones, eliminates neurotransmitter fatigue, and chronic fatigue. The second essential is Maximized Nerve Supply which is created by correcting subluxations and restoring spinal curves. The third essential to Maximized Living is Maximized Quality Nutrients which delivers high quality nutrients to the body, reduces inflammation, balances hormones, and allows the body to heal itself. The fourth essential is Maximized Oxygen and Lean Muscle. This essential creates lean muscle, allows the body to be fat burning, and balances hormones. The final essential of Maximized Living is Minimized Toxins. This component addresses detoxifying from toxins and limiting exposure to modern common-day toxins.³⁴

Roberto and Sousley report on a case study in which a patient presented to the office with a 20-year diagnosis of type 2 diabetes. After undergoing corrective chiropractic care and modifying dietary habits, the patient experienced resolution of their type 2 diabetes. The patient was able to stop taking all medications, and their blood-glucose levels returned to a normal range.¹⁷

After receiving 4 months of corrective chiropractic care and dietary modifications of Maximized Living care, the patient in the present case study was able to completely stop using his CPAP machine and later tested at a 99% oxygen level. He was able to sleep unassisted throughout the night and had more energy. His quality of life dramatically increased, not only in the resolution of OSA, but by the resolution of anxiety, acid reflux, depression, weight loss, was able to stop taking all medications. This collection of positive health changes agrees with the research that subluxations, impaired cervical curve, FHP, and dietary habits all contribute to the effect on health conditions.^{18,19,30,33}

Conclusion

This case study focused on the effectiveness of corrective chiropractic care, including subluxation reduction, curve correction, and decreasing FHP, as well dietary modification in a patient with OSA. This study is an example of the positive effectiveness of corrective chiropractic care and dietary modification in resolving OSA and dramatically increasing the patient's quality of life. The patient experienced improvement in other health conditions as well. Since there is currently limited research on this topic, this study adds to the body of research regarding OSA.

A limitation of this study is that only one OSA patient was used in the sample of the study. Further research is needed with a larger sample size to confirm the efficacy of the results. Furthermore, another limitation includes the fact that there were multiple factors involved in this case including corrective chiropractic care and dietary modifications. Therefore, further research should be conducted in order to separately measure the effectiveness of each factor.

References

1. Ho ML, Brass SD. Obstructive sleep apnea. *Neurol Int* 2011; 3(15):60-67.

2. Thakre TP, Mamtani M, Ujaoney S, Kulkarni H. Association of plasma homocysteine with self-reported sleep apnea is confounded by age: results from the national health and nutrition examination survey 2006-2006. *Sleep* 2012;2012:1-9.
3. Punjabi NM. The epidemiology of adult obstructive sleep apnea. *Proc Am Thorac Soc* 2008;5:136-143.
4. "Sleep Apnea." <http://www.sleepapnea.org/learn/sleep-apnea.html>. American Sleep Apnea Association, C2012. Web. 30 Nov 2012.
5. Guilleminault C, Tilkian A, Dement WC. The sleep apnea syndromes. *Annu Rev Med* 1976;27:465-484.
6. The Report of an American Academy of Sleep Medicine Task Force. Sleep-related breathing disorders in adults: recommendations for syndrome definition and measurement techniques in clinical research. *Sleep* 1999;22:667-689.
7. Yang EH, Hla KM, McHorney CA, Havighurst T, Badr MS, Weber S. Sleep apnea and quality of life. *Sleep* 2000;23(4):1-7.
8. Rajagopalan N. Obstructive sleep apnea: not just a sleep disorder. *Postgrad Med J* 2011 Apr;57(2):168-175.
9. Young T, Evans L, Finn L, Palta M. Estimation of the clinically diagnosed proportion of sleep apnea syndrome in middle-aged men and women. *Sleep* 1997;20(9):705-706.
10. Knecht KM, Alosco ML, Spitznagel MB, Cohen R, Raz N, Sweet L, Colbert LH, Josephson R, Hughes J, Rosneck J, Gunstad J. Sleep apnea and cognitive function in heart failure 2012 Apr 16;2012:1-7.
11. Ucar ZZ, Cirak AK, Olcay S, Uysal H, Demir AU, Ozacar R. Association of duration of sleep and cardiovascular and metabolic comorbidities in sleep apnea syndrome. *Sleep* 2012;2012:1-8.
12. Epstein LJ, Kristo D, Strollo PJ, Friedman N, Malhotra A, Patil SP, Ramar K, Rogers R, Schwab RJ, Weaver EM, Weinstein MD. Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults. *J Clin Sleep Med* 2009;5(3):263-276.
13. Kent C. Surface electromyography in the assessment of changes in paraspinal muscle activity associated with vertebral subluxation: a review. *J Vert Sublux Res* 1997;1(3):15-22.
14. Hart JF. Persistence of vertebral misalignments detected on radiographs of the cervical spine during chiropractic care: a case study. *J Vert Sublux Res* 1997;1(4):49-53.
15. Pero J, Jockers D. Improvement in cervical curvature and health outcomes in a patient with rheumatoid arthritis undergoing chiropractic care to reduce vertebral subluxation. *J Vert Sublux Res* 2012 July 26;2012:77-81.
16. Shaikewitz M. A demographic and physical characterization of cervical spine curvature and degeneration. *J Vert Sublux Res* 1996 ;1(1):41-48.
17. Roberto F, Soursley E. Resolution of type 2 diabetes mellitus in a patient undergoing subluxation based chiropractic care and dietary recommendations: a case study. *J Vert Sublux Res* 2011 July; 2011:73-81.
18. Morningstar MW, Strauchman MN, Weeks DA. Spinal manipulation and anterior headweighting for the correction of forward head posture and cervical hypolordosis: a pilot study. *J Chiropr Med* 2003 Spring;2(2):51-54.
19. Harrison DE, Betz JW, Ferrantelli JR. Sagittal spinal curves and health. *J Vert Sublux Res* 2009 July 31; 1-8.
20. Hardick, B.J., Kimberly Roberto, and Dr. Ben Lerner. "Maximized Living Nutrition Plans: The Solution to the Dangers of Modern Nutrition." Celebration: Maximized Living, 2009. Print.
21. Rodenstein D. Driving in Europe: the need of a common policy for drivers with obstructive sleep apnea syndrome. *J Sleep Res* 2008;17:281-284.
22. Sivertsen B, Overland S, Glozier N, Bjorvatn B, Maeland JG, Mykletun A. The effect of OSAS on sick leave and work disability. *Eur Respir J* 2008;32:1497-1503.
23. Tulmac M, Tireli E, Ebinc H, Simsek V, Dogru MT, Yildirim N, Kisa U, Ekici MS. Effect of overnight nasal continuous positive airway pressure treatment on the endothelial functions in patients with obstructive sleep apnea. *Anatolian Journal of Cardiology* 2012;12:560-565.
24. Kim YD, Ko S, Kim D, Lim H, Lee JH, Kim MH. The effects of incremental continuous positive airway pressure on arterial oxygenation and pulmonary shunt during one-lung ventilation. *Korean J Anesthesiol* 2012 Mar;62(3):256-259.
25. Brostrom A, Arestedt KF, Nilssen P, Stromberg A, Ulander M, Svanborg E. The side-effects to CPAP treatment: the development and initial validation of a new tool for the measurement of side-effects to CPAP treatment. *J Sleep Res* 2010;19:603-611.
26. Kuhn D. A descriptive report of change of cervical curve in a sleep apnea patient: the importance of monitoring possible predisposing factors in the application of chiropractic care. *J Vert Sublux Res* 1999 Mar;3(1):1-9.
27. Dobson GJ, Blanks RHI, Boone WR, McCoy HG. Cervical angles in sleep apnea patients: a retrospective study. *J Vert Sublux Res* 1999 Mar;3(1):1-15.
28. Lynch S, Boone WR. Somatovisceral responses to chiropractic adjustments. *Vert Sublux Res* 2009 Mar 17;2009:1-5.
29. "What is the Chiropractic Subluxation?" <http://www.chiro.org/LINKS/subluxation.shtml>. Chiro.org, C1995-2012. Web. 2 Dec 2012.
30. Kent, C. Models of vertebral subluxation: a review. *J Vert Sublux Res* 1996 Aug; 1(1):1-7.
31. Morningstar M, Jockers D. Improvement in forward head posture, cervical lordosis, and pulmonary function with chiropractic care, anterior head weighting and whole body vibration: a retrospective study. *J Pediatr Matern & Fam Health* 2009 Oct12;2009:1-7.
32. "About Pettibon: Proven Spine and Posture Correction." <http://pettibonsystem.com/about>. Pettibon System, Inc, 2012. Web. 2 Dec 2012.
33. Gilbert PA, Khokhar S. Changing dietary habits of ethnic groups in Europe and implications for health. *Am J Public Health Nations Health* 2008;66(4):203-215.
34. "The 5 Essentials are the Core Foundation of Maximized Living." <http://www.maximizedliving.com>. Maximized Living, C2012. Web. 1 Dec 2012.

Figures

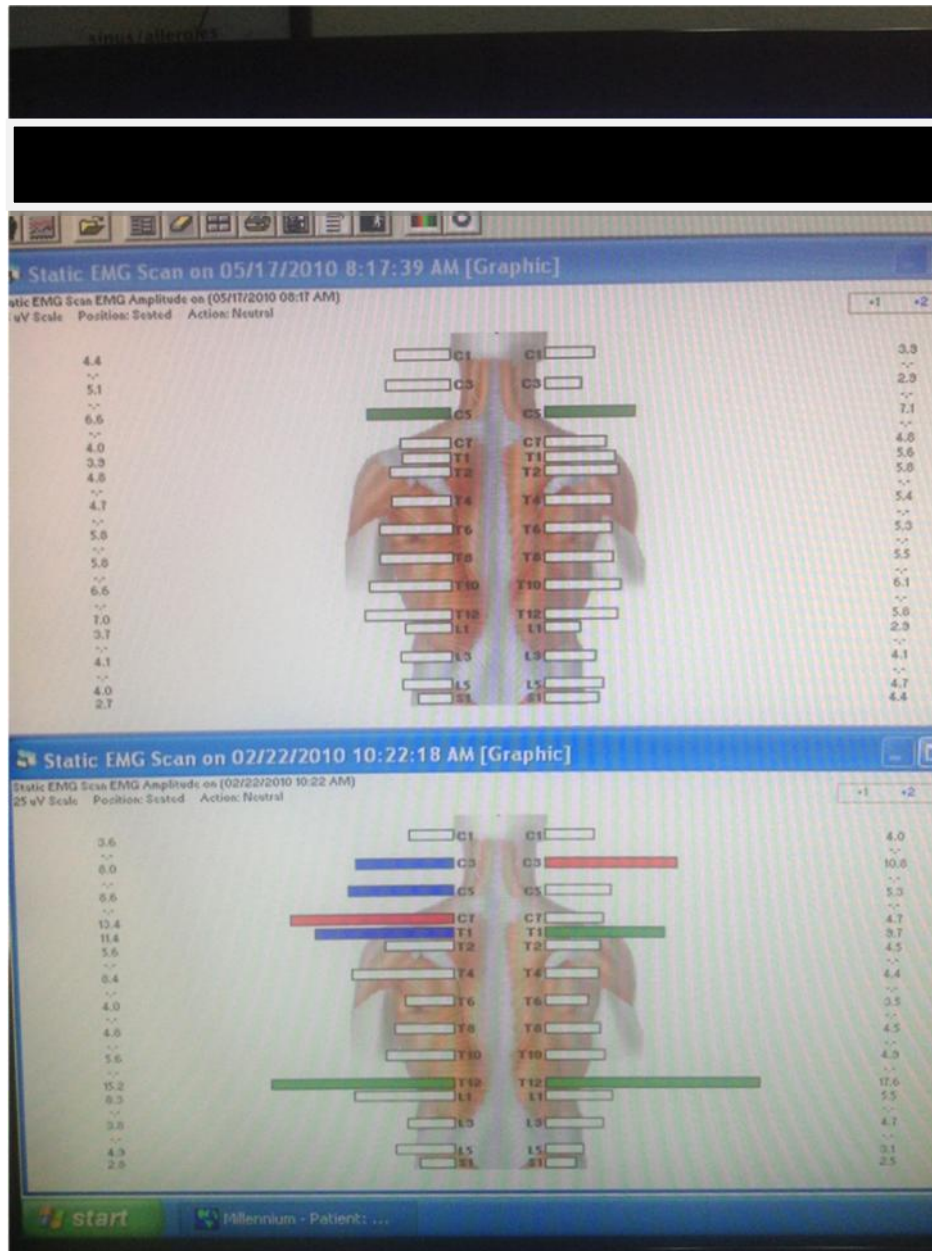


Figure 1. Surface electromyography (SEMG) scans: The initial examination SEMG scan is on the bottom, and the post-management exam taken after 3 months is on the top. The bar graph shows paraspinal muscle hypertonicity compared to normal as indicated by the following colored bar graphs, representing degrees of severity: white = within normal limits, blue = mild, green = moderate, red = severe, black = extremely severe.



Figure 2. Lateral cervical radiographs: the left radiograph was taken at the time of the initial examination, and the right radiograph is the 3 month follow-up x-ray.