The Effects of Chiropractic Manipulative Therapy on Heart Rate Variability and Heart Rate in Patients with History of Low Back Pain

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Abstract.

Objective: To investigate whether chiropractic manipulative therapy (CMT) will have an effect on the autonomic nervous system (ANS) and alter the heart rate variability (HRV) and heart rate (HR).

Design: Data was collected from the experimental group pre- and post- full spine CMT and was analyzed using heart rate, and heart rate variability measured using total power output of the heart. Data was analyzed for the group as a whole, and for subgroups divided by gender. These findings showed statistically significant positive changes in the heart rate and heart rate variability. The heart rate for the experimental group showed a decrease of more than double that found in the control group.

Participants: There were 28 participants in the study and each one answered questions about their health history and went through a brief lumbar regional examination. The participants consisted of 15 between the ages of 18-65, and both male and female patients were chosen to participate

Results: These findings showed statistically significant positive changes in the heart rate and heart rate variability. The heart rate for the experimental group showed a decrease of more than double that found in the control group.

Conclusion: The results of this experiment helped to support years of subjective evidence proposed by chiropractors in a clinical setting. The results of this experiment helped to support years of subjective evidence proposed by chiropractors in a clinical setting. Infinite possibilities exist for more research on this subject. This is a positive step on chiropractic's journey toward acceptance by the medical community, and the population as a whole.

Introduction

The idea that chiropractic manipulative therapy (CMT) can have an effect on the nervous system is at the heart of modern chiropractic theory. As chiropractors, it is our responsibility to test this idea and learn more about how CMT affects the nervous system. Many aspects of nervous system function can be utilized to test this theory. For this study, we have concentrated on the effects of CMT on the autonomic nervous system in particular, using heart rate variability and changes in heart rate as the measure of autonomic function.

Materials and Methods

The autonomic nervous system (ANS) has two main components - the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS). Stimulation of the sympathetic nervous system will increase heart rate, and stimulation of the parasympathetic nervous system will decrease heart rate. The sino-atrial (SA) node of the heart is the "pacemaker" of the heart, where the heartbeat impulse is generated approximately 100-120 times per minute at rest.[1] The autonomic nervous system has regulatory control over the SA node, however, slowing the heart rate of a healthy individual to approximately 50-70 beats per minute at rest.[1] In turn, the ANS affects and is affected by factors such as respiration and blood pressure. Heart rate (HR) is a measure of the total number of beats per minute, and heart rate variability (HRV) is a measure of the intervals between heartbeats. This interval may vary as a result of the factors mentioned above. As a person's health declines, HRV will decline (the intervals will remain more constant), indicating that the ANS is no longer regulating the heart rate properly. This makes HRV a valuable tool for assessing the function of the ANS.

There is unlimited potential for study using heart rate variability. For the purposes of this experiment, we have decided to concentrate on HRV and heart rate (HR) before and after

the adjustment, to try and support the idea that CMT can influence the ANS. Another similar study performed at Logan College of Chiropractic, entitled "The Effects of Thoracic Chiropractic Manipulative Therapy on Heart Rate Variability and Heart Rate," found statistically significant changes in HR after CMT. This study has been similarly designed, however utilizes activator adjusting and limits the subject population to those with a history of low back pain.

The purpose of this experiment is to gather data on changes in heart rate variability and heart rate pre- and post-adjustment, and to analyze that data for statistical patterns. We are hopeful that our research will encourage further study into the field of heart rate variability and heart rate, and on the affects of CMT on the human body.

For the purposes of this experiment the Activator adjusting protocol was used to perform the CMT. Activator is a low-force technique that is preferred by many patients compared to more aggressive techniques. In addition, much research has been done in the field of activator adjusting and its effectiveness. The activator instrument is a small hand held instrument that is used to reposition the misaligned vertebra in a safe and gentle manner. Activator Methods Chiropractic Technique utilizes the Dear-field leg check as diagnosis for spinal subluxations. In this leg lengths are checked with the patient in two different positions, to help localize the patient's area of involvement. There are three possibilities that can be seen when taking the subject from position one to position two. Possibility one is when a short leg is seen in position one which lengthens to any degree when taken into position two. This indicated the doctor should begin evaluation at the feet, legs and pelvis. Possibility two is seen when a short leg in position one shortens in position two relative to its length in position one. This finding indicates the doctor begin evaluation at the lumbar spine. The third and final

possibility is seen when the patient's legs are even in position one and remain even when brought into position two. This finding indicates the doctor begin evaluation at the pubic symphysis.

To determine if adjustment is necessary and to which side the adjustment must be applied the doctor utilizes the Short Long Rule. The Short Long Rule states that if following an isolation test PD the leg is short in position one and lengthens in position two the subluxation is to the PD side. However, if the PD leg is short in position one and is shorter yet in position two the subluxation is to the side opposite the PD.

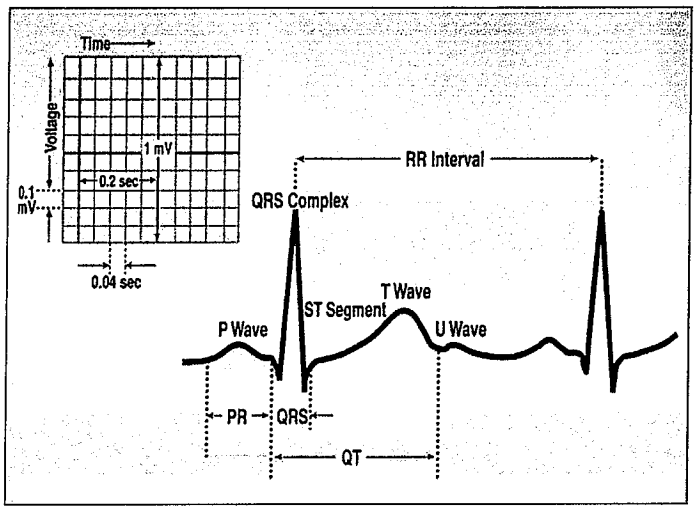

Fig. 1-1

The Activator Methods Chiropractic Technique utilizes three forms of testing isolation, pressure and stress tests. Isolation tests are specific active movements on the subject 's part that help the doctor to locate and evaluate subluxated motion segments. The pressure test involves the doctor providing a gentle force into the subluxation in the line of correction. Conversely the stress tests involve the doctor providing a gentle force into the motion segment in the direction of the subluxation.

The HRV instrument used for this study is the HRVScan (sm), developed by MedPond, LLC. It consists of a testing unit, software, and an internet-based test evaluation server. The testing unit consists of a handheld personal data assistant (PDA) with three input connectors where standard EEG lead wires can be attached. Disposable gel electrodes will be used to attach the EEG leads to the patient being tested. The testing unit senses changes in the electrical potential of the patient's skin, caused by electrical activity in the heart. HRV will be measured by the R-R interval, and the total number of beats per minute will determine heart rate. R-R interval is demonstrated below as the interval between R waves on the ECG readout. The R wave represents the maximum ventricle depolarization phase of the heartbeat (Fig. 1-1).

We searched the chiropractic literature for activator technique, low back pain, and heart rate variability. We searched the medical literature for heart rate variability. There are many articles on activator technique and low back pain, with positive results. There were numerous articles on heart rate variability due to the recent emergence of this field of research. Many professionals in the chiropractic field state that there is a dire need for research concerning the affect of CMT on the nervous system. The study of the effect of chiropractic on the ANS is one way to attract the interest of medical professionals and researchers.

Much research has already been done in the areas of chiropractic and the effect on the autonomic nervous system. Henderson (et.al.) states, "Chiropractic adjustments delivered by AAI may "normalize" articular afferent input to the CNS with subsequent recovery of muscle tone, joint mobility and sympathetic activity"[5]. This research supports the hypothesis that chiropractic may have an effect on the sympathetic nervous system. The research experiment previously mentioned, led by Norman Kettner, DC, addressed CMT's affect on HRV and HR in particular. This project concluded "there was statistically significant data that demonstrated a

change in HR following CMT in the thoracic spine."[6] It was stated in this particular article that these changes might be dependent on the vertebral levels treated using CMT. However, we feel that research supports positive results in areas other than the thoracic spine. Gillette (et.al) hypothesized that "a chiropractic lumbar thrust would produce sufficient force to co activate all the mechanically sensitive receptors".[4] Colloca and Keller also reported that, "neuromuscular responses were elicited in 95% of the low back patients from AAI [activator adjusting instrument] adjustments."[2] These studies are similar in effect, that they all support a change in the nervous system with Chiropractic manipulation therapy.

Activator Methods technique is one of the most thoroughly researched and recognized methods of spinal CMT. Literature and research studies clearly demonstrate the effectiveness of Activator CMT on musculoskeletal dysfunction. A literature review performed by Osterbauer, Fuhr, and Hildebrandt found that "manually assisted short lever adjusting [using an Activator instrument] seemingly is capable of beneficially altering the cause/effect relationship of spinal subluxations."[8] We believe that this supports our idea that CMT using Activator Methods can have the same effect on the ANS as the high-velocity low amplitude adjusting used in the Kettner study. Polkinghorn and Colloca studied treatment of lumbar disc herniation using activator technique, with positive results. They strongly advocate the use of activator CMT, stating "the use of an AAI...provides definitive benefits over side posture manipulation of the lumbar spinal treatment of resistive disc lesions."[9]

Eingorn and Muhs explained the relationship between the autonomic nervous system and involuntary physiologic activities (internal organs, glands, and cardiac functions). They stated that, "the technique of HR analysis known as HRV could be extremely useful in assessment of treatment outcomes in clinical chiropractic practice."[3] The use of HRV is

widely known in the fields of cardiology, neurology, and psychology. The medical community on HRV has done many studies as well. Buchheit, (et.al.) performed a study on HRV in the elderly and found a relationship between physical fitness and HRV. They state, "In very old subjects a long term sportive lifestyle, which increases total energy and physical activity intensity, is associated with a higher HRV and vagal related indexes and thus may counteract the age-related decline in cardiac autonomic control."[1] Another study performed at the Kyoto Prefectural University of Medicine found that low HRV was a "powerful predictor of clinical prognosis in patients with congestive heart failure."[7] Heart rate variability is clearly seen by the medical community as a valid tool to measure a person's health. If chiropractic can demonstrate statistically significant improvements in HRV in patients due to CMT, this will help to further validate chiropractic to the medical community as treatment for visceral disorders.

For the purposes of this experiment we have decided on the following working hypothesis: Chiropractic manipulative therapy will cause a statistically significant change in heart rate variability and heart rate, when performed using activator methods chiropractic technique on patients with a history of low back pain.

Volunteers were recruited from the Logan College of Chiropractic student body. A total of 28 volunteers showed up for the screening procedure. The subjects completed the attached consent form (Appendix A), and eligibility questionnaire (Appendix B), asking about history of low back pain and any other significant problems that may interfere with the results. Exclusion criteria were problems including, but not limited to: cardiovascular disease, nervous system disorders, medication that alters cardiovascular/neuromuscular activity, and low back

pain other than of a musculoskeletal origin.. All subjects will have a history of low back pain but will be asymptomatic at the time of the project. Low back pain history will be defined as mild to severe low back pain of musculoskeletal origin, experienced within the last year previous to the screening date. Patients were then evaluated using Logan College of Chiropractic's standard lumbar regional (Appendix C). A baseline HRV scan was then taken on each patient. The data was collected and evaluated to determine if the subject's initial HRV could be improved upon, and that they met the additional criteria mentioned above. It was determined that 24 of the initial 28 volunteers were eligible to participate in the study. Subjects were then contacted by telephone, and asked to participate in the study on a volunteer basis. A total of 15 subjects agreed to enter the study and will be randomly assigned to either the control group or experimental group. The subjects are all between the ages of 18-65, and both male and female patients were chosen to participate. No subjects were chosen who exhibit any contraindications to activator adjusting. Subjects were required to have a history of low back pain, but to be asymptomatic at the time of their participation in the project.

Once a participant was accepted into the study, he or she was randomly assigned to be a part of either an experimental or a control group. The experimental group received a series of three adjustments using the activator methods protocol detailed in the "Limitations" section. The control group also attended three sessions, during which a "sham" activator adjustment was given. This consisted of the patient being placed on the high-low table in the upright position, then being lowered into the prone position. The examiner then performed the activator protocol basic scan in the same manner as with the experimental group, however no adjustment was made using the activator instrument. An Activator Thrust Sheet (Appendix D) and a SOAP note (Appendix E) were completed with each visit. Then both the experimental and

control groups were connected to the HRV machine for pre- and post-treatment HRV scans. The post-treatment scan was performed a minimum of thirty seconds after the completion of the treatment.

Results

The variables measured for the purposes of this experiment consisted of heart rate, measured in beats per minute; and heart rate variability, measured using total power output of the heart ms2/hz.

The average change in BPM for the entire group was as follows: The experimental group had a decrease of 2.56 BPM, and the control group had a total decrease of 1.10BPM. (Fig 4-1) When broken down by gender, the differences were as follows: Males in the experimental group had a decrease of 1.97 BPM; males in the control group had a decrease of 1.37 BPM. Females in the experimental group had a decrease of 5.53 BPM; females in the control group had a decrease of .73 BPM. (Fig 4-2)

The average change in total power output for the entire group was as follows: The experimental group had an increase of 278.78; the control group had a decrease in total power output of 16.46. (Fig 4-3) When broken down by gender, results were as follows: males in the experimental group had a total power output increase of 317.12, males in the control group had an increase of 114.82. Females in the experimental group had an increase of 87.07; females in the control group had a decrease of 191.50. (Fig. 4-4)

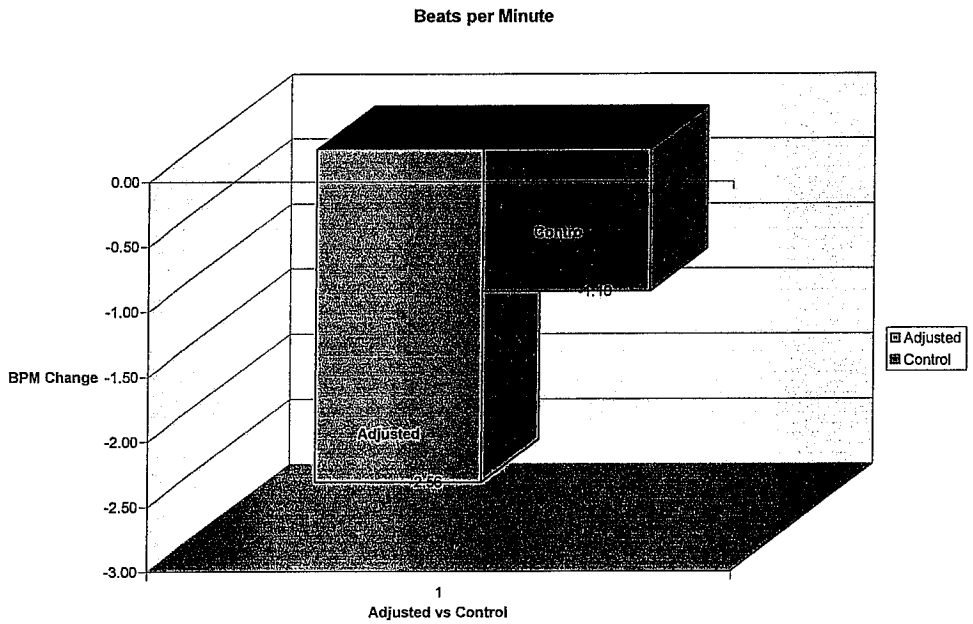
Beats per Minute
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
BPM Change
Adjusted
Control
1
Adjusted vs Control

Fig. 4-1

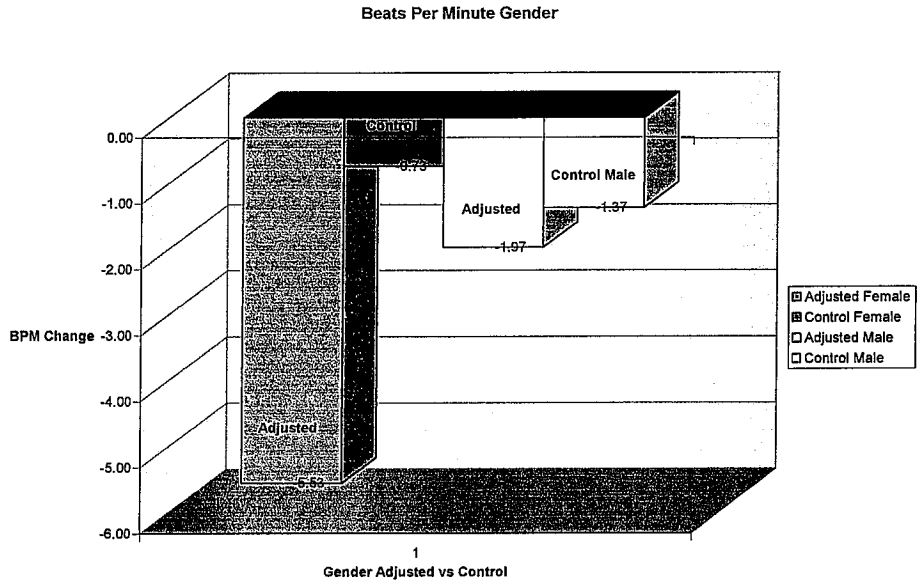
Beats Per Minute Gender
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
BPM Change
Control
-0.73
Control Male
-1.37
Adjusted
-1.97
Adjusted
Adjusted Female
Control Female
Adjusted Male
Control Male
1
Gender Adjusted vs Control

Fig. 4-2

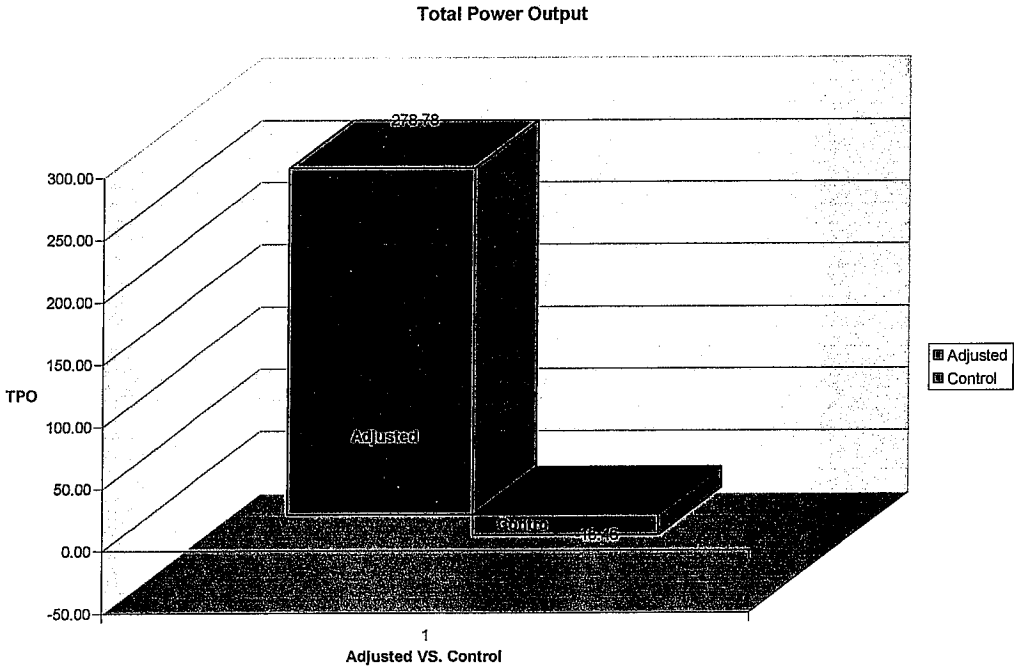
Total Power Output
300.00
250.00
200.00
150.00
TPO
100.00
50.00
0.00
-50.00
Adjusted
Control
1
Adjusted VS. Control
Adjusted
Control

Fig. 4-3

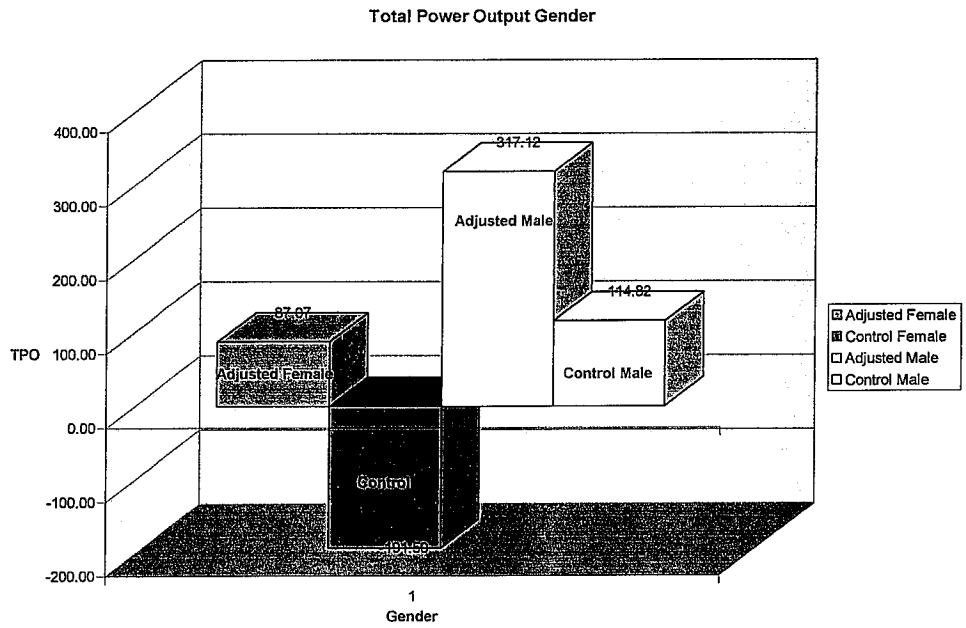
Total Power Output Gender
400.00
300.00
200.00
TPO 100.00
0.00
-100.00
-200.00
317.12
Adjusted Male
114.82
87.07
Adjusted Female
Control Male
Control
1
Gender
Adjusted Female
Control Female
Adjusted Male
Control Male

Fig. 4-4

Discussion

The purpose of this experiment was to test the hypothesis that chiropractic manipulative therapy would cause a statistically significant change in heart rate variability and heart rate. The parameters of this experiment included using the activator method chiropractic technique on patients with a history of low back pain.

The data in this study was analyzed using heart rate, and heart rate variability measured using total power output of the heart. Data was analyzed for the group as a whole, and for subgroups divided by gender. These findings showed statistically significant positive changes in the heart rate and heart rate variability. The heart rate for the experimental group showed a decrease of more than double that found in the control group. When broken down by gender, females in particular showed a significant decrease in heart rate when the experimental group was compared to the control. The total power output of the heart increased for the entire experimental group, whereas the control group showed a decrease in total power output of the heart. Males in both groups showed an increase, but the experimental group showed an increase of more than double that of the control group. Females in the experimental group had an increase in total power output, and those in the control group showed a decrease.

This study was in part a continuation of an experiment by Kettner, Payne, Reynolds, Rogers, Mrozek, Zhang, and Thompson titled "Effects of Thoracic Chiropractic Manipulative Therapy on Heart Rate Variability and Heart Rate." This study also found significant changes in heart rate and R-R interval following thoracic chiropractic manipulative therapy. Another study involving the activator methods by Colloca and Keller reported, "neuromuscular responses were elicited in 95% of the…low back patients from AAI adjustments." When

combined, these studies are a strong indicator of the positive effects of CMT on the autonomic nervous system.

Heart rate and heart rate variability are measures that are well known and utilized in the fields of cardiology, neurology, and psychology. Using HR and HRV as a measure of the efficacy of chiropractic therapy is an excellent way for chiropractic to gain the attention and respect of the traditional medical community.

Due to the design and setting, there were some limitations to this experiment. Senior interns at Logan College of Chiropractic performed all of the manipulations. Participants were recruited from the student body of Logan College, which may be exposed to an increased level of stress due to the academic setting. Due to scheduling conflicts, some of the participants had a variable amount of time lapse between adjustments. The level of participation also resulted in control and experimental groups that were smaller than ideal, however they were large enough to make the results statistically significant.

Conclusions

The results of this experiment helped to support years of subjective evidence proposed by chiropractors in a clinical setting. When combined with the previous experiment by Kettner, et al, these experiments support the hypothesis that CMT can have a positive effect on the autonomic nervous system. Infinite possibilities exist for more research on this subject. Another research group has already made use of the resources and data used for this experiment in order to continue this area of study. This is a positive step on chiropractic's journey toward acceptance by the medical community, and the population as a whole.

References

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APPENDIX A

CONSENT FORM

The Effects of Lumbo-Sacral Chiropractic Manipulation on HRV and Heart Rate

I_____ have been asked by Dr. John Zhang and Logan interns to participate voluntarily in this research study called "The Effect of Lumbo-Sacral Chiropractic Manipulation on HRV and Heart Rate", sponsored by the Research Department at Logan College of Chiropractic. The purpose of this study is to determine the cardiovascular and neurologic response from lumbo-sacral CMT.

I understand that my participation in this study is voluntary and that my participation may require me to:

a. Participate in the study for 2-3 weeks of CMT.

b. Allow interns from Logan College of Chiropractic to perform Activator Method of CMT.

c. Undergo cardiovascular function test/ HRV and HR to be recorded pre and post CMT.

I have been told that my participation in the study may or may not produce a direct benefit to me through the experiment. I understand that the results of this study may be published and/or made public. My name or identification associated to my name, or my file of vital information will not be revealed to anyone not directly associated with the study (i.e. testers or supervisors). All of my personal information will remain confidential.

I have been informed of the possible risks from CMT and physiological testing. These may include exacerbation of low back pain and a transient skin reaction from the electrodes used for HRV analysis. At any time if I feel that I am at risk of injury, I will be allowed to stop my participation and be excused from the study.

In event that I feel I have suffered an injury as a result of my participation in this study, I will be instructed to contact the Chairman of Logan College of Chiropractic Institutional Review Board, Dr. John Gutweiler at 636-227-2100 Ext.310. Dr. John Gutweiler will then refer me to the appropriate individuals to review the matter with me.

I have read the above statements and the Interns of Logan College of Chiropractic have explained to me regarding the purpose of the research project. I have been able to ask questions and express any concerns with any of the above mentioned procedures dealing with the study. Accordingly, I believe I understand the purpose of this study as well as the potential risks and benefits involved. I hereby give my free and informed consent to participate in this study.

_____ _____

Date and Time Signature of Subject

_____	_____
Signature of Witness	Print name of Subject

APPENDIX B

Survey

Date: ___/___/___

1. Gender
   □Male □Female

2. Age group
   □ 20-25
   □ 26-30
   □ 31-35
   □ 36-40
   □ Above 41

3. Have you undergone surgery recently?
   □ yes □ no

4. Do you take any medications now?
   □ yes □ no

   If yes list all medications: _____

5. Do you have low back pain?
   □ yes □ no

6. Do you have irregular heartbeats (arrhythmia)?
   □ yes □ no

7. Do you have a history of cardiovascular disease?
   □ yes □ no

8. Have you ever been adjusted by a chiropractor?
   □ yes □ no

9. Have you ever had an activator adjustment?
   □ yes □ no

APPENDIX E

CONTROL

Date:
Time:
ID#:

SOAP NOTE

S: The patient presents today for a control group study with no chief complaint and no complaint of pain.
O: See Activator Thrust Sheet dated _____
A: Segmental Dysfunction
P: Patient is participating in a control group and will receive the Activator Methods Basic Scan but will receive no thrust to any vertebral segment. The above stated procedure will be performed by a qualified Logan intern and supervised by Dr. Montgomery.

ADJUSTED

Date:
Time:
ID#:

SOAP NOTE

S: The patient presents today to participate in the adjusting group of a research study with no chief complaint and no complaint of pain.
O: See Activator Thrust Sheet dated _____
A: Segmental Dysfunction
P: Patient is participating in the adjusting group and will receive the Activator Methods Basic Scan and manipulation of the listed segments according to the AMCT protocol. The above stated procedure will be performed by a qualified Logan intern and supervised by Dr. Montgomery.

APPENDIX C

LOGAN CHIROPRACTIC CLINICS
LUMBAR EXAM FORM

Patient Name _____ Age _____ Sex _____

Date Attending Clinician ( ) Intern

VITAL SIGNS
Seated BP (R)_____(L)_____Resp_____RPM
Pulse_____BPM Ht_____Wt_____Temp_____°F

APPEARANCE, MOOD & ORIENTATION
(Circle each as appropriate) A&OX3 NAD WDWN
Other_____

VISUAL INSPECTION
L/S Muscle Symmetry ( ) Symmetrically Equal
Other_____
L/S Posture A-P_____
Lat_____

PALPATION
Lumbar Spine Musculature
( ) Normal Tone, no tenderness, swelling, masses, or heat ( ) except:

_____

_____

Interspinous Spaces_____

Related Areas
Lymph _____
L.E. Pulses _____
Other _____
Abdominal Exam_____

_____

RANGE OF MOTION		Active All NP ( ) except ( )	Passive All FNP ( ) except ( )	Resisted All NP ( ) except ( )
Flexion	60°			
Extension	25°			
Rotation 45°	R			
	L			
Lat Flexion 25°	R			
	L			

MOTOR (Graded 0-5)

( ) All 5/5 bilaterally except: ( )	R	L
Hip Flexion – Illiopsoas (L1,2,3)		
Leg Extension – Quadriceps (L2,3,4)		
Gluteus Medius (L5)		
Hip Extension – Gluteus Maximus (S1)		
Hip Adduction (L2,3,4)		
Tibialis Anterior (L4)		
Extensor Hallucis Longus (L5)		
Peroneous Longus and Brevis (S1)		

SENSORY

Dermatomes (light touch)
( ) All intact and equal bilaterally ( ) except:

	R	L		R	L		R	L
L1			L2			L3		
L4			L5			S1		
S2								

Other Sensory

( ) All below are unremarkable bilaterally ( ) except:	R	L
Sharp/Dull		
Vibratory Perception		
Position Sense		
Babinski		
Pain Perception		

CIRCUMFERENTIAL MEASUREMENTS	R	L
Thigh @ 5" proximal to superior patellar pole		
Thigh @ 7" proximal to superior patellar pole		
Calf @ 5" distal to inferior patellar pole		

LEG LENGTH	R	L
"Actual" (ASIS to medial malleolus)		
Apparent (Umbilicus to medial malleolus)		

REFLEXES – Deep Tendon (Graded 0-4)	R	L
Patellar (L4)		
Achilles (S1)		

ORTHOPEDIC
Standing - ( ) All tests unremarkable ( ) except:

Gait	
Toe Walk (S1,S2)	
Heel Walk (L4,L5)	
Adam's Sign	

( ) All tests negative ( ) except:

	R	L	Location of Pain
Kemps - Standing			
Seated			
Dejerine's Triad			
Valsalva			
Bechterew's			
Tripod Sign			
Kemp's - Seated			

Supine - ( ) All tests negative ( ) except:

SLR			
WLR			
Braggard's			
Sicard's			
Milgram's			
Goldthwait's			
Patrick FABERE			
Laguerre's			
Gaenslen's			

Prone - ( ) All tests negative ( ) except:

Hibb's			
Nachlas			
Ely's			
Yeoman's			

F = Full; NP = No Pain; I = Intact; ATP = Able To Perform

APPENDIX D

LEVEL	RIGHT	LEFT
PELVIS		
PUBIS		
L5		
L4		
L3		
L2		
L1		
T12		
T11		
T10		
T9		
T8		
T7		
T6		
T5		
T4		
T3		
T2		
T1		
T1 RIBS		
C7		
C6		
C5		
C4		
C3		
C2		
C1		
OCCIPUT		

ID #:_____.

CONTROL: Y or N

Charting:

S:

O:

A:

P: