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Original Articles

Effects of Upper and Lower Cervical Spinal Manipulative Therapy on Blood Pressure and Heart Rate Variability in Volunteers and Patients With Neck Pain: A Randomized Controlled, Cross-Over, Preliminary Study

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Abstract

Objective: The aims of this study were to examine autonomic nervous system responses by using heart rate variability analysis (HRV), hemodynamic parameters and numeric pain scale (NPS) when either upper (C1 and C2) or lower (C6 and C7) cervical segments were manipulated in volunteers, and whether such response would be altered in acute mechanical neck pain patients after spinal manipulative therapy (SMT).

Methods: A randomized controlled, cross-over, preliminary study was conducted on 10 asymptomatic normotensive volunteers and 10 normotensive patients complaining of acute neck pain. HRV, blood pressure (BP) and heart rate (HR), and NPS were recorded after upper cervical and lower cervical segments SMT in volunteer and patient groups.

Results: The standard deviation of average normal to normal R-R intervals (SDNN) increased (83.54 ± 22 vs. 105.41 ± 20; $P = .02$) after upper cervical SMT. The normalized unit of high frequency (nuHF), which shows parasympathetic activity, was predominant (40.18 ± 9 vs. 46.08 ± 14) after upper cervical SMT ($P = .03$) with a significant decrease (109 ± 10 vs. 98 ± 5) in systolic BP ($P = .002$). Low frequency to high frequency (LF/HF) ratio, which shows predominance of sympathetic activity increased (1.05 ± 0.7 vs. 1.51 ± 0.5; $P = .02$) after lower cervical SMT in the healthy volunteers group. However, there was an increase in SDNN (70.48 ±

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18 vs. 90.23 ± 20; $P = .02$ and 75.19 ± 16 vs 97.52 ± 22; $P = .01$), a decrease in LF/HF ratio (1.33 ± 0.3 vs. 0.81 ± 0.2; $P = .001$ and 1.22 ± 0.4 vs. 0.86 ± 0.3; $P = .02$), which was associated with decreased systolic BP (105 ± 10 vs. 95 ± 9; $P = .01$ and 102 ± 9 vs. 91 ± 10; $P = .02$) and NPS scores (3 ± 1 vs. 0; $P = .01$ and 3 ± 1 vs. 1 ± 1; $P = .03$) following both upper and lower cervical SMT in the patient's group. The baseline HR was 67 ± 9 vs 64 ± 5 (upper cervical) and 65 ± 7 vs 69 ± 11 (lower cervical) in both the healthy volunteer' and patient' groups.

Conclusion: Upper cervical SMT enhances dominance of parasympathetic and lower cervical SMT enhances dominance of sympathetic activity in this young volunteer group. However, dominance of parasympathetic activity was found in patients with neck pain that received both upper and lower cervical SMT.

Introduction

Hemodynamic parameters (blood pressure [BP] and heart/pulse rate) have been studied pre and post cervical[1–5] and thoracic manipulation.[2,6–8] Hemodynamic changes have also been reported following atlas SMT, although the results are somewhat controversial with no significant changes in BP[1] or decrease in BP.[9–11] The results of studies concerning SMT to treat hypertension have not been clinically concluded[12–14] with the bias of hypotensive complication[12] and decreased diastolic BP.[13] The possible underlying mechanisms of spinal manipulative therapy (SMT) and hemodynamic changes, such as autonomic regulation, the effects of the pressor reflex and anatomical abnormal positions, are still poorly understood.[2,3,10,11]

Heart rate variability (HRV) analysis is a noninvasive and widely used technique[15–21] which can provide important clinical information on the autonomic nervous system (ANS) and central nervous system because cyclical variation in heart rate is mediated by central neural mechanisms via baroreceptors and chemoreceptors.[17] HRV is used mostly to predict heart conditions, such as myocardial infarction[22] and to hypothesize the underlying mechanism of anesthetic drugs on hemodynamic changes.[20,21]

The sympathetic and parasympathetic components of HRV are active over different frequency ranges. The low-frequency component (LF, 0.05– 0.15 Hz) is influenced by both cardiac sympathetic and parasympathetic activity[16] and the high-frequency component (HF, > 0.15 Hz) originates from cardiac parasympathetic activity.[18] Therefore, the LF/HF ratio reflects dominance of cardiac sympathetic activity.[19,20]

Clinical information on the effect of SMT on the ANS and central nervous system using HRV analysis is sparse. HRV analysis showing cardiac autonomic functions has been conducted following spinal manipulation in the cervical[2,5] and thoracic regions.[2,6] As well, HRV analysis was examined in pain-free patients vs patients with lower back pain who received one chiropractic treatment at L5.[23] However, information on hemodynamic parameters and HRV analysis is still lacking in acute mechanical neck pain patients after receiving SMT in the upper (C1 and C2) and lower (C6 and C7) cervical regions.

In this study, two hypotheses were tested: 1) parasympathetic response would be predominant after SMT of an upper cervical segment (C1 and C2 vertebrae) and sympathetic response would be predominant after SMT of a lower cervical segment (C6 and C7) in painless healthy volunteers, and 2) this predominance of parasympathetic or sympathetic responses would be altered in acute mechanical neck pain patients after SMT. The aims of this study are therefore to investigate whether there is a relationship between SMT of the upper versus lower cervical spine and autonomic response in pain free subjects and acute mechanical neck pain patients.

Methods

This study was approved by the International Medical University's (IMU) Joint-Committee of the Research and Ethics Committee with IRB number; IMUJC 181110. Ten asymptomatic normotensive volunteers and ten normotensive patients presenting to an academic chiropractic clinic complaining of acute neck pain (American Society of Anesthesiologist physical status I and II) were recruited with written informed consent in this study. A computer based random number generator produced a list used to assign the participants to receive lower and upper SMT. Acute mechanical neck pain was defined as pain in the anatomic region of the neck for which it is not possible to identify a specific pathological cause of pain and the duration of pain is not over 6 weeks. It generally