The Effects of Thoracic Manipulation on Heart Rate Variability: A Controlled Crossover Trial

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Abstract

Objective: The objective of this study was to measure the effects of thoracic spinal manipulation on heart rate variability (HRV) in a cohort of healthy young adults.

Methods: A controlled crossover trial that was conducted on 28 healthy young adults (23 men and 5 women; age range, 18-45 years; mean age, 29 ± 7 years) measured HRV before and after a sham procedure and a thoracic spinal manipulation.

Results: In healthy young adults, thoracic spinal manipulation was associated with changes in HRV that were not duplicated by the sham procedure. The ratio of the powers of the low-frequency and high-frequency components increased from 0.9562 ± 0.9192 to 1.304 ± 1.118 (P = .0030, Wilcoxon signed rank test). In subjects undergoing sham spinal manipulation, there was no statistically significant change in the low-frequency or the high-frequency component of the power spectrum; neither was there any in the ratio of the two regardless of whether the comparison was made using the paired t test or the Wilcoxon signed rank test.

Conclusion: High-velocity and low-amplitude manipulation of the thoracic spine appears to be able to influence autonomic output to the heart in ways that are not duplicated by a sham procedure or by other forms of somatic/physical therapies. (J Manipulative Physiol Ther 2006;29:603-610)

Key Indexing Terms: *Spinal manipulation; Autonomic nervous system; Heart rate*

Various forms of innocuous somatic stimulation have been shown to modulate such aspects of cardiovascular function as heart rate (HR), blood pressure, and regional blood flow. In some instances, these effects are accompanied by, and perhaps attributable to, alterations in autonomic output to the cardiovascular system. For example, it has previously been shown that cervical manipulation results in changes in HR and HR variability (HRV) that are not achieved with a sham manipulation.[1] At present, it is uncertain whether autonomic responses to spinal manipulation are limited to the cervical spine or whether similar results can be achieved by manipulation of other regions of the spine. Thus, the present study was undertaken to measure the effects of thoracic spinal manipulation on HR and HRV in a cohort of healthy young adults.

Methods

Twenty-eight healthy adults (23 men and 5 women) participated in a controlled crossover trial of the effects of upper thoracic spinal manipulation and sham spinal manipulation on HR and HRV. For each subject, the two treatment procedures were performed 1 week apart at approximately the same time of day. A minimum cohort size of 25 subjects was chosen with consideration that statistically significant alterations in cardiovascular outcome measures had been shown in a pilot study with 17 data sets[2] and in a study on the effects of cervical spinal manipulation with 24 complete data sets.[1] Thirty-one subjects were initially recruited. One subject had frequent premature ventricular contractions, another subject failed to attend the second treatment session, and yet another subject displayed a systolic pressure higher than 140 mm Hg at both treatment sessions; therefore, the cohort had 28 complete data sets for analysis.

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Subjects were recruited on the basis that they did not have current neck and upper back pain. Before each intervention, the subjects were asked to assess their level of cervicothoracic spinal discomfort using a visual analogue scale (VAS) at the full extent of active left and right cervical rotations. On the VAS, 0 represented complete comfort and 10 represented "the worst pain imaginable." On this basis, the levels of pain (mean ± SD) on full active left and right rotations before the sham and authentic stimulations were 0.7 ± 1.5, 0.3 ± 0.8, 0.2 ± 0.8, and 0.6 ± 1.4, respectively. In other words, on the day of the trials, subjects had, at most, trivial levels of cervicothoracic discomfort at the extremes of active cervical rotation.

Subjects were excluded if they had (1) a history of cervicothoracic surgery, fracture, or dislocation; (2) a known anatomical abnormality in the cervicothoracic region; (3) a history of cervicothoracic trauma within the previous 3 months or persistent symptoms from an earlier trauma; (4) a history of cancer; (5) a history of stroke; (6) a history of positional vertigo; or (7) a history of chronic or recurrent inflammatory disease. In addition, subjects were excluded if they were currently receiving an anticoagulant or a steroid therapy or if they were currently engaged in litigation for spinal injury. The study was approved by the human research ethics committee of the Royal Melbourne Institute of Technology.

Subjects were examined for the presence of carotid bruits as well as positional vertigo and nystagmus (with the neck held in extension and rotation) as contraindications to cervical manipulation and involvement in this study because attempted upper thoracic manipulation may result in inadvertent manipulation of the cervical spine. The validity of the screening tests used has been questioned,[3] and the fact that no contraindication to manipulation was found was not taken to indicate zero risk. Similarly, immediately before each trial, blood pressure was measured with a sphygmomanometer, and subjects with a systolic pressure of 140 mm Hg or higher or a diastolic pressure of 90 mm Hg or higher were excluded from the trial. Subjects were encouraged to report any discomfort immediately. Exit questionnaires were provided but subjects did not report unpleasant effects from treatment.

The mechanical stimuli were applied to the upper thoracic spine (first to fourth vertebral levels). The order of presentation of the thoracic and sham manipulations was determined by a coin toss immediately before the first trial for each subject. The sham and thoracic manipulations were performed with the subjects in the prone position. With regard to the selection of the site for manipulation in the thoracic spine within the studies described, conventional clinical indicators from the literature were used. Different authors may have used slightly different terminologies, but essentially they all described much the same set of palpable indicators of tissue quality and motion. By way of example, Cleveland[4] suggested certain defining characteristics of the manipulable lesion: vertebral malposition, abnormal vertebral motion, abnormal joint play or end feel, soft-tissue abnormalities, and muscle contraction or imbalance. McPortland et al[5] used a similar set of criteria: tenderness, asymmetry of joint position, restriction of range of motion, and tissue texture abnormality. Tenderness was ranked by each subject in response to palpation over the spinal joints. Restriction of range of motion was defined as abnormality of resistance and abnormal end feel. Tissue texture abnormality was defined as a sense of fullness over the joint space. Faye and Wiles[6] described the use of static palpation in the detection of abnormal tissue texture, temperature, contour, and tenderness while advocating the use of motion palpation to determine normal active range of motion, hypermobile or aberrant motion, and capsular end feel. End feel has been used clinically to identify the location of segmental restriction of cervical motion.[7] In addition, Vernon and Gitelman[8] attempted to validate the use of algometry and tissue compliance in the identification of the manipulable lesion, albeit with the use of mechanical devices.

The validity of static and motion palpation procedures in identifying the manipulable lesion has not been well investigated and certainly has been questioned.[9] Nonetheless, motion palpation has been advocated as the assessment of choice in identifying the site of the manipulable lesion and in selecting the manipulative procedure best suited to correct the lesion.[6] Recent work by Humphreys et al[10] suggests that cervical motion palpation is a valid and reliable method of assessing hypomobility. Motion palpation alone or in combination with static palpation has been used for this purpose in several clinical trials involving cervical spinal manipulation.[11-16] In this study, sites for the application of thoracic manipulation were chosen on the basis of relatively restricted joint play and relative paraspinal hypertonicity, which have been found to have good intraexaminer and interexaminer reliabilities in this region of the spine.[17]

One of two types of manipulation was used, depending on the location of restriction of vertebral motion on the day of the trial. These manipulations are of the types commonly referred to as "cross-bilateral adjustment" and "combination adjustment." The cross-bilateral adjustment was applied as described by Gitelman and Fligg.[18] Specifically, the clinician stood on the side of the subject's upper thoracic region with the ipsilateral hand reaching across the subject to apply pressure to a contralateral thoracic transverse process. The contralateral hand was used to brace the ipsilateral transverse process of the first vertebral level below. (Thus, with the hands crossed, the clinician makes contact on either side of the subject's spine, hence the name of the technique.) Pressure was applied to separate the hands until tissue resistance was detected. Then, a high-velocity and low-amplitude thrust was applied, resulting in an audible sound. This technique has been used previously in