Immediate Effects of the Audible Pop From a Thoracic Spine Thrust Manipulation on the Autonomic Nervous System and Pain: A Secondary Analysis of a Randomized Clinical Trial

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Abstract

Purpose: This study investigated the immediate effects of audible joint sounds following a supine T3-T4 spinal thrust manipulation on the autonomic nervous system activity using a fully automated pupillometry system in patients with chronic neck pain. An additional aim was to determine if audible sounds as perceived by the therapist were associated with the reduction of pain following manipulation.

Methods: One hundred subjects with chronic neck pain completed the study protocol. The Mann-Whitney *U* test was used to compare the change scores of the 3 measuring points between the one-pop and multiple-pop groups. Subjects were randomized into either a manipulation or a mobilization group. A method of automated pupillometry was used in this study to capture pupil responsiveness.

Results: The analysis showed that there was no significant difference between the 2 groups ($P > .05$). The Kruskal-Wallis test was used to compare the median change scores between the mobilization, no-pop, and pop groups. The analysis showed that there was no statistically significant difference in the amount of change in pupil diameter between the 3 groups ($P > .05$).The Mann-Whitney *U* test demonstrated that the no-pop group ($P = .031$) and the multiple-pop group ($P = .014$) had a significant reduction of pain; however, it did not reach the minimal clinically significant level of 13 mm on the visual analog scale.

Conclusions: The results of this study provided evidence that the presence of joint sounds does not influence the overall activity of the autonomic nervous system following a thrust manipulation or contribute to the reduction of pain in patients with chronic neck pain. (J Manipulative Physiol Ther 2011;34:37-45)

Key Indexing Terms: *Musculoskeletal Manipulations; Autonomic Nervous System; Pupil; Pain*

Thrust manipulation is a commonly used intervention with proven effectiveness for patients with neck and low back pain.[1-6] Although the exact mechanisms underlying manipulative techniques are still unknown, it appears that there are both mechanical and neurophysiological effects.[7,8] During a thrust manipulation, it is possible to elicit an audible pop.[9-14] Traditionally, it has been believed by both clinicians and patients that manipulation to restore movement was performed successfully only when a "cracking" sound was produced.[11,12,15-19] Recent research has questioned if the audible pop itself has any therapeutic value and if it is necessary to achieve a successful outcome.[12,16,19-22] Flynn et al[12,19] demonstrated that low back pain patients who experienced an audible pop during a lumbopelvic manipulation achieved no better outcomes in the short or long term than patients who did not experience an audible pop. Cleland et al[16] found that, after the application of a thoracic spine thrust manipulation, the number of audible pops did not result in greater short-term changes in pain, range of motion, and disability in a subgroup of patients with neck pain.

Although it has not been confirmed conclusively, audible sounds during spinal manipulative treatments have been associated with a cavitation process within the facet joints.[11,17,23] Cavitation is the formation or release of gas from the synovial fluid within the joint caused by separation of joint surfaces resulting in an intracapsular reduction in pressure.[9,10,12,14,19,20,24,25] As a result of the capsular movement that occurs during the manipulation maneuver and because gas occupies a larger space than

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fluid, there could be a relative elongation of the joint capsule causing the depolarization of mechanoreceptors. This depolarization could possibly result in a reflex muscle relaxation and increase in range of motion of the cavitated joint.[9,13,24] Increased mechanoreceptor activity results in impulses projecting on the dorsal horn of the spinal column, which appear to contribute to hypoalgesia of the dorsal horn of the manipulated segment.[2,14] This hypoalgesia can be demonstrated by an increased pain threshold in segmentally related tissues.[5,26]

Hypotheses have been proposed offering mechanical, neurophysiological, and psychological rationales[7,8] to explain the positive outcomes of manipulation. Bialosky et al[8] have presented a neurophysiological model that identifies several interacting pathways within the peripheral and central nervous system, which could explain the effects of manipulation. It was suggested that the effects of manipulation could either influence or be influenced by the autonomic nervous system. It has been previously demonstrated that manipulation can result in immediate sympathoexcitatory effects.[27-34] Normal functioning of the autonomic nervous system is essential because it is responsible for maintaining normal quality of tissues.[35-37] It appears that a close relationship exists between pain and the autonomic nervous system[38,39]; therefore, its parameters could be regarded as objective measures of pain in humans.[40-42]

The pupil is an organ that receives innervation from both the sympathetic and parasympathetic nervous system exclusively. Both autonomic components influence the diameter of the pupil.[34,37,43,44] Based on a negative feedback mechanism within the autonomic nervous system and its exclusive innervation, the pupil diameter can be considered as a direct "live" reflection of the functional balance between the sympathetic and parasympathetic nervous system.[37,43,45-48] A simultaneous increasing activity of the sympathetic system and decreasing parasympathetic activity will result in a dilation of the pupil.[34,43,49,50] In addition, it has been demonstrated that sympathetic activation through the upper thoracic spine segments can cause pupil dilation.[51]

Considering the relationship between pain and the autonomic nervous system, it could be possible that audible sounds caused by thrust manipulation have a direct effect on the functioning of the autonomic system. Previous studies have evaluated the direct effect of audible sounds during thrust manipulation on pain and functional outcomes. We have previously reported that, within a group of chronic neck pain patients, no immediate reduction of pain was achieved following an upper thoracic thrust manipulation; nor was an overall change in sympathetic functioning demonstrated compared with a sham intervention group.[52] Within that study, the presence of audible sounds was not considered as a factor, which could have influenced the study results. The effects of audible sounds on pain perception and neurophysiological mechanisms (specifically the autonomic nervous system) following thrust manipulation have not been demonstrated at this time. Hence, the purpose of this study was to determine if audible sounds during a thrust manipulation have an immediate effect on pain perception within a group of chronic neck pain patients. An additional purpose was to determine if there was a positive correlation between the presence of audible sounds during an upper thoracic thrust manipulation and a change in autonomic function using a method of automated pupillometry.

Material and Methods

Subjects

Based on a power analysis to achieve a power of 0.80 and an effect size of 0.5, 100 consecutive subjects between May and August of 2008 with chronic cervical pain were recruited from 5 outpatient physical therapy clinics in Northwest Indiana. For the purpose of this study, *cervical pain* was operationally defined as the presence of nonspecific pain in the cervical and cervicothoracic region down to T4, which was provoked with neck movements.[53,54] *Chronicity* was operationally defined as pain that had been present for at least 3 months[55] and had not subjectively changed in intensity. All available subjects were screened for eligibility criteria. To participate, subjects had to be between the ages of 18 and 65 years and able to speak and read the English language fluently. After review of medication use and physician consultation, all subjects were instructed not to take any medication that could alter the functioning of the autonomic nervous system for at least 24 hours before participating in the study. In addition, subjects were instructed not to consume caffeinated drinks, smoke, or eat anything for at least 12 hours before the study. Subjects were excluded from this study if they were previously diagnosed with autonomic diseases such as the Horner syndrome; had a history of current neurological, ocular, and/or retinal disease; used 2 or more alcoholic beverages daily; or trained for endurance sports. This study was approved by the Institutional Review Board at NOVA Southeastern University. All subjects provided written consent before participating in the study.

Automated Measures. To obtain an impression about the autonomic system, the pupil diameter and its response to stimuli can be measured.[34,47,48,50,56,57] A method of automated pupillometry was used in this study to capture pupil responsiveness. Pupillometry has been previously used to measure the pupil and has been shown to be an easy, valid, and reliable method of assessing the nervous system while limiting the presence of much examiner bias.[46,47,50,58-64] The pupil responses before, during, and after the manipulation were measured with the fully automated Vorteq system (Fig 1). The Vorteq system for