3-Dimensional Cervical Movement Characteristics and the Influence of Thoracic Treatment on a Subgroup of Acute Neck Pain Patients

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Abstract

Objective: The purpose of this study was to investigate the influence of thoracic high-velocity low-amplitude thrust (HVLAT) manipulation on quantitative and qualitative 3-dimensional cervical spine kinematic patterns in a subgroup of patients with acute neck pain.

Methods: Thirty patients with acute neck pain, aged 20 to 59, received a thoracic HVLAT manipulation. Three-dimensional kinematics of the cervical spine were registered pretreatment and posttreatment using an electromagnetic tracking system. Quantitative and qualitative parameters were calculated for axial rotation, lateral bending, and flexion-extension movement. Subjective pain ratings were measured with the visual analogue scale and the Neck Disability Index and were collected pretreatment and posttreatment.

Results: After treatment, the range of motion of the main motion improved significantly for axial rotation ($P = .034$), lateral bending ($P < .001$), and flexion-extension ($P = .031$). Although for axial rotation as the main motion, the smoothness of the flexion-extension movement improved significantly after treatment ($P = .036$), the reverse was true for flexion-extension as the main motion. Visual analogue scale scores exhibited a statistically ($P < .001$) and clinically significant reduction of pain sensation. The mean change in Neck Disability Index scores only exhibited a statistically significant improvement 1 week after treatment.

Conclusion: Thoracic HVLAT manipulation led to positive changes in quantitative and qualitative aspects of 3-dimensional cervical spine kinematics. Because of the 1-intervention group design, external factors influencing the healing process could not be eliminated. (J Manipulative Physiol Ther 2018;xx:1-xxx)

Key Indexing Terms: *Manipulation, Spinal; Range of Motion, Articular; Movement; Physiology; Neck Pain*

Introduction

Neck pain is generally described as pain perceived in the posterior region of the cervical spine. This region is bounded superiorly between the nuchal line, laterally by the margins of the neck, and inferiorly by an imaginary transverse line through the T1 spinous process.[1,2] Nonspecific neck pain can be defined as simple neck pain without a specific underlying disease causing the pain. Commonly used synonyms such as *tension neck syndrome* and *cervical brachial syndrome* primarily describe symptoms of nonspecific neck pain but do not offer any inferences on their possible causes. Nonspecific neck pain can be diagnosed through clinical assessment ruling out suggestions for serious conditions (red flags), for example, space-occupying lesions, vascular insufficiency, compression of the spinal cord, and traumatic or systemic inflammatory processes. The Task Force on Neck Pain and Its Associated Disorders has developed a clinical classification system for neck pain patients.[3] On the basis of specific symptoms and clinical indications, the following differentiation has been proposed: grade I = no signs of major pathology and no or little interference with daily activities; grade II = no signs of major pathology, but interference with daily activities; grade III = neck pain with neurological signs or symptoms; and grade IV = neck pain with signs of major pathology.[4]

Based on their clinical appearances, 3 different forms of neck pain are classified: acute, subacute, and chronic neck pain. Within current international research, however, different perspectives coexist regarding symptom duration of those different forms of neck pain. Whereas German literature declares neck pain with symptoms

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lasting between 0 and 3 weeks as acute, the Belgian Healthcare Knowledge Center follows the classification of Binder[5-7]: acute neck pain (<4 weeks' duration); sub-acute (1-4 months' duration); and chronic (>4 months' duration).

Symptoms of nonspecific neck pain share characteristics of symptoms of whiplash-associated disorders, grades I and II. Haldeman et al describe the following symptoms corresponding to grade I: pain, stiffness, and tenderness of the neck, but no physical signs[3]; for symptoms corresponding to grade II, the same neck complaints and other musculoskeletal impairments (eg, decreased range of motion [ROM] and tender spots). Following the Intego Network, between 1994 and 2006, the incidence rate of patients experiencing neck pain in need of medical advice accounted for 24.84% of the Belgian population.[8] However, it must be mentioned that the actual incidence rate might be even higher because of selection bias for participants who were actively seeking medical advice.

Prevalence rates of nonspecific neck pain tend to vary in Western Europe for the years 1991 to 2004. More specifically, studies have been reporting rates between 5% and 22%.[5,9-12] Following a meta-analysis of the Neck Pain Task Force conducted for the years 1980 to 2006, the 12-month prevalence rate for neck pain was 12.1% to 71.5 % in the general population and 27.1% to 47.8% in the working population.[4] Compared with numerous studies on neck pain conducted in North America, The Netherlands, and Scandinavia, research on the epidemiology of neck pain is still lacking in the German and Belgian/Flemish populations.[13,14]

Treatment of neck pain constitutes an essential cost factor within the health care system.[15] Already in 1996, Borghouts et al estimated the yearly treatment costs of patients with neck pain in The Netherlands at $686 million.[11] In Germany, costs for treatment of spine diseases are estimated at €7.2 billion, accounting for 3.2% of the gross €223.6 billion in health care costs in 2002.[5]

Physiotherapy has been proposed as an intervention for patients with neck pain; however, there is no consensus on which technique might serve as the gold standard for treatment.[16,17] Recent guidelines for physical therapists recommend different interventions, for example, stretching exercises, coordination and strengthening exercises, upper quarter and nerve mobilization, traction, cognitive/behavioral therapy, and cervical and thoracic mobilization/manipulation.[18] Manual therapeutic treatment of neck pain entails manipulation and mobilization of both the cervical spine and the thoracic spine. Both treatments are commonly combined with exercises and have been found to be efficient.[19] Martinez-Segura et al that cervical and thoracic high-velocity low-amplitude thrust (HVLAT) manipulations are similarly effective in reducing pain and improving movement functions in patients with neck pain[20] (see also Suvarnnato et al[21]). Because manual therapeutic treatment of the cervical spine might entail possible adverse effects, treatment of the thoracic spine has been recommended in the last few years.[22-24] Current literature suggests that manual therapy at the level of the thoracic spine may also have beneficial effects on nonspecific neck pain and may entail less potential risk than cervical manual therapy. Likewise, the Orthopedic Section of the American Physical Association recommends thoracic spine manipulation as treatment for acute neck pain.[25] Recent research has accumulated evidence for the effectiveness of thoracic manipulation in reducing acute neck pain, improving neck function, and increasing quality of life.[26] Studies conducted by Fernández de-las-Peñas et al revealed that even a single thoracic spine manipulation might suffice to reduce neck pain, with visual analogue scale (VAS) scores measuring subjective pain decreasing from 5.5 before the manipulation to 2.9 directly after treatment.[27] Moreover, the authors observed an increase in the cervical ROM. Other studies support the effectiveness of thoracic manipulation as a suitable treatment for mechanical neck pain.[28,29] Specifically, manipulations of the thoracic spine have led to short-term improvements in ROM and improvement of disability. Those improvements of both subjective pain ratings and muscular function can also be observed in daily practice.

Different explanations are presented for the effectiveness of thoracic manipulation as a treatment for acute neck pain. From a biomechanical perspective, normal functioning of the cervical spine highly depends on functioning of the thoracic spine. Therefore, malfunction of the thoracic spine might likely impede both muscular function and regular movements.[30] Other explanations point toward neurophysiological effects.[20,31] One model developed by Bialosky et al links mechanical stimuli (ie, manual therapeutic interventions) to neurophysiological effects such as hypoalgesia, neuromuscular and endocrine reactions, and peripheral, spinal, and supraspinal mechanisms.[32] Chu et al found that a HVLAT manipulation of the thoracic and cervical spine released an excitatory response of the sympathetic nervous system (SNS), which, in turn, was associated with pain reduction and reduced mechanosensitivity in symptomatic individuals.[33] The ROM is an often-used indicator of effects of manual therapy in patients with neck pain. Motion palpation techniques, however, have been found to be unreliable.[34,35]

In clinical practice, simple and effective 2-dimensional methods, such as use of a handheld goniometer or cervical ROM goniometer, are most often used for measurement of ROM. Although their results indicate high reliability and precision, both methods are limited by their inability to record complex movements with greater than 1 center of rotation. That is why those methods are not able to display the natural 3-dimensional movement of the cervical spine.[36] Other investigations have reported the noninvasive, suitable, and accurate application of electromagnetic tracking systems (ETSs) for biomechanical and kinesiological research on movements.[37-42]