

Research Paper Review

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Bilateral and multiple cavitation sounds during upper cervical thrust manipulation BMC Musculoskeletal Disorders 2013; 14: 24

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ABSTRACT

Background

The popping produced during high-velocity, low-amplitude (HVLA) thrust manipulation is a common sound; however to our knowledge, no study has previously investigated the location of cavitation sounds during manipulation of the upper cervical spine. The primary purpose was to determine which side of the spine cavitates during C1-2 rotatory HVLA thrust manipulation. Secondary aims were to calculate the average number of pops, the duration of upper cervical thrust manipulation, and the duration of a single cavitation.

Methods

Nineteen asymptomatic participants received two upper cervical thrust manipulations targeting the right and left C1-2 articulation, respectively. Skin mounted microphones were secured bilaterally over the transverse process of C1, and sound wave signals were recorded. Identification of the side, duration, and number of popping sounds were determined by simultaneous analysis of spectrograms with audio feedback using custom software developed in Matlab.

Results

Bilateral popping sounds were detected in 34 (91.9%) of 37 manipulations while unilateral popping sounds were detected in just 3 (8.1%) manipulations; that is, cavitation was significantly (P < 0.001) more likely to occur bilaterally than unilaterally. Of the 132 total cavitations, 72 occurred ipsilateral and 60 occurred contralateral to the targeted C1-2 articulation. In other words, cavitation was no more likely to occur on the ipsilateral than the contralateral side (P = 0.294). The mean number of pops per C1-2 rotatory HVLA thrust manipulation was 3.57 (95% CI: 3.19, 3.94) and the mean number of pops per subject following both right and left C1-2 thrust manipulations was 6.95 (95% CI: 6.11, 7.79). The mean duration of a single audible pop was 5.66 ms (95% CI: 5.36, 5.96) and the mean duration of a single manipulation was 96.95 ms (95% CI: 57.20, 136.71).

Conclusions

Cavitation was significantly more likely to occur bilaterally than unilaterally during upper cervical HVLA thrust manipulation. Most subjects produced 3–4 pops during a single rotatory HVLA thrust manipulation targeting the right or left C1-2 articulation; therefore, practitioners of spinal manipulative therapy should expect multiple popping sounds when performing upper cervical thrust manipulation to the atlanto-axial joint. Furthermore, the traditional manual therapy approach of targeting a single ipsilateral or contralateral facet joint in the upper cervical spine may not be realistic.

ANALYSIS

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Background Information

The cracking, popping or clicking noise produced during spinal manipulation (or adjustment) is a common sound to physiotherapists, osteopaths and chiropractors. The predominant theory regarding the origin of the popping sound is still the cavitation model of joint cracking originally proposed by Unsworth in 1971 (1), whereby a rapid increase in joint volume creates an area of low pressure that is subsequently filled with synovial fluid, causing the collapse of CO2 gas bubbles in the joint space, resulting in an audible cracking sound. Many practitioners and patients alike equate a "successful" treatment with the associated pop that supposedly accompanies a joint release.

While it is not uncommon for each adjustment to be associated with multiple cavitation sounds (2-4), the question of where these sounds originate (i.e. from the adjusted joint or an adjacent joint) remains unanswered. To date, only two studies (4, 5) have investigated this question. The current study was designed to investigate the side (location), duration and/or number of audible popping sounds produced during upper cervical spine thrust manipulation. The primary purpose of the study was to determine which side of the upper cervical spine cavitates during a rotatory C1-2 HVLA thrust manipulation. Secondary purposes included establishing the duration of cavitation sounds, upper cervical manipulation procedures and the average number of popping sounds per manipulation.

PERTINENT RESULTS

Cavitation Characteristics

Of 132 total cavitations, 72 occurred ipsilateral and 60 occurred contralateral to the targeted C1-2 articulation. A cavitation was no more likely to occur on the ipsilateral than the contralateral side (Pearson Chi-square = 1.100; p = 0.294).

Left-sided C1/2 SMT:

Bilateral popping sounds were detected in 17 (94.4%) of the 18 upper cervical rotatory HVLA thrust manipulations, whereas unilateral popping sounds were detected in just 1 (5.6%) of the thrust manipulations.

Right-sided C1/2 SMT:

Bilateral popping sounds were detected in 17 (89.5%) of the 19 upper cervical rotatory HVLA thrust manipulations, whereas unilateral popping sounds were detected in just 2 (10.5%) of the 19 thrust manipulations.

Cavitation was significantly (binomial test, p < 0.001) more likely to occur bilaterally than unilaterally. Cracking sounds were 11.3 times more likely to occur bilaterally than unilaterally. An average of 3.57 (95% CI: 3.19, 3.94) distinct pops per C1-2 HVLA thrust manipulation procedure were observed.

CLINICAL APPLICATION & CONCLUSIONS

Clinical Implications:

Prior research (4, 5) has indicated that cavitations originate largely in the contralateral facet joint. The current study refutes this finding, suggesting that cavitations are largely bilateral – at least in the upper cervical region studied in this project. It is relevant to consider the C1/2 manipulation utilized in this study, which differs from the C3/4 manipulation utilized in the other studies. This could account for the different findings. The authors suggest that the likelihood of eliciting one single cavitation when adjusting the C1/2 joint is very low and that the each single adjustment will result in an average of 3-4 cavitations (this likely mimics what most practitioners see – or hear – in their offices).

Although some reports have suggested otherwise (6, 7), anecdotal evidence suggests that there is an association between clinical outcomes and the popping sound. Based on the findings of this study, practitioners of spinal manipulative therapy can safely expect multiple popping sounds when performing upper cervical thrust manipulation to the atlanto-axial region. Furthermore, the traditional manual therapy approach of targeting a single ipsilateral or contralateral facet joint in the upper cervical spine may not be realistic.

STUDY METHODS

Patient Eligibility:

Nineteen asymptomatic subjects (10 females and 9 males) were recruited by convenience sampling former patients from a private physical therapy outpatient clinic in Brescia, Italy.

Inclusion Criteria:

- 1. Patient presented with no neck pain (defined as pain in the region between the superior nuchal line and first thoracic spinous process) over the past 3 months, and
- 2. were between 18 and 70 years of age.

All potential participants were screened for relative and absolute contraindications for cervical manipulation.

Exclusion Criteria:

- Any red flags tumour, fracture, metabolic diseases, rheumatoid arthritis, osteoporosis, resting blood pressure greater than 140/90 mmHg, prolonged history of steroid use, etc.
- 2 or more positive neurologic signs consistent with nerve root compression (muscle weakness involving a major muscle group of the upper extremity, diminished upper extremity deep tendon reflex, or diminished or absent sensation to pinprick in any upper extremity dermatome)
- Diagnosis of cervical spinal stenosis
- Bilateral upper extremity symptoms
- Evidence of central nervous system disease (hyperreflexia, sensory disturbances in the hand, intrinsic muscle wasting of the hands, unsteadiness during walking, nystagmus, loss of visual acuity, impaired sensation of the face, altered taste, the presence of pathological reflexes)
- History of whiplash injury within the previous 3 months
- Prior surgery to the neck or thoracic spine
- Neck pain within the previous 3 month period

Practitioners

A single, U.S. licensed physical therapist with 12 years of clinical experience using spinal manipulative therapy performed all of the upper cervical HVLA thrust manipulations in this study.

Treatment

A single rotatory HVLA thrust manipulation directed to the upper cervical spine (C1-2) with the patient supine was performed.

Microphone placement

Skin mounted microphones were secured bilaterally over the lateral aspect of the transverse process of C1. The sound wave signals and resultant popping sounds during the manipulations were recorded for later data extraction and analysis.

STUDY STRENGTHS / WEAKNESSES

Limitations

- The results from upper cervical manipulation techniques may not be generalizable to the middle and lower cervical spine, where manipulation involves different combinations of primary and secondary, physiologic or accessory component levers, and
- as only one practitioner administered all of the upper cervical thrust manipulations it cannot be assumed that the force, direction and technique would be identical in other practitioners administering the same procedure. (EDITOR'S NOTE: *This is a common difficulty when conducting manual medicine research. Clinicians are different as individuals, and this is a difficult parameter to account for in laboratory research. Having said that, this is not a reason in this particular study to discount the results.*)

Strengths

• The authors were comprehensive in their design and in designing their data and sound collection techniques.

Additional References

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