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Mobilizations of the asymptomatic cervical spine can reduce signs of shoulder dysfunction in adults

Lynda McClatchie^a, Judi Laprade^b, Shelley Martin^c, Susan B. Jaglal^{a,b}, Denyse Richardson^a, Anne Agur^{d,*}^a Graduate Department of Rehabilitation Sciences, University of Toronto, 500 University Avenue, Toronto, Ontario, Canada M5G 1V7^b Department of Physical Therapy, University of Toronto, 160-500 University Avenue, Toronto, Ontario, Canada M5G 1V7^c Spine and Sport Physiotherapy Centre, 123 Edward Street, Suite 500, Toronto, Ontario, Canada M5G 1E2^d Division of Anatomy, Department of Surgery, University of Toronto, Medical Sciences Building, 1 King's College Circle, Toronto, Ontario, Canada M5S 1A8

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ABSTRACT

Generalized shoulder pain is a common problem that is difficult to treat and frequently recurrent. The asymptomatic cervical spine must be ruled out as a cause of any shoulder pain, as it can have a similar presentation to an isolated shoulder disorder. Previous studies have shown that lateral cervical glide mobilizations to the asymptomatic cervical spine at C5/6 can affect peripheral pain, but none have examined shoulder pain. A randomized, blinded, placebo-controlled, cross-over trial was used to examine the immediate effects of cervical lateral glide mobilizations on pain intensity and shoulder abduction painful arc in subjects with shoulder pain. Twenty-one subjects received interventions of both cervical mobilization and placebo over two sessions. Pain intensity using a visual analog scale (VAS) and painful arc were assessed prior to and following application of cervical mobilization or placebo intervention. Evaluation of cervical mobilization revealed the shoulder abduction painful arc ($12.5^\circ \pm 15.6^\circ$, $p = 0.002$) and shoulder pain intensity (1.3 ± 1.1 cm, $p < 0.001$) were significantly decreased. The results of this study suggest that any immediate change in shoulder pain or active shoulder range of motion following cervical mobilizations indicate that treatment directed toward the asymptomatic cervical spine may expedite recovery.

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1. Introduction

The prevalence of shoulder pain as reported in the literature ranges from 7 to 34% in the adult population (Chard et al., 1991; Badley and Tennant, 1992; Van der Windt et al., 1996). Despite its prevalence, the pathophysiology of shoulder pain has not been well defined (de Winter et al., 1999; Groenier et al., 2003), and the diagnosis is complicated by the large number of structures in the shoulder region (Bamji et al., 1996; Pope et al., 1997). Differentiation between various shoulder disorders is important to implementing effective treatment (Green et al., 1998), but the differential diagnosis is often complex as a broad spectrum of intrinsic and extrinsic conditions may produce shoulder pain (Nevasier, 1983). The tendons of the rotator cuff or long head of biceps (Lyons and Orwin, 1998; Van der Heijden, 1999), calcium deposits within tendons (Turner-Stokes, 1996), degenerative changes in the glenohumeral or acromioclavicular joint (Prescher, 2000), or inflammation in the bursae surrounding the shoulder (Koester et al.,

2005) are some of the structures which cause pain around the shoulder.

Generalized shoulder pain is frequently recurrent (Winters et al., 1999) and can remain present for over three years after onset (Chakravarty and Webley, 1993; Croft et al., 1996; Badcock et al., 2002), with one study indicating that 50% of subjects with shoulder pain had persistent problems three years later (MacFarlane et al., 1998). Research has shown that long-term shoulder pain can lead to a considerable restriction of work and leisure activities (Wells, 1982). Persistence of the problem can lead to lengthy treatment in physiotherapy and frequent general practitioner appointments (Wells, 1982).

Shoulder pain can arise from a cervical spine disorder, and therefore the neck must be ruled out as a potential cause of pain (Manifold and McCann, 1999). Radiculopathy arising from the cervical spine is difficult to differentiate from localized shoulder pathology because the sensory distribution extends from the base of the neck to the outer edge of the shoulder (Wilson, 2005). Sobel et al. (1997) found that restricted mobility in the cervicothoracic spine in patients with shoulder pain did not seem to recover significantly after 26 weeks. These investigators suggested that if intervention at the cervicothoracic spine was included in

* Corresponding author. Tel.: +1 416 978 8855; fax: +1 416 978 3844.
E-mail address: anne.agur@utoronto.ca (A. Agur).

management of patients with shoulder pain, the tendency for shoulder disorders to recur could be decreased.

Cervical spine mobilization techniques can be used during therapy to affect more peripheral symptoms (Vicenzino et al., 1996; Sterling et al., 2001). Previous studies have shown that chronic elbow pain and temporomandibular joint (TMJ) pain can be reduced by a mobilization intervention to the asymptomatic neck (Vicenzino et al., 1996; Stiesch-Scholz et al., 2003). However, utilizing this technique for the treatment of shoulder symptoms has rarely been studied (Bergman et al., 2004). Bergman et al. (2004) examined the effectiveness of manual therapy directed toward the cervicothoracic spine and adjacent ribs for patients with shoulder pain. Participants were randomized into groups receiving manual therapy in addition to usual medical care (advice, analgesics, non-steroidal anti-inflammatory drugs), or usual medical care alone. Pain radiating to the neck region was not criterion for exclusion, and the manipulative therapy included specific mobilizations or manipulations at the discretion of the therapist. The primary outcome measure was patient-perceived recovery, which was recorded on a seven point scale. Other outcomes included the severity of shoulder pain and functional disability. The results showed that at 12, 26 and 52 weeks follow-up, the manual therapy group demonstrated significant improvement for all outcome measures.

A link between the asymptomatic cervical spine and the painful shoulder has not been clearly established in the literature. The objective of this study was to determine whether the utilization of cervical lateral glide mobilizations of the asymptomatic cervical spine at C5, C6, and C7 could immediately reduce the intensity and/or range of the painful arc in subjects with generalized shoulder pain who were previously unresponsive to traditional shoulder treatment.

2. Methods

Approval for this study was granted by the University of Toronto Research Ethics Board (Protocol reference #14011).

2.1. Subjects

Subjects were recruited from a private orthopaedic physical therapy practice in Toronto, Canada, from August 2005 through May 2006. Each subject was currently being treated for generalized unilateral shoulder pain. Both male and female subjects were included in this study if they were age 18 or older, had an insidious onset of unilateral shoulder pain of at least six weeks duration, demonstrated a painful arc with shoulder abduction, and had no current or previous complaints of neck pain within the past year. Patients with shoulder pain were excluded if they had symptoms of paresthesia or neurological deficits, previous surgery or dislocation of the affected shoulder, clinically definitive arthritis of the shoulder on X-ray or had a cortisone injection for the current episode of shoulder pain. Prior to entering the study, subjects must have been unresponsive to 2–4 recent physiotherapy sessions addressing shoulder pain through “traditional” methods of movement patterns, strengthening and modalities such as ultrasound and cryotherapy. The short duration of shoulder treatment to patients prior to admittance into this study was purposeful, as a change in treatment direction would likely be warranted if the patient’s shoulder signs and symptoms had not changed following 2–3 weeks of treatment and home exercises. A sample size calculation of 21 subjects was determined using data from the first 12 subjects to detect a statistically significant difference in shoulder pain with 80% power.

2.2. Study design

This was a randomized placebo-controlled cross-over trial. It was an exploratory pilot study to determine if a subsequent RCT would be appropriate. Subjects were randomized by a coin toss to receive either the cervical lateral glide mobilization or the placebo intervention during the first session. The subject returned for the second session within four days and underwent the same measurement protocol, but the second examiner performed the intervention that was not received during the first session. All outcome measures were assessed both before and after the intervention and conducted by the first investigator, who was blinded to which treatment intervention was received. The second examiner performed the predetermined cervical lateral glide mobilization or placebo treatment condition. Informed consent was obtained as per protocol, and all participants were required to attend two sessions of approximately 40 min duration (Fig. 1).

2.3. Intervention

2.3.1. Technique of lateral cervical glide mobilization

A lateral cervical glide mobilization was the technique chosen for this study, with the subject seated and the thoracic spine resting against the back of the chair, head in a neutral position, feet resting flat on the floor, and arms relaxed with hands in their lap. The lateral aspect of the spinous processes of C5, C6, and C7 was landmarked on the ipsilateral side of the subject’s painful shoulder. The examiner’s thumb remained on the lateral aspect of the spinous process of C5, with the opposite hand placed on the subject’s non-affected shoulder or head for counterbalance as a lateral movement toward the non-painful side was applied with the mobilizing hand (Mulligan, 1995) (Fig. 3). Mobilizations were conducted for 2 min each at C5, C6 and C7, with small amplitude end range movements (Grade IV+). The placebo treatment condition involved the examiner resting her hands in the same positions as the mobilization technique, but without the application of external force.

2.3.2. Outcomes measured

A 10 cm visual analog scale (VAS) for pain measurement was completed by the subject following the shoulder abduction trials. The VAS has been shown to be a valid, reliable and responsive measure of a subject’s perceived level of pain (Price et al., 1994; Guerra de Hoyos et al., 2004).

Active cervical spine range of motion in all planes (flexion, extension, bilateral side-bending) was measured using a cervical range of motion goniometer (CROM), which has been shown to be a valid and reliable tool for the measurement of cervical range of motion in the sagittal and frontal planes (Ordway et al., 1997; Tousignant et al., 2000). A Myrin goniometer was used to measure bilateral cervical rotation, and has been shown to be a reliable tool for measurement in the transverse plane (Balogun et al., 1989; Malstrom et al., 2003).

Manual muscle testing of shoulder abduction at 90° was tested on the unaffected side followed by the affected side using an electrogoniometer. The resistance was applied by the examiner proximal to the subject’s elbow joint. Active shoulder range of motion into abduction was performed to determine the presence and extent of a painful arc. Reflective adhesive stickers were placed in five locations on the subject: sternal notch, anterior tip of the right and left shoulder at the acromion process, affected side elbow crease and proximal wrist crease. These points were used as landmarks from which the angle of the painful arc within the shoulder abduction range of motion could be accurately measured. Shoulder abduction was videotaped with the subject facing the video camera so that the reflective markers were clearly seen. The

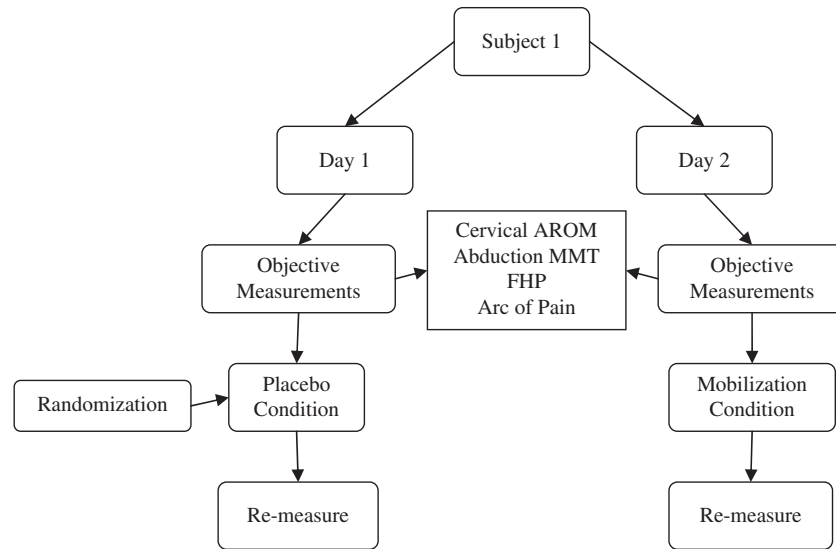


Fig. 1. Summary of methodology.

starting position for this test was with the palm of the affected arm facing outward (external rotation of the shoulder) and the arm by their side. While performing active shoulder abduction, the subject kept the thumb on the uninvolved side down until the start of their shoulder pain, then kept the thumb raised until the end of the painful arc (Fig. 2A and B). The digital video camera (Samsung SC-D353, China) was mounted on a standard adjustable tripod at a standard position 220 cm from the subject. The beginning and end of the arc of pain with shoulder abduction was later quantified using software (Virtual Dub freeware) to identify the precise frames in which the subject began to raise and lower their thumb on the uninvolved side to indicate the start and end of their shoulder pain,

respectively. The abduction angle was determined on those chosen frames by using the measuring tool in Adobe Photoshop™ CS2.

Cervical AROM was performed first, followed by shoulder abduction manual muscle testing. The subject was then positioned in front of the camera with adhesive markers as outlined previously to perform shoulder abduction. Three trials of shoulder abduction were recorded, with the subject indicating the start and end of the arc of pain each time. The measurements from the painful arc from each of the trials were averaged together to represent the true arc of pain. Subjects indicated the intensity of their pain during shoulder abduction on the VAS.

Following these measures, the predetermined intervention (i.e. mobilization or placebo) was then performed by the second examiner as outlined previously. Subsequent to this intervention, the first examiner returned for re-measurement of all pre-intervention outcome measures. A second VAS was then completed by each subject to indicate the intensity of post-intervention shoulder pain. After the completion of the second session, each subject was

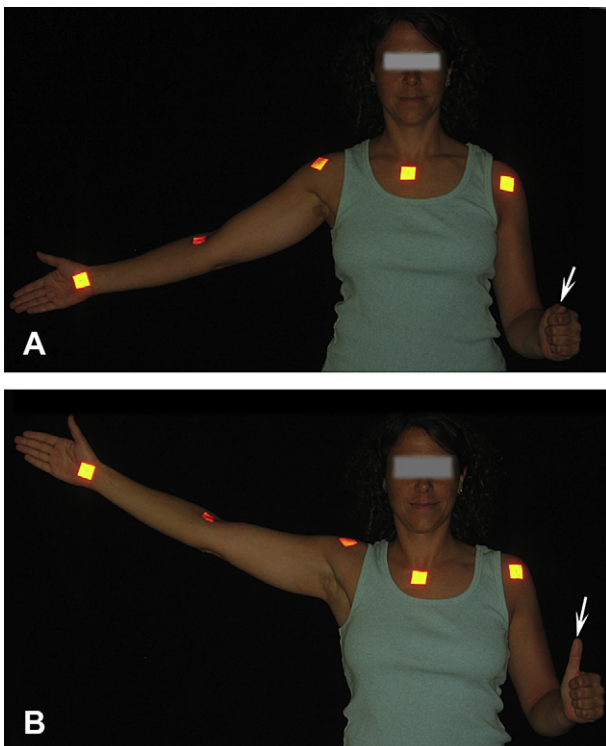


Fig. 2. Measurement of painful arc during shoulder abduction.



Fig. 3. Positioning for cervical lateral glide mobilization.

asked by the examiner to describe the perceived difference between the two treatment techniques. Answers were recorded on subject data sheets.

2.4. Data analysis

The Statistical Package for the Social Sciences (SPSS) version 14.0 was used for data analysis. Paired *t*-tests were used to evaluate pre-post mobilization as well as pre-post placebo for the following outcomes: cervical spine range of motion, shoulder abduction manual muscle testing, shoulder pain intensity and shoulder range of motion. A paired *t*-test was used to determine if there was a significant difference ($p < .05$) between the mean averages of the placebo and cervical mobilization conditions. A Pearson correlation test was used to determine if a relationship existed between shoulder abduction arc of pain and shoulder pain intensity.

3. Results

3.1. Subjects

Twenty-one subjects (14 females, seven males) with an average age of 49.8 (± 9.8) years volunteered and consented to participate in the study. Forty-three percent of subjects reported a unilateral shoulder problem, and 57% reported a previous resolved neck problem more than one year prior to commencing participation in the study. Seven subjects were randomized to the mobilization condition during the first session, while 14 subjects received the placebo condition (Fig. 1). Each subject recognized that the mobilization and placebo interventions were different from each other, however, no subject realized that the placebo intervention was not therapeutic.

3.2. Pain measures

There was a significant difference ($p < 0.001$) in the intensity of shoulder pain as measured by VAS before and after the mobilization treatment condition (Table 1). A 1.3 ± 1.1 cm decrease in the mean VAS score post-mobilization was recorded when compared with the pre-mobilization pain score. Eighteen subjects (86%) showed an average decrease of 1.5 cm of shoulder pain post-mobilization condition. Following the placebo condition, the 0.2 ± 0.6 cm decrease in the mean VAS score was not statistically significant ($p = 0.078$) (Table 1). Using a paired *t*-test, the mobilization and placebo conditions were found to be significantly different ($p = 0.0002$), with a treatment effect of -1.038 .

The radius of the arc of pain with shoulder abduction diminished significantly after both the mobilization ($12.5^\circ \pm 15.6^\circ$, $p = 0.002$) and the placebo ($8.8^\circ \pm 12.7^\circ$, $p = 0.005$) conditions (Table 1). In comparing pre- and post-mobilization shoulder arc of pain to pre- and post-mobilization VAS scores, 14 subjects (66.7%)

showed a decrease in the arc of pain with shoulder abduction of $21.2^\circ \pm 12.49^\circ$ with a concurrent decrease in VAS score averaging 1.4 ± 0.9 cm. The post-mobilization painful arc with shoulder abduction and post-mobilization decrease of shoulder pain intensity showed a moderate correlation ($r = 0.595$).

3.3. Physical measures

There was no significant difference in pre-post placebo cervical flexion ($-1.4^\circ \pm 5.3^\circ$, $p = 0.242$), extension ($-0.5^\circ \pm 5.5^\circ$, $p = 0.693$), right side-bending ($-0.1^\circ \pm 5.3^\circ$, $p = 0.595$), left side-bending ($0.3^\circ \pm 4.4^\circ$, $p = 0.769$), right rotation ($-0.4^\circ \pm 5.9^\circ$, $p = 0.769$), or left rotation ($-0.3^\circ \pm 4.9^\circ$, $p = 0.793$). There was no significant difference in the pre-post mobilization cervical flexion ($-1.2^\circ \pm 6.5^\circ$, $p = 0.410$), extension ($0.8^\circ \pm 5.5^\circ$, $p = 0.534$), right side-bending ($-0.7^\circ \pm 5.2^\circ$, $p = 0.533$), left side-bending ($-0.4^\circ \pm 4.1^\circ$, $p = 0.636$), right rotation ($1.1^\circ \pm 4.4^\circ$, $p = 0.251$), or left rotation ($1.3^\circ \pm 6.5^\circ$, $p = 0.359$). Shoulder abduction strength was not significantly different following the placebo condition (-0.4 ± 0.9 kgf, $p = 0.057$), nor following the mobilization condition (-0.01 ± 1.1 kgf, $p = 0.984$).

4. Discussion

This is the first study to show that cervical lateral glide mobilizations can immediately decrease the intensity of shoulder pain beyond a placebo effect, with movement into shoulder abduction in the likely absence of shoulder pathology. Eight subjects (38.1%) showed a decrease in the intensity of shoulder pain of more than 1.3 cm following the mobilization condition, compared to one subject (4.8%) following the placebo intervention. The 1.3 cm difference on VAS score following the cervical lateral glide mobilization is statistically significant, and also indicates a clinically relevant change, as the minimal clinically important difference has been shown to be 1.3 cm (Bird and Dickson, 2001; Gallagher et al., 2001).

No studies have been found to date which examine the effect of cervical lateral glide mobilizations on shoulder pain, but there are similar studies involving the elbow. A study by Stiesch-Scholz et al. (2003) demonstrated an immediate positive effect on TMJ pain following cervical mobilizations. However, they did not examine the cervical spine for concurrent symptoms. Vicenzino et al. (1996) examined 15 subjects with chronic elbow pain that were previously unresponsive to conventional elbow treatment, none of whom reported neck pain. A significant decrease in elbow pain and increase in grip strength was noted immediately following the application of cervical lateral glide mobilizations at the C5/6 level with the subject supine. The cervical lateral glide mobilization technique in the study by Vicenzino et al. (1996) was performed in a supine position, while the mobilizations in the current study were performed in a weight-bearing position. This choice of subject positioning in the current study was supported by Mulligan (1995), who found that any gains achieved by mobilizations in supine may be diminished or lost upon returning to an upright position.

It is likely that in a clinical setting, patients would present with various types of shoulder area pain, so the inclusion criteria in the current study were broad to allow for generalizability of results. The subjects included were non-symptomatic in their cervical spine with no limitation in cervical range of motion during the study, but a treatment effect with shoulder pain beyond placebo was demonstrated following a cervical lateral glide mobilization at C5, C6 and C7. In assessing joints such as the shoulder, the common practice is to examine the joints above and below the localized pain during an assessment to rule out involvement from those areas (Magee, 1987; Richardson and Iglarsh, 1994). It may not be appropriate to only use tissue-based reasoning, since that alone does not

Table 1
Pre-post condition (placebo and mobilization) scores

	Pre-condition mean \pm SD	Post-condition mean \pm SD	Mean difference \pm SD	<i>P</i> * [two- tailed]
VAS – placebo (cm)	3.5 \pm 2.3	3.2 \pm 2.5	0.2 \pm 0.6	0.078
VAS – mobilization (cm)	3.7 \pm 2.0	2.4 \pm 2.1	1.3 \pm 1.1	<0.001
Arc of pain – placebo ($^\circ$)	31.4 \pm 22.3	22.6 \pm 18.0	8.8 \pm 12.7	0.005
Arc of pain – mobilization ($^\circ$)	33.0 \pm 21.6	20.5 \pm 17.6	12.5 \pm 15.6	0.002

Abbreviation: SD, standard deviation; * *P*-value of two-tailed *t*-test
Paired samples significance.

always accurately indicate the true source of the problem and justify the course of management (Aina and May, 2005). The results of the current study indicated that a statistically and clinically significant decrease in the intensity of shoulder pain was observed post-mobilization condition, which lends credence to the argument that the cervical spine might still be involved in shoulder pain in the absence of any objective cervical limitations or symptom reproduction. If the asymptomatic cervical spine was examined thoroughly through manual therapy techniques during the assessment of a painful shoulder, the patient might be able to determine any immediate change in the intensity of shoulder pain or improvement in active shoulder range of motion. The patient should take note of any existing pain while initially performing shoulder abduction, and notice the intensity of shoulder pain during abduction again after a mobilization technique has been performed. This would allow for any immediate changes in shoulder pain to be observed. If any increases or decreases of pain intensity or shoulder range of motion is noted, the clinician can be more confident that a cervical component to that patient's pain likely exists. Treatment could be planned accordingly to involve the cervical spine.

There was no change in cervical range of motion before and after either the placebo condition or the mobilization condition. Since cervical movement was not limited at the onset, no significant increase or decrease was expected. If the cervical spine did exhibit any initial limitations in range of motion, it would likely have been addressed immediately as part of therapy for the subject's shoulder pain. Similarly, no change in shoulder strength was noted following the placebo or mobilization interventions. This might suggest that neither the shoulder abductor muscles nor the C5 myotome was affected. The significant decrease in perceived intensity of shoulder pain immediately following the cervical lateral glide mobilization may be indicative of cervical spine involvement without concurrent clinically significant shoulder abduction weakness. The outcome measures of cervical range of motion and shoulder abduction strength were included in this study to demonstrate that those objective measurements may not show limitations during a clinical shoulder assessment, but mobilizations to the asymptomatic cervical spine can still alter shoulder symptoms.

A significant decrease in the radius of the arc of pain with shoulder abduction was noted both post-placebo and post-mobilization condition. It could be inferred into clinical practice that there may be a decrease in the intensity of shoulder pain with a concurrent decrease in the radius of the painful arc with shoulder abduction. In those patients who present with an arc of pain with shoulder abduction, cervical mobilization techniques to the asymptomatic cervical spine may serve to decrease both the intensity of shoulder pain and the radius of the abduction arc of pain. There have been no other studies found which have examined the change in a painful arc in shoulder abduction following a cervical intervention, but there is existing research examining improvement in shoulder external rotation range of motion following cervical mobilizations. Schneider (1989) reported significantly increased shoulder external rotation range of motion following cervical mobilizations in patients with suspected capsular contractures of the glenohumeral joint. It was proposed by Schneider (1989) that the restriction in shoulder movement was likely not capsular but perhaps due to cervical somatic structures referring pain to the shoulder region and initiating spasm in shoulder musculature. It was also suggested that the improvement in shoulder movements following cervical mobilization may have had a neurological basis by positively affecting a nerve root impingement.

A placebo intervention was included in this study to strengthen the internal validity (Tundle, 2006) and provide a control group. Placebo has been defined as an intervention used in a clinical trial

that is administered with the intention of mimicking some other intervention so that a comparison can be made (Vickers and de Craen, 2000). Placebos are common in drug studies, and have been used previously for physical interventions such as ultrasound, spinal manipulation and surgery (Vickers and de Craen, 2000). The placebo response is complex, and is thought to be influenced by patient expectation and the enthusiasm and belief of the therapist (Vicenzino et al., 1996). In this study, all subjects were asked to differentiate between the two interventions after both treatment sessions had been completed. Interestingly, each subject recognized that the mobilization intervention and the placebo condition were different from each other, but no subject realized that the placebo condition was not therapeutic. Subjects described the mobilization condition as more aggressive or less comfortable than the placebo condition.

This exploratory pilot study has demonstrated that a cervical lateral glide mobilization can provide a clinically significant improvement in shoulder beyond that of placebo. This suggests that despite the lack of objective findings at the cervical spine upon assessment, it can be a source of shoulder pain. Clinicians choose appropriate treatment techniques to improve pain or movement in an affected area, so a clinician should not rule out the cervical spine as a source of non-specific shoulder pain, especially when the patient has been non-responsive to shoulder treatment.

The limitations to this study include the small sample size and the use of a standardized treatment intervention. The number of subjects recruited may not be representative of the population that might present with generalized shoulder pain. As well, in order to maintain consistency among subjects, one type of cervical mobilization was utilized. Clinically, several different mobilizations would likely be attempted to determine which was most effective to decrease pain or increase range of motion in the affected area. Perhaps if the mobilization techniques were more individualized for each subject, a larger change in shoulder pain might have been seen following the mobilization condition.

5. Conclusion

This study has shown that cervical lateral glide mobilizations can decrease the intensity of shoulder pain with movement into shoulder abduction, and this treatment effect is beyond placebo. It should be emphasized that the design of this study was an exploratory pilot, and not to provide ongoing treatment to address each subject's generalized shoulder pain. The intent was to apply a specific cervical lateral glide mobilization to determine if that subject's shoulder pain or shoulder abduction range of motion could be immediately altered. No previous studies have been found that examine the effect of cervical lateral glide mobilizations on shoulder pain, but there are similar studies involving the elbow. These findings bolster the argument that addressing the cervical spine in patients with more peripheral symptoms, even in the absence of cervical signs and symptoms, may expedite the rate of recovery. If during an assessment for shoulder pain any initial change in shoulder pain is noticed through cervical manual therapy techniques, continued therapy involving the cervical spine might provide more efficient management of shoulder pain and functional limitations, increasing patient satisfaction and decreasing treatment costs.

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