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Original article

The addition of cervical unilateral posterior–anterior mobilisation in the treatment of patients with shoulder impingement syndrome: A randomised clinical trial

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ABSTRACT

Shoulder impingement syndrome (SIS) is a complex, multi-factorial problem that is treated with a variety of different conservative options. One conservative option that has shown effectiveness is manual therapy to the thoracic spine. Another option, manual therapy to the cervical spine, has been studied only once with good results, evaluating short-term outcomes, in a small sample size. The purpose of this study was to investigate the benefit of neck manual therapy for patients with SIS. The study was a randomised, single blinded, clinical trial where both groups received pragmatic, evidence-based treatment to the shoulder and one group received neck manual therapy. Subjects with neck pain were excluded from the study. Comparative pain, disability, rate of recovery and patient acceptable symptom state (PASS) measures were analyzed on the 68 subjects seen over an average of 56.1 days (standard deviation (SD) = 55.4). Eighty-six percent of the sample reported an acceptable change on the PASS at discharge. There were no between-groups differences in those who did or did not receive neck manual therapy; however, both groups demonstrated significant within-groups improvements. On average both groups improved 59.7% (SD = 25.1) for pain and 53.5% (SD = 40.2) for the Quick Disabilities of the Shoulder and Hand Questionnaire (QuickDASH) from baseline. This study found no value when neck manual therapy was added to the treatment of SIS. Reasons may include the lack of therapeutic dosage provided for the manual therapy approach or the lack of benefit to treating the neck in subjects with SIS who do not have concomitant neck problems.

1. Introduction

Shoulder impingement syndrome (SIS) is the most common cause of shoulder pain and disability (Chipchase et al., 2000; Kuijpers et al., 2006; Harrison and Flatow, 2011). The problem is most prevalent in middle-aged adults but is also common in younger athletes (Garofalo et al., 2010). Initially, SIS was described as extrinsic compression of the subacromial bursa or tendon (Neer, 1983). Recently other causes have been implicated, including compression, entrapment, or mechanical irritation of the long head of the biceps tendon or between the undersurface of the rotator cuff and the glenoid or glenoid labrum (Ludewig and Reynolds, 2009). The condition is complex and potentially caused by multiple factors (Rossi, 1998; Imhoff et al., 2000; Ticker et al., 2000). Most individuals with SIS exhibit muscle imbalances, unidirectional capsular restrictions, and inflammation of selected space occupying structures, often reporting pain during overhead activities or during resisted movements of the shoulder (Garofalo et al., 2010).

Diagnosis of SIS requires a detailed exploration of the clinical history and a comprehensive physical examination (Kappe et al., 2013). Patients with SIS often report anterior shoulder pain that is worse at night without a definitive history of trauma. Symptoms are often long-lasting, typically presenting for three months or greater. The Hawkins-Kennedy and the Neer's test are commonly positive and more useful as a negative finding (Hegedus et al., 2008, 2012). Outside instances of calcification of the tendon, imaging is

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not particularly useful in the diagnosis of acute SIS (Garofalo et al., 2010) except in early stages when diagnostic ultrasound may provide value (Read and Perko, 1998). Magnetic resonance imaging is useful in identifying the rotator lesions that often accompany SIS but not necessarily the dynamic impinging activities.

Although no definitive treatment protocol has been exclusively accepted (Dorrestijn et al., 2009), conservative treatment techniques applied to the affected shoulder consisting of manual therapy mobilisation (Ho et al., 2009), strengthening (Kromer et al., 2009; Ellenbecker and Cools, 2010), and a home exercise program designed to address the strength imbalances (Ellenbecker and Cools, 2010) have exhibited benefits in comparative trials. Kuhn (2009) recommended a progressive, conservative approach using mobilisation, strengthening and a home exercise program dividing care into three phases. The three phases included 1) a pain control phase, 2) an early strengthening phase, and 3) an advanced strengthening phase. Progression from one phase to the next was recommended only once pain is controlled (Kuhn, 2009).

Others (Strunce et al., 2009; Walser et al., 2009; Mintken et al., 2010) have recently suggested that targeted adjunctive regions outside the shoulder may be beneficial in the treatment of SIS and general shoulder pain. In a systematic review, Walser et al. (2009) reported that two of the three randomised controlled trials that examined the influence of thoracic manipulation on SIS, demonstrated statistically and clinically significant improvements. Authors of two case series of patients with shoulder dysfunction (Strunce et al., 2009; Muth et al., 2012) credited thoracic manual therapy as one of many interventions that was associated with recovery of the individuals within the series.

A number of studies have also suggested a relationship of neck dysfunction (e.g., whiplash) and SIS (Chauhan et al., 2003; Abbassian and Giddins, 2008; Feleus et al., 2008). To our knowledge, only one study (McClatchie et al., 2009) has examined the treatment of neck-only mobilisations for patients with SIS and *no* concomitant neck conditions. McClatchie et al. (2009) reported immediate improvements in shoulder range of motion in subjects with shoulder disorders after mobilisation to the neck. In the crossover study with 21 participants, outcomes were assessed after only one treatment session. What remains unclear is whether benefits occur *beyond* immediate effects when neck mobilisation is used in subjects with SIS. The objective of this study is to investigate whether treatment directed at the neck and shoulder is more beneficial than treatment directed solely at the shoulder for patients with SIS.

2. Method

2.1. Design

The study was a randomised, single blinded, controlled trial. The trial was registered with clinicaltrials.gov in 2012 under the protocol number 12812 and was approved by the Walsh University Human Subjects Review (HSR) Board.

2.2. Participants, therapists and centers

Physiotherapy patients, age 18 and older, with SIS, who attended care at a physiotherapy outpatient or academic physiotherapy setting, were screened for eligibility by treating physiotherapists. We targeted individuals with external or internal impingement signs and did not attempt to differentiate between the two forms. For patients to meet inclusion requirements, each required: 1) report of pain or dysfunction with overhead activities; 2) demonstration of pain during active shoulder movements; 3) demonstration of a positive Neer/Hawkins-Kennedy test; 4) recent onset within the last 12 months; 5) report of non-traumatic onset; 6) demonstration of a painful arc of the arm from 60° to 120° of flexion, and 7) report of a baseline pain level of $\geq$2/10 on an 11 point numeric scale. Exclusion criteria included the presence of any red flags, a history of frozen shoulder, disorders of the acromioclavicular joint, degenerative arthritis of the glenohumeral joint, known calcifying tendonitis (if identified by radiograph), shoulder instability, posttraumatic disorders, or shoulder surgery and/or elbow, hand, wrist and blatantly misdiagnosed cervical spine disorders.

Patients were treated in one of 9 outpatient clinical/academic centers in the USA ($N = 8$) or South Africa ($N = 1$) by one of 10 physiotherapists (6 males, 4 females). The mean age of the physiotherapists was 44.1 (standard deviation (SD) = 4.4) years, with 20.3 (SD = 5.9) years of experience. Four (4) of the clinicians had a doctorate degree (3 = DPT, 1 = PhD) and nine of the 10 had earned post-graduate manual therapy certifications/diplomas. All the physiotherapists participated in a 1-h webinar to standardise the treatment approach suggested by Kuhn (2009).

2.3. Procedures

After examination, completion of patient HSR consent, and completion of outcomes measures, patients were randomised by roll of die into the shoulder treatment plus neck mobilisations or the shoulder treatment only groups. Treatment was prescribed in a pragmatic fashion and both arms of the randomised trial received evidence-based treatment for SIS as suggested by Kuhn (2009). Kuhn's (2009) approach advocates the use of a modified treatment that is unique to each individual patient and is based on their hypothesised underlying dysfunctions/causes. As stated, the approach consists of three stepwise phases in which progression occurred when pain markedly subsided from the previous visit (a reduction of 2 points on an 11 point pain scale). The clinical and home treatment programs were modified for all subjects in each phase regardless of presentation, and the dosage of the interventions was specific to the examination findings. The treatment methods included manual therapy, self- and externally-applied stretching, isotonic strengthening, and restoration of normative movement.

The manual therapy interventions to the neck consisted of grade III posterior–anterior mobilisations, performed in prone for 30 repetitions for 3 sets. Since any comparable shoulder symptoms during mobilisation to the cervical spine was an exclusion criterion, and since none of the subjects exhibited active neck symptoms, the posterior–anterior mobilisation was performed to the stiffest or the patient's most painful segment, or as Maitland described, a joint sign (Maitland, 2001). When no joint signs were present, the posterior–anterior was performed to either C5–C6, or C6–C7 at the same side of the neck as the shoulder impingement. In occasions where both pain and stiffness were present at multiple levels the clinician was able to identify the targeted level for mobilisation. This process was followed for each visit until the patient was discharged from care. Patient discharge, treatment length, and frequency of treatment were determined by the physiotherapists, although some patients terminated treatment themselves. Outcome measures were collected and sealed in the patient's file until discharge from physical therapy. Participants were eligible for analysis if they received at least one additional (beyond baseline) follow-up visit with outcomes measures capture.

2.4. Outcomes

Physiotherapists were blinded to the collected self-report outcomes in the study. The primary outcome measure of the study was

the Quick Disabilities of the Shoulder and Hand Questionnaire (QuickDASH) (Beaton et al., 2005). The QuickDASH uses 11 questions associated with various activities of daily living, which are rated from 1 to 5, with a range within the values of no difficulty to inability. The tool has demonstrated good test-retest reliability and has a minimal clinically important difference (MCID) score of 8 points in subjects with shoulder pain (Mintken et al., 2009).

The numeric pain rating scale for pain (NPRS) was a secondary outcome measure. We used a 1-point NPRS placed upon a 10-cm line, with 0 representing no pain, 5 indicating moderate pain, and 10 representing worst possible pain. Michener et al. (2011) reported that the MCID for the NPRS was 2.17 for both surgical and non-surgical subjects with shoulder pain. Both the primary and secondary measures were captured at baseline, 2 days, and at discharge.

Additional measures included the *Patient Acceptable Symptom State* (PASS) (Kvamme et al., 2010), total visits, and total days in care. The PASS is the condition beyond which patients consider their state as acceptable suggesting they are unlikely to seek further treatment (Kvamme et al., 2010). The definition of the PASS is anchored to the personal experience of the patient including satisfaction and adaptation to symptoms and was captured at discharge only. The, variable, 'total visits' was calculated by summating all visits during the care of the patient, whereas 'Total days in care' was calculated by calculating the total days between the baseline visit and discharge.

Demographics, self-report of rate of recovery (RoR), and physiotherapists' qualitative determination of compliance to the home exercise program was also captured. Demographic variables were captured at baseline and included: age, gender, duration of symptoms, irritability, race/ethnicity, height and weight, shoulder limitations during movement, and eventually within and between session treatment effects. Self-report of RoR was scored as (0–100%) and was captured at discharge. Scoring ranged from 0% (meaning not at all) to 100% (meaning totally recovered) and was a variant of the single alphanumeric evaluation, which has been used with patients with shoulder pain (Williams et al., 2007). Home exercise compliance captured at discharge was scored with a Likert scale of 1 = *Highly Compliant*, 2 = *Compliant*, 3 = *Not Compliant* and 4 = *Extremely Not Compliant*.

2.5. Sample size determination

Using a fixed-effects, repeated measures multivariate analysis of variance (MANOVA), for within- and between-measures interaction, while using the primary outcome measure (QuickDASH), and estimating an expected effect size of 0.2 in favor of the shoulder and neck pain group, at 80% power, a standard error of 0.05, and a drop-out rate of 20%, we estimated the need for a minimum sample size of 58 for statistical significance, but targeted enrollment of 70 to account for potential drop outs.

2.6. Data analysis

All analyses were performed using SPSS version 20.1 (IBM, Chicago, IL). Descriptive statistics describing both groups were calculated and baseline comparative statistics were analyzed. Further, we analyzed between-group differences in discharge NPRS and QuickDASH scores, percent change of NPRS and QuickDASH (calculated as baseline minus discharge values, divided by baseline valuesx100), and raw change of NPRS and QuickDASH scores using *t*-tests. The difference in PASS levels among groups at discharge was calculated using a Chi-square (χ^2).

A repeated measures multivariate analysis of variance (RM-MANOVA), for within- and between-measures interaction was used to analyze differences in the primary measure (QuickDASH) and secondary measure (NPRS) at follow-up periods. The clinical outcomes NPRS and QuickDASH were examined in the analysis of three time points. Although RM-MANOVA is robust to moderate deviations from normality (Tabachnick and Fidell, 2012), the normality of the distributions of each dependent variable, at each time point, for both groups was plotted with histograms, normal distribution curves, and Q–Q plots to assure a visual fit. Furthermore, Shapiro–Wilk analyses were used to analyze each of the cells for skewness/kurtosis. Linearity was examined using bivariate scatter plots of observed residual values against the expected values.

Mild deviations from normality were noted for the NPRS and QuickDASH data as examined by Shapiro-Wilk tests with four of twelve comparisons being significant ($P < 0.05$); however, Q–Q plots for the variables in question visually represented data that were normally distributed. The non-normality was found in discharge measurements of NPRS and QuickDASH with positive skewness created by multiple measures of lower than average values for subjects who experienced marked clinical improvement. Comparing NPRS variable patterns with the other NPRS time points showed linearity with elliptical patterns. The scatter plot shapes would suggest that the relationships do not demonstrate high linearity. The deviations noted are consistent with outcomes demonstrating clinical effectiveness of interventions; therefore, no variable transformation was performed prior to analysis. An $\alpha = 0.05$ was considered significant for all analyses.

3. Results

Initially, 78 subjects were screened for inclusion into the study (Fig. 1). Three were deemed ineligible and one declined to participate. Seventy-four (74) subjects were enrolled and of these, six did not return for a required follow-up visit. The mean age of the 68 subjects who completed the trial was 52.6 years (SD = 14.1) and subjects reported an average duration of 11.7 weeks (SD = 14.7) since the most recent initiation of symptoms. The mean NPRS and QuickDASH was 5.9 (SD = 2.1) and 35.5 (SD = 16.9) respectively. There were no statistically significant baseline differences between the two groups in any variable (Table 1). There were no adverse events to any of the manual therapy procedures or treatment provided to any of the patients.

Both groups markedly improved from baseline averaging 3.7 (SD = 2.2) points change in NPRS, 21.9 (SD = 17.1) points change in the QuickDASH, 59.7% (SD = 25.1) change from baseline on pain and 53.5 (SD = 40.2) change in QuickDASH from baseline. There were no between-group differences ($P > 0.05$) for total visits, total days in care, pain, or disability scores at discharge, when evaluating raw discharge scores, raw change scores, and percent change of pain and disability scores (Table 2). There were no differences ($P > 0.05$) in PASS scores between those with and without neck treatment.

Box's test for homogeneity of variance–covariance was not significant with $P = 0.104$; therefore, Wilks' Λ was used to interpret the full analysis. There were no between-group differences for the composite dependent variable, Wilks' $\Lambda = 0.966$, $F(2,65) = 1.14$, $P = 0.327$, partial $\eta^2 = 0.034$. There was no time*group interaction, Wilks' $\Lambda = 0.939$, $F(4,63) = 1.03$, $P = 0.400$, partial $\eta^2 = 0.061$. There was a within-group difference for the composite dependent variable, Wilks' $\Lambda = 0.247$, $F(4,63) = 48.11$, $P < 0.001$, partial $\eta^2 = 0.753$.

Continued analysis revealed that each dependent variable was significant for time with NPRS [$F(2,132) = 110.28$, $P < 0.001$, partial $\eta^2 = 0.626$ and disability [$F(2,132) = 80.04$, $P < 0.001$, partial $\eta^2 = 0.548$. Pairwise comparisons would suggest that for NPRS and QuickDASH, each time point was significantly different from the other time points with $P < 0.001$ (Fig. 2).

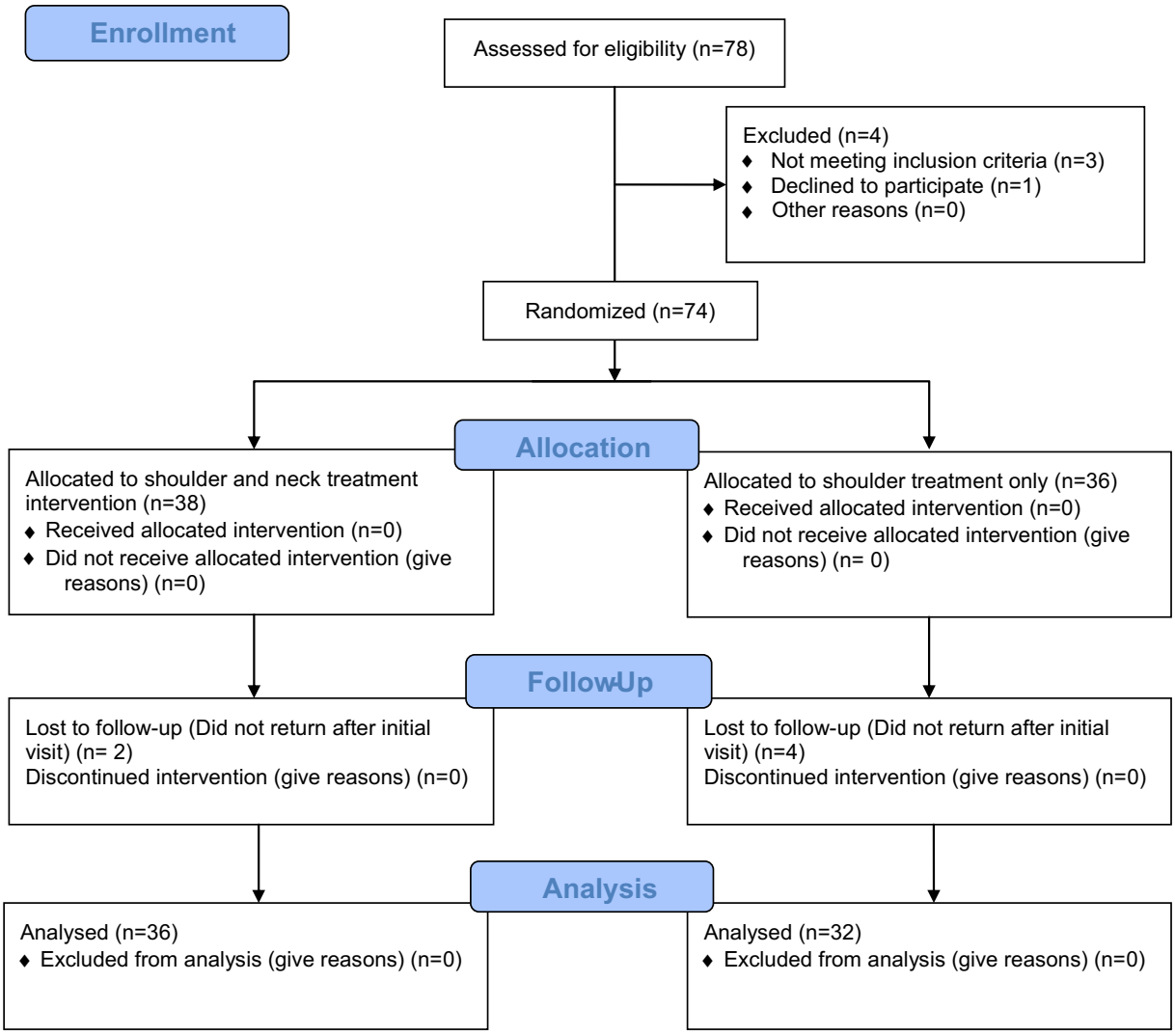

Fig. 1. Consolidated Standards of Reporting Trials (CONSORT) flow chart of study enrollment.

4. Discussion

The objective of this study was to examine the benefit of cervical spine manual therapy treatment in addition to shoulder treatment for patients diagnosed with SIS. Our results suggest that there is no benefit in the addition of cervical spine joint mobilisation for treatment in patients with SIS when evaluating the outcomes of pain, disability, and PASS. This finding is in contrast to that of McClatchie et al. (2009) who reported immediate improvements in shoulder range of motion and in report of pain after a single treatment to the neck. We feel there are several potential reasons why our findings are in contrast to those previously reported.

Our pragmatic trial was designed to allow clinicians to progress patients through a stepwise program for SIS based on symptomatic improvement of each individual patient. The approach was selected because SIS has numerous suggested underlying causes (Neer, 1983; Ludewig and Reynolds, 2009). The approach allowed clinicians to focus on the primary impairments of each patient within the boundaries of evidence-based parameters. Whereas the shoulder treatment was pragmatic, the treatment to the neck was standardised. Neck mobilisations were performed on the stiffest or most painful segment, on the side of the impaired shoulder, using 3 bouts of 30 s Grade III mobilisations (Maitland, 2001). There is a risk that this approach was sub-therapeutic, as other studies have reported poor outcomes when a prescriptive mobilisation approach was used for patients with impairments of the spine (Cleland et al., 2009, Dunning et al., 2012). When neck mobilisations are provided pragmatically (similar to clinical practice), the benefit appears to be as effective as a manipulative approach on subjects with mechanical neck pain (Leaver et al., 2010) and low back pain (Cook et al., 2012). Although not an outcome measure within the study, most patients volunteered that they did not feel the neck mobilisation was therapeutic or contributory toward their recovery from shoulder dysfunction.

Our results are markedly different than those reported in the randomised crossover trial of McClatchie et al. (2009). Upon close inspection the studies are also notably different in methodology. On average, outcomes in our study were captured 56.1 days (SD = 55.0) from baseline whereas McClatchie et al. (2009) looked at a within-visit change at a *single* visit; our average patient was seen 9.3 times (SD = 6.3). In addition, the outcomes measures in the two studies were different; McClatchie et al. (2009) looked at pain and range of motion whereas we looked at pain, the PASS, function, and RoR. The subjects in McClatchie et al. (2009) study were those that were previously unresponsive to 2–4 conventional physiotherapy visits and the manual therapy treatment received was a lateral glide to

Table 1
Descriptive characteristics of the study subjects grouped by all, shoulder treatment only, and shoulder treatment and neck treatment ($N = 68$).

Variable	All Subjects Mean (SD)/frequency $N = 68$	Shoulder and neck treatment Mean (SD)/frequency $N = 36$	Shoulder treatment only Mean (SD)/frequency $N = 32$	*P*-value
Age (years)	52.6 (14.1)	54.1 (12.9)	51.0 (15.5)	0.38
Gender	37 = Male 31 = Female	23 = Male 13 = Female	14 = Male 18 = Female	0.10
Race	62 = White 2 = Black 1 = Hispanic	32 = White 2 = Black 0 = Hispanic	30 = White 0 = Black 1 = Hispanic	0.23
Irritable	16 = Yes 48 = No 4 = Missing	8 = Yes 25 = No	8 = Yes 23 = No	0.89
Height (inches)	67.7 (4.6)	68.6 (4.4)	66.9 (4.6)	0.14
Weight (pounds)	181.0 (37.7)	179.4 (41.3)	182.8 (33.9)	0.72
Duration of symptoms (weeks)	11.7 (14.7)	12.9 (17.6)	10.4 (10.6)	0.52
Active limitation at baseline	63 = Yes 5 = No	33 = Yes 3 = No	30 = Yes 2 = No	0.72
Within session change	64 = Yes 1 = No	33 = Yes 3 = No	31 = Yes 1 = No	0.36
Between session change	62 = Yes 5 = No	34 = Yes 2 = No	28 = Yes 3 = No	0.52
Baseline QuickDASH	35.5 (16.9)	33.0 (16.5)	38.3 (17.3)	0.20
Baseline NPRS	5.9 (2.1)	5.7 (2.2)	6.1 (1.9)	0.50
Percent compliant with exercise	34 = Very compliant 27 = Compliant 2 = Not compliant 3 = Extremely non compliant 2 = Missing	17 = Very compliant 15 = Compliant 0 = Not compliant 3 = Extremely non compliant	17 = Very compliant 12 = Compliant 2 = Not compliant 0 = Extremely non compliant	0.16

the neck (with a comparator that was a placebo). Both groups in our study received dedicated shoulder treatment and assessment was longitudinal with between- and within-group analyses.

As stated, manual therapy to the thoracic spine has demonstrated improvement in shoulder dysfunction (Walser et al., 2009) and there may be biomechanical reasons for these findings. Individuals with a SIS have notably less thoracic mobility (and greater thoracic kyphosis) than individuals with healthy shoulders (Crawford and Jull, 1993; Greenfield et al., 1995; Kibler, 1998). End-ranges of shoulder flexion and abduction require upper thoracic rotation (Culham and Peat, 1993). Although past studies have shown a direct influence of neck contributions to the shoulder (Chauhan et al., 2003; Abbassian and Giddins, 2008; Feleus et al., 2008), in those cases the neck was clinically impaired. In the present study, our inclusion/exclusion decreased the likelihood that patients with contributory neck conditions were enrolled in the trial. Based on the findings of our study, we feel that unless the targeted neck examination generates symptoms within the shoulder, the neck is unlikely to influence the outcome of the shoulder.

In our study, 41.2% of individuals enrolled reported acute shoulder disorders of less than 1 month. Although our age distribution in the study does not reflect the three phases of impingement suggested by Neer (1983), the acuity of the condition, which involves reversible inflammation, edema, and hemorrhage in the rotator cuff may have contributed to the significant within-groups improvements in both groups. Long-term impingement has been associated with mechanical disruption of the rotator cuff tendons and changes in the coracoacromial arch with osteophytosis along the anterior acromion (Neer, 1983), and are also associated with substitution movement patterns, soft tissue and capsular changes, and changes in overall conditioning (Mannava et al., 2012). It is possible that these changes were not present in the majority of patients in our study as they were in past studies involving thoracic manipulation and subsequent improvement in shoulder pain, range and disability involved subjects. On average, in the previous studies subjects reported problems ≥ 4 months (Strunce et al., 2009; Walser et al., 2009; Mintken et al., 2010; Muth et al., 2012).

Table 2
Comparative values at discharge: variables include total visits, total days in care, patient acceptable symptom state (PASS), pain (NPRS) and disability (QuickDASH).

Variable	All Subjects Mean (SD)/frequency $N = 68$	Shoulder and neck treatment Mean (SD)/frequency $N = 36$	Shoulder treatment only Mean (SD)/frequency $N = 32$	*P*-value
Total days in care	56.1 (55.0)	59.7 (70.2)	52 (29.6)	0.57
Total visits	9.3 (6.3)	9.6 (6.7)	8.9 (5.9)	0.69
Discharge NPRS score	2.2 (1.5)	2.3 (1.8)	2.2 (1.2)	0.75
Discharge QuickDASH score	13.6 (8.8)	13.6 (10.5)	13.6 (6.6)	0.99
Raw change score NPRS	3.7 (2.2)	3.4 (2.3)	3.9 (2.1)	0.42
Raw change score QuickDASH	21.9 (17.1)	19.4 (17.4)	24.7 (16.6)	0.20
Percent change NPRS	59.7 (25.1)	59.0% (26.2)	60.5% (24.2)	0.81
Percent change QuickDASH	53.5 (40.2)	51.2% (43.3)	56.2% (36.8)	0.62
PASS scores	56 = Acceptable 10 = Unacceptable	28 = Acceptable 7 = Unacceptable	27 = Acceptable 3 = Unacceptable	0.44

NPRS = numeric pain rating scale; DASH = disabilities of the shoulder and hand questionnaire; PASS = patient acceptable symptom state.

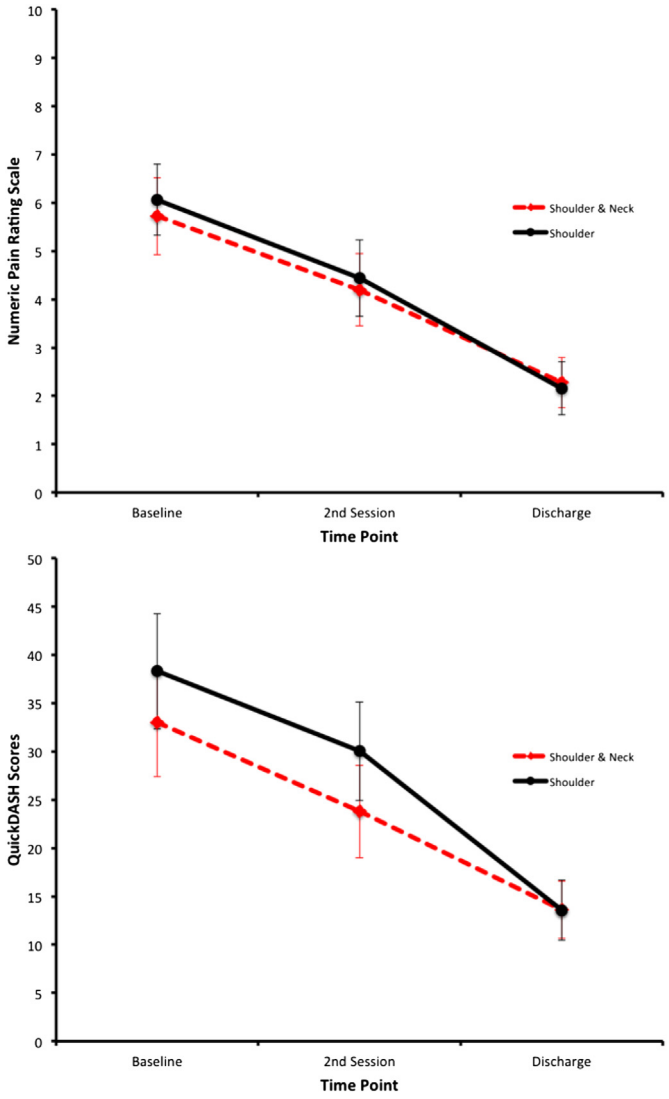

Fig. 2. Effect of supplementing shoulder treatment with mobilisation of the cervical spine on pain and disability scores in subjects with shoulder impingement syndrome.

4.1. Limitations

This study was single blinded for outcomes only and the outcomes were captured for short-term only. Calcific tendinitis was an exclusion criterion but not all subjects were imaged prior to enrollment and there is a risk that some individuals were missed. A majority of the clinicians in the study were experienced or certified in manual therapy and had clinical experiences of >20 years. As stated previously, the inclusion/exclusion criteria likely eliminated subjects who would be likely to benefit from the addition of cervical intervention if they presented with SIS and contributory cervical pathology. The sample that presented in this study may not fully represent the spectrum of patients that have SIS since a large proportion for the subjects was fairly acute in their onset of symptoms. It is likely that the majority of the subjects exhibited external impingement although we did not attempt to differentiate between internal and external impingement and are not aware of any studies that have identified that one form of impingement is more likely to benefit from cervical mobilisation versus the other.

5. Conclusion

Subjects who met the criteria for clinically diagnosed shoulder impingement syndrome did not experience additional benefit when a standardised cervical mobilisation on a tender cervical segmental level was added to a comprehensive shoulder treatment protocol.

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