Short-term effects of thoracic spinal manipulations and message conveyed by clinicians to patients with musculoskeletal shoulder symptoms: a randomized clinical trial

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Study design: Randomized clinical trial.

Objectives: To evaluate the effects of high-velocity, low-amplitude thrust manipulations (HVLATMs) and various messages on patients with musculoskeletal shoulder symptoms.

Background: Previous studies indicated that HVLATM directed at the thoracic spine and ribs resulted in improvements of shoulder range of motion, pain, and disability in patients with musculoskeletal shoulder symptoms. These studies did not explore if the outcome was dependent on thrust location, clinician communication with the patient, or if there were any lasting effects.

Methods: A consecutive sample of 100 patients with shoulder pain was randomized into four groups. Patients received one intervention session including: six thoracic HVLATM (spine versus scapula), a message about HVLATM (neutral versus positive), and standardized home exercises. Outcome measures included shoulder Numeric Pain Rating Scale (NPRS), NPRS with impingement testing, and Shoulder Pain and Disability Index (SPADI). Measurements were recorded prior to intervention, immediately following intervention, and at short-term follow-up. Kruskal–Wallis statistics were used for between-group comparisons and Wilcoxon signed ranks for within-group comparisons.

Results: Eighty-eight patients (22 per group) completed the study. Statistically significant differences were found for within-group comparisons for most time points assessed. No statistical differences were found for between-group comparisons.

Conclusion: Patients improved following the interventions. Neither the type of HVLATM nor the message conveyed to the patients had a significant effect on the patients' improvements.

Level of evidence: 1b

Keywords: Physical therapy, Manipulation, Thoracic spine, Shoulder pain

Introduction

Shoulder pain is among the three most commonly reported musculoskeletal conditions in adults^{1,2} and its effects on general health can be disabling.³ In Washington State in 2005, non-traumatic work-related shoulder disorders cost on average \$27 689 per claim with a mean loss of 296 workdays.⁴

Previous studies have shown that patients with musculoskeletal shoulder pain tend to lack thoracic

mobility when compared to patients without shoulder dysfunction.^{5,6} Lewis *et al.*⁷ found that altering posture in patients with musculoskeletal shoulder pain improves pain free range-of-motion (ROM) during shoulder elevation. Treating the structures surrounding the shoulder, such as the thoracic spine may, therefore, be an effective conservative approach in managing patients with musculoskeletal shoulder pain.^{8–11}

The provision of high-velocity, low-amplitude thrust manipulations (HVLATMs) to the thoracic spine may improve musculoskeletal shoulder pain. Mechanical effects such as increased mobility and decreased

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stiffness^{9,10} and central mechanisms such as altered pressure pain threshold¹² have been proposed as explanations for the short-term benefits of thoracic HVLATM in the management of musculoskeletal shoulder pain. In addition, the neurophysiological effects of HVLATM such as decreased pain and increased ROM, could be related to positive messages conveyed by the clinicians to their patients regarding their own belief of the efficacy of HVLATMs.^{13–15} These interactions warrant consideration as they have been shown to affect the outcome of therapeutic interventions.^{13–17}

Although HVLATM of the thoracic spine and ribs has been shown to increase shoulder ROM, as well as decrease pain¹⁰ and disability¹¹ in patients suffering musculoskeletal shoulder pain,⁸ the quality of the publications is low and lacking control or comparison groups. Among studies that have examined the effects of thoracic spinal HVLATM on shoulder pain and function, the effect of different types of verbal messages conveyed by the clinician to the patients has not been investigated. Further higher quality randomized clinical trials have, therefore, been suggested.¹⁸

The purposes of the present research were to evaluate, in patients with musculoskeletal shoulder symptoms: (1) the effect of a series of prone HVLATM directed toward the thoracic spine, as compared to a sham HVLATM directed toward the scapula;¹⁹ and (2) the effect of the type of message and language used by the clinician on shoulder pain and functional outcomes.

Methods

This clinical trial was conducted in the outpatient rehabilitation services department at the University of Connecticut Health Center. The health center's Institutional Review Board provided approval for the protocol (IRB no. 11-135-3). In addition, this study was registered through ClinicalTrials.gov (registration no. NCT01743833).

Experimental design and variables

Two-way factorial true experimental design.

Participants

Women and men with shoulder pain that was not post-surgical were recruited from the University of Connecticut Health Center Department of Outpatient Rehabilitation clinic/center. Consecutive sampling of patients that presented to the clinic/center was scheduled to complete a pre-screening questionnaire to determine their interest and willingness to participate in the study. A flow diagram according to the Consolidated Standards of Reporting Trials (CONSORT) statement illustrates the progress of study participants through the trial (Fig. 1). This study required them to undergo one session of thoracic spinal manipulation. Research team members

that were licensed physical therapists with more than 9 years of clinical practice in musculoskeletal management reviewed each pre-screening questionnaire for potential admission to the study. Once informed consent was attained, the patients were asked to complete an intake questionnaire. Patients that met the initial inclusion criteria underwent a standard physical therapy examination for contra-indications for HVLAM. The standard of care physical therapy examination consisted of a cervical screening, shoulder active ROM, shoulder passive ROM, shoulder resistive ROM, and special testing discussed below in the inclusion and exclusion criteria. Before the provision of HVLATM, outcome measures were collected by one of the two evaluating therapists for all patients. The therapist performing the examination was blinded to group allocation, and performed all measures before the interventions, immediately following the interventions and at a short-term follow-up.

Inclusion criteria

Patients between the ages of 18 and 69 years were included if they presented with shoulder pain greater than or equal to 2/10 but less than or equal to 8/10 at time of testing. Additionally the patients had to be able to perform shoulder active range of motion (AROM) above the horizontal.^{20,21} Additional requirements for inclusion were the ability to lie prone with arms at their side and at least one of the following signs or symptoms: (1) a positive Hawkins–Kennedy Sign;^{22,23} (2) a positive Neer Impingement Sign;^{22,23} (3) painful resisted abduction; and (4) painful resisted external rotation at 0° of abduction with the elbows bent to 90°.²¹

Exclusion criteria

Patients were excluded if they had any of the following:

1. a history of instability, fracture or bone tumor in the thoracic spine;
2. a bleeding disorder or the use of anticoagulant therapy;
3. acute rheumatoid arthritis or ankylosing spondylitis;
4. signs and symptoms of myelopathy or cauda equina syndrome;
5. a systemic infection that may involve the spinal column, ribs, or shoulder girdle;
6. a history of osteoporosis or fracture of shoulder girdle bones;
7. presence of radiculopathy with progressive signs;
8. primary complaints of neck or thoracic pain;
9. a positive cervical distraction test;
10. a positive Spurling's test;
11. a large three-dimensional limitation of arm motion of greater than 20° with any passive motion of the shoulder, as compared to the contralateral side, to rule out adhesive capsulitis;
12. a previous history of shoulder surgery such as a rotator cuff repair;
13. physical therapy or chiropractic treatment to the shoulder or thoracic spine within the 3 months before participation in the study;

Figure 1 CONSORT diagram of the flow of the study.

14. cortisone or other fluid injection into the shoulder joint within 30 days of participation in the study;
15. a history of multiple sclerosis or neuropathy;
16. current pregnancy;
17. inability to attend a short-term follow-up;
18. spinal fusion;
19. the presence of signs of upper motor neuron lesion or myelopathy.

Sample size calculation

An *a priori* power analysis was performed to determine an adequate sample size required for the study. Mean change in SPADI score from pre-intervention to short-term follow-up was selected as the primary endpoint for sample size calculation. A difference of 17 points on SPADI was considered the threshold for a clinically meaningful change.²⁴ For estimation of variability, a standard deviation of 19 was chosen based on the study by Tveita *et al.*²⁴ These parameters resulted in an effect size of 0.895.

With the alpha value set at 0.05 and beta set at 0.2 (power: 80%), the estimated sample size per group was 20 per group (80 total).^{25,26} To account for attrition and patients lost at follow-up, the sample size was inflated to 100 patients.

Randomization

Patients that successfully met all criteria for inclusion following the physical therapy examination were then randomly allocated into one of four groups by one of the two physical therapists that provided the interventions: (1) thoracic HVLATM with positive message; (2) scapular (sham) HVLATM with positive message; (3) thoracic HVLATM with neutral message; and (4) scapular (sham) HVLATM with neutral message.

The website <http://www.randomization.com> was used to generate treatment assignments for study participants. A block randomization scheme was

used to permit equal allocation to each of the four study groups. One hundred patients were randomized to one of four treatment groups (25 per group) into one block. One hundred patients were randomized to account for possible attrition during the study and to account for patients that might have been lost to follow-up.

When the study had progressed to within 75% of the required number of patients, the lead author ensured that there was no more than 10% differences between both genders in the four groups, all four groups were equal in size, and each evaluating and treating therapist had an equal number of patients. A numbered code was created for the four groups that only the two treating physical therapists knew. This process ensured blinding of the evaluating physical therapists that were taking the measurements at all three time points.²⁷

Interventions

Interventions consisted of HVLATM, verbal messaging, and a home exercise program. The type of HVLATM and verbal message received by patients were the defining variables that distinguished the study groups.

Patients viewed a video of the HVLATM (thoracic or scapular) and listened to a standardized verbal message (positive or neutral) specific to their group assignment.

Verbal messaging

The positive message stated:

‘We think that pushing on your upper back will decrease your pain and improve your shoulder motion. We expect that you will feel better after the push to your upper back area and that the push will speed up the healing of your shoulder’.^{16,28}

The neutral message stated:

‘We do not know if pushing on your upper back will decrease your pain or improve your shoulder motion. We do not know what to expect after we push on your upper back and the push may not change the pain and motion in your shoulder’.

Following the provision of the positive or neutral messages, the treating physical therapist provided the patients with either thoracic HVLATM or scapular HVLATM as follows:

1. thoracic HVLATM: The investigator stood at the patient’s head for the technique which was at the level of the superior angle of the scapula which corresponds to T1–2. The investigator stood at the side of the patient for the technique applied at the level of the spine of the scapula and the inferior angle of the scapular which corresponds to T3–4 and T6–7, respectively. The technique was executed as described by Strunce *et al.*¹⁰ Three manipulations (one at each spinal segment T1–2, T3–4, and T6–7) were performed in one direction and three manipulations were performed in the opposite direction at the same

levels for a total of six thoracic HVLATM in order to ensure rotation in both directions (Fig. 2A);

2. scapular (sham) HVLATM: The investigator applied the scapular HVLATM in a ventral-lateral direction through the superior angle of the scapula (T1–2), the spine of the scapula (T3–4), and the inferior angle of the scapula (T6–7). Three manipulations (one at each spinal segment T1–2, T3–4, and T6–7) were performed in one direction and three manipulations were performed in the opposite direction for a total of six scapular HVLATM (Fig. 2B).

Following the intervention, the dependent measures were collected a second time by the investigator that took the measurements at baseline. The measurements were then given to the principal investigator for recording. The evaluating therapist then provided patients with a home exercise sheet and reviewed with them the instructions to avoid lifting, reaching and carrying at and above shoulder level, and to not modify medication intake until their short-term follow-up. Additionally, patients were instructed to perform high, mid and low row exercises for 15 repetitions once daily at home and were scheduled for their 1-week (short-term) follow-up visit. Upon return, patients were asked about their home exercise program adherence.

Outcomes

Outcome measures included the Shoulder Pain and Disability Index (SPADI)²⁵ and the Numeric Pain Rating Scale (NPRS). The SPADI was considered the primary outcome measure, as it is a validated tool for the measurement of shoulder pain and disability in an outpatient setting. The reliability of the SPADI has been reported as intraclass correlation coefficients ≥ 0.89 ,²⁹ with a Cronbach alpha > 0.90 .²⁹ The minimally detectable change (MDC) for the SPADI has been reported to be 18.³⁰ The NPRS contained five levels: (1) average shoulder pain in the last 48 hours; (2) present shoulder pain; (3) most shoulder pain during AROM arm elevation; (4) most shoulder pain during the Neer’s test; and (5) most shoulder pain during the Hawkins–Kennedy tests. The test retest reliability of the NPRS ranges from 0.67 to 0.96.^{31–34} The MDC for the NPRS applied to the upper extremity has been reported as 3.³¹

The SPADI and NPRS tests were used to evaluate the changes before and following intervention. The same physical therapist that was blinded to the interventions evaluated the same dependent variables before the interventions, immediately following the interventions, and at a 1-week short-term follow-up.

Statistical analyses

Descriptive statistics (means, standard deviations, frequency counts, minimum and maximum values) were carried out using Excel Version 2010 (Microsoft Corporation) for the patients’ characteristics including age, gender, average shoulder pain, shoulder

Figure 2 (A) Thoracic manipulation: the cranial hand (X) applies a direct PA pressure as a stabilizing force at the contralateral transverse process/articular pillar. The caudal hand (arrow) applies a direct P–A force to the inferior articular pillar to generate a gapping force to the facet. (B) Scapular manipulation: the hand nearest the therapist (X) provides a stabilizing force in an anterior-lateral vector. The opposite hand (arrow) provides a thrust in an anterior lateral vector in line with the ribcage.

condition chronicity, shoulder ROM values, and the presence of an audible or palpable pop. Descriptive statistics were also used to characterize patients' baseline measures, which included the SPADI and NPRS for least, most, average, and present pain. Inferential statistics were analyzed with HVLATM (thoracic versus scapular), messaging (positive versus neutral), and treatment allocation (thoracic positive, scapular positive, thoracic negative, and scapular negative) as the grouping variable. The Shapiro–Wilk test was used to determine if the data were normally distributed ($P < 0.05$). The Levene's test was used to assess for homogeneity of variances with the same threshold for significance. The data were not normally distributed and were, therefore, analyzed with non-parametric statistics.

The Mann–Whitney U test was used to determine if there were differences following: (1) thoracic HVLATM as compared to scapular HVLATM; and (2) positive message regarding thoracic HVLATM, as compared to a neutral message regarding thoracic HVLATM. The time frames analyzed for the SPADI, NPRS, and shoulder impingement testing outcomes were between: (1) pre-intervention and post-intervention; (2) post-intervention and short-term follow-up; and (3) pre-intervention and short-term follow-up. The Kruskal–Wallis test was used to determine which of the four interventions resulted in the greatest improvements in SPADI, NPRS, and impingement testing outcomes (1) immediately following the intervention and (2) at short-term follow-up. Wilcoxon signed ranks tests were used to determine within-group differences between pre-intervention and the short-term follow-up within the thoracic and scapular HVLATM. A Bonferroni correction was used to adjust for multiple NPRS comparisons (alpha adjusted to 0.01) for all analyses. Inferential statistics were conducted using SPSS version 20 (IBM Corp. Released 2011.

IBM SPSS Statistics for Windows, Version 20.0; IBM Corp., Armonk, NY, USA).

Results

Five hundred and ninety-six patients with shoulder pain were screened for eligibility from 8 June 2011 to 5 December 2012. Of the 596 patients with shoulder pain screened for eligibility, 192 agreed to participate and signed informed consent. Ninety-five patients were excluded by the intake questionnaire or the clinical examination. Of the 97 that were randomly assigned, nine were lost to follow-up (Fig. 1). Enrolment was discontinued at 97 patients to ensure equal numbers in the treatment groups. A total of 54 women and 34 men (22 patients per group) with a mean age of 49 ± 11 years and mean shoulder pain duration of 6 ± 9 months completed the study. Table 1 summarizes the baseline demographics, as well as the clinical characteristics for each intervention group.

Statistical analysis was performed using the originally assigned groups. No statistically significant differences in the SPADI, NPRS, and impingement outcomes were found between manipulative techniques, between positive and neutral messages, or between the four distinct intervention groups immediately following the intervention, at the short-term follow-up, or between immediate post-intervention and the short-term follow-up.

Statistically significant differences were found for symptom duration between the groups (Table 1) and for within-group comparisons, when all 88 patients were compared immediately following the intervention and at short-term follow-up (Table 2). The mean change scores at these time intervals were not greater than the MDC for the SPADI²⁹ or NPRS³¹ (Table 3). Large effect sizes (0.98) with a large (95%) confidence interval were observed between post-treatment and the

1-week follow-up and between pre-treatment and the 1-week follow-up for average pain (NPRS). A large effect size (0.90) with a large (95%) confidence interval was also observed between pre-treatment and the 1-week follow-up for the SPADI (Table 4).

Discussion

The purpose of this study was to examine the short-term effects of HVLATM in conjunction with verbal messaging in patients with musculoskeletal shoulder pain. While all patients improved following the interventions, neither the type of HVLATM nor the message conveyed to the patients had a significant effect on SPADI or NPRS scores. Additionally, while statistically significant changes in SPADI and NPRS were noted for the entire cohort from pre-intervention to short-term follow-up, these changes failed to reach the MDC suggesting that the improvements in pain and function are likely related to the measurement error associated with these outcome measures, as opposed to evidence of a therapeutic effect.

This is the first reported study to investigate the effects of thoracic spine or scapular HVLATM and messaging, on shoulder pain and function in patients with musculoskeletal shoulder symptoms in a randomized comparison group clinical trial. Additionally, this is the first time a study evaluated shoulder pain and function outcomes beyond the immediate effect of thoracic manipulation. The results indicated that all interventions, regardless of the type of HVLATM or message delivered, resulted in immediate and short-term follow-up improvements in shoulder pain and function.

Previous studies have shown immediate reductions in pain and disability following Thoracic HVLATM in patients with shoulder impingement^{10,11} and rotator cuff tendinopathy.⁸ In the present study, we observed statistically significant, clinically irrelevant

changes among the entire cohort in SPADI and NPRS across the three time points. These observed changes may in part explain previous reports indicating immediate reductions in pain and disability with thoracic HVLATM.

The mean improvements in present pain and pain during impingement testing (NPRS) were 1.5 or less on the 11-point scale. The improvements on the SPADI were 11.4 or less on a scale of 100. None of these improvements were statistically significant for any of the between-group comparisons. The patients' average and present pain, pain during arm elevation, Neer's test, Hawkins–Kennedy tests, and SPADI between the post-intervention measurements and the short-term follow-up continued to change. These changes, however, were not statistically significant for any of the between-group comparisons. Although not clinically significant,^{30,31} the statistically significant differences recorded when all patients were analyzed at the three times that data were collected may explain previous reports in the literature that indicated that thoracic HVLATM caused immediate reductions in pain and disability in patients with shoulder impingement^{10,11} and rotator cuff tendinopathy.⁸

While the scapular HVLATM was intended to create a non-therapeutic comparison, we cannot be confident that there was no treatment effect associated with scapular HVLATM. Although the direction of the force applied through the scapulae was ventral-lateral, it may have directed impulses through the ribs and thoracic spine. In fact, cavitation was noted in 11.4% cases, indicating that a significant mobilizing force may have occurred when performing a scapular HVLATM. These findings, in combination with the recent report by de Oliveira *et al.*,³⁵ suggest that the location of the HVLATM may not matter, implying that the observed changes in symptoms and pressure pain thresholds reported in the literature are secondary to neurophysiological effects.

Table 1 Baseline demographics and self-report variables of patients undergoing HVLATM* (N=88)

Variables	Thoracic positive	Scapular positive	Thoracic neutral	Scapular neutral	P value
Age (years)	52.3±8.5	45.9±13.2	48.5±12.0	48.1±10.4	0.297 [†]
Sex (female)	13 (59.0%)	15 (68.1%)	14 (63.6%)	12 (54.5%)	0.811 [‡]
Symptoms duration (months)	4.1±3.4	7.3±7.4	2.9±3.0	6.6±6.1	0.009 [§]
Shoulder ROM (flexion)	154.5°±11.8°	155.2°±13.6°	157.0°±14.1°	148.2°±19.4°	0.232 [†]
SPADI	48.3±18.5	43.6±18.5	40.7±19.9	49.4±20.8	0.417 [†]
NPRS (least)	1.3±2.2	1.5±1.8	0.8±1.2	1.5±1.8	0.478 [§]
NPRS (most)	7.3±1.5	6.9±1.8	6.4±2.0	7.0±2.1	0.534 [§]
NPRS (average)	4.2±1.4	4.1±1.6	4.0±2.0	4.5±1.7	0.844 [†]
NPRS (present)	2.9±2.2	3.2±1.7	3.4±2.6	3.0±2.4	0.891 [§]

Note: *Data are means±standard deviations unless denoted otherwise.

[†]One-way ANOVA.

[‡]Chi-square.

[§]Kruskal–Wallis H test.

HVLATM, high-velocity low-amplitude thrust manipulation; SPADI, Shoulder Pain and Disability Index; NPRS, Numerical Pain Rating Scale; thoracic positive, thoracic HVLATM with a positive verbal message; scapular positive, scapular HVLATM with a positive verbal message; thoracic neutral, thoracic HVLATM with a neutral verbal message; scapular neutral, scapular HVLATM with a neutral verbal message.

Table 2 Combined group comparisons for pre-intervention, immediate post-intervention and short-term follow-up for shoulder pain and function in patients receiving HVLAMTs (N=88)*

Variable	Pre-intervention	Post-intervention	Short-term follow-up	P value pre-post intervention [†]	P value post-short-term follow-up [†]	P value pre-short-term follow-up [†]
Average pain (NPRS)*	4.2±1.7	4.2±1.7	3.3±1.8	0.801	<0.001	<0.001
Present pain (NPRS)*	3.1±2.2	2.7±2.5	2.0±1.8	0.102	0.002	<0.001
Pain with AROM (NPRS)*	4.3±2.4	3.5±2.6	3.6±2.6	<0.001	0.688	0.004
Pain Neer (NPRS)*	4.7±2.5	3.9±2.6	4.0±2.4	<0.001	0.779	<0.001
Pain Hawkins–Kennedy (NPRS)*	4.8±2.7	4.0±2.0	4.0±2.6	<0.001	0.768	0.009
SPADI*	44.5±19.4	42.4±20.2	36.5±19.5	<0.001	0.001	<0.001

Note: *Data are means ± standard deviations unless denoted otherwise.

[†]Wilcoxon signed ranks test.

HVLATM, high-velocity low-amplitude thrust manipulation; SPADI, Shoulder Pain and Disability Index; NPRS, Numerical Pain Rating Scale.

Positive numbers indicate improvement in symptoms of pain and function.

Bonferroni correction alpha level set to $P=0.01$ for repeated tests with NPRS.

Further research using thoracic extension self-mobilization exercises at home, as well as longer follow-up periods, would be valuable to investigate their longer-term efficacy as an adjunct to HVLATM of the thoracic region. The addition of such an intervention could allow the patient to maintain and build upon any biomechanical or neurophysiological effects that may decrease symptoms, improve AROM, and restore function.³⁶

There are limitations to this study. We did not take into account patient factors such as fear avoidance behaviors, anxiety and depression, and patient satisfaction, which may have influenced the shoulder outcome measures.^{37–40} Previous studies suggested that verbal and surgical interventions resulted in decreased fear avoidance behaviors^{41,42} and improved patient satisfaction⁴³ without improvements in functional outcomes.

A second limitation was that there was a statistically significant difference in symptom duration between the groups at baseline. Our question to the patients for symptom duration was, ‘How long ago did your current episode of shoulder pain start?’. This did not allow us to capture acute exacerbations of chronic symptoms and may have created outliers for symptom duration in each group. A Mann–Whitney *U* Test, however, showed that there was no statistically significant difference in the five levels of the shoulder NPRS measurements ($P>0.046$) and the SPADI ($P>0.077$) between patient with symptoms

0–3 months ($n=47$) and those with more chronic symptoms, i.e. greater or equal to 3.5 months ($n=41$) between all three time points.

Conclusion

A comparison of all 88 patients with musculoskeletal shoulder pain at three time intervals showed statistically significant improvements in pain and function immediately following HVLATM and various messages about the benefits of HVLATM. The differences that were found were not greater than the minimal clinically important differences for the NPRS. In the case of the SPADI, the change score between pre-intervention and the short-term follow-up was 8.74 when all 88 patients were compared between these two time frames. Although this finding is greater than 8 that has been reported as the minimal clinically important differences of the SPADI in the literature,⁴⁴ the difference is less than the MDC or measurement error for this instrument. The clinical implications of this finding are therefore, questionable. The type of HVLATM (thoracic spine or scapular) or the message (positive or neutral) conveyed to the patients did not significantly impact the patients’ improvements.

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Table 3 Change scores for combined group comparisons for shoulder pain and function in patients receiving HVLAMTs (N=88)*

Variable	Pre-post intervention	Post-short-term follow-up	Pre-short-term follow-up
Average pain (NPRS)	0.79 (−0.54–2.11)	1.64 (0.88–2.41)	1.64 (0.90–2.38)
Present pain (NPRS)	1.09 (0.08–2.09)	1.41 (0.58–2.24)	1.76 (0.99–2.54)
Pain with AROM (NPRS)	1.57 (0.69–2.44)	0.53 (−0.30–1.36)	1.36 (0.63–2.10)
Pain Neer (NPRS)	1.62 (0.74–2.50)	0.41 (−0.28–1.11)	1.42 (0.70–2.14)
Pain Hawkins–Kennedy (NPRS)	1.53 (0.61–2.46)	0.56 (−0.26–1.38)	1.36 (0.60–2.12)
SPADI	3.53 (1.67–5.39)	5.85 (2.94–8.76)	8.74 (6.00–11.49)

Note: *95% confidence interval.

HVLATM, high-velocity low-amplitude thrust manipulation; SPADI, Shoulder Pain and Disability Index; NPRS, Numerical Pain Rating Scale.

Table 4 Effect size for within-group comparisons for shoulder pain and function in patients receiving HVLMs ($N=88$)*

Variable	Cohen's <i>d</i> pre-post intervention	Cohen's <i>d</i> post-1-week intervention	Cohen's <i>d</i> pre-1-week intervention
Average pain (NPRS)	0	0.98	0.98
Present pain (NPRS)	0.35	0.11	0.47
Pain with AROM (NPRS)	0.62	0.29	0.61
Pain Neer (NPRS)	0.65	0.41	0.66
Pain Hawkins-Kennedy (NPRS)	0.70	0.61	0.64
SPADI	0.80	0.79	0.90

Note: *95% confidence interval.

SPADI, Shoulder Pain and Disability Index; NPRS, Numerical Pain Rating Scale.

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