A Preliminary Randomized Clinical Trial on the Effect of Cervicothoracic Manipulation Plus Supervised Exercises vs a Home Exercise Program for the Treatment of Shoulder Impingement

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ABSTRACT

Objective: The purpose of this study was to investigate changes in pain, disability, and range of movement after cervicothoracic manipulation plus exercise therapy in individuals with unilateral shoulder impingement syndrome.

Methods: Forty-one patients (30 men, 11 women; aged 47 ± 9) diagnosed with unilateral shoulder impingement syndrome attended 10 sessions for 5 weeks (2 sessions/wk). Eligible patients were randomly allocated to 2 study groups: cervicothoracic manipulation plus exercise therapy ($n = 21$) or home exercise program ($n = 20$). The outcomes measures included the visual analog scale (VAS); the Disabilities of the Arm, Shoulder, and Hand score; Shoulder Disability Questionnaire; subacromial impingement syndrome (Hawkins-Kennedy Test and Neer Test); and shoulder active range of motion (movements of flexion, extension, rotation, adduction, and abduction). Assessments were applied at baseline and 24 hours after completing 5 weeks of related interventions.

Results: After 5 weeks of treatment significant between-group differences were observed in the Disabilities of the Arm, Shoulder, and Hand score ($P = .012$); however, no statistically significant differences were achieved for Shoulder Disability Questionnaire ($P = .061$) and pain intensity ($P = .859$). Both groups improved with regard to disability and clinical tests for detecting subacromial impingement syndrome.

Conclusions: This clinical trial suggests that cervicothoracic manipulative treatment with mobilization plus exercise therapy may improve intensity of pain and range of motion compared with the home exercise group alone; the home exercise group had significant changes for flexion, extension, adduction, and abduction, but not for external and internal rotation movement in patients with shoulder impingement. (J Chiropr Med 2017;16:85-93)

Key Indexing Terms: *Shoulder Impingement Syndrome; Musculoskeletal Manipulations; Pain; Disability Evaluation; Movement*

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INTRODUCTION

Shoulder pain may be characterized by the presence of pain in the anterior, lateral, or posterior aspect of the shoulder, including the lower cervical spine and shoulder blade region. Several factors contribute to subacromial impingement syndrome, including rotator cuff weakness, posterior capsule tightness, poor scapulohumeral rhythm, and muscle imbalance of the scapular upward rotation force couple.¹ The most prevalent diagnosis, among the different causes of shoulder pain, is rotator cuff tendinopathy with impingement.² The prevalence of shoulder pain ranges from 20% to 50% in the general population.³

Many treatments for shoulder impingement syndrome (SIS) are available in clinical practice.⁴⁻⁸ Combined treatments composed of exercise and other therapies tended to yield better effects than single-intervention therapies.⁴

Exercise therapy and other physical therapies, such as kinesiotaping, specific exercises, and acupuncture, are effective treatment for patients at an early stage of SIS.^{4,5} Manual therapy directed at the thoracic spine, as a standard treatment or combined with exercise, has been reported to improve pain and disability and increase global rating scale change for SIS.⁶⁻⁹ However, the mechanisms by which thoracic spinal manipulative therapy (SMT) improves pain and shoulder motion have not been established. Limited thoracic spine mobility has been linked to shoulder pain.^{10,11} Spinal manipulative therapy has been reported to have neurophysiological effects, including shoulder muscle performance and central nervous system hypoalgesia.¹² It has been proposed that the neurophysiological effect of joint manipulation may alter the inflow of sensory information to the central nervous system.^{13,14} There is evidence that SMT stimulates primary afferent neurons from paraspinal tissues and pain processing.¹⁴ The clinical justification behind thoracic SMT for shoulder pain is in part based on the concept of regional interdependence described by Wainner et al,¹⁵ who suggest that seemingly unrelated impairments in remote anatomic regions may be associated with primary symptoms in subacromial shoulder pain.

A systematic review and several controlled trials reported short-term beneficial patient-rated outcomes with the use of manual therapy to the thoracic spine and shoulder.^{6,7,16,17} In addition, recent studies have reported improvements in patient's rated pain and function after a single treatment of thoracic SMT in patients with subacromial impingement syndrome, but they did not find mechanical changes in thoracic spine or shoulder mobility.^{14,18} However, none of these studies included a symptomatic or asymptomatic control group for comparison in the controlled trials. Furthermore, no studies included cervicothoracic mobilization with and without impulse technique and exercise therapy in low cervical spine for the upper thoracic spinal dysfunction in SIS. Both therapies can have significant benefits on pain and disability for the treatment of shoulder impingement. The aim of this preliminary randomized clinical trial was to investigate changes in pain, disability, and range of movement after 10 sessions of cervicothoracic manipulative treatment plus exercise therapy compared with a home exercise program in patients with unilateral shoulder impingement.

METHODS

Participants

Patients with unilateral shoulder pain compatible with a medical diagnosis of SIS within the dominant right hand were screened for eligibility criteria in this clinical trial.¹⁹ Patients were eligible if they reported the following¹: pain or dysfunction with overhead activities²; pain during active shoulder movements³; positive Neer/Hawkins-Kennedy test⁴; recent onset of pain within the last 12 months⁵;

nontraumatic onset⁶; baseline pain level of ≥ 2 out of 10 on an 11-point numeric scale.

Patients were excluded if they exhibited any of following criteria¹: the presence of any red flags²; a history of frozen shoulder³; disorders of the acromioclavicular joint⁴; degenerative arthritis of the glenohumeral joint⁵; known calcifying tendonitis (if identified by radiograph)⁶; posttraumatic disorders; or⁷ shoulder surgery or elbow, hand, or wrist surgery and blatantly misdiagnosed cervical spine disorders.

The study was approved by the local Ethics Committee (Servicio Andaluz de Salud) in accordance with the Helsinki Declaration. All patients signed an informed consent before their inclusion. This study has been registered as trial number NCT02214199.

Outcome Measures

In this study, a visual analog scale (VAS) was used to assess the intensity of pain. The VAS is a 10-cm line anchored with 0 at one end representing no pain and 10 at the other end representing the worst pain imaginable.²⁰ It has been reported to be reliable and valid for assessing pain intensity, and it was selected as an outcome measure based on its ability to detect immediate changes in pain exhibiting a minimal clinically important difference between 0.9 and 1.1 cm.^{21,22}

The Disabilities of the Arm, Shoulder, and Hand (DASH) is a 30-item self-reported questionnaire. It has physical function items, symptom items, and social/role items.²³ This is a self-report questionnaire where patients can rate difficulty and interference with daily life on a 5-point Likert scale. The DASH scoring formula is $[(\text{sum of } n \text{ responses}) / n] - 1$ where n represents the number of completed items. The score test ranges from 0 (no disability) to 100 (most severe disability).

The Shoulder Disability Questionnaire (SDQ) is a pain-related disability questionnaire that contains 16 items describing common situations that may induce symptoms in patients with shoulder disorders. All items refer to the preceding 24 hours. Response options are either yes or no, and the "not applicable" category should be used when the situation at issue did not occur during the preceding 24 hours. A final score is calculated by dividing the number of positively scored items by the total number of applicable items and subsequently multiplying the score by 100, resulting in a final score ranging between 0 (no disability) and 100 (all applicable items positive).²⁴

The Neer and Hawkins-Kennedy tests are used to identify possible subacromial impingement syndrome. In the Neer test, the therapist stabilizes the patient's scapula with one hand while passively flexing the arm as it is internally rotated. If the patient reports pain in this position, then the result of the test is positive.²⁵ The Hawkins-Kennedy test is best performed with the patient in a relaxed sitting position. The patient is examined while sitting with the shoulder flexed to 90° and elbow flexed

to 90°. The therapist grasps and supports proximal to the wrist and elbow to ensure maximal relaxation; the therapist and the patient then quickly rotate the arm internally. Pain located below the acromioclavicular joint with internal rotation is considered a positive test result.²⁶ The pooled sensitivity and specificity for the Neer test is 79% and 53%, respectively, and for the Hawkins-Kennedy test is 79% and 59%, respectively.²⁷

The shoulder active range of motion of flexion, extension, rotation (internal and external), adduction and abduction were measured using a digital goniometer (NORAXON Desktop DTS; Noraxon, Scottsdale, AZ).

Procedure

The principal investigator (A.M.C.S.) provided verbal and written explanations of study, and all participants signed informed consent. After the baseline examination, patients were randomly assigned to receive either cervicothoracic manipulative therapy plus exercise therapy or a home exercise program. Every group was treated by a physical therapist with more than 15 years of experience in the management of individuals with shoulder pain. All participants were attended in a physical therapy clinic twice per week for 5 weeks (10 sessions). Concealed allocation (ratio 1:1) was performed using a computer-generated randomized table of numbers created before the start of data collection by a researcher not involved in the recruitment or treatment of patients (S.V.M.). Individual and sequentially numbered index cards with the random assignment were prepared. The index cards were folded and placed in sealed opaque envelopes. Another therapist, blinded to the baseline examination (G.A.M.P.), opened the envelope and proceeded with treatment according to the group assignment. Outcomes were taken by an assessor blinded to group allocation at baseline and 24 hours after intervention (M.F.S.).

The sample size was calculated using Ene 3.0 Software (GlaxoSmithKline, Autonomic University of Barcelona, Barcelona, Spain). The calculations were based on detecting differences of 10 units in DASH score assuming a 2-tailed test, an α level of .05, and a desired power (β) of 80%. The estimated desired sample size was calculated to be at least 17 participants per group. The sample was increased to 20 to allow for 15% dropout.²⁸

Interventions

Cervicothoracic Mobilization With and Without Impulse Technique and Exercise Therapy. A treatment package of SMT was applied to the lower, middle, and upper cervicothoracic spine. Previous clinical trials investigated the effects and outcomes of thoracic SMT in patients with shoulder pain, specifically high-velocity, low-amplitude thrusts applied at the end of the joint motion.^{6,7,27} In our study, the patients received repetitive lateral translation from both sides at the beginning of the treatment (Fig 1). After this technique, the patients received 5

Fig 1. Repetitive lateral translation from both sides.

manipulation techniques on the thoracic spine¹: technique lift with impulse, high velocity, and low amplitude applied to the midthoracic area, consisting of a manipulation of axial distraction with fulcrum on the thoracic area (Fig 2)²; dog technique manipulation in flexion applied to (a) the upper thoracic spine (T1-T4) (Fig 3), (b) the midthoracic spine (T5-T8) (Fig 4), and (c) the low thoracic spine (T9-T12) (Fig 5)

Fig 2. Technique lift with impulse, high velocity, and low amplitude applied to the midthoracic area.

Fig 3. Dog technique manipulation in flexion applied to upper thoracic spine (T1-T4).

³; manipulation with impulse applied to the midthoracic area: therapist contacted the transverse process for manipulation with the thumb facing inferior and the contralateral thumb directed toward the head. This technique consists of an earlier movement of compression with both pisiform bones (Fig 6). All participants received SMT twice per week for 5 weeks in a clinical setting and performed stretching and muscle strengthening exercises for 30 minutes twice a day. The patients received a handout for exercises; previously, these exercises were demonstrated to the patients for the first time at the beginning of the study. The protocol of exercises was the following: flexion and extension exercises with arms in front of a wall, shoulder flexion 90°, and pose with hand on healthy shoulder; counter-resistance exercises with elbow flexion 90° and an elastic band; counter-resistance exercises with shoulder flexion 90° and an elastic band; shoulder flexion with elbow extension holding a bar (1-4 kg); shoulder flexed to 90° and elbow extended holding a bar (1-4 kg); body lift from a seated position with elbows extended; exercises for flexion, extension, rotation, and head tilt; and exercises with shoulder circles.

Home Exercise Program. The patients performed a home exercise program for 30 minutes twice a day. In this program, the patients performed stretching and muscle strengthening exercises (detailed in previous paragraph) of the shoulder girdle for 5 weeks.

Fig 4. Dog technique manipulation in flexion applied to midthoracic spine (T5-T8).

Fig 5. Dog technique manipulation in flexion applied to low thoracic spine (T9-T12).

Data Analysis

SPSS Version 20.0 for Windows (IBM, Armonk, NY) was used for the data analyses. After a descriptive analysis, the normal distribution of variables was verified by means of the Kolmogorov-Smirnov test. The Levene test was used to assess for homogeneity of variances. The data were not normally distributed and were therefore analyzed with nonparametric statistics. The χ^2 and within-group analyses with McNemar tests were used to compare categorical data for the Neer and Hawkins-Kennedy tests. The Mann-Whitney *U* test was used to determine if there were differences between groups at each time point. The nonparametric Wilcoxon signed test was used to examine differences from baseline to post-treatment for VAS, DASH, SDQ, and active range of motion. $P < .05$ was considered significant in all tests.

RESULTS

Participants

Fifty-one patients were recruited, 10 were excluded, and 12 men and 29 women, aged 25 to 58 years (mean 48.5 ± 7 years) diagnosed with unilateral shoulder impingement met the inclusion criteria and were randomly assigned to the manipulative plus exercise group ($n = 21$) or home exercise group ($n = 20$). There was 1 loss to follow-up in the home exercise group (Fig 7). Anterior and posterior shoulder pain was

Fig 6. Manipulation with impulse applied to the midthoracic area.

Fig 7. Design and flow of participants through the trial. DASH, Disabilities of the Arm, Shoulder, and Hand; ROM, range of motion; SIS, shoulder impingement syndrome.

reported by 65% of study participants, 27.5% reported upper or lateral side of the shoulder, and 7.5% reported dorsolateral forearm pain. The mean duration of shoulder pain history was 6.2 ± 2.7 months. Baseline demographic characteristics were similar between groups for all variables (Table 1). There were no unintended effects in the study groups.

Changes in Shoulder Pain and Disability

After 5 weeks of treatment, significant between-group differences were observed in DASH ($Z = -2519$, $P = .012$); however, no differences were achieved for shoulder disability ($Z = -1.874$, $P = .061$) or pain intensity ($Z = -0.177$, $P = .859$). Within-group comparisons indicated significant differences in DASH and SDQ between baseline and post-treatment period in both groups; however, only the manipulative plus exercise group had a significant improvement for pain intensity. Table 2 shows preintervention and postintervention

values and within- and between-group changes in scores with associated 95% confidence interval for pain and disability of the shoulder.

Changes in Clinical Tests for Detecting Subacromial Impingement Syndrome

The χ^2 test identified no significant differences between groups for the Neer test ($P = .320$) and Hawkins-Kennedy test ($P = .577$) at 5 weeks post-treatment. Within-group analysis with the McNemar test indicated significant changes from baseline values only for the home exercise group ($P = .031$) in the Hawkins-Kennedy test. At baseline, 100% of patients in the home exercise group presented a positive result on Hawkins-Kennedy test, whereas only 52.6% were positive after treatment.

Changes in Shoulder Active Range of Motion

The Mann-Whitney U test identified no significant differences between groups for active range of motion in

Table 1. Patient Characteristics at Baseline

Characteristic	Home Exercise Group n = 20	Manipulative + Exercise Group n = 21	P
Mean age	51.21 ± 5.29	46.85 ± 8.02	.052
Age range	38-58	25-57	
Body mass index (kg/m ²)	28.64 ± 3.69	29.31 ± 3.69	.513
Men/women	13/7	15/6	.724
History of shoulder pain (mo)	6.05 ± 4.02	6.28 ± 3.57	.847
Pain localization			.800
Anterior part of the shoulder	11 (57.9)	11 (52.4)	
Posterior part of the shoulder	3 (15.88)	1 (4.8)	
Upper side of the shoulder	—	7 (33.3)	
Lateral side of the shoulder	4 (21.1)	—	
Dorsolateral part of the forearm	1 (5.3)	2 (9.5)	

Values are expressed as absolute and relative frequencies (n = 40) for categorical variables and as means ± standard deviations for continuous variables. There were no differences between groups ($P > .052$).

flexion ($Z = -0.305$, $P = .761$), external ($Z = -0.565$, $P = .572$) and internal ($Z = -1.235$, $P = .217$) rotation, and abduction ($Z = -0.737$, $P = .461$). Within-group comparisons identified significant differences between baseline and post-treatment period for all range of motion in the manipulative plus exercise group; however, the home exercise group had significant changes for flexion, extension, adduction, and abduction. Table 3 shows preintervention and postintervention values and within- and between-group changes with associated 95% confidence interval for shoulder active range of motion.

DISCUSSION

The present study has indicated that both modalities of treatment reduce disability and positive results on clinical tests for detecting subacromial impingement syndrome in patients with shoulder impingement. In addition, cervicothoracic manipulative treatment plus exercise therapy improves intensity of pain and range of motion compared with the home exercise group, whereas the home exercise group had significant changes for flexion, extension, adduction, and abduction but not for external and internal rotation movement.

However, future randomized controlled trials are required to further confirm these findings.

Our results are in agreement with those reported by Delgado-Gil et al⁵ and Teys et al,²⁹ who reported that patients with shoulder impingement symptoms who received 4 sessions of Mulligan mobilization with movement exhibited better outcomes for pain-free range of shoulder flexion and maximal external rotation. In the literature, manual therapy has been reported to be more effective in reducing pain than exercise alone.^{30,31} Neurophysiologic mechanisms underlying spinal manipulation are not completely understood, but there are theories that explain how hypoalgesia could occur as a result of manual therapy. Mechanical force from manual therapy initiates a cascade of neurophysiologic responses in the peripheral and central nervous system.³² Manual therapy in addition to usual care might diminish the severity of shoulder and neck pain and increase mobility.³³ However, other studies have reported no significant differences for intensity of pain in SMT vs a sham group.^{8,13} According to the pain intensity result from Chen et al,³⁴ our study did not report significant differences in pain intensity between groups. The magnitude of change in pain with impingement tests (Hawkins and Neer) identified in our study was similar

Table 2. Mean ± SD for Pain, DASH, Shoulder Disability and Within-Group and Between-Groups Score Change (95% CI)

Outcome/Group	Baseline	Post-treatment	Within Group P	Within-Group Change Score	Between-Group Change Score
VAS (cm)					
Home Exercise	5.53 ± 1.38	4.56 ± 2.22	.054	0.81 (0.01, 1.62)	−0.09 (−1.64, 1.46)
Manipulative + Exercise	5.57 ± 1.46	4.65 ± 2.32	.039 ^a	0.95 (0.02, 1.88)	
DASH (0-100)					
Home Exercise	78.21 ± 17.10	68.81 ± 20.48	.036 ^a	8.75 (1.27, 16.22)	18.26 (5.15, 31.36)
Manipulative + Exercise	61.48 ± 18.32	50.55 ± 18.16	.001 ^a	10.70 (6.85, 14.54)	
SDQ (0-100)					
Home Exercise	72.04 ± 16.84	57.81 ± 27.90	.022 ^a	14.06 (3.22, 24.91)	10.63 (−4.80, 26.05)
Manipulative + Exercise	62.50 ± 17.00	47.19 ± 17.38	.001 ^a	15.00 (8.61, 21.39)	

CI, confidence interval; DASH, Disabilities of the Arm, Shoulder, and Hand; SD, standard deviation; SDQ, Shoulder Disability Questionnaire; VAS, visual analogue scale.

^a Significant Wilcoxon signed test ($P < .05$).

Table 3. Mean $\pm$ SD for Shoulder AROM and Within-Group and Between-Groups Score Change (95% CI)

Outcome/Group	Baseline	Post-treatment	Within Group <i>P</i>	Within-Group Change Score	Between-Group Change Score
AROM Flexion (°)					
Home Exercise	147.89 $\pm$ 21.4	159.1 $\pm$ 18.7	.012 ^a	−10.06 (−17.36, −2.76)	−0.12 (−10.85, 10.60)
Manipulative + Exercise	145.71 $\pm$ 10.6	159.2 $\pm$ 12.9	.001 ^a	−13.25 (−18.73, −7.76)	
Extension (°)					
Home Exercise	48.26 $\pm$ 15.97	57.00 $\pm$ 18.41	.0036 ^a	−8.74 (−14.33, −3.15)	4.86 (−6.55, 16.27)
Manipulative + Exercise	40.95 $\pm$ 17.20	52.14 $\pm$ 17.23	.001 ^a	−11.19 (−22.38, −0.01)	
External Rotation (°)					
Home Exercise	59.21 $\pm$ 22.8	69.38 $\pm$ 21.3	.068	−9.06 (−18.45, 0.33)	−7.72 (−19.32, 3.87)
Manipulative + Exercise	64.76 $\pm$ 12.8	77.10 $\pm$ 12.6	.001 ^a	−12.10 (−18.25, −5.94)	
Internal Rotation (°)					
Home Exercise	57.89 $\pm$ 15.3	63.75 $\pm$ 17.4	.319	−3.12 (−8.78, 2.53)	−6.40 (−18.57, 5.77)
Manipulative + Exercise	60.24 $\pm$ 18.6	70.15 $\pm$ 18.1	.003 ^a	−9.90 (−15.03, −4.76)	
Adduction (°)					
Home Exercise	19.16 $\pm$ 12.21	28.79 $\pm$ 13.01	.022 ^a	−9.63 (−16.70, −2.57)	−0.21 (−7.21, 6.79)
Manipulative + Exercise	23.00 $\pm$ 11.25	29.00 $\pm$ 8.63	.001 ^a	−6.00 (−9.97, −2.03)	
Abduction (°)					
Home Exercise	120.0 $\pm$ 34.9	139.7 $\pm$ 33.7	.019 ^a	−19.68 (−35.62, −3.64)	5.53 (−13.80, 24.88)
Manipulative + Exercise	122.8 $\pm$ 19.0	134.1 $\pm$ 23.3	.011 ^a	−11.15 (−18.32, −3.92)	

AROM, active range of motion; SD, standard deviation.

^a Significant Wilcoxon signed test ($P < .05$).

to that reported by a clinical trial after a single session of thoracic manipulation in individuals with subacromial impingement syndrome.⁸ Clinical trials that incorporated thoracic spinal manipulation as part of a manual therapy treatment protocol identified improved patient-reported outcomes over comparative treatments without spinal manipulation.^{33,35}

Some studies have reported that mobilizations in addition to exercise were not more effective in pain and disability than exercise alone.^{34,36} In a comparative study of home exercises and supervised exercises for shoulder impingement, no differences between groups were identified in the intensity of pain, disability, physical activity and work, and active range of motion.³⁷ Nevertheless, surgery and exercises compared with a placebo laser have been reported to have statistical differences,³⁸ and an intervention with exercises produced higher improvement than shockwave therapy after 6 weeks.³⁹ The results in our study are similar to those reported in the treatment with proprioceptive exercises and conventional physiotherapy.⁴⁰

Limitations

A number of limitations should be considered when interpreting the results of this study. First, only 1 blinded therapist provided both treatments, which limits the generalizability of the results. Second, we do not know the long-term follow-up effects of the intervention. Third, this study is not a double-blind clinical trial. Fourth, there was no control group that did not receive any physical therapy intervention or a control group receiving thoracic but not cervical manipulation. Fifth, there is a lack of power analysis in this preliminary clinical trial. Therefore, future randomized clinical trials are now needed.

CONCLUSIONS

This study suggests that cervicothoracic manipulative treatment and exercise therapy improve intensity of pain and range of motion compared with home exercise alone. The home exercise group had significant changes in flexion, extension, adduction, and abduction but not in external and internal rotation movement in patients with shoulder impingement. However, both modalities of treatment reduce disability and positive results on clinical tests for detecting subacromial impingement syndrome. Because of the small sample size, these findings should be considered with caution.

FUNDING SOURCES AND CONFLICTS OF INTEREST

No funding sources or conflicts of interests were reported for this study.

CONTRIBUTORSHIP INFORMATION

Concept development (provided idea for the research): S.V.-M., E.M.F.-E.

Design (planned the methods to generate the results): A.M.C.-S.

Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): A.M.C.-S.

Data collection/processing (responsible for experiments, patient management, organization, or reporting data): M.F.-S.

Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): M.E.A.-F.; G.A.M.-P.

Literature search (performed the literature search): S.V.-M., E.M.F.-E.

Writing (responsible for writing a substantive part of the manuscript): A.M.C.-S.

Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): S.V.-M.; M.E.A.-F.; G.A.M.-P.; M.F.-S.; E.M.F.-E.; A.M.C.-S.

Other (list other specific novel contributions) Intervention: S.V.-M.

Practical Applications

- Cervicothoracic manipulative treatment with mobilization and exercise therapy improved intensity of pain.
- Cervicothoracic manipulative treatment with mobilization and exercise therapy and a home exercise program reduced disability in patients with shoulder impingement.
- Cervicothoracic manipulative treatment with mobilization and exercise therapy improved all range of motion compared with home exercise alone. The home exercise group had significant changes only in flexion and abduction.

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