
Effectiveness of Rehabilitation for Patients with Subacromial Impingement Syndrome: A Systematic Review

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ABSTRACT: Prior systematic reviews of rehabilitation for non-descript shoulder pain have not yielded clinically applicable results for those patients with subacromial impingement syndrome (SAIS). The purpose of this study was to examine the evidence for rehabilitation interventions for SAIS. The authors used data source as the method. The computerized bibliographic databases of Medline, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), and the Cochrane Database of Systematic Reviews were searched from 1966 up to and including October 2003. Key words used were “shoulder,” “shoulder impingement syndrome,” “bursitis,” and “rotator cuff” combined with “rehabilitation,” “physical therapy,” “electrotherapy,” “ultrasound,” “acupuncture,” and “exercise,” limited to clinical trials. Randomized clinical trials that investigated physical interventions used in the rehabilitation of patients with SAIS with clinically relevant outcome measures of pain and quality of life were selected. The search resulted in 635 potential studies, 12 meeting inclusion criteria. Two independent reviewers graded all 12 trials with a quality checklist averaged for a final quality score. The mean quality score for 12 trials was 37.6 out of a possible 69 points. Various treatments were evaluated: exercise in six trials, joint mobilizations in two trials, laser in three trials, ultrasound in two trials, and acupuncture in two trials. The limited evidence currently available suggests that exercise and joint mobilizations are efficacious for patients with SAIS. Laser therapy appears to be of benefit only when used in isolation, not in combination with therapeutic exercise. Ultrasound is of no benefit, and acupuncture trials present equivocal evidence. The low to mediocre methodologic quality, small sample sizes, and general lack of long-term follow-up limit these findings for the development of useful clinical practice guidelines. Further trials are needed to investigate these rehabilitation interventions, the superiority of one intervention over another, and the long-term outcomes of rehabilitation. Moreover, it is imperative that clinical guidelines are developed to indicate those patients who are likely to respond to rehabilitation. *J HAND THER.* 2004;17:152–164.

Shoulder pain is second only to low back pain in occurrence, affecting approximately 16% to 21% of the population.^{1–3} Moreover, approximately one-fifth of all disability payments for musculoskeletal disorders are for patients with shoulder disorders.⁴ The most frequent cause of shoulder pain is subacromial impingement syndrome, accounting for 44% to 60% of all complaints of shoulder pain during a physician office visit.^{5,6}

Subacromial impingement syndrome (SAIS) is characterized by shoulder pain that is exacerbated with arm elevation or overhead activities.^{7,8} This pain is caused by functional compromise of the subacromial structures: rotator cuff, long head of the biceps tendons, and the bursae.^{9,10} Degeneration of the rotator cuff due to tension overload and overuse may lead to “intrinsic impingement,”^{11,12} whereas “extrinsic impingement” is theorized to be caused by encroachment of the subacromial contents by the entities bordering the space.^{9,13} The potential mechanisms causing structural compression include dysfunctional glenohumeral and scapulothoracic kinematics,^{8,14–18} degeneration and inflammation of the tendons or bursae,^{19–21} acromial morphology,^{21–24} postural dysfunctions of the upper quarter,^{25–28} weak

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or dysfunctional rotator cuff and scapular musculature,^{7,29–35} and capsular laxity or tightness.^{10,30,36,37} These potential mechanisms can occur singularly or in combination.

Evidence suggests that a variety of factors most likely contribute to the functional compromise of the subacromial space in patients with SAIS. However, it is unclear as to the role of each individual mechanism, the relationships between these factors, or the association with functional loss and disability. The lack of understanding of the etiology of SAIS is evident with the numerous treatment options proposed for this disorder. Rehabilitation may involve the use of physical modalities, strengthening, motor control techniques, stretching, joint mobilizations, manual techniques, patient education, and functional mobility retraining.

Five systematic reviews regarding the efficacy of rehabilitation of patients with shoulder disorders have been published.^{38–42} Four of these reviews^{38–41} included studies of patients with a variety of shoulder diagnoses or nondescript shoulder pain. These results have limited use for clinical practice, because without specific diagnoses there is insufficient guidance for the development of treatment programs. Moreover, because different diagnoses may respond differently to an intervention, summarizing across different diagnoses may obliterate potentially important findings of effectiveness. The use of diagnostic labels would allow for the development of clinically useful practice guidelines for rehabilitation, because it is likely that patients will respond best to interventions that address the etiology, affected tissues, impairments, and the relevant biomechanics specific to their diagnosis.

One recent systematic review⁴² examined the efficacy of exercise and manual therapy for patients with SAIS. The results of this review are limited by the fact that some of the included studies did not clarify the existence of SAIS in the sample,^{43,44} contained a portion of patients without SAIS,⁴⁵ or used a sample of patients who were status post subacromial decompression surgery.⁴⁶ Thus, conclusions from published systematic reviews have limited use in evidence-based clinical decision making of rehabilitation interventions for patients with SAIS due to the aforementioned clinical and methodologic flaws.

The purpose of this systematic review was to examine the evidence for rehabilitation strategies for patients with SAIS—specifically, the efficacy of non-surgical nonpharmacologic treatment procedures. Conclusions should aid in the development of clinical practice guidelines for SAIS.

METHODS

Data Source

Bibliographic databases of Medline, Cumulative Index to Nursing and Allied Health Literature

TABLE 1. Yield from Computerized Search Strategies

Key Words	Medline	CINAHL	Cochrane
1. Shoulder	25,627	986	1,121
2. Shoulder Impingement Syndrome	850	159	30
3. Bursitis	2,827	129	104
4. Rotator Cuff	2,809	136	102
5. or/1 – 4	28,036	1,309	1,195
6. Rehabilitation	226,652	3,932	9,242
7. Physical Therapy	4,146	7,544	2,415
8. Electrotherapy	12,396	176	127
9. Ultrasound	188,987	1,332	3,490
10. Exercise	119,399	6,106	396
11. Acupuncture	8,781	1,725	1,476
12. or/6 – 11	532,883	18,726	28,064
13. Clinical trial	437,012	15,811	244,656
14. Random assignment	1,256	6,392	840
15. Placebo	92,108	22,383	80,285
16. or/13 – 15	454,651	21,400	262,952
17. 5 + 12 + 16	401	8	225

(CINAHL), and Cochrane Central Register of Controlled Trials Register were searched from 1966 up to and including October 2003 with the search strategy defined in Table 1. Additionally, the references of all retrieved studies and all relevant conference proceedings were hand-searched. These search strategies yielded 634 eligible studies from the bibliographic databases, and hand-searching resulted in one additional eligible study for a total of 635.

Study Selection

Studies were included if they were a randomized controlled trial or clinical trial comparing physical interventions used for nonsurgical nonpharmacologic treatment of patients with SAIS with another intervention, no treatment, or a placebo treatment. The outcome measures must have included clinically relevant and adequately described measures of pain, functional loss, or disability. The study subjects must have been adults with inclusion criteria of signs and symptoms consistent with SAIS, which are listed in Table 2.

Data Extraction

Computerized and hand-searching resulted in 635 potentially appropriate trials, with 12 of those meeting the eligibility criteria. Each trial was assessed independently by two examiners using a quality checklist developed according to Sackett's guidelines⁴⁷ and described by MacDermid in the introduction article of this special issue. This checklist consisted of 23 items, with each item assigned a 0, 1, or 2 quality point for a total of 69 possible points. Agreement between the two examiners was assessed to determine the presence of a discrepancy of greater than one quality point on any single quality checklist

TABLE 2. Selection Criteria Used to Define SAIS

<i>Selection Criteria</i>	<i>Studies</i>
Inclusion criteria	
History	
Complains of shoulder pain	(48-51;53-59)
Complains of shoulder pain in C5-6 dermatome	(53)
Examination	
Tenderness to palpation of biceps or rotator cuff tendons	(51;53)
Painful arc of shoulder abduction between 40–120 degrees	(48-50;53;56;59)
Pain with active arm elevation	(54;55)
Hawkin’s – Kennedy Test (61)	(53-55;57)
Neer Test (62)	(48-51;53;55;57)
Speed’s Test (63)	(53)
Yocum Test (63)	(53)
Jobe Test (63)	(53)
Resisted painful or weak shoulder abduction	(50;53;55;58;59)
Resisted painful or weak shoulder abduction in the scapular plane (Empty Can or Full Can test)	(51;56)
Resisted painful or weak shoulder external rotation	(50;53;55;59)
Resisted painful or weak shoulder internal rotation	(50;53;55;59)
Resisted painful elbow flexion	(58)
Resisted painful supination	(58)
Cyriax diagnosis	(60)
Other	
Impingement Test (lidocaine injection)	(48;49;57)
Exclusion criteria	
History	
Pregnant	(50;59)
Systemic or neurological disease	(55)
Corticosteroid injections 3 months prior to treatment	(59;59)
Previous physical therapy or chiropractic care for their shoulder	(55;59)
Shoulder surgery	(53)
Glenohumeral dislocation	(53;55)
Examination	
Clinical findings of:	
Frozen shoulder	(50;54;56;59)
Acromioclavicular joint arthritis	(48;49;54;59)
Full-thickness rotator cuff tear	(48;49;54;56;59)
Bicipital tendonitis	(56;59)
Inflammatory rheumatoid arthritis	(56;59)
Inflammatory arthropathy /osteoarthritis	(50;54;57-59)
Shoulder instability	(48;49;54)
Primary scapulothoracic dysfunction	(54)
Reproduction of shoulder symptoms with cervical movements	(48;49;53-55)
Cervical pain with arm elevation	(53)
Other	
Radiographic evidence of calcific periarthritis	(58)
Radiographic evidence of degenerative changes	(58)
Workmen’s compensation claim/litigation	(55;56)

item. If a discrepancy existed, the single item was discussed to reach consensus. The total quality score for an individual study was calculated by summing the 23 item scores for each examiner and then averaging their two final scores.

RESULTS

The 12 included studies were all randomized clinical trials or randomized controlled clinical trials investigating the efficacy of physical interventions for the treatment of patients with SAIS. Two studies^{48,49} were combined for this systematic review, because they reported outcomes for the same group of subjects at two different follow-up periods. The mean quality score of included trials was 37.6, ranging from 33.5 to 41 points out of a total of a possible 69 points.

The inclusion criteria for study subjects of the trials are depicted in Table 2. Generally, the diagnosis of SAIS was described with the presence of the shoulder pain in all trials, positive impingement signs of resisted painful or weak abduction in seven trials, Neer test in six trials, Hawkins-Kennedy test in four trials, painful arc in five trials, and resisted painful or weak shoulder external rotation and internal rotation in four trials. Two of the 12 studies used the impingement injection test for diagnostic confirmation of SAIS.

The physical interventions for patients with SAIS include exercise, manual therapy, and physical agents. The treatment regimens of the 12 included trials for the treatment of patients with SAIS can be categorized into five types: exercise, joint mobilization, ultrasound, acupuncture, and laser. Treatments were performed in combination or in isolation. Descriptions of the treatments of the included trials are outlined in Table 3.

A variety of outcome measures were used to determine the effects of the physical interventions used in the included studies. All studies included a primary outcome measure of pain, using a numeric rating or visual analog scale (VAS). The majority of studies (ten of 12) included a direct relevant measure of functional loss or disability, whereas two studies included indirect measures of either a global rating of change⁵⁰ or a measure of strength in a functional position.⁵¹ Numerous scales designed to assess function loss and disability in patients with shoulder disorders are available and have been assessed with regard to their psychometric properties.⁵² However, one study used a self-report scale that has not demonstrated reliability and validity in assessing outcomes.^{48,49}

DISCUSSION

This systematic review examined the evidence for the efficacy of rehabilitation interventions for patients with SAIS. The limited evidence currently suggests that exercise, joint mobilization, and laser therapy are effective in decreasing pain and improving function in patients with SAIS. Ultrasound

TABLE 3. Summary of Evidence for Rehabilitation for Patients with Subacromial Impingement Syndrome

Study	Patients	Intervention	Parameters	Measurements	Results	Level of Evidence	Quality Score
Ludewig and Borstad, 2003 ⁵³	N = 92 Dropouts: 8%; n = 4 for group 1, n = 3 group 2, n = 2 group 3 Age: 49 Symptoms duration: NA 98% males; construction workers with regular overhead activity	Group 1: n = 34; symptomatic intervention; home exercise program of two stretches, two strengthening, and one relaxation exercise Group 2: n = 33; symptomatic control; no placebo Group 3: n = 25; asymptomatic control	Frequency: Daily; except strengthening, three ×, week Duration: 8 weeks	Outcome measures: <i>Pain:</i> Work-related pain, ten-point numeric rating summary of six items <i>Function:</i> Self-report, Shoulder Rating Questionnaire (SRQ) <i>Disability:</i> Work-related disability, ten-point numeric rating summary of four items <i>Satisfaction:</i> Satisfaction with shoulder use, one ten-point numeric rating item Measurement intervals: Baseline 8–12 weeks	Between groups: Group 1 vs. 2: Intention-to-treat analysis; Group 1 had significantly less work-related pain (p <0.05), less work-related disability (p <0.05), greater self-report shoulder function (SDQ) (p <0.001); Greater satisfaction with their shoulder approached significance (p = 0.06)	1b	41
Bang and Deyle, 2000 ⁵⁵	N = 52 Dropouts: n = 2 (1 from each group) Age: 45, 42 (24–65) Symptoms duration: 4.4, 5.6 months	Group 1: Supervised exercise Group 2: Supervised exercise + manual joint mobilization Mobilizations: aimed at increasing movement of shoulder, cervical, and upper thoracic spine; massage, manual stretching Groups 1 and 2: Supervised exercise: two stretches, six strengthening exercises	Frequency: 30 minutes; two × week Duration: three weeks; for a total of six treatments	Outcome measures: <i>Pain:</i> Rating of pain (VAS) during resisted break tests of active abduction, ER and IR Self-report pain; six-point pt Likert scale <i>Function:</i> Self-report questionnaire; nine items; six-point Likert scale <i>Strength:</i> Isometric shoulder strength (abduction, ER, IR) Measurement intervals: Baseline one month (post treatment) two months	Between groups: <i>one-month follow up:</i> Group 2 vs 1: Group 2 had significantly less pain with resisted tests (p = 0.002) and greater strength (p = 0.016) <i>Two-month follow ups:</i> Group 2 vs 1: Group 2 had significantly improved self-reported shoulder function and pain (p = 0.005) Within group: <i>Pain:</i> Group 1 had 35% reduction, group 2 70%. <i>Function:</i> Group 1 had 17% improvement, group 2 35%. <i>Strength:</i> Group 1 no increase, group 2 16% increase	1b	38.5

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TABLE 3. (continued)

Study	Patients	Intervention	Parameters	Measurements	Results	Level of Evidence	Quality Score
Brox et al., 1993, 1999 ^{48,49}	N = 125 Dropouts: 10% at 2.5 years Age: 48 (23–66) Symptoms duration: 3 months Previous unsuccessful Rx of PT, NSAIDs, and steroids	Group 1: Arthroscopic surgery, then after: supervised exercise Group 2: Supervised exercise Group 3: Placebo (detuned laser) Groups 1 and 2: Supervised exercise aimed at normalizing dysfunctional movement patterns, stretching, and strengthening; patient education three visits	Frequency: Group 1: NA Group 2: 1 hour; two × week Group 3: NA Duration: Group 1: 20 treatment three to six months Group 2: 30 treatment three to six months Group 3: 12 treatment six weeks	Outcome measures: <i>Pain and Function:</i> Neer shoulder score: ~Pain (35 points) ~ Clinical function (30 points): strength, reaching, stability ~ Range of motion (25 points) ~ Radiologic evaluation (10 points) <i>Pain:</i> Self-report pain at rest, night, during tasks <i>Function:</i> Self-report function (2 items) Measurement intervals: Baseline three months 6 months 2.5 years	Between groups <i>Three- month and six-month follow up:</i> Intention to treat analysis; groups 1 and 2 had higher Neer scores vs 3 (p <0.001). No difference in outcomes between groups 1 and 2 <i>2.5-year follow up:</i> Intention-to-treat analysis; groups 1 and 2 vs 3: Group 1 (p <0.001) and group 2 (p <0.01) less pain at rest, night, and during activity; great ability to take down something from a wall cupboard and carry 5 kg at the side. groups 1 and 2: no differences, except for increased ability of group 2 to take something down from a wall cupboard (p <0.05)	2b	1993: 39.5 1999: 36.5
Conroy and Hayes, 1998 ⁵⁴	N = 14 Dropouts: 0 Age: 51, 55 Symptoms duration: NA N = 42 Dropouts: n = 3	Group 1: Supervised exercise Group 2: Supervised exercise + joint mobilization Joint mobilizations: to improve motion at the glenohumeral joint; accessory joint mobilizations Groups 1 and 2: Exercise: moist heat, AROM, stretching, strengthening, soft tissue mobilizations, patient education	Frequency: Group 1: 60 min; three × week Group 2: 90 minutes; Three × week Duration: three weeks; nine treatments	Outcome measures: <i>Pain:</i> Over 24 hours and with subacromial compression testing; VAS <i>Function:</i> Examiner-rated overhead function; three items, three-point Likert scale AROM: abduction, flexion, ER, IR; (goniometer) Measurement intervals: Baseline Post-treatment (within one to three days)	Between groups: Group 2 vs 1: Group 1 had less pain over 24 hours (p = 0.008) and less pain with subacromial compression testing (p = 0.032), No AROM or function differences Within group: Group 1: no differences pre- to posttreatment Group 2: less 24-hour pain (p = 0.005), pain with subacromial compression testing (p = 0.003) Unable to determine effect of treatment per group AROM and self-report function	2b	39

Rahme et al; 1998 ⁵⁷	<p>N = 42 Dropouts: <i>n</i> = 3 Age: 42 Symptoms duration: >1 year Previous PT or injection not effective in 37 of 42 patients</p>	<p>Group 1: Supervised exercise</p> <p>Group 2: Open anterior acromioplasty surgery; supervised exercise after No specific exercises listed</p>	<p>Frequency: Two to three × week</p> <p>Duration: Up to six months; unknown number of treatments</p>	<p>Outcome measures: <i>Pain:</i> Total pain = pain at rest (VAS) + pain rated with “pour out of pot” maneuver with 1 of water Success defined as >50% reduction in total pain <i>Function:</i> NA</p> <p>Measurement intervals: Baseline six months one year</p> <p>Outcome measures: <i>Pain and Function:</i> Modified Constant-Murley score Pain (15 points), one item ADL’s (20 points), four items AROM (40 points), four motions Power (25 points), one item</p> <p>At four months: only pain and ADL’s portion collected, treatment necessity after trial, opinion of acupuncture treatment</p> <p>Measurement intervals: Baseline four weeks (post-treatment) four months</p>	<p>Between groups: <i>six month follow up:</i> No statistically significant difference <i>One-year follow up:</i> Intention-to-treat analysis revealed 76% success with surgery versus 19% with exercise only (p <0.0005)</p>	2b	34
Kleinhenz et al, 1999 ⁶⁰	<p>N = 52 Dropouts: cc <i>n</i> = 7 at four weeks, <i>n</i> = 17 at four months Age: 34, 37 Symptoms duration: >4 weeks</p>	<p>Group 1: Acupuncture Acupuncture: 12 points out of a possible 20 acupuncture points</p> <p>Group 2: Placebo acupuncture needling</p>	<p>Frequency: 20 minutes; two × week</p> <p>Duration: four weeks; eight treatments</p>	<p>Outcome measures: <i>Pain and Function:</i> Modified Constant-Murley score Pain (15 points), one item ADL’s (20 points), four items AROM (40 points), four motions Power (25 points), one item</p> <p>At four months: only pain and ADL’s portion collected, treatment necessity after trial, opinion of acupuncture treatment</p> <p>Measurement intervals: Baseline four weeks (post-treatment) four months</p>	<p>Between groups: <i>At four weeks</i> Group 1 vs. 2: Intention to treat analysis, Group 1 demonstrated less total score on the modified Constant-Murley score (p = 0.014)</p> <p>Within groups: <i>At four weeks and four months</i> Group 1 demonstrated no pain differences baseline to four weeks, and four week to four months. group 2 demonstrated significantly less pain at four months compared with 4 weeks</p>	2b	39

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TABLE 3. (continued)

Study	Patients	Intervention	Parameters	Measurements	Results	Level of Evidence	Quality Score
Berry et al; 1980 ⁵⁰	N = 60 Dropouts: 0 Age: 51–56 Symptoms duration (mean): 16–18 months	Group 1: Acupuncture Group 2: Steroid injection + placebo tolmetin sodium Group 3: Steroid injection + active tolmetin sodium Group 4: Ultrasound Group 5: Placebo ultrasound and placebo tolmetin sodium	Frequency: 10 minutes of ultrasound; two × week Duration: four weeks; eight treatments	Outcome measures: <i>Pain:</i> Self-report: VAS and four-point Likert scale <i>Function:</i> Global rating of change; patient and examiner AROM: Shoulder abduction (goniometer) Success or failure, based on the need for steroid injection after four weeks Measurement intervals: Baseline four weeks (posttreatment)	Between groups: No differences between groups on any of the outcome measures Within groups: All groups demonstrated improvement in pain and AROM shoulder abduction (p <0.01)	2b	34
Nykanen et al, 1995 ⁵⁶	N = 73 Dropouts: 6 Age: 66, 67; (37–81) Symptoms duration: >2 months	Group 1: Pulsed ultrasound + supervised exercise Ultrasound: pulsed (1:4), 1.0 mHz, 1.0 w/cm ² Group 2: Placebo ultrasound + supervised exercise Groups 1 and 2: Supervised exercise of stretch strengthen, and massage	Frequency: 10 minutes of pulsed ultrasound; three × week Duration: Three to four weeks; 10– 12 treatments	Outcome measures: <i>Pain:</i> Index (VAS); pain during “empty can” test <i>Function:</i> Self-report ADL Index (VAS) AROM: Shoulder abduction (goniometer) Measurement intervals: Baseline Three to four weeks (posttreatment) four months 12 months	Between groups: No difference on outcome measures post treatment, four months, 12 months (p <0.05). Within groups: <i>Group 1:</i> Pain reduced significantly at posttreatment, four months, 12 months (p <0.001); ADL significantly reduced at posttreatment (p <0.001), four months (p <0.01), 12 months (p <0.05) <i>Group 2:</i> Pain reduced significantly at posttreatment (p <0.001), four months (p <0.05), 12 months (p <0.01); ADL significantly reduced at posttreatment (p <0.01)	2b	38.5

England et al; 1989 ⁵⁸	<p><i>N</i> = 30 Dropouts: 0 Age: 48 (18–78) Symptoms duration: >4 weeks; Mean: 12.5 weeks Patients with bicipital or supra spinatus tendonitis</p>	<p>Group 1: Laser Laser: 3-mW gallium–arsenic diode laser of 904 nm wavelength, 4000 Hz with 180-nanosecond pulse, peak power 10 W</p> <p>Group 2: Placebo laser</p> <p>Group 3: Drug therapy of naproxen sodium (550 mg two times daily)</p>	<p>Frequency: Five minutes of laser; three × week</p> <p>Duration: two weeks; six treatments</p>	<p>Outcome measures: <i>Pain:</i> Rating (VAS) <i>Function:</i> Self-report (VAS) <i>AROM:</i> Shoulder flexion, abduction, extension (goniometer) <i>Stiffness:</i> Self-report (VAS) <i>Restriction:</i> Self-report (VAS)</p> <p>Measurement intervals: Baseline Post-treatment (two weeks)</p>	<p>Between groups: Group 1 vs. 2: Group 1 had significantly greater AROM extension (p = 0.05), greater AROM flexion (p = 0.005), greater AROM abduction (p = 0.005), less subjective report of restriction (p = 0.005), less pain (p = 0.001), less stiffness (p = 0.05) and greater subjective report of function (p = 0.05)</p>	2b	33.5
Vecchio et al; 1993 ⁵⁹	<p><i>N</i> = 35 Dropouts: 0 Age: 54.4 (17–77) Symptoms duration (mean): 15 months</p>	<p>Group 1: Laser + supervised exercise Laser: 30-mW gallium–aluminium arsenide diode laser, 830 nm wavelength, 9 J/cm² × each tender point (up to 5) 5000 Hz</p> <p>Group 2: Placebo laser + supervised exercise</p> <p>Groups 1 and 2: Pendulum exercise, wall-climbing exercise for ROM</p>	<p>Frequency: 10 minutes of laser; two × week</p> <p>Duration: eight weeks; nine treatments</p>	<p>Outcome measures: <i>Pain:</i> Pain on resisted abduction (examiner-rated), self-rating for night, rest, and pain with movement (VAS) <i>Function:</i> Self-report (VAS) one item <i>AROM:</i> Painful arc during elevation (examiner rated)</p> <p>Measurement intervals: Baseline four weeks eight weeks</p>	<p>Between groups: No significant differences between groups on measures of pain, function or AROM</p>	2b	38.5
Saunders; 1995 ⁵¹	<p><i>N</i> = 24 Dropouts: 0 Age: 50.3 (37–64) Symptoms duration: >4 weeks</p>	<p>Group 1: Laser + patient education Laser: 40-mW gallium–arsenic diode laser, 820 nm wavelength, 30 J/cm², 5000 Hz</p> <p>Group 2: Placebo laser + patient education</p> <p>Groups 1 and 2: Patient education: advice on how to use their arm to decrease symptoms</p>	<p>Frequency: 3 minutes of laser; three × week</p> <p>Duration: three weeks; nine treatments</p>	<p>Outcome measures: <i>Pain:</i> Rating (VAS) <i>Function:</i> No self-report <i>Muscle force:</i> Transducer-measured “empty can” break test for supraspinatus <i>Tenderness:</i> Amount of pressure that induced pain at greater tuberosity measured by myometer</p> <p>Measurement intervals: Baseline Post-treatment (three weeks)</p>	<p>Between groups: Group 1 vs. 2: Group 1 had significantly less pain (p <0.05), greater muscle force (p <0.001), and less tenderness (p <0.05)</p>	2b	39

VAS = visual analog scale; NA = not available; Sec = seconds; Rep = repetitions; PT = physical therapy; NSAIDs = nonsteroid antiinflammatory drugs; ER = external rotation; IR = internal rotation; AROM = active range of motion; ADLs = activities of daily living.

appears to be of no benefit, and acupuncture yielded equivocal findings from two trials. The number of trials examining each specific intervention was limited, and the quality of these trials was moderate. The outcome measures were not consistent between trials for the measures of pain and self-report shoulder function, therefore preventing the pooling of results for a meta-analysis.

Is Therapeutic Exercise Effective?

Therapeutic exercise was the most well-investigated form of rehabilitation. The therapeutic exercise programs within the trials generally consisted of stretching the anterior and posterior shoulder girdle, muscle relaxation techniques, motor learning to normalize dysfunctional patterns of motion, and strengthening the rotator cuff and scapular muscles. Improvements in pain, patient satisfaction, levels of disability and functional loss, strength, shoulder range of motion, pain with subacromial compression, and overall shoulder use have been demonstrated with therapeutic exercise programs.^{48,49,53-56}

Evidence from level 1 and 2 randomized controlled studies indicates that therapeutic exercise is more effective in reducing pain and improving functional loss than placebo in both short- and long-term follow-up^{48,49} and more effective than no intervention in short-term follow-up.⁵³ Specifically, Brox et al.^{48,49} examined the effects of therapeutic exercise as compared with placebo laser treatment in a group of patients with degeneration and inflammation (tendinosis) of the rotator cuff. The exercise program was focused on normalizing dysfunctional neuromuscular patterns, initiated with antigravity exercises, then progressed to strengthening of the rotator cuff and scapular musculature. These exercises were performed under the supervision of a physical therapist and as part of the patient's home exercise program. At three and six months, there was significant improvement in a composite score of pain, function, and range of motion as compared with a placebo laser group. At 2.5 years, therapeutic exercise demonstrated less pain and improved disability as compared with a placebo laser. This trial was rated as a level 2, as recommended by Sackett⁴⁷ in trials in which confidence intervals are wide.

In a recent level 1 trial, Ludewig et al.⁵³ examined the effects of a ten-week home exercise program of stretching, strengthening, and a motor relearning technique in construction workers with regular exposure to overhead activity. These workers responded favorably to exercise with less work-related pain, less work-related disability, and greater self-reported shoulder function as compared with those construction workers not receiving any intervention.⁵³

Within-group analysis in several trials of therapeutic exercise focused on pretest–posttest change associated with a varied combination of stretching, strengthening, active range of motion, soft tissue mobilizations, and massage. Analysis of these level 1 and 2 trials indicate that these types of programs of therapeutic exercise are generally effective in reducing pain, improving shoulder range of motion, and self-reported shoulder function from preintervention to postintervention.⁵⁴⁻⁵⁶

Given the current evidence, therapeutic exercise is indicated as an effective intervention for patients with SAIS as opposed to no treatment or placebo treatment. However, in several studies, the interventions were vaguely described, thus making the techniques difficult to replicate. It is unclear what the optimal exercise regime is or the frequency and intensity of an exercise program. It is also unclear if a supervised rehabilitation program is superior to a prescribed home exercise program. Exercise is effective for patients with SAIS; however, we do not know which patients specifically respond to exercise(s). Not all patients within these trials responded to exercise. Future research is needed to determine clinical measurements that predict a favorable response among patients with SAIS or that differentiate among the different levels of rehabilitation required.

How Does Therapeutic Exercise Compare with Surgery?

When compared with surgical interventions, the evidence for therapeutic exercise is conflicting. A level 2 trial by Brox et al.^{48,49} demonstrated similar outcomes at three months, six months, and 2.5 years for patients treated surgically compared with those treated with therapeutic exercise. Rahme et al.⁵⁷ in a level 2 trial demonstrated similar findings with six-month follow-up, but at one-year follow-up, there was significantly greater pain reduction in the group treated surgically. There was no measure of patient report of function in this study. Additionally, patients may have been biased toward a better response to surgery from the outset, because most of the patients (88%) stated that previous injection or therapy was not effective before the start of the study. These findings indicate that surgery may be best used in patients who have failed exercise or injection.

Given the conflicting evidence, it seems reasonable that patients with SAIS should undergo a trial of therapeutic exercise intervention before surgical measures are considered. Identification of those patients that are most likely to respond to exercise or surgery could prove particularly useful in choosing the most appropriate intervention for individual patients. More specific evidence on the type, in-

tensity, and duration of exercise-based interventions is required to maximize the effectiveness of this approach in selected patients.

Rahme and colleagues⁵⁷ performed various tests before the start of their study to determine their usefulness in predicting which patients would have a successful outcome with surgery and rehabilitation. Patients in this randomized trial responded overwhelmingly to surgery, thus only that group contained enough subjects to use for a prediction model of success. Pain levels and two provocative tests developed by the authors, hand in neck test and pour out of pot test, were significant predictors of surgical success. The ability to separate those patients with a "better outcome" versus those with a "worse outcome" using these variables had a high sensitivity (78%) and specificity (90%).

Is Manual Therapy Effective?

Manual therapy techniques combined with therapeutic exercise, particularly upper quarter joint mobilization, appear to provide better outcomes than therapeutic exercise alone. Bang and Deyle⁵⁵ in a level 1 study demonstrated greater short-term improvement in pain and self-reported shoulder function when therapeutic exercise was combined with manual therapy. The manual therapy was primarily focused on glenohumeral joint mobilization, but attention was also given to the other joints and soft tissues of the cervical spine, thoracic spine, and shoulder girdle. Furthermore, Conroy and Hayes⁵⁴ in a level 2 study demonstrated significant improvement at posttreatment with those patients receiving joint mobilization, soft tissue mobilization, and therapeutic exercise when compared with those patients receiving only soft tissue mobilization and exercise treatment.

The evidence for the addition of joint mobilization to an exercise program is moderately strong. The study by Bang and Deyle⁵⁵ was performed across four rehabilitation centers on 52 subjects, thereby increasing the generalizability of their results. Conversely, Conroy and Hayes⁵⁴ had only 14 subjects treated in one single clinic. Neither study described an algorithm or guidelines for selection of joint mobilization techniques used. In light of the current evidence, it appears that the addition of joint mobilization techniques in combination with therapeutic exercise should be favored over exercise alone in the treatment of patients with SAIS. It is unclear as to the specific joint mobilization technique(s) that may provide benefit. Also, further research to identify which patients are most likely to respond to manual therapy and exercise may prove useful in making decisions about the management of individual patients with SAIS.

Is Laser Therapy Effective?

Low-level laser therapy is not commonly used as a physical agent in the United States. Theoretically, laser energy is transmitted to induce cell proliferation. A level 2 study by England et al.⁵⁸ revealed a short-term benefit on pain, self-reported function, active range of shoulder motion, stiffness, and restriction after two weeks of treatment as compared with a placebo laser. Additionally, the same low-level laser two-week treatment also demonstrated better pain relief and improvement in shoulder range of motion than nonsteroidal antiinflammatory medications.⁵⁸ Patients in this study had either supraspinatus or bicipital tendonitis, both of which may be associated with functional compromise of the subacromial space. A second level 2 study by Saunders⁵¹ demonstrated significant improvements in pain, strength, and tenderness at the greater tuberosity after three weeks in patients treated with laser therapy and advice on activity avoidance to reduce symptoms as compared with those treated with placebo laser and advice.

Conflicting results were demonstrated by Vecchio et al.⁵⁹ in a study comparing those treated with laser therapy and range of motion exercises compared with those treated with placebo laser and range of motion exercise. At four- and eight-week follow-up, there was no difference between groups with regard to pain, range of motion, function, or strength.

Although the current evidence is conflicting, it appears low-level laser therapy is more beneficial than placebo when applied as a single intervention for patients with SAIS. However, in combination with therapeutic exercise of active range of motion exercises, laser therapy has not demonstrated an additive benefit for reducing pain and improving function. It is not known if laser therapy would provide a benefit as an adjunct to other forms of treatment regimens of therapeutic exercise with or without joint mobilization. Given the relatively strong evidence for active rehabilitation, further research is needed to clarify the potential clinical use, optimal dosage, and mechanism of action for laser therapy as an adjunct to a therapeutic exercise program.

Is Ultrasound Therapy Effective?

Ultrasound therapy has not demonstrated effectiveness in the treatment of patients with SAIS. Nykanen⁵⁶ revealed no significant differences between those patients treated with pulsed ultrasound and a supervised exercise program and those treated with placebo ultrasound on the measures of pain, self-reported function, and range of motion at posttreatment or at long-term follow-up at four and 12 months. Furthermore, Berry et al.⁵⁰ demonstrated no significant reduction in pain, function, or range of

motion after four weeks of ultrasound when compared with placebo, acupuncture, steroid injection, or nonsteroidal antiinflammatory medications. The type of ultrasound (continuous or pulsed) was not described in this study. Neither of the level 2 studies investigating ultrasound demonstrated a beneficial effect of ultrasound in patients with SAIS. Given the current evidence, ultrasound therapy is not supported for use in patients with SAIS. It is unclear if different ultrasound dosing would provide benefit.

Is Acupuncture Effective?

Acupuncture treatment trials^{50,60} have provided equivocal evidence of effectiveness. Berry et al.⁵⁰ in a level 2 trial compared patients treated with acupuncture with those treated with placebo, ultrasound, steroid injection, or nonsteroidal antiinflammatory medications. Results revealed no differences between groups with regard to pain, self-reported function, or shoulder range of motion immediately posttreatment at four weeks. Conversely, Kleinhenz et al.⁶⁰ in a level 2 study demonstrated short-term benefits with regard to pain, function, and range of motion. In long-term follow-up at four months, these differences were no longer demonstrated. This is consistent with systematic reviews addressing the use of acupuncture for patients with shoulder pain; acupuncture is beneficial in managing pain in the short term but has no long-term benefits.^{38,41} Given the current evidence, acupuncture is not promoted or refuted for use in patients with SAIS because of the limited investigation and conflicted evidence at this time.

CONCLUSIONS

Based on the available evidence for the physical rehabilitation of patients with SAIS, clinical practice guidelines were developed. The current literature most strongly supports the use of therapeutic exercise to strengthen the rotator cuff and scapular muscles and to stretch the soft tissues of the anterior and posterior shoulder. Therapeutic exercise appears to be more effective when combined with joint mobilization techniques focused on the shoulder and upper quarter. A course of therapeutic exercise is recommended over no treatment or a placebo treatment, and should be attempted to reduce symptoms and restore function before surgery is considered. Laser therapy appears to be efficacious as an individual treatment, perhaps best used in those individuals who are unable to exercise. Laser has demonstrated no effect when combined with therapeutic exercise, and therefore is not recommended for use in combination with therapeutic exercise. Ultrasound is currently not supported, whereas

acupuncture is not refuted or promoted for the treatment of patients with SAIS.

The evidence to support rehabilitation interventions for patients with SAIS is limited and the quality of trials was moderate. The interventions examined were varied, the outcome measures used were inconsistent, and the results of some studies were conflicting. This leaves room for extensive clinical investigation of the optimal intervention strategies for patients with SAIS and determination of the variables that predict those who are most likely to respond to different interventions. Only half of the 12 trials had a placebo group that received either just a sham form of treatment or no treatment as opposed to an alternative form of treatment. This limits the ability to recommend physical interventions over a "wait and see" approach or no treatment. The follow-up time periods in most trials were short-term only. Treatment intervention efficacy was examined past the point of the last treatment in only six of the 12 trials. This limits the conclusions as to the long-term effectiveness of these interventions. Future research endeavors should examine the efficacy of well-defined therapeutic interventions for SAIS in both short-term and long-term outcomes. A placebo or no intervention group should be used for comparison for those interventions that have limited or no evidence.

The diagnosis of SAIS in the trials examined in this review was made based on a variety of clinical signs and symptoms as indicated in Table 2. This is a limitation of the research assessing interventions for SAIS, because there is no consensus in the literature for the diagnosis of SAIS. Future research should focus on the validity of clinical diagnosis of SAIS. A final limitation of these recommendations is the search strategy. Searching was limited to trials published in the English language, thus potentially limiting the strength and breadth of recommendations.

CLINICAL PRACTICE RECOMMENDATIONS

The following are grade B recommendations derived from level 1 or 2 studies. They are based on the ability of the indicated interventions to improve pain and functional loss or disability levels. These guidelines were devised to assist the clinician in evidence-based clinical decision making in patients with SAIS.

1. Therapeutic exercise aimed at stretching the anterior and posterior shoulder girdle, and strengthening of the rotator cuff and scapular stabilizing muscles is recommended over no treatment.
2. Therapeutic exercise combined with joint mobilizations aimed at improvement of mobility or

reduction of pain of the upper quarter is recommended.

3. Therapeutic exercise is recommended over surgical intervention for the first treatment option.
4. Low-level laser therapy as an adjunct to therapeutic exercise is not recommended.
5. Laser therapy as a single intervention is recommended in patients who are unable to perform therapeutic exercise.
6. Ultrasound therapy as an adjunct to therapeutic exercise or as a single intervention is not recommended.
7. Acupuncture as a single intervention is not discouraged or promoted.

REFERENCES

1. Picavet HS, Schouten JS. Musculoskeletal pain in The Netherlands: prevalences, consequences and risk groups, the DMC(3)-study. *Pain*. 2003;102:167-78.
2. Urwin M, Symmons D, Allison T, et al. Estimating the burden of musculoskeletal disorders in the community: the comparative prevalence of symptoms at different anatomical sites, and the relation to social deprivation. *Ann Rheum Dis*. 1998; 57:649-55.
3. Pope DP, Croft PR, Pritchard CM, Silman AJ. Prevalence of shoulder pain in the community: the influence of case definition. *Ann Rheum Dis*. 1997;56:308-12.
4. Nygren A, Berglund A, von Koch M. Neck-and-shoulder pain, an increasing problem. Strategies for using insurance material to follow trends. *Scand J Rehabil Med Suppl*. 1995;32:107-12.
5. van der Windt DA, Koes BW, de Jong BA, Bouter LM. Shoulder disorders in general practice: incidence, patient characteristics, and management. *Ann Rheum Dis*. 1995;54:959-64.
6. Vecchio P, Kavanagh R, Hazleman BL, King RH. Shoulder pain in a community-based rheumatology clinic. *Br J Rheumatol*. 1995;34:440-2.
7. Ludewig PM, Cook TM. Alterations in shoulder kinematics and associated muscle activity in people with symptoms of shoulder impingement. *Phys Ther*. 2000;80:276-91.
8. Lukasiewicz AC, McClure P, Michener L, Pratt N, Sennett B. Comparison of 3-dimensional scapular position and orientation between subjects with and without shoulder impingement. *J Orthop Sports Phys Ther*. 1999;29:574-83.
9. Neer CS. Anterior acromioplasty for the chronic impingement syndrome in the shoulder: a preliminary report. *J Bone Joint Surg [Am]*. 1972;54:41-50.
10. Fu FH, Harner CD, Klein AH. Shoulder impingement syndrome. A critical review. *Clin Orthop*. 1991;269:162-73.
11. Budoff JE, Nirschl RP, Guidi EJ. Debridement of partial-thickness tears of the rotator cuff without acromioplasty. Long-term follow-up and review of the literature. *J Bone Joint Surg [Am]*. 1998;80:733-48.
12. Uthoff HK, Hammond DI, Sarkar K, Hooper GJ, Papoff WJ. The role of the coracoacromial ligament in the impingement syndrome. A clinical, radiological and histological study. *Int Orthop*. 1988;12:97-104.
13. Bigliani LU, Levine WN. Subacromial impingement syndrome. *J Bone Joint Surg [Am]*. 1997;79:1854-68.
14. Warner JJ, Micheli LJ, Arslanian LE, Kennedy J, Kennedy R. Scapulothoracic motion in normal shoulders and shoulders with glenohumeral instability and impingement syndrome. A study using Moire topographic analysis. *Clin Orthop*. 1992; 285:191-9.
15. Endo K, Ikata T, Katoh S, Takeda Y. Radiographic assessment of scapular rotational tilt in chronic shoulder impingement syndrome. *J Orthop Sci*. 2001;6:3-10.
16. Ludewig PM, Cook TM. Translations of the humerus in persons with shoulder impingement symptoms. *J Orthop Sports Phys Ther*. 2002;32:248-59.
17. Poppen NK, Walker PS. Normal and abnormal motion of the shoulder. *J Bone Joint Surg [Am]*. 1976;58:195-201.
18. Deutsch A, Altchek DW, Schwartz E, Otis JC, Warren RF. Radiologic measurement of superior displacement of the humeral head in the impingement syndrome. *J Shoulder Elbow Surg*. 1996;5:186-93.
19. Paletta GA Jr, Warner JJ, Warren RF, Deutsch A, Altchek DW. Shoulder kinematics with two-plane x-ray evaluation in patients with anterior instability or rotator cuff tearing. *J Shoulder Elbow Surg*. 1997;6:516-27.
20. Ogata S, Uthoff HK. Acromial enthesopathy and rotator cuff tear. A radiologic and histologic postmortem investigation of the coracoacromial arch. *Clin Orthop*. 1990;254:39-48.
21. Banas MP, Miller RJ, Totterman S. Relationship between the lateral acromion angle and rotator cuff disease. *J Shoulder Elbow Surg*. 1995;4:454-61.
22. Vaz S, Soyer J, Pries P, Clarac JP. Subacromial impingement: influence of coracoacromial arch geometry on shoulder function. *Joint Bone Spine*. 2000;67:305-9.
23. Tuite MJ, Toivonen DA, Orwin JF, Wright DH. Acromial angle on radiographs of the shoulder: correlation with the impingement syndrome and rotator cuff tears. *AJR Am J Roentgenol*. 1995;165:609-13.
24. Prato N, Peloso D, Franconeri A, et al. The anterior tilt of the acromion: radiographic evaluation and correlation with shoulder diseases. *Eur Radiol*. 1998;8:1639-46.
25. Solem-Bertoft E, Thuomas KA, Westerberg CE. The influence of scapular retraction and protraction on the width of the subacromial space. An MRI study. *Clin Orthop*. 1993;296: 99-103.
26. Kebaetse M, McClure P, Pratt NA. Thoracic position effect on shoulder range of motion, strength, and three-dimensional scapular kinematics. *Arch Phys Med Rehabil*. 1999;80:945-50.
27. Ludewig PM, Cook TM. The effect of head position on scapular orientation and muscle activity during shoulder elevation. *J Occup Rehab*. 1996;6:147-58.
28. Wang CH, McClure P, Pratt NE, Nobilini R. Stretching and strengthening exercises: their effect on three-dimensional scapular kinematics. *Arch Phys Med Rehabil*. 1999;80:923-9.
29. Cools AM, Witvrouw EE, Declercq GA, Danneels LA, Cambier DC. Scapular muscle recruitment patterns: trapezius muscle latency with and without impingement symptoms. *Am J Sports Med*. 2003;31:542-9.
30. Warner JJ, Micheli LJ, Arslanian LE, Kennedy J, Kennedy R. Patterns of flexibility, laxity, and strength in normal shoulders and shoulders with instability and impingement. *Am J Sports Med*. 1990;18:366-75.
31. Reddy AS, Mohr KJ, Pink MM, Jobe FW. Electromyographic analysis of the deltoid and rotator cuff muscles in persons with subacromial impingement. *J Shoulder Elbow Surg*. 2000;9: 519-23.
32. Leroux JL, Codine P, Thomas E, Pocholle M, Mailhe D, Blotman F. Isokinetic evaluation of rotational strength in normal shoulders and shoulders with impingement syndrome. *Clin Orthop*. 1994;304:108-15.
33. Bartolozzi AR, Andreychik D, Ahmad S. Determinants of outcome in the treatment of rotator cuff disease. *Clin Orthop*. 1994;308:90-7.
34. Hawkins RJ, Dunlop R. Nonoperative treatment of rotator cuff tears. *Clin Orthop*. 1995;321:178-88.
35. Wadsworth DJ, Bullock-Saxton JE. Recruitment patterns of the scapular rotator muscles in freestyle swimmers with subacromial impingement. *Int J Sports Med*. 1997;18:618-24.
36. Harryman DT, Sidles JA, Clark JM, McQuade KJ, Gibb TD, Matsen FA III. Translation of the humeral head on the glenoid with passive glenohumeral motion. *J Bone Joint Surg [Am]*. 1990;72:1334-43.
37. Tyler TE, Nicholas SJ, Roy T, Gleim GW. Quantification of posterior capsule tightness and motion loss in patients with shoulder impingement. *Am J Sports Med*. 2000;28:668-73.

38. Green S, Buchbinder R, Hetrick S. Physiotherapy interventions for shoulder pain. *Cochrane Database Syst Rev.* 2003; 2:CD004258.
39. Philadelphia Panel evidence-based clinical practice guidelines on selected rehabilitation interventions for shoulder pain. *Phys Ther.* 2001;81:1719-30.
40. van der Heijden GJ. Shoulder disorders: a state-of-the-art review. *Baillieres Best Pract Res Clin Rheumatol.* 1999;13:287-309.
41. van der Heijden GJ, van der Windt DA, de Winter AF. Physiotherapy for patients with soft tissue shoulder disorders: a systematic review of randomised clinical trials. *BMJ.* 1997; 315:25-30.
42. Desmeules F, Cote CH, Fremont P. Therapeutic exercise and orthopedic manual therapy for impingement syndrome: a systematic review. *Clin J Sports Med.* 2003;13:176-82.
43. Winters JC, Sobel JS, Groenier KH, Arendzen HJ, Meyboom-de Jong B. Comparison of physiotherapy, manipulation, and corticosteroid injection for treating shoulder complaints in general practice: randomised, single blind study. *BMJ.* 1997; 315:1320-5.
44. Winters JC, Jorritsma W, Groenier KH, Sobel JS, Meyboom-de Jong B, Arendzen HJ. Treatment of shoulder complaints in general practice: long term results of a randomised, single blind study comparing physiotherapy, manipulation, and corticosteroid injection. *BMJ.* 1999;318:1395-6.
45. Ginn KA, Herbert RD, Khouw W, Lee R.A randomized, controlled clinical trial of a treatment for shoulder pain. *Phys Ther.* 1997;77:802-9.
46. Anderson NH, Sojbjerg JO, Johannsen HV, Sneppen O. Self-training versus physiotherapist-supervised rehabilitation of the shoulder in patients treated with arthroscopic subacromial decompression: a clinical randomized study. *J Shoulder Elbow Surg.* 1999;8:99-101.
47. Sackett DL, Straus SE, Richardson WS, Rosenberg W, Haynes RB. *Evidence-based Medicine* New York: Churchill Livingstone, 2000.
48. Brox JI, Staff PH, Ljunggren AE, Brevik JI. Arthroscopic surgery compared with supervised exercises in patients with rotator cuff disease (stage II impingement syndrome). *BMJ.* 1993;307:899-903.
49. Brox JI, Gjengedal E, Uppheim G, et al. Arthroscopic surgery versus supervised exercises in patients with rotator cuff disease (stage II impingement syndrome): a prospective, randomized, controlled study in 125 patients with a 2 1/2-year follow-up. *J Shoulder Elbow Surg.* 1999;8:102-11.
50. Berry H, Fernandes L, Bloom B, Clark RJ, Hamilton EB. Clinical study comparing acupuncture, physiotherapy, injection and oral anti-inflammatory therapy in shoulder-cuff lesions. *Curr Med Res Opin.* 1980;7:121-6.
51. Saunders L. The efficacy of low level laser therapy in supraspinatus tendonitis. *Clin Rehabil.* 1995;9:126-34.
52. Michener LA, Leggin BG. A review of self-report scales for the assessment of functional limitation and disability of the shoulder. *J Hand Ther.* 2001;14:68-76.
53. Ludewig PM, Borstad JD. Effects of a home exercise programme on shoulder pain and functional status in construction workers. *Occup Environ Med.* 2003;60:841-9.
54. Conroy DE, Hayes KW. The effect of joint mobilization as a component of comprehensive treatment for primary shoulder impingement syndrome. *J Orthop Sports Phys Ther.* 1998;28:3-14.
55. Bang MD, Deyle GD. Comparison of supervised exercise with and without manual physical therapy for patients with shoulder impingement syndrome. *J Orthop Sports Phys Ther.* 2000;30:126-37.
56. Nykanen M. Pulsed ultrasound treatment of the painful shoulder a randomized, double-blind, placebo-controlled study. *Scand J Rehabil Med.* 1995;27:105-8.
57. Rahme H, Solem-Bertoft E, Westerberg CE, Lundberg E, Sorensen S, Hilding S. The subacromial impingement syndrome. A study of results of treatment with special emphasis on predictive factors and pain-generating mechanisms. *Scand J Rehabil Med.* 1998;30:253-62.
58. England S, Farrell AJ, Coppock JS, Struthers G, Bacon PA. Low power laser therapy of shoulder tendonitis. *Scand J Rheumatol.* 1989;18:427-31.
59. Vecchio P, Cave M, King V, Adebajo AO, Smith M, Hazleman BL. A double-blind study of the effectiveness of low level laser treatment of rotator cuff tendonitis. *Br J Rheumatol.* 1993;32:740-2.
60. Kleinhenz J, Streitberger K, Windeler J, Gussbacher A, Mavridis G, Martin E. Randomised clinical trial comparing the effects of acupuncture and a newly designed placebo needle in rotator cuff tendonitis. *Pain.* 1999;83:235-41.
61. Hawkins RJ, Kennedy JC. Impingement syndrome in athletes. *Am J Sports Med.* 1980;8:151-8.
62. Neer CS. Impingement lesions. *Clin Orthop.* 1983;173:70-7.
63. Magee DJ. *Orthopedic Physical Assessment* 3rd ed. Philadelphia: WB Saunders Co, 1997.