LITERATURE REVIEW

MANIPULATIVE THERAPY FOR SHOULDER PAIN AND DISORDERS: EXPANSION OF A SYSTEMATIC REVIEW

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ABSTRACT

Objective: The purpose of this study was to conduct a systematic review on manual and manipulative therapy (MMT) for common shoulder pain and disorders.

Methods: A search of the literature was conducted using the Cumulative Index of Nursing Allied Health Literature; PubMed; Manual, Alternative, and Natural Therapy Index System; Physiotherapy Evidence Database; and Index to Chiropractic Literature dating from January 1983 to July 7, 2010. Search limits included the English language and human studies along with MeSH terms such as *manipulation*, *chiropractic*, *osteopathic*, *orthopedic*, *musculoskeletal*, *physical therapies*, *shoulder*, etc. Inclusion criteria required a shoulder peripheral diagnosis and MMT with/without multimodal therapy. Exclusion criteria included pain referred from spinal sites without a peripheral shoulder diagnosis. Articles were assessed primarily using the Physiotherapy Evidence Database scale in conjunction with modified guidelines and systems. After synthesis and considered judgment scoring were complete, with subsequent participant review and agreement, evidence grades of A, B, C, and I were applied.

Results: A total of 211 citations were retrieved, and 35 articles were deemed useful. There is fair evidence (B) for the treatment of a variety of common rotator cuff disorders, shoulder disorders, adhesive capsulitis, and soft tissue disorders using MMT to the shoulder, shoulder girdle, and/or the full kinetic chain (FKC) combined with or without exercise and/or multimodal therapy. There is limited (C) and insufficient (I) evidence for MMT treatment of minor neurogenic shoulder pain and shoulder osteoarthritis, respectively.

Conclusions: This study found a level of B or fair evidence for MMT of the shoulder, shoulder girdle, and/or the FKC combined with multimodal or exercise therapy for rotator cuff injuries/disorders, disease, or dysfunction. There is a fair or B level of evidence for MMT of the shoulder/shoulder girdle and FKC combined with a multimodal treatment approach for shoulder complaints, dysfunction, disorders, and/or pain. (J Manipulative Physiol Ther 2011;34:314-346)

Key Indexing Terms: *Chiropractic; Manipulation; Shoulder; Shoulder Pain; Randomized Controlled Trials*

In 2008, McHardy et al[1] published the first extensive systematic review of chiropractic treatment of upper extremity conditions and disorders. McHardy et al required that research articles include "a peripheral diagnosis and chiropractic intervention." Research articles were excluded "if (1) pain was referred from proximal or spinal sites, (2) the patient was referred for surgical intervention, (3) the condition was not amendable to chiropractic

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treatment, or (4) a red-flag condition or diagnosis was present (unless post-surgical rehabilitation occurred)." The authors also required that treatment had to be either "peripheral or spinal or a combination of both."[1] They further wrote "there is a paucity of literature that describes the singular use of high-velocity, low-amplitude (HVLA) thrust manipulation of the extremities."[1]

A number of extremity mobilizations, manipulations, techniques, or "moves" were included in a textbook by BJ Palmer as long ago as 1911; and teaching the use of adjustive extremity technique, including mobilization and adjunctive or multimodal therapies, such as exercise and/or what was later termed *physical therapy*, can be dated back at least 100 years.[2-5] As others have posited, there is an apparent disconnect between the services chiropractors actually provide, the public perception of the services provided by chiropractors, and what some within the profession believe should be provided.[1] Although many if not most chiropractors provide various physiotherapy modalities including exercise prescription, electrical modalities and ultrasound, and a range of soft tissue techniques as well as joint mobilization for extremity disorders, medicine and the public tend to focus solely on the traditional HVLA adjustment or manipulation applied to the spine.[1,6] As many chiropractors actually use a broad multimodal approach to extremity care as outlined above, research should be directed to this broader, more inclusive definition of chiropractic care.[1,7]

Building upon the work of McHardy et al and using similar methodology, structure, and format, this is an expansion and update of that seminal work. The present research review includes additional chiropractic studies subsequently published as well as other similar manual and/or manipulative therapy research.[1]

For the purposes of this updated and expanded literature review, the term *chiropractic* has been replaced by *manipulative therapy* to facilitate inclusion of all similar, related, peer-reviewed literature. For this review, the authors define *manipulative therapy* as inclusive of all "manual" or "adjustive" procedures and/or therapy that includes grades I to IV++ of mobilization techniques and procedures and grade V manipulation, or HVLA thrust manipulation, with and without adjunctive or multimodal therapy.[1,8-11]

Since the publication of the McHardy et al review, Bronfort et al[12] (2010) have published a comprehensive summary of the scientific evidence regarding the effectiveness of manual therapy in the management of a broad spectrum of common musculoskeletal conditions seen by chiropractors including disorders of the spine and the lower and upper extremities, and nonmusculoskeletal complaints. Of interest, Bronfort et al[12] appraised literature regarding manual therapy for the shoulder. However, Bronfort et al restricted their selection of evidence to only the largest, highest-quality, and methodologically "best" randomized controlled and/or clinical trials (RCTs). They did not consider research that did not meet a stringent level for RCTs nor other types of studies.[12,13] Although the Bronfort review is of undoubted value to some, using such a limited number of studies does not fully align with evidence-based medicine or care (hereafter EBC) as conceived by Sackett et al[14] and others.[12,13] For example, the efficacy of a new drug therapy, initially tested in narrowly defined and stringent RCTs, may be later determined to be less effective in clinical practice because of the complexity of the heterogeneity of patient populations, comorbidities, as well as patient compliance. Furthermore, patient and practitioner preferences cannot be taken into account solely through RCTs; yet these variables are often found in different degrees in a variety of other studies.[12-21] There are flaws in most every research study and all research designs; one must be cognizant of these limitations and interpret the findings carefully, not discounting all findings outside of the most stringent of RCTs. Therefore, in the interest of painting as broad a view of the existing evidence, this review will accept a broader range of RCTs, as well as single-group pretest posttest designs (SGPPDs), case series, and case reports, with a consensus view that all are still needed in the context of a larger review as vital components in guiding the delivery of "best patient care" and in developing new lines and areas of research.[12-21]

As Johnson[22] suggests, Sackett et al[14] originally developed EBC to improve practice and best patient care, improved practice and best patient care never being intended to be derived solely from RCTs, but rather derived from "tracking down the best external evidence." Regrettably, one large, apparently well-designed RCT can be misleading, skew and distort knowledge, and do much harm when used unscrupulously out of context.[23,24] In this regard, Manchikanti et al[23] have suggested that "the hierarchy of evidence has done nothing more than glorify the results of imperfect experimental designs on unrepresentative populations in controlled research environments above all other sources of evidence that may be equally valid or far more applicable in given clinical circumstances."

Haldeman et al[13] and others have suggested that up to 80% of the practice of medicine is still based on and supported by sources with lesser levels of evidence than only large, high- or very high quality, methodologically faultless RCTs.[14,15,22,25-27] Where then, or from what other studies, can such types of evidence be found: information "to improve practice and best patient care … for each individual, taking into account singular, individual clinical characteristics, co-morbidities and personal values and preferences for each particular individual…"?[13-15,22] As Shacklock[28] notes in a commentary about a systematic review of manual therapy for neural mobilization "patient-therapist interactions are critical in affecting patient compliance which inevitably produces physical effects in the tissues. So even though this systematic review is appropriately directed at the holy grail (high level

evidence), the therapist should not be deterred from using their clinical acumen in dealing with subtle nuances that have not yet been measured. There is simply much more research to be done before we can base treatment on randomized controlled trials and I am not aware of any systematic review or meta-analyses system for evaluating large scale qualitative phenomena, yet."

A variety of reviews and research looking at current interventions and how often such interventions are actually "evidenced based" has been forced to admit the lack of RCTs, particularly high-level RCTs, in the majority of cases, with consensus-based expert opinion required for best evidence guidelines.[20,23,29-31] However, so-called experts can be wrong.[20,23,32-34] It must also be acknowledged that, although it appears to be improving, there is as of yet no comprehensive consensus of internationally accepted and fully agreed upon gradated levels of EBC.[35-38]

How is it possible then to practice without RCTs, or to develop a linear understanding of literature gaps, or to develop research to fill those gaps and develop better designed trials and studies to improve best patient care without listing or reviewing all levels of evidence and RCTs?[26,27,39-43] In fact, most diagnoses have no RCTs undergirding them to guide practitioners.[13] Indeed, one of the RCTs listed in this study was developed directly and indirectly from the McHardy et al review and was further dependent on information generated through the included case series and reports (studies now often and/or generally excluded).[1,44] The answer is that all levels of evidence, as intended by Sackett et al[14] and others, must be considered.[13,15-19,28]

Therefore, building upon the McHardy et al[1] seminal effort and the recent work by Brantingham et al,[7] this review has adopted similar methodology using a parallel structure. This present review expands on and updates this work by reviewing all relevant professional sources, including chiropractic literature.[1] In addition, this review uses Bronfort et al[12] and other systematic reviews yet, unlike either previous study, will examine the shoulder alone. While acknowledging the previous work of these groundbreaking 2008 and 2010 reviews, the conclusions in this article are solely those of the included authors.[1,7,12]

Various treatments included in this review of manipulative therapy suggest possible alternatives for (a) those who may not or should not have surgery, (b) those who may not or should not chronically use nonsteroidal anti-inflammatory drugs (NSAIDS), and (c) those for whom exercise alone has not been effective.[7,12,39,45,46] Research into the application of manual therapy techniques has erupted, including intensive investigation by nearly all professions that treat the shoulder with manual and manipulative therapy (MMT) techniques. These investigations with and without multimodal or rehabilitative care include exploration into the most common manipulative method used by chiropractors, HVLA manipulation or thrust technique.[12,25,47] Broadly revisiting MMT studies to review the quantity, quality, and types of research published is needed, with the goal of ranking, grading, and presenting common characteristics. The purpose of this study to provide an update and a fuller, broader, general, and more expansive review of past, current, new, and innovative multimodal MMT approaches being developed to treat common shoulder disorders, pain, and dysfunction.

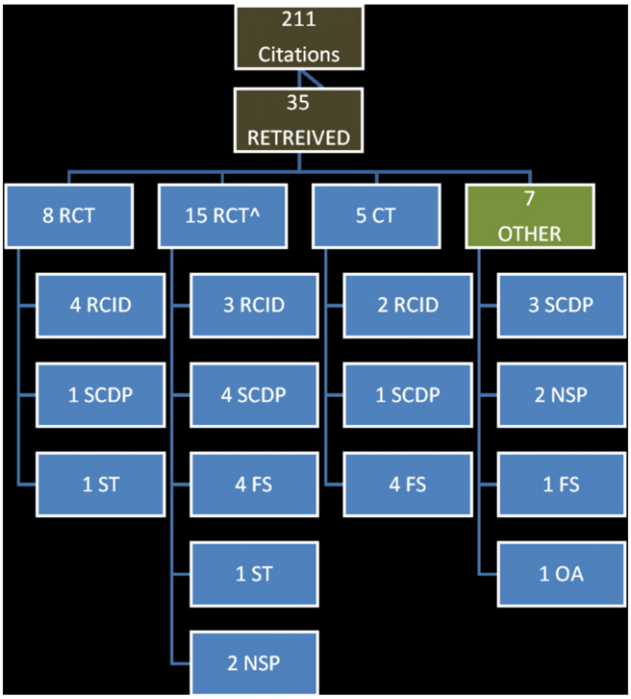

Fig 1. *Specific types of studies selected. (Color version of figure is available online.)*

Methodology

For this systematic review, a search of the literature was conducted using the Cumulative Index of Nursing Allied Health Literature; PubMed; Manual, Alternative, and Natural Therapy Index System; Physiotherapy Evidence Database (PEDro); and Index to Chiropractic Literature inclusive of literature dating from January 1983 to July 7, 2010. Search limits were set to include the English language, abstract, and human studies. Search terms included *shoulder and spinal adjustments*, *spinal manipulation*, *mobilization and peripheral diagnosis or diagnosis*, and *randomized clinical trials and/or randomized controlled trials*. Other search terms used were *manipulation* and one of the following terms: *chiropractic*, *osteopathic*, *orthopedic*, *musculoskeletal*, *physical therapies*, and *manual therapies*. There were 84 citations retrieved from the Cumulative Index of Nursing Allied Health Literature, 64 citations were retrieved from PubMed, 49 citations were

Table 1. *Whole systems research considerations scale*[60]

	Point if "yes"
1 Intervention included entire clinical encounter (rather than single procedure only)	
1a ● Intervention tested "package" of care	1
2 Patient preferences/expectations assessed	
2a ● Treatment preference or expectations assessed	1
3 Intervention individualize to the patient	
3a ● Practitioner could use clinical judgement to modify procedures	1
3b ● Practitioner could use clinical judgement to modify number of visits, duration of care	1
4 Intervention representative of usual practice	
4a ● Delivered by experienced by practitioners	1
4b ● Procedures/protocols based on usual practice, as documented by case reports, case series of large observational studies	1
4c ● Principal investigator delivered treatments (−1)	−1
4d ● Fees for services were representative of usual practice	1
5 Comparison group representative of "real life"	
5a ● "Real-life" comparisons such as no treatment, waiting list, or standard medical care use	1
5b ● Sham/placebo procedure same as procedures used in usual practice (such as soft tissue therapy) (−1)	−1
6 Outcome assessments measured effects important to patients	
6a ● Primary outcomes were patient-based measures (pain, function, health status)	1
6b ● Satisfaction assessed	1
7 General/systemic/QOL effects assessed	
7a ● Health status or QOL instrument administered pre- and postintervention	1
Total	11

Total maximum score = 11, with 0 to 3 rated "low," 4 to 7 rated "medium," and 8 to 11 rated "high." *QOL*, Quality of life.

retrieved from the Index to Chiropractic literature; 11 citations were from the Manual, Alternative, and Natural Therapy Index System; and 3 citations were taken from PEDro for a total of 211 citations retrieved. Once the articles were reviewed, 35 were deemed useful for our review (Fig 1).

In the McHardy et al[1] review, when describing *chiropractic treatment*, they noted that there was a paucity of studies using HVLA thrust manipulation for the upper extremity, including the shoulder. In addition, it was found that, with manipulative or manual therapy treatment of shoulder pain and disorders, chiropractors generally used the "multimodal" approach.[1] However, as will be demonstrated, use of HVLA manipulation is beginning to incrementally increase in research. Multimodal procedures include the use of exercise, strengthening, and stretching (rehabilitation), along with numerous soft tissue therapies, manual or instrument assisted, splinting, electrical, and mechanical modalities and techniques.[1] Multimodal procedures are most often combined with manipulation and/or mobilization, and/or other manual, functional, or rehabilitative procedures such as proprioceptive neuromuscular facilitation (PNF).[1] Very few peer-reviewed articles reviewed by McHardy et al[1] used what they called the "classic" approach, spinal or extremity manipulation only; most used the "multimodal" approach. Reflecting the more common multimodal practice that at least three quarters of the chiropractic profession use, this literature review replaces the term *chiropractic* by the term *manipulative therapy* to facilitate inclusion and review of all literature from accessible peer-reviewed sources.[48,49]

Inclusion and Exclusion Criteria

Inclusion criteria were based upon but modified from McHardy et al[1] and Brantingham et al[7] and required a shoulder peripheral diagnosis and some form of manipulative therapy with and/or without multimodal or adjunctive therapy. Articles were excluded when (1) pain was referred from spinal sites (without a peripheral shoulder diagnosis), with a minimum requirement of diagnoses such as "shoulder pain and/or dysfunction"; (2) there was referral for surgical intervention (unless there was documented full postsurgical healing with or without rehabilitation); (3) the condition was not amendable for manipulative therapy (RA, fracture, ligament tear with instability, etc), (4) a red-flag diagnosis (signs of infection, drug abuse, weight loss, previous malignancy, chronic nonmechanical pain, bone deformities, widespread neurological symptoms, violent trauma, swelling, pain at rest, night sweats, HIV, etc) was identified; or (5) there was a peripheral diagnosis absent a description of management or intervention.[47,50-52] In the current review, osteopathic, physical therapy, and other medical literature, including a doctoral dissertation, were included; however, review-type articles were excluded. Non–peer-reviewed literature, conference proceedings, grand rounds, and discussion articles that did not render treatment were also excluded.

Data were abstracted independently by 3 of the authors (independent assessment and combined agreement regarding the PEDro and whole systems research [WSR] scores). Most articles were obtained as electronic PDFs, with a few hard-copy articles scanned and shared from the Cleveland Chiropractic College Los Angeles library.

Table 2. *Levels of evidence, RCTs, CTs and other studies*[56-58]

The levels of evidence used below are primarily derived from Harbour and Miller.[56]

Grade A: good evidence from relevant studies
- Studies with appropriate designs and sufficient strength to answer the questions.
- Results are both clinically important and consistent with minor exceptions at most.
- Results are free of significant doubts about generalizability, bias, and design flaws.
- Negative studies have sufficiently large sample sizes to have adequate statistical power.

Grade B: fair evidence from relevant studies
- Studies of appropriate designs of sufficient strength, but with inconsistencies or minor doubts about generalizability, bias, design flaws, or adequacy of sample size
- Evidence solely from weaker designs, but confirmed in separate studies

Grade C: limited evidence from studies/reviews
- Studies with substantial uncertainty due to design flaws or adequacy of sample size.
- Limited number of studies weak design for answering the question addressed.

Grade I: No recommendation can be made because of insufficient or nonrelevant evidence.
- No evidence that directly pertains to the addressed question either because studies have not been performed or published, or are nonrelevant.

Condition	Quality		Grade of evidence
RCIDs[a]	RCTs or CTs[a] 2 VHQ[b] 5 HQ 3 MQ 1 LQ	Systematic reviews Systematic reviews with minimal and/or greater support for MMT combined with (and/or a few RCTs/studies without) exercise/rehab and/or multimodal care for treatment of RCID Bronfort et al[12] Green et al[39] Desmueles et al[40] Ho et al[46] McHardy et al[1] Supportive case report(s) and series (CR, CS): Krenner and Fung[101] (2005) WSR (CR) 7 Pribicevic and Pollard[52] (2005) WSR (CS) 8	B There is fair evidence (B) for the treatment of a variety of RCIDs using MMT[c] to the shoulder,[d] shoulder girdle,[e] and/or the FKC[f] usually combined with (and in some cases without) exercise and/or multimodal therapy (see individually cited studies and/or Tables 3-7).
SCDP[a]	RCTs or CTs 2 VHQ 4 HQ 1 MQ	Systematic reviews Systematic reviews with minimal and/or greater support for MMT combined with (and/or a few RCTs/studies without) exercise/rehab and/or multimodal care for treatment of SCDPs Bronfort et al[12] Ho et al[46] McHardy et al[1] Supportive SGPPDs or studies and/or (CR) case report(s) and series (CS): SGPPDs: Mintken et al[96] 2010 WSR Struance et al[103] 2009 WSR (SGPPD) Lynch et al[104] 2008 WSR	B There is fair evidence (B) for the treatment of a variety of SCDPs using MMT to the shoulder, shoulder girdle, and/or the FKC usually combined with (and in some cases without) exercise and/or multimodal therapy (see individually cited studies and/or Tables 3-7).
FS[a]	RCTs or CTs 1 VHQ 2 HQ 3 MQ	Systematic reviews Systematic reviews with minimal and/or greater support for MMT combined with (and/or a few RCTs/studies without) exercise/rehab and/or multimodal care for treatment of FS Bronfort et al[12] Green et al[39] Ho et al[46] McHardy et al[1] Supportive case report(s) and series (CR, CS): Krenner and Fung[101] (2005) WSR (CR) Pribicevic and Pollard[52] (2005) WSR (CS)	B There is fair evidence (B) for the treatment of FS (adhesive capsualitis) using MMT to the shoulder, shoulder girdle, and/or the FKC usually combined with (and in some cases without) exercise and/or multimodal therapy (see individually cited studies and/or Tables 3-7).

Table 2. (*continued*)

ST disorders[g]	RCTs or CTs 2 HQ 1 MQ	Systematic reviews Systematic reviews with minimal and/or greater support for MMT combined with (and/or a few RCTs/studies without) exercise/rehab and/or multimodal care for treatment of ST disorders Bronfort et al[12] Ho et al[46] McHardy et al[1] Supportive case report(s) and series (CR, CS): Krenner et al[101] (2005) WSR (CR) Pribicevic and Pollard[52] (2005) WSR (CS)	B There is fair evidence (B) for the treatment of ST disorders using MMT to the shoulder, shoulder girdle, and/or the FKC usually combined with (and in some cases without) exercise and/or multimodal therapy (see individually cited studies and/or Tables 3-7). MMT may mean manual or manipulative therapy but generally suggests in this review the use of ST techniques such as trigger/pressure point therapy using ischemic compression and/or pressure point therapy and/or local petrissage or transverse friction massage, often followed with therapeutic stretch. MMT can also mean the use of postisometric relaxation technique applied to a single or multiple joint area with stretch. Various modifications and other specialized ST techniques are listed in Tables 3-7 or see individually cited studies.
NSP[h]	RCTs 2 HQ	Supportive SGPPDs or studies and/or (CR) case report(s) and series (CS): SGPPD Wang and Meadows[108] 2010 WSR (CS) Rimbey[97] 2005 WSR (CR)	C There is limited evidence (C) for the treatment of minor NSP disorders using MMT NSP = minor (referred) NSP; NSP = minor peripheral NSP (and/or also known as minor peripheral nerve injuries and/or disorders or MPNIDs such as minor cervical brachial or cervical brachialgia and/or minor brachial plexus and/or entrapment disorders: for details, see articles Overall, too few studies, small sample size, and/or not large or fully powered studies and/or enough systematic reviews at this time.
Shoulder OA	RCTs No MMT RCTs devoted to OA (some RCTs have isolated patients that have had a diagnosis of shoulder OA)	(See individually cited studies and/or Tables 4 and 5). RCTs Shoulder OA patients included RCTs in: Knebl et al[41] Pribicevic et al[44] (2010) CR Cibulka and Hunter[109]	I There is insufficient evidence (I) for the treatment of shoulder OA using MMT. There is an insufficient level of evidence for MMT with or without exercise or multimodal therapy in the treatment of OA of the shoulder. MMT may/must be added cautiously to standard care (=exercise and/or rehabilitation and/or multimodal care). Consider early referral to appropriate practitioner if no or poor early response.

[a] *RCID*, Rotator cuff injuries disease or disorders; *SCDP*, shoulder complaints, dysfunction, disorders and/or pain; *FS*, frozen shoulder; *RCT*, randomized controlled trial (treatment vs placebo); *RCT^*, randomized clinical trial (treatment vs another treatment; usually comparative treatment demonstrated superior to placebo or standard care); *CT¥*, a controlled or clinical trial with systematic assignment (pseudo- or partial randomization) or nonrandomization, but with inclusion, exclusion, controlled, independent, and dependent variables vs placebo and/or comparative treatment.

[b] Very high quality score = 9-10, HQ score = 7-8, MQ score = 5-6, LQ = 3-4 (derived from PEDro).

[c] *MMT* = manual or manipulative therapy = grades I-IV++ mobilization and grade V HVLA manipulation; as well as soft tissue procedures (trigger point therapy, transverse friction massage, therapeutic massage, proprioceptive neurofacilitation techniques, etc).

[d] Shoulder = For this article, denotes the GH joint and/or also the AC joint and SC joint.

[e] *Shoulder girdle* is defined in various ways and is *not* standardized but in this article often refers to studies that defined it as the cervical and thoracic spines and upper rib joint dysfunction causing pain from the base of the neck to the elbow (see individually cited studies and/or Tables 3-7).

[f] *FKC* = MMT applied to all the above defined under *MMT* and shoulder girdle or shoulder, including C-T-spines, upper ribs and/or GH, AC, and SC joints and/or as well as the entire upper extremity, including through the elbow and wrist.

[g] ST disorders = soft tissue disorders (of the shoulder). ST of the shoulder = trigger points and/or pressure/tender points and/or taut muscle or fascial and/or myofascial bands with local or referred pain without or with applied pressure into the involved muscles and fascia in and/or around the shoulder/shoulder girdle or FKC; also known as *myofascial pain and dysfunction syndrome* (MPDS and/or similar terminology).

[h] NSP = (minor referred) neurogenic shoulder pain is also known as *minor peripheral nerve injuries and/or disorders* or MPNIDs (serious neurological pathology from diabetes or other neurological disease must be ruled out and referred to the appropriate practitioner).

First, relevant articles were read, reviewed, and assessed with the valid and reliable PEDro scale or ranking system.[53,54] It uses an 11-point scale (the first point being an eligibility criteria not counted or included as part of the score, as it relates to external validity); thus, the score is ranked from "10 best" to "0 the worst."[53,54] For PEDro, methodological scores of 9 to10 are considered excellent, 6 to 8 as good, 4 to 5 as fair, and 3 or less as poor methodological quality.[55] However, for this review, we have used guideline and scoring recommendations per Harbour and Miller, a previous review, and the SIGN and CCGPP guidelines.[7,56-58] It is suggested that PEDro

Table 3. *Summary of research on randomized controlled trials, randomized clinical trials, and clinical trials*

Author	Study	Condition	Participants/length of study	Intervention	Outcome measures/results	Methodology	PEDro [e]/ WSR [f]
Bennell et al,[78] 2010	RCT	RCID [a]	N = 112 93% completed Ave age 60 ± 12.4 10 tx/8wk 11 and 22 wk follow-ups	MT, Exercise and Education vs Placebo: sham ultrasound with nontherapeutic gel lightly for 10 min MT: soft tissue massage, A and P shoulders 6 min Supine GH joint grade IV (into 50% resistance): shoulder abducted at 45° and then 90° with A-P and Inf Mbl 4×/30 s each Spinal Mbl (lower c/s and t/s-4 min each) grade IV Exercises: scapular retraining (adducted/ depressed held 10 s/5×, first week 15× 5 then 5×); doctor passively puts scap and shoulder through elevation/protraction then retraction/ depression, then assist pt, then pt does independently Taping: to keep scap retracted and thoracic spine in extension Home exercises: scap retraining w/ strengthening of rot cuff mm's with good posture—with elastic band: 1st week 2×/d then once daily Home exercise program [b] (details, see Bennell[115] 2007): isometric scap setting, isometric ext rot against wall, active ext rot, pec minor stretch, wall push up, chin tuck, resisted (band) ext rot, thor ext lying over rolled towel, resisted (elastic band): scap, ext rot, int rot, and horizontal rowing, and ext and int rot at 90° abduction, Corner or anterior shoulder stretch Resisted (band) ext and int rot at 45° abd in scap plane	SPADI Likert SF-36 and AQoL instruments Isometric mm shoulder strength Adherence to tx protocol Results: At 11 wk no significant difference between groups but with 2nd outcomes MT significantly better in self reported and objective measures of strength (CI 0.87-2.34) At 22 wk: MT significantly better in SPADI (7.1 points, CI 0.3-13.9) and within group changes sig ($P < .001$) Secondary SPADI outcomes sig better too (mm strength, interference with activity, and AQoL) No difference between those who did all exercises and those that did exercises only 59% of time Trial Completion: MT = 52/57 or 91% Placebo = 57/61 or 93%	Power calculated and full sample size Blinding: adequate ITT: adequate	9
Pribicevic et al,[44] 2010	RCT	RCID see SIS [c] below					
Atkinson et al,[79] 2008	RCT	RCID	N = 60 Ave age 42 Range 18-76	MT vs Sham or Placebo Laser MT to GH: shoulder girdle mostly HVLA to GH, AC, or SC	Sig in favor of MT for ALG and goniometry (ROM) $P < .05$ Clinically meaningful ↓ NRS 20 points	Power calculated Blinding: single Sample underpowered,	7

			6 txs 2×/wk for 3 wk	Adjustments per assessment (Shafer and Faye, and Peterson and Bergmann) Most used: For the GH: Ext Rot glide, A-P glide, Int Rot glide, and S-I with combined A-P For the AC joint adjustments for restricted S-I, then A-P shear	(↓ pain) for MT per Friedman test (placebo significant with ↓ NRS of 10.63 points) Significantly for MT with Friedman's test for Global ROM $P < .01$: for abduction, flexion, external rotation (and flex, ext, and adduction); for placebo only abduction and flexion Adverse effects: none	ITT not adequate 5 dropouts from placebo	
Senbursa et al,[43] 2007	CT	SIS	N = 30 Ave age 48.8 ± 7.9 MT 3 tx/wk for 4 wk ~12 txs Ex 1/d for 4 wk 12th tx, follow-up	MT and Exercise vs Exercise MT: GH Cyriax-Mbl and TFM of supraspinatus PNF (including rhythmic stabilization and hold-relax) Mbl of the scapula lat to med under med edge (prone) Exercise and stretching at the clinic and training for home SIS exercise program (see below) Exercise: Trained by physical therapist Home SIS program (rotator cuff, rhomboids, lev scap, and serratus ant) with elastic band Cyriax Technique (ref 1984): restoration of "accessory motions" are described but pictures in paper of the GH joint give no directions	Goniometry (ROM) Neer FAQ MM tests: flexion, abduction, int and ext rot strength and trigger points located by ALG Results: VAS, sig for both groups (night pain, with motion, with rest) MT appeared to be sig better for overall pain MT ROM was sig improved in flex, abd, ext rot and sig improvement in Neer FAQ all ~ $P < .05$ MM tests not commented on specifically Adverse effects not mentioned	Randomization stated but not described in any manner or place Power not calculated Blinding: single for ROM ITT not adequate	6
Conroy and Hayes,[26] 1998	RCT	SIS	N = 14 Ave age 52 50.7-55.0 y/o 9 txs 3tx/wk/3 wk	MT = MPT + Rehab vs Rehab Both had a standard flexibility and strengthening program + heat + ST+ patient education Exercises: pendulum, postural correction, physiological stretching with cane, and towel assisted ext and int rot, and noninvolved arm assisted horiz add Rot cuff strengthening and chair press and int and ext rot isometrics Correction of asym scapulothoracic motion and rhythm Avoid painful overhead work, etc. MT: Maitland technique for accessory motion: inf (in flex) glide, post glide, ant glide, and long axis traction glide Note: Mbl at mid not end ROM	Significant: 1st 24 h only: ↓ shoulder pain ↓ pain on impingement test Otherwise no difference between groups: both significant for ROM and functional tests Adverse effects: none	Power calculated and sample size small = low power Blinding: single (assessors) ITT: inadequate 1 drop out from control/rehab	7

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Table 3. (*continued*)

Author	Study	Condition	Participants/length of study	Intervention	Outcome measures/results	Methodology	PEDro [e]/ WSR [f]
Bang and Deyle,[25] 2000	RCT	SIS	N = 52 Ave age 43 ± 9.1 6 tx/3 wk 1 m follow-up 2 m mail follow-up	MT: MPT + Exercise vs Exercise Both had a standard flexibility and strengthening program MT (Maitland) (grades I-V) most used: Mbl: caudal glide in flex and abd Mbl to ↑ flex and int rot C/s, T/s and upper rib Mbl and manipulation Stretches: Ant/Pos mm and capsule ST to involved mm Strength: elastic band 1. Flexion elbow extended 2. Scaption 3. Rowing (flex elbow ext) 4. Horizontal abduction 5. Seated press ups 6. Elbow push ups	Sig effect size for MT Functional assess questionnaire (modeled on Oswestry scale) = 9 functional questions w/ a VAS 5 best-0 worst scale Maximum Best = 45 Worst = 0 Use of electric dynamometer to test pre and post isometric strength For: internal and external rotation and abduction VAS with orthopedic tests and resisted muscle "break" tests However, without power calculations not definitive or generalizable Adverse effects: none reported	Power not calculated Blinding: single (assessors) ITT: not clearly/adequately described 3 dropouts	7
Dickens et al,[80] 2005	RCT	SIS	N = 85 Ave age 54.5 26-73 y/o All: 1. 3 failed steroid injections 2. scheduled for surgery Tx 1-2/wk at hospital until pt capable of maintaining therapy on their own 6 mo follow-up	MT + Exercise + Advice (45 pts) vs Control (Control = waiting list/no tx/normal activities) (40 pts) MT: C/s, T/s glenoid Mbl Exercise: Nonstandardized Strengthen rotator cuff and scapulothoracic muscles and scapular stabilization Good posture with exercise and work MT per Corrigan and Maitland tech Only for restricted accessory motion for: GH joint, A-P, long axis caudal glide, AC joint A-P and long and long axis caudal glide, cerv (P-A), thoracic (P-A, transverse) Also ↓ physiologic ROM mobilized to ↑ pain free ROM	Significant for C-MFS for functional recovery (100 best/0 worse) C-MFS: MT: increased avgas 20 pts Control: increased 0.65 pts Significant: MT: 11 pts did not need surgery ($\chi^2 = 11.2$, $P = .0008$) Remainder → surgery Control: 100% surgery Adverse effects: none reported	Adequate power Blinding: single (assessors) ITT: covered	8
Citaker et al,[81] 2005	CT	SIS	N = 40 Ave age = 54.2 ± 9.86 Used Stage II patients (per Neer) Thickening and fibrosis ages 25-40 Syndrome is described patho/clear eligibility	Mobilization vs PNF No treatment description Both groups: hot packs, exercises with elastic band for concentric and eccentric strengthening of the shoulder muscles and Codman's pendular exercises (all 5 planes less than 45° ROM)	Goniometry VAS No sig diff between groups for VAS Both had sig and lg VAS changes for intragroup at Night/Day and Active/Motionless measurements Mbl Active Day VAS ↓ 5.8 cm, $P = .001$ PNF Active Day VAS ↓ 5.9 cm, $P = .001$	Randomization is stated but is not described Concealed allocation not described Power not calculated Blinding: none ITT: not addressed	4

			not described Tx 20 w/ 3 wk of theraband use		Both groups: Post ROM ↑ sig all $P \leq .05$, as did their post within group UCLA post treatment Pain, function, ant flex range and power and pt satisfaction all $P \leq .05$ UCLA score of fair/poor to good/excellent: Mbl 33.22 ± 2.95 pts PNF 29.97 ± 4.60 pts Adverse effects: not reported Drop outs: not reported		
Munday et al,[82] 2007	RCT	SIS	N = 30 Ave age 22.5 16-38 y/o 8 txs/3 wk 1 mn follow-up	MT: HVLA/Grade 5 vs Sham Ultrasound MT: for ↓ accessory motions/end feel (Shafer and Faye techniques) Adjust: AC joint: GH flexed ~90° then A-P any I-S contra-indicated (distracts AC joint) or supine A-P directly on humeral head; stabilize with other hand (ditto); or bilat reinforced pisiform contact; standing practitioner behind standing patient; lift I to S on AC joint. GH: per ↓accessory motions (caudal or lat distraction, S-I in flex or ABD, etc) 1st/upper ribs/scapula: mobilization/manipulation C-T spines not treated	VAS SFMPQ ALG Significant in favor of MT VAS and SFMPQ at the 1 mo follow-up ALG (PPT) at the 8th visit and 1 mn follow-up However, small sample size is not definitive nor generalizable Drop outs: none	Power not calculated Blinding: single (participants) ITT: adequate	6
Surenkok et al,[83] 2009	RCT	SIS: 12 cases RCID: 10 cases (tendinopathy) FS: 7 cases	N = 39: 13 per Ave age 54.3 ± 14.6 1 tx	MT vs Placebo vs Control MT: Scap Mbl sup-inf gliding, rot gliding, and distraction of scapula Sets of 10 mobs with 30 s between Sham = taking up the "hand position" only Control = no treatment	C-MFS VAS Pain ROM Scapular position (digital inclinometer) Results: Sig in favor of scap Mbl: ↑ flex, ↑ ABD, and overall ↑ ROM Scap upward rot, and for improvement in the C-MFS Comparing baseline to posttreatment	Apparent post hoc power inadequate Blinding: double (patients and assessors) ITT: adequate	8
Pribicevic et al,[44] 2010	RCT	SIS: 20 cases RCID: 20 cases OA: 1 case AC injury: 1 case	N = 42 Ave age 42 (range 18-45) 8 txs/4 wk 4 mn follow-up	Manipulation vs Multimodal MT + Exercise + ST + Modalities vs Placebo Sham Ultrasound MT: HVLA grade 5 for ↓ accessory motions/end feel C-T spine, SC, AC manipulation GH joint: seated flexion with A-P or inferior thrust	VAS ROM Orthopedic examinations Results: significantly in favor of the multimodal manipulative therapy	Power calculated: fully powered for primary outcome measures Blinding: double (assessors and subjects) ITT: covered	9
Bergmann et al,[84] 2004	RCT	SCDP[d] Pain between neck and elbow at rest or w/	N = 150 UC = 71 UC+AMT = 79 Ave 48.1 ± 11.8-12.4	UC vs UC + AMT No GH MT UC: info, advice, meds (acetominophen/paracetimol or NSAIDs), repeat if	Outcome Measures: 1° 7 Point Likert Scale Also asked dichotomous "Cured?"	Power calculated and full sample size Blinding: adequate ITT: adequate	8

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Table 3. (*continued*)

Author	Study	Condition	Participants/length of study	Intervention	Outcome measures/results	Methodology	PEDro [e]/ WSR [f]
		movement of shoulder DG for shoulder complaints (Bergman et al 2010 below)	UC: 2.3-2.5 v w/ GP Follow-ups: 6, 12, 26 and 52 wk after 1st tx	improvement, if no or min improve, steroid injections up to 2×, if no improve at 6 wk then physical therapy (exercise therapy, massage, modalities) UC + AMT: up to 6 MT treatments: Cyriax, Greenman (osteopathic), Lewit MT techniques: HVLA manipulation/ thrust and specific mobilization techniques Also Cerv and Thor spines (and up ribs) examined for joint dysfunction and pain in shoulder on move of C-T spines (and ribs) MT: no other tx such as exercise, massage, advice, etc.	2nd 1. Shoulder pain 2. Shoulder fnc disability 3. General health Results: At 6 wk: no significant difference between groups At 12 (43% v 21%) and 52 (52% v 35%) wk: Stat Sig more "cured" or "recovered" in MT group Significantly more improved in main complaint and all outcomes consistently favored MT Adverse effects: not reported		
Bergmann et al,[47] 2010	RCT	SCDP DG for shoulder complaints: 1. Shoulder pain w/ ↓ ABD (~ related to subacromial structures) 2. SP with ↓ ext rot ~ GH joint 3. SP w/ C-T spine and adjacent ribs w/ joint dysfunction	N = 150 UC = 71 UC + AMT = 79 Ave age 48.1 ± 12.4 Duration shoulder complaint: <6 to >26 mo	UC vs UC + AMT (No GH MT) DG: 1. Shoulder ROM in a) Active ABD to head b) Passive ABD to head c) External Rotation grade with 4 point scale: pain (p) no p, lite p, p and severe p If no abnormalities then physical examination of C-T spine: pain, ↓ passive ROM w/out overpressure, radiation, and hand over/under tests, impingement test, rib mob test, AC joint stress test and C-T spine jt dysfunction (same p scale) UC + AMT Advice, therapy—1st 2 wk info re shoulder complaints and prognosis, advice on ADL, oral analgesics (or NSAIDs); up to 3 corticosteroid injections If sx's >6 wk add PT = 9 txs/3 mns (Exercises, massage and modalities for both groups) MT: 6 txs grade IV Mbl and HVLA grade V thrust to the C-T spines and upper ribs UC: 6 MT txs/12 wk added	SPS: 4 "factors" 1. Shoulder pain 2. Neck pain 3. Shoulder mobility 4. Neck mobility At 6 wk: no difference between groups At 12 wk: MT: favored/significantly favored for shoulder and neck pain $P < .05$ At 26 wk: MT: favored for shoulder pain and mobility and neck mobility Conclusion: MT with UC ↓ shoulder and neck pain severity and ↑ shoulder and neck mobility $P < .05$ Adverse effects: not reported	Power calculated and full sample size Blinding: adequate ITT: adequate	7

McClatchie et al,[85] 2009	RCT Cross-over trial Coin toss: 1st tx MT or placebo, next tx: opposite tx	SCDP SD: unilateral insidious onset shoulder pain w/ painful arc of Abd Secondary to joint dysfunction in asymptomatic C-spine (no sx's from C-spine ≥ 1 y) 57% reported having had C-spine pain in the last year	N = 21 Ave age 49.8 ± 9.8 Duration: ≥ 6 wk 2 tx, 4 d btw-one each protocol w/ follow-up after each Before entry in this RCT: Unresponsive to 'traditional PT' of the shoulder for shoulder pain inc. exercise, stretch and modalities for 2-4 sessions	MT vs Placebo MT: Lat glide grade IV+ Mbl of C5, C6 and C7 for 2 min Pt seated, no rot or lat flex of neck; operator contacts SP's of C5,6,7 on side of shoulder pain and mobilizes grade IV+ toward nonpainful side (light oscillating end range gentle impulses (small amplitude) at end range (accessory) movements (Mulligan technique 1995 cited) Placebo: same set up w/ simply resting hand in the MT position, no application of force	VAS for pain after abd C-spine ROM (CROM) MM testing of ABD at 90° ROM: Arc of Abd for pain and degrees Results: MT: Sig ↓VAS for shoulder pain $P < .05$-v-no change in VAS for placebo No significant difference between groups for C-ROM or MM strength Abd Claim 1st study to demonstrate immediate ↓ pain per asymptomatic MT of the C-spine (C5,6,7) Adverse effects: not reported	Power calculated Sample size adequate Blinding: double (participants and assessors) ITT: adequate	7
Chen et al,[24] 2009	RCT	SCDP Shoulder pain and disability Duration avg: 10.2 mo Unilateral shoulder pain and stiffness > 1 mo < 140° flex or abd or ↓ 10 cm hand behind back deficit and pain or stiffness during accessory motions	N = 90 Ave age 65.1 ± 12.7 Up to 10 txs/8 wk; average 8; mimimum 6 Initially 2×/wk then 1x/wk	MT + Exercise vs Exercise ~ Control MT: grades II-IV, but only grades II and III used (passive accessory motions for the GH, AC and SC, the shoulder girdle, either in oscillation or a sustained stretch with or without tiny amplitude oscillations (Maitland 1991)) GH: 70% received A-P glide in Abd; most common AC: 10% received A-P and P-A glide SC: 0%/no joint dysfunction or pain Advice on ADL + exercises aimed at restoring neuromuscular control, dynamic stability and ↑ function. Exercises specific to each pt in a pain free manner w/ gradually ↑ complexity 2×/d Control group: same exercise and advice/no MT	Outcome measures Primary: SPADI Secondary: Likert (completely recovered to significantly deteriorated) ROM: active flex and abd (with photography) Hand behind back ROM with tape measure At 1 and 6 mo both groups SPADI was significant and had had MCID beneficial change No significant difference between groups All other outcomes significant but no difference between groups but continuing improvement in both at 6 mo No adverse effects noted	Power calculated Full sample size ITT: adequate 1 patient withdrew due to ↑ pain	7
Teys et al,[86] 2008	RCT	SCDP Shoulder pain w/ movement Shoulder pain with <100° flexion elevation Duration >1 mo <1 y	N = 24 Ave age 46.1 20-64 24×3 txs Mulligan's MWM Each patient received all 3 treatments	MWM vs Sham ~ mimic of MWM vs Control ~ no treatment GH only based on research many shoulder disorders cause head of humerus on flex to translate excessively anterior and superior MWM: Thenar eminence placed on humeral head A to P glide while stabilizing scapula, pt flex arm to pain onset while a careful post gliding force (at a right angle to flexion) is applied. 3×/10 reps, 30s between sets	Outcome measures: ROM: Scapular plane in flexion ALG with PPT Significant in favor of MWM for ROM vs sham and control, with increase of 16° compared with 4° sham and 0° with control $P = .000$ Significant in favor MWM for ALG for ↑ PPT vs sham and control No adverse effects reported	Power calculated Randomization Full sample size Blinding: Teys was a repeated measures, crossover, double-blinded randomized placebo controlled trial (found in paper in methods) ITT: adequate	9

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Table 3. (*continued*)

Author	Study	Condition	Participants/length of study	Intervention	Outcome measures/results	Methodology	PEDro [e]/ WSR [f]
				Sham: one hand placed on clavicle and sternum, other hand on post humeral head with min pressure and simulated A to P glide on clavicle; pt flex arm only half way Control: Seated for same time period			
Winters et al,[51] 1997	RCT	SCDP SGG: shoulder girdle: pain and sometimes slightly ↓ GH movement not related to synovial structures but due to functional disorders of the C, T spines or upper ribs SG: synovial: pain with limited GH movement in ≥1 directions (due to subacromial, AC or GH or combination)	N = 172 SGG N = 58 SG N = 114 Ave age 49.1 ± 14.4 Duration 3-9 mo MT or PT: 1×/wk for 6 tx's Steroid Inj: 1-3 Follow-up: 2, 6, and 11 wk (2.75 mo)	SGG intervention = MT or PT SG intervention = corticosteroid injection (SInj), MT or PT MT: manipulation (grade V) or mobilization (grade I-IV) only To the cervical, thoracic spines and upper ribs, AC and GH joints No additional exercise therapy "Eindhoven" techniques not described PT = "classic" exercise therapy, massage and modalities (or physical applications) SInj: Synovial structure-joint capsule, subacromial space or AC joint	SPS: 6 item questionnaire with a NRS-101 pain scale Pain at rest during motion, at night, sleeping problems, inability to lie on affected side and radiating pain Converted to a 7-28 points score (no pain to severe pain) Significant for MT over PT in the SGG: greater ↓ SPS (pain) and ↑ numbers feeling "cured" at 11 wk Significant for SInjs for SG over MT and PT at 11 wk for ↓ pain MT and PT > SInj "cured" and both had significant ↓ in pain in SPS 2 y follow-up: no significant differences between groups MT > "cured" SInj < "cured" = 95%	Power calculated Full sample size ITT: Adequate	7
Knebl et al,[41] 2002	CT	SCDP OA 76% Bursitis 21% Neurological disorders (unspecified) 21% Healed fractures 10% ↓ ROM 63% Pain 33% ↓ ROM w/ pain 4%	N = 29 Ave age 65-85 Group 1: MT Group 2: Placebo [g] 1. 1 ADL affected by shoulder dysfunction 2. ROM: >25% but <75% abduct or flexion Treatment: 1× wk for 5 wk Follow-up: wk 6 and 9 7 assessments over a total of 14 wk (3.5 mo)	MTST: Side-lying affected shoulder up. The shoulder is placed in 7 positions Extension with elbow flexed, flexion with elbow extended, compression of humeral head-arm abducted, then head compressed into G cavity, then circumducted or mobilized, then in the same position, tractioned and circumducted, then adducted with external rotation w elbow flexed, adduction w/ ext rot and elbow flexed, arm abducted with pumping or oscillating inferior pump or glide mobilization = mobilization and muscle energy technique or another form of mobilization = (stretch to barrier and patient resists or holds isometrically 5-10 s, patient relaxed and operator	Outcome measures 1. ROM 2. Physical functioning: A "functional scale" assessing ADL such as "put on shirt, brush hair, or take a shower." This scale is not referenced, validity and reliability unknown, but at least 1 ADL had to be negatively affected by ↓ shoulder ROM and/or pain for inclusion. Not used in the follow-up or after 5th tx 3. Pain 0-10 (10 worst) ROM: significant ↑ ($P < .05$) within group change for both groups MTST maintained the significant ↑ after the 6 wk follow-up Pain: significantly ↓ ($P < .05$) in both groups and descriptively > in the tx group	Double blind: patients and assessors No description of randomization technique or concealed allocation Power not calculated ITT: not adequate Two dropped out (1 died). No report regarding this data	5

				therapeutically stretches 10 s, release and repeat). See Knebl 2003 Placebo: putting the shoulder into the 7 positions and then doing nothing	Temporary adverse effects of soreness/ stiffness reported by tx group but resolved. Numbers not noted		
Bulgen et al,[42] 1984	RCT	FS SInj 1× wk 3 wk Mobilization and ice therapy with PNF stretching: 3× wk 6 wk (18 txs) Follow-up: 1× wk 6 wk, then 1× mo for 6 mo	N = 42 Ave age 55.8 Range 44-74 Duration: 1/2 < 3 mo 1/2 > 3 mo	a) SInj b) MMT c) Ice therapy with PNF stretching d) No treatment All groups: Pendular exercises and option of NSAIDs and diazepam 5 mg at night	Nonstatistical report that all had a decrease in pain and a general decrease in use of pain medication but 17 continued to have mild residual pain > "ice" group ROM: Significant overall ↑ at 6 wk for steroid ($P = .02$) At the end of 6 mo all equally and significantly increased ($P \leq .02$) Note: significant loss of overall ROM remaining for all at 6 mo	Power not calculated ITT: adequate Blinding: assessor Randomization: stated but not described	5
Nicholson,[27] 1985	CT	FS	N = 20 10 per group Avg age 53 ± 2 Duration: Tx: 27.6 wk (6.9 mo) Control: 30.8 wk (7.7 mo) Treatment: 2-3x/wk for 4 wk Total 8-12	Manual Therapy + Standard Clinic and Home Exercises (MTex) vs Clinic and Home Exercises (EG) Mobilization techniques of Cyriax, Maitland, Kaltenborn and Mennell grades I-IV starting with lesser grades (no grade V) Exercise 3x/d in direction of ↓ ROM and to ↑ strength + pendulum exercise per each patient's indications. Mob began in "neutral" with generally "gliding or distractive" (ie, abduction to 25° with inferior glide; later ↑ abduction or lateral distraction or mobilization into flexion or abduction) techniques, later mobilization toward and ↑ end ROM	Significant in favor of MT + exercise at 4 wk for ↑ in passive abduction Both groups significantly ↑ ROM and ↓ pain Self report by patients: MTex: 9/10 stated shoulder felt better after treatment EG: 5/10 stated shoulder felt better after treatment Adverse effects: 1 pt temporarily aggravated	Power not calculated Randomization: coin toss with next pt auto assigned, repeated Allocation: concealment not apparent Blinding: assessor ITT: not addressed	6 WSR 7
Vermeule et al,[87] 2006	RCT	FS HGMT (hands contact close to glenohumeral joint): 10-15 oscillations applied as grade III or IV per tolerance and applied to (each) "end feel" ROM restriction above; and this might be repeated in a slightly different plane or with alight	N = 100 Mean age: 51. 7 (8.6) Median duration: 8 mo (6-14) 80% prev tx'd by PT's; 60% had received SInjs 24 txs/12 wk (range 18-21.5) Tx: 2/wk Tx'd: only phase II FS = severe ↓ in ROM and pain primarily at end ROM	MT only (no general exercise Rx'd): Glenohumeral joint only Maitland and Kaltenborn Techniques (grades II-IV only) HG and LG Mbl techniques used: For HGMT and LGMT, "end feel" ROM in Flex, ABD, and Ext Rot passively assessed each time for both groups At the beginning for both groups accessory motions II (per LG see below), III or IV (per group) first concentrated on inferior glides, for example: at end ROM of flexion, the prox humeral head might be oscillated into inferior (or S-I) glide; or into lateral glide, or anterior glide.	All groups improved significantly from baseline to FU for within group change for ROM, VAS at rest, movement and at night, and for the SRQ and SDQ questionnaires and the SF-36 However there were significant changes in favor of HGMT for passive ABD and Ext Rot and active Ext Rot, for the valid and reliable SRQ and for the SDQ with a trend toward greater improvement in active ABD Overall HGMT more effective in ↑ ROM and ↓ disability than LGMT No difference in outcomes with either primary (idiopathic) or secondary (diabetes, cardiac, prolonged	Power calculated Full sample size Randomized Concealed allocation ITT: adequate Blinding: assessors	7

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Table 3. (*continued*)

Author	Study	Condition	Participants/length of study	Intervention	Outcome measures/results	Methodology	PEDro [e]/ WSR [f]
		addition of added rotation, etc. LGMT: Same mobilizations but grade II only or within the pain free ROM (below discomfort or painful restriction, not at "end fee;" ROM). However after LGMT used PNF patterns within pain-free ROM and had the pts do Codman pendular exercises		Next either HGMT or LGMT was applied: no exercise Rx'd, but advised to use shoulder in ADL	immobilization or trauma) FS patients; nor was there a difference whether they had ±15-cm^3 joint distention (diagnostically) Adverse effects: minor temporary soreness reported only		
Buchbinder et al,[88] 2007	RCT	FS	N = 144 Duration pain: Avg 6 mo Range 3-60 mo 8 txs/6 wk 2/wk for 2 wk 1/wk for 4 wk	Both groups received steroid-joint distention injections first This has been shown to significantly ↓ pain and ↑ function/ROM up to 6 wk but not sustained at 12 wk. Question: Would MT help after 12 wk? Then randomized to either: MT (mobilization with "PT" or exercise therapy) vs Sham/placebo ultrasound and nontherapeutic gel (no exercise) Manual therapy: cervical, thoracic and GH mobilization with end ROM and accessory motions + rotator cuff strength and coordination exercise, stretching GH joint, scapular stabilization and proprioception exercise Medication allowed and recorded	SPADI Overall pain (0-10) Active shoulder ROM SF-36 AQoL Patient perceived recovery 5-point Likert scale SPADI and overall pain: sig and clin meaningful within-group changes for both at 6, 12 and 26 wk AQoL ↑ equally for all Sig ↑ in flex, abd and ext rot for MT at 6 and 12 wk ROM was greater at all points in the MT group Significant difference in favor of MT for PPR At all time points $P = .002$ Adverse effects: mod-marked worsening 6 wk MT 0, Placebo 3 12 wk MT 3, Placebo 5 26 wk MT 3, Placebo 8	Power calculated Full sample size ITT: adequate Blind assessors	9

Yang et al,[89] 2007	RCT	FS 2nd or stiffness phase	N = 23 Mean age 55.7 Range 46.8-68.1 Duration 10-32 mo 2 groups: each randomly received 3 different tech/GH only Group 1: A-B-A-C Group 2: A-C-A-B Each treatment 3 wk 2×/wk for 12 wk for a total of 24 treatments	Three mobilization techniques (grade III or IV) 1. MRM = shoulder moved to about 40° abduction or a "resting position" and 10-15 repetitions of mobilization (either ROM oscillation below pain or end ROM or accessory motions) 2. ERM techniques at end of full ROM both end feel spring (or over pressure) and/or at ERM accessory motions with 10-15 repetitions 3. MWM or MWM…Mulligan Combines sustained manual technique of "gliding" or accessory motion with combined and concurrent physiologic (assisted) or passive (operator) ROM 3× 10 reps with 1 min between Mulligan based the technique on "repositioning" bone positional faults	Disability scale Flexi-SF Classifies as low, medium or high ICC reliability is .90 Shoulder ROM or kinematics tested using FASTRAK motion analysis (ICC reliability =.91-.99) Humeral elevation, abduction in scapular plane, hand to neck and hand to scapula, scapulohumeral rhythm, external and internal rotation motions tested Significant in favor of ERM and MWM techniques for FLEX-SF $P < .01$ in arm elevation, scapulohumeral rhythm, humeral external and internal rotation motions Significant for MRM for correcting scapulohumeral rhythm better Overall: ERM and MWM more effective in ↑ mobility and function	Power calculated Full sample size calculated but 7 dropouts (N = 30 to N = 23; caused low *post hoc* power) ITT: adequate Blind assessors 2 subjects failed to attend tx after randomization 5 subjects lost to MRM mobilization (mid range) = N 23	7
Rainbow,[105] 2008	CT 1st subject randomized next allocated A-B, etc	FS	N = 8 Age range 30-65 Duration: ≥6 mo 12 treatments: 2/wk for 6 wk	Group 1 Manipulation to the C-T spines and shoulder (GH) joint (grade 5 HVLA thrust) + exercise vs Group 2 Grade 3-4 Mobilization + exercise Exercises 3× per day: Pendulum and Wall walking Manipulation to the C-T spines and GH joint per Bergman et al[9] 2002 and motion palpation using PARTS and provocation testing per Shafer and Faye 1990 Limit 2 GH manipulations per tx (frequently A-P in flexion or flexion with inferior glide; other techniques per examination) If co-morbidity: no I-S with A-P moves or testing through provocation	Both reported significant improvement with SPADI Descriptively: Group 1: decreased 54.2 pts Group 2: decreased 24.0 pts Group 1 appeared significantly better $P = .029$ Intragroup + outcome for both groups descriptively larger for manipulation With small sample, no generalization can be made between group differences Adverse effects: none reported	Power not calculated ITT: adequate	5/WSR 6
Surenkok et al,[83] 2009		FS	N = 7	See above in SIS section			

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Table 3. (*continued*)

Author	Study	Condition	Participants/length of study	Intervention	Outcome measures/results	Methodology	PEDro [c]/ WSR [f]
Andersen and Parkin-Smith,[90] 2003	RCT	MPDS/ST Trigger and/or tender points/taut bands (per Travel and Simmonds 1983 and Simmonds 1991)	N = 30 Age range: 18-55 Tx: 5 tx over 3 wk 1 mo follow-up Dx: Shoulder girdle mm's (trap, lev scap and infraspinatus, dx; per Simmonds 1992, confirmed by ALG)	Group A: Ice + gentle passive stretch (per Travel and Simmons 1992) Group B: Heat + gentle passive stretch (per Travel and Simmons 1992)	Intergroup: no significant differences $P > .05$ Intragroup: both groups NDI beneficial/ significant change: > MCID of 7.5 pts NRS and SFMPQ significant and clinically meaningful beneficial change ROM some significant change at 3 wk ($P < .05$) ALG significant at 3 wk and 1 mo $P < .05$	Power essentially adequate Sample adequate for subjective measures ITT: not adequate	4
Van den Dolder and Roberts,[91] 2003	RCT	(MPDS/STD) Trigger points of the shoulder/ shoulder girdle with concurrent multiple diagnoses: SIS, RCIDs, tendinitis, OA, soft tissue injury, and/or shoulder pain	N = 29 Ave age 64.4 Range 18-80 y Duration 26-30 mo MT group: 6 txs/2 wk Control: Waiting list	MT: massage while muscles stretched Massage to lateral border of scapula, in full shoulder flexion, posterior (p) deltoid, at end ROM horizontal flex, at end range of back a deltoid, and pectoralis major in the stretch position all 15-20 min Control group	PSFS SFMPQ VAS PPI ROM: abd, flex, hand behind back Significant and clinically meaningful in favor of massage for essentially all outcomes: all $P < .05$ Without sham, part of improvement may be Hawthorne effect	Power not calculated ITT: not adequate Blind assessors	7
Hains et al,[92] 2010	RCT	MPDS/ST Shoulder only with 1 shoulder pain (in shoulder or upper arm) at rest or during movement TP's: supraspinatus, infraspinatus, deltoid and proximal bicep Ruled out C-T spine cause of shoulder pain or referred disk pain, neurogenic pain, etc	N = 41 MT N = 18 Control N =16 Crossover Ave age 46.5 Duration >4 mo Outcomes: 15 txs, 30 d and 6 mo posttreatment At 6 mo control "crossed-over" Outcome measures for control that crossed over after 15 txs	MT: TrP to shoulder muscles vs Control: TrP to Cerv and Thor spines Trigger points: 15 s of pressure per point	SPADI and NRS: significant and clinically in favor of MT (↓44 pts and ↓75% compared with Control (↓ 13.1 pts and ↓29%) after 15 txs MT significant and similar at 30 d and 6 mo Crossover at 6 mo: Control 15 txs: SPADI sig and clin improved an add ↓ 26.8 points Adverse effects: none reported	Power not calculated Crossover treatment of control ITT: not adequate Blind assessor	8
Coppieters et al,[93] 2003	RCT	NSP and/or MPNID Paresthesia and	N = 20 Ave age 45.3 ± 13.8 Duration: 2.7-3.1 m	MT vs Therapeutic Ultrasound (US) MT: lateral glide to C5, C6, C7 3× for 4.5 min each	Shoulder raise and pressure NRS pain ROM	Power not calculated Small sample size ITT: adequate	7

		unpleasant feeling of stretch [forearm and hand pins and needles] and not loss of sensation Rule out diabetes and serious systemic/ neurologic disorders not amenable to MT	Neural tissue provocation test 1 (NTPT1) for median nerve: 1. ABD and lat rot of arm (shoulder) 2. Shoulder (girdle) gently depressed 3. Supination of initially flexed forearm 4. Ext of wrist and elbow (and involuntary raising of shoulder) = test 5. + = ↑ symptoms and pain 1 Treatment with pre and post OM	Mobilization grades II and III with slow oscillation Patient supine with no lateral flexion or rotation of C-spine US dose: 0.5 W/cm^2 for 5 min	MT: all OM sig $P < .05$ Shoulder raise and pressure ↑ (unclear as to what this means) NRS ↓ significantly 1.5 pts ROM of elbow extension ↑ ~20° (with NTPT1) significantly and clinically meaningful US: all nonsignificant $P > .05$	Blind assessor	
Coppieters et al,[94] 2003	RCT	NSP and/or MPNID Rule out diabetes and serious systemic/ neurologic disorders not amenable to MT	N = 20 Ave age 47.8 ± 14.1 Duration: 2.7-3.2 m +NTPT1 + C-T spines joint dysfunction 1 Treatment with pre and post OM	MT vs Therapeutic Ultrasound (US) Grades I and IV Mobilization C5-T1 Patient supine with no lateral flexion or rotation of C-spine US dose: 0.5 W/cm^2 for 5 min	Pain drawing % MT: all OM sig $P < .05$ NRS: ↓ sig 1.5 points ROM: elbow extension ↑ 19.4° (with NTPT1) significantly and clinically meaningful NTPT1: sx provocation significantly ↓ 43.4% US: all nonsignificant $P > .05$	Power not calculated Small sample size study ITT: adequate Blind assessor	8

ALG, algometry; *AMT*, additional manual therapy; *AQoL*, health-related quality of life measure; *Ave*, average; *C-MFS*, Constant-Murley Functional Score; *DG*, Dutch Guidelines; *FS*, frozen shoulder; *HG*, high grade; *ITT*, intention to treat; *Likert*, patient perceived global rating of change; *LG*, low grade; *Mbl*, grade I, II, III, IV mobilization; *MMT*, Maitland mobilization technique; *MPDS*, myofascial pain and dysfunction syndrome; *MPNID*, minor peripheral neurogenic shoulder (& arm) pain or minor peripheral nerve injuries and/or disorders; *MPT*, manual physical therapy; *MT*, manual therapy; *MTST*, MT or Spencer Technique; *NDI*, Neck Disability Index; *Neer FAQ*, Neer Functional Assessment Questionnaire; *NRS*, Numerical Pain Rating Scale; *NSP*, neurogenic shoulder pain; *PNF*, proprioceptive neuromuscular facilitation; *PPT*, pressure pain threshold; *PPI*, present pain index; *PSFS*, Patient Specific Function Scale; *RCID*, rotator cuff injuries, disease or disorders; *SCDP*, shoulder complaints, dysfunction, disorders or pain; *SD*, shoulder dysfunction; *SDQ*, Shoulder Disability Questionnaire; *SFMPQ*, Short-Form McGill Pain Questionnaire; *SInj*, steroid injection; *SIS*, shoulder impingement syndrome; *SPADI*, shoulder pain and disability index; *SPS*, shoulder pain score; *SRQ*, Shoulder Rating Questionnaire; *ST*, soft tissue; *STD*, soft tissue disorder; *TFM*, transverse friction massage; *UC*, usual care from general practitioner.

[a] RCID: >3 mo duration shoulder pain, >3 on 0-10 pain scale with active abduction or ext rot + a + impingement test.

[b] Complete rot cuff tear with + drop arm and substantial weakness ruled out (see Bennell et al[78] for inclusion/exclusion details).

[c] SIS: ↓ or painful shoulder ROM/+ impingement test with MRI confirmation.

[d] SCDP: secondary to: cervical/thoracic and adjacent rib dysfunction and/or disorders C-T-rib MT only … no GH MT; defined as "shoulder pain" from base of neck to elbow.

[e] PEDro ratings[1,55,68]: very high quality 9-10; high quality 7-8; medium quality 4-6; low quality 1-3.

[f] WSR ratings: highest quality 11; high quality 8-11; moderate quality 4-7; low quality 0-3.

[g] Placing the shoulder in all 7 Spencer Technique positions is a form of mobilization (possibly not functioning as a "sham" tx).

Table 4. *Summary of research on case series and case reports*

Author	Diagnosis	Treatment/management	Reported outcome
	(RCIDs): SIS		
Pribicevic and Pollard,[52] 2005	*SIS* and associated ST disorders RCID disorders 4 cases of SIS *Generally:* 1. Pain, shoulder 2. Pain, arc of abduction 3. ↓ ABD and ext rot ROM with pain 4. + Impingement tests Hawkins, Neers 5. + Common: resisted supraspinatus tests for pain 5. Trigger points/mm tightness/tenderness in SITS and shoulder muscles 6. ↑ VAS, ↓ ROM, ↓ ADL and work, sports activities. 1. 1st patient 42 y ♂ : injury from overhead lifting/work Restricted C5/6, T2/3, and AC inferior glide: 5 txs 2. 2nd ♀ 32 y overweight, shoulder injury from adjustive technique. Restricted C5/6, T3/4, A/C, S/C: 4 txs 3. 3rd patient 29 y ♂ factory worker. Injury repetitive shoulder movements and keyboard work. Restricted C5/6 and T2/3, A/C. ↑Kyphosis : 5 txs 4. 4th patient 40 y ♀. Pain over scapula. Injury after cleaning walls at home before painting. Restricted C5/6, T3/4, A/C and Scapula. 4 txs	Treatment all: MT: 1. HVLA: for restricted motions. Shoulder: gradual ↑ amplitude to GH joint in ext rot, also Inferiorly to the A/C joint and A-P to S/C joint Activator 2 apparatus applied to increase GH external rot, or inferior movement of AC joint (1 patient concern and request after 1st treatment. Diversified spinal manipulations to typically T3/4 and C5/6. 2. Ischemic pressure or TrP tx to SITS mms as appropriate (using T-bar), or rhomboids, up trap, lev scap. 3. Transverse friction massage to: Post tenomuscular jnx infraspinatus, coracoacromial lig, insert supraspinatus on gr tuberosity. 4. Phonophoresis [1% steroid cream] 7 min 2.2 W/cm^2 Basic exercise program: 5. Emphasis on isomet strength of supraspinatus and infraspinatus mms (after initial pain relief) a. Isometrics: 4X10 reps, 2-3X/d. b. Elastic band exercises also implemented shortly after isometrics at same frequency. c. + shoulder shrugs, wall push-ups and scap retraction exercises. Average number of txs: 4.5 txs	*Pribicevic (2005) WSR (CS)* 8 *Outcomes and Treatment Multi-modal MT approach to shoulder:* MT +Rehab (exercise therapy, soft tissue treatment, modification of ADL) + Modalities (ultrasound + 1% steroid cream: phonophoresis) + advice/education 4.5 visits average per patient (end of care=EOC) *Outcomes: at EOC, and 2 at 1 mo, 2 at 2 mo:* *VAS:* ABD/other from VAS ~3-8. EOC all clinically large ↓ in VAS ending at or about ~0 *ROM* (goniometry): Large ↑ with full restoration of passive and active ROM (as noted) *Return to normal ADL, work,* and *sport* (RAWS): All returned to RAWS with no restrictions

Table 5. *A summary of research on miscellaneous case series, case reports, and SGPPDs*

Author	Diagnosis	Treatment/management	Reported outcome
Vermeulen et al,[95] 2000	FS Duration: Ave 8.4 mo (range 3-12 mo) 7 patients: 4 ♂, 3 ♀ (6 had previous GP+ physical therapy, 1 no tx. All with unsatisfactory outcomes) *Generally:* 1. Painful stiff shoulder ≥3 mo 2. 50% ↓ ROM of GH in ABD of Flex, or in Ext Rot (compared with opposite) 3. Max GH joint space 15 cm^3 per injection capacity 4. Exclude diabetes mellitus, recent severe trauma or deformity/damage due to past trauma, osteoporosis, 5. Rule out other systemic disorders such as cardiovascular disease, RA, etc *Outcome measures:* 1. Active ROM 2. Passive ROM 3. Pain (not specified or clear what method used (NRS, VAS, dichotomized scale yes-no?) but taken at baseline, at 3-mo follow-up and 9-mo FU) for ADL and at night 4. Functional scale (5 point Likert Scale)	MT: 18 txs (SD 14-22) over 3 mo. Tx 2×/wk for 12 wk Outcomes at baseline and at 3 and 9 mo of follow-up Grade III to IV ERM Techniques = EMT (Maitland technique) Treatment all: MT to GH joint (only) as indicated by assessment of end ROM and end feel spring or give and/or by accessory motions. 1. ERM of the GH joint = a. *Begin 1st with*: mid range oscillating mobilization to warm up tissues/prepare tissues (grade II). Next: b. 10-15 Mobs at end of physiological ROM (grade III to IV as appropriate) or c. At End ROM, 10-15 Mobs with *added* accessory motion (inf glide, A-P glide, axial elongation or traction) at the GH joint (grade III to IV). e. Fine tune by changing angle, or decreasing or increasing grade III to IV. Decrease amplitude or angle if ↑ sxs d. Contact close to humeral head for mobilization (for safety)	WSR (CS) 7 *Outcomes and treatment* *ROM* 3 mo: ↑ active ROM a. Flex ↑ from 113° to 147° b. ABD↑ 91° to 151° c. Ext Rot ↑ 13° to 31° d. Passive ROM: similar ↑ in the above 3 planes At 6 mo, all patients maintained ROM at 6 mo *Functional Scale:* At 3 mo: 3 "much improved" and 3 "improved" and 4 reported shoulder function as "excellent", 2 as "good" and 1 as "moderate", 1 not reported on. At 12 mo: 3 "much improved", 3 "improved", 1 "no change." Pain: at 3 and 6 mo, 5 reported no pain, 2 reported pain.

rankings are better clarified and rated with this slightly more rigorous scoring: a very high quality RCT (VHQ) is a 9 to 10 with a very low risk of bias, a high-quality RCT (HQ) is a 7 to 8 with low risk of bias, a moderate-quality RCT (MQ) is a 4 to 6 with a high risk of bias, and low- or poor-quality RCTs (LQ) are rated a 1 to 3 with very high risk of bias.[7,56,59]

As part of our desire to survey a broad evidence base, WSR was used, which is especially relevant to observational study of "body-based" usual practice, studies difficult to blind.[60] Whole systems research assessment was developed to analyze Complimentary and Alternative Medicine (CAM) and for commonly used, but minimally researched, treatments or therapies.[61,62] Whole systems research emphasizes the value of assessing model validity; and model validity encompasses the need for research to adequately address the unique healing theory and therapeutic context of a CAM or new intervention in a variety of studies such as SGPPDs, prospective case series, and reports, as well as pilot and other designs and studies, central to the development of WSR.[61,62] Whole systems research analyzes the congruence between the paradigm of the system being investigated and the research methodology being used with observation of the full intervention and clinical encounter, individualized treatment, patient preferences and clinical judgment, practitioner experience, comparison to "real-life treatment" such as waiting list or standard care, use of valid and reliable outcome measures, and so forth.[61,62] Whole systems research uses a developed checklist; and in this study, the original WSR was used and slightly modified for case series and reports.[60,62] The WSR assessment system or tool has not yet been demonstrated to be valid and reliable, although significant work is developing in this direction and may allow a minimal ranking possibly beyond simple subjective opinion.[60-64] Whole systems research's ratings are as follows: 8 to 11 points are rated as HQ, 4 to 7 points are rated as MQ, and finally 0 to 3 points are rated as LQ (Table 1).

Using the guidelines per PEDro, some of the earliest shoulder chiropractic trials used precomputerized randomization procedures. Precomputerized randomization and concealed allocation were achieved by means of placing equal numbers of folded and obscured sheets of paper (15 or 30 per group, marked group 1 or 2) into a container. The sheets of paper were then thoroughly mixed to achieve discontinuity and were then retrieved carefully and blindly from the container. At each additional subject randomization point, containers were again held in such a manner that folded sheets and group allocation were concealed, and obtained to achieve randomization and concealed allocation. This technique, long used by medicine, has largely been replaced by new, easier computerization techniques.[65] Slow adoption of the computerized system was due in part to financial barriers (particularly for the chiropractic profession) and lack of

Table 6. *A summary of research on SCDP, SGPPDs*

Author	Diagnosis	Treatment management	Reported outcome
Mintken et al,[96] 2010	*SCDP* N = 80 Average age: 41.5 ± 13.5 *"Shoulder pain"* Extensive orthopedic tests provided (see article)). Most negative; particularly instability and ruled out other serious pathology such as fracture, etc. + GH/synovial pathology essentially ruled out A prospective single-arm trial to determine a priori prognostic variables that predict a successful outcome for patients with shoulder pain who receive only cervical and thoracic HVLA manipulation and mobilization Outcome measures: SPADI NRS FABQ (Fear Avoidance Beliefs Questionnaire) TSK (Tampa scale Kinesiophobia) Global Rating of Change (15-point scale from + 7 (« a very great deal better ») to −7 (etc) C-T ROM Scapular motion and position Posture Accessory motions Note: many variables looked at to determine a prognostic or clinical prediction for success	MT 3 txs MT + simple cervical and thoracic mobility exercises. 1 group immediate pre-post test 1. Lower cervical mobilization 30 s lateral translation of C5-7 6X each side HVLA thrusts: 2× each 2. HVLA thrust seated midrange distraction to midthoracic spine (seated, patient with arms crossed, operator distraction/axial elongation by operator chest and/or light added P-A motion) 3. HVLA thrust, supine A-P thrust through patient elbows for cervicothoracic junction or spine 4. HVLA thrust, supine A-P through elbows to upper thoracic spine 5. HVLA thrust, supine A-P thrust to mid or lower thoracic spine 6. HVLA prone, mid range P-A (bilateral) mid to upper thoracic spine All MT was delivered (each subject received 2 thrusts with each technique or the mobilization as described). Exercises: supine AROM exercises Cervical (the "3 finger ROM exercise") appears to be AROM in rotation (neutral or slight flexion) to either side 10 reps, 3-4×/d Thoracic (supine, hands behind neck with fingers interlaced, lie on rolled towel at apex of thoracic kyphosis) slightly flex and then extend over towel 10 reps, 3-4×/d No adverse reactions reported Technique as described by Mintken et al[96] (appear similar to "diversified procedures or techniques" per Bergman[9] 2002)	WSR (SGPPD) 8 Outcome measures: Primary GROC A +4 GROC = success After second tx if +4 GROC tx stopped After 3rd tx if +4 GROC = success, if < than +4 GROC = failure. The 5 variables that predict success with this treatment: The 5 variables (out of many more including all outcome measures, examination procedures, etc) that predict success with "*shoulder pain"* patients (who do not have an apparent or apparent GH pathology or serious disorder): 1. Pain-free shoulder flexion <127° 2. Pain-free internal rotation <53° 3. Negative Neer impingement test result 4. Not taking any type of medication for shoulder 5. Duration <90 d If 4/5 = 100% success If 3/5 = 95% success If 2/5 = 78% success For all that achieved > +4 = 61% of 80 patients with shoulder pain had a successful outcome as described above. Those with success had significantly more shoulder flexion ROM, and significant and clinically meaningful decrease in SPADI and NRS *all*, $P < .01$ Must be cautious with extrapolation of these findings as there was no control and these findings need to be confirmed in future research.
Struance et al, 2009[103]	*SCDP* N = 21 Average age: 47 ± 12.6 *"Shoulder pain"* Secondary: possible mild impingement disorder Shoulder pain 18-65 yrs, ↓ GH ROM, and either a: + H-K or + Neer Impingement test. Ruled out cervical spine causation (by passive accessory motion and other special tests: only the cervicothoracic junction and thoracic spines treated) Orthopedic examination of the shoulder, cervical and thoracic spines: + GH/synovial pathology essentially ruled out	MT 1 treatment: cervicothoracic, thoracic and upper ribs HVLA thrust manipulation only for tx of "shoulder pain" 1 tx: VAS outcome measure taken after a repeat of H-K and Neer's tests. Other outcome tests then collected. Treatments: 1. Seated distraction manipulation for the cervicothoracic junction; subject's arm behind neck – axial elongation or distraction with slight P-A or extension thrust with operator's chest (seated general cervicothoracic thrust/applied whether dysfunction palpable or not). For restricted extension 2. Supine unilateral upper rib A-P thrust	WSR (SGPPD) 6 Outcome measures: Primary: GROC: +4.2 points (median +5 points) = average moderate improvement (range 0-7) Secondary: VAS: ↓32 mm (or 51% decrease in pain) ROM (GH or shoulder): ↑ global ROM of 30-38° ↑ flexion, abduction and rotation) Author

	(serious pathology, RA, infection, rot cuff tear, FS, serious spinal pathology such as infections, osteoporosis, fracture, nerve root, neurogenic or neurological disorders, etc) Prospective single arm study: to determine effects of cervicothoracic and thoracic HVLA thrust in tx of "Shoulder pain" Outcome measures: GROC (15 point scale from + 7 (« a very great deal better ») to −7 (etc) GH ROM VAS	3. Supine thoracic "flexion/opening" manipulation (for restricted flexion) 4. P-A thoracic bilateral thrust No adverse reactions reported Technique as described by Mintken et al[96]; appears similar to "diversified procedures or techniques" per Bergman[9] 2002)	
Wang and Meadows, 2010[108]	Diagnostic category: *NSP minor* A minor peripheral neurogenic (referred) shoulder (and arm) pain, injury and/or disorders (see above) N = 13 Neck pain with or without referred C5 area (shoulder or arm) pain, increased by movement. 1. Had to have a facilitated segment (see below) 2. Had to be weaker and "give way" in either external rotation and/or ABD within 3 mm tests Average age: 36 ± 9.76 Shoulder weakness due to current or past neck and/or shoulder pain and current associated cervical joint dysfunction (with an apparent "facilitated segment" C5-7) Weak shoulder external rotation due to a C5-6 facilitated segment; per Korr (see Wang 2010) ↓ external rotation (and or ↓ elevation/ABD of the shoulder) ROM and/or strength common dx findings in *most* Shoulder Pain and/or Disorders. Existing neck or shoulder pain? 8 yes, 5 no Neck or shoulder pain intensity at baseline n = 8 (Ave NRS 3.25 ± 1.49) Cervical, shoulder orthopedic and/or neurological tests to rule out/exclude serious pathology Outcome measures: Primary: Pre- and post-tx dynamometer ext rot mm strength tests: Handheld strength dynamometer for testing shoulder external rotator strength (pre- and posttreatment). Note: only ext rot tested. Secondary: Facilitated Segment Screening tests: *k* inter-examiner agreement	MT 1 tx (a time-series pre-test and post-test study) 1. Weak ext rot 2. Cervical C5 "facilitated segment" (or joint dysfunction causing ext rot weakness) components hypothesized as: 1. Brisk reflex 2. Tenderness to palpation (Supraspin, Infraspin, Deltoid mm) 3. Hypertonicity (same muscles) 4. Hypersensitivity (in upper back, scapula, or upper arm) 4. Trophic change (color change) in upper back, scapula, or upper arm MT: MT to the Cerv spine: lateral glide in a slight inferior and medial direction on the same side as the ext rot mm weakness at C5/6 (Maitland technique). 1-2 oscillations per second for 5 minutes. Patient supine with no lateral flexion or rotation of C-spine Adverse effects: 2 subjects withdrew due to an ↑ in shoulder pain (from N = 15 to N = 13)	WSR (SGPPD) 6 Outcomes Post MT tested immediately after grade III mobilization and also: 1. immediately 2. at 10 minutes 3. at 20 minutes 4. and at 30 minutes for External Rotator mm strength with dynamometer. *Significant for an ↑ in Ext Rot strength immediately after mobilization only* *P* = .003 Not otherwise significant. Dx and agreement on a "Facilitated Segment" Interexaminer agreement for a facilitated segment in this study: Kappa = Good to fair for brisk reflex, tenderness, hypersensitivity and hypertonicity but, poor for trophic change)

GROC, Global Rating of Change.

Table 7. *Summary of related and miscellaneous case reports*

Author	Diagnosis	Treatment/Management	Reported outcome
Rimbey,[97] 2005 A minor peripheral neurogenic shoulder (and arm) pain or minor peripheral nerve injuries and/or disorders May be part of a thoracic outlet syndrome	*NSP* (or MPNIDs) and *SCDP* Shoulder pain (and pain and tingling in 1st 3 digits) due to: Diagnosis: pectoralis minor entrapment with underlying cervical disk herniation Duration: 4 mo before referral to DC History: 1. Painful shoulder and digits ≥4 mo 2. DTRs OK, no sens deficits, cerv compress/distraction negative. 3. 1st examination, MD dx: cerv strain. Tx was no overhead lifting, light duty ≤10 lb; PT modalities; after 2 wk no improvement. 4. Then MRI dx of C5/6 HNP and facet and ligt hypertrophy w/ mild foram encroachment. 5. Physiatrist gave 3 epidural injections + PT = EMS, heat, stretching = no improvement. 6. Physiatrist referral to DC Diagnosis (DC): Shoulder pain with tingling in 1st 3 digits; no neck pain. 1. Forward, abnormal C-T posture; raised/elevated rt shoulder, elevation of shoulder pain and ↑ tingling in digits 2. ABD raised scapula early 3. Shoulder ROM WNL but ↑ sxs 4. ↓ C-ROM in rot w/ ext and lat flex w/ ↑ sxs. DTRs brisk, no sensory loss C5-8; Compress tests − 5. + Roos test, + impingement under Pectoralis major and minor (by + TrP tenderness w/ ↑ sxs). + Wright abduction test (similar to a NPTP1 test). 6. Joint dysfunction C5/6, C7/T1 and rt 1st rib 7. Patient allowed light duty Outcome measures: 1. VAS 1-5 (out of 10 worst) 2. C-ROM, shoulder-ROM 3. Shoulder ABD/elevation 4. Pectoralis major and minor + TrP 5. + Roo test, + Wright abduction test 6. Joint dysfunction C5/6, C7/T1 1 ♀ patient 51 y department store clerk with job duties of overhead lifting, pulling and pushing 10-75 lb boxes 8 h/d. Gradual or insidious onset.	MT (DC): 6 Txs Total tx over 10 wk 1. Cerv manual traction 2. HVLA: diversified spinal manipulations to typically C5/6 and C7/T1 3. Soft tissue/TrP tx to Pec MM: including myofascial release = light press over fascia/TrP in direction of restricted motion 30 s; ART tech = ↑ press TrP while Pec mm's contract, stretched after in ABD and Ext Rot, held 3 times 20 s. 3. Postisometric relaxation (PNF). Patient supine, arm and elbow flexed and int rot (operators hand stabilizing elbow), press over fascia beneath coracoid process in inf direction; gentle sup to inf press applied to drive coracoid superior (patient lightly resists), after stretch 3× 20 s. Basic exercise program to focus on scapular retraction and strengthening of upper quadrant: 1. Scapula retraction /depression (scp rt) 10X held 15 s each 2. Wall angles. Patient's back up against wall, shoulders rot backward to touch wall with scp rt then ABD arms to 90° 3. Seated rows (band) around feet pull back flexing elbow and ext arms = retracts scap, stretches pec mm's. 4. Patient sets and maintains scap rt while taught to push, lift and elevate	WSR (CR) 7 Outcomes and treatment ROM 9th wk: 1. Joint dysfunction resolved 2. TrP in Pec mm's resolved 3. Posture slightly improved 4. Ortho tests 5. VAS appears resolved to 0
Cibulka and Hunter, 1985[109]	ACOA Shoulder OA 1 patient 1. One patient, a 35 yr ♀ with gradual/insidious onset of pain playing softball 2. On presentation, moderate pain at rest and moderate to severe pain on activity 3. Pain at the AC joint with adduction, and with hand over head and under head (int rot with add)	MT Mobilization grade IV (Kaltenborn technique-see paper) 6 txs over 5 weeks 1. Patient supine with arm along side in neutral. Operator grasps distal aspect of arm, other hand is placed on anterior (the up portion of the humeral head) and mobilizes, oscillating in A-P 4-5x, then repeated in 2 minutes 2. Passive stretching in internal rotation (statically held for ~2 minutes). Arm was	WSR (CR) 6 Outcomes and treatment: After 6 weeks and after 5 months: ROM at 6th week and 5 month follow-ups: 1. No pain in shoulder reported at rest or with activity

	4. Full shoulder ROM but pain with int rot and add 5. Full passive ROM but active or passive internal rot of the humerus caused the coracoid process to move P-A and inferior and the clavicle to rotate forward (earlier than opposite side) 6. Crepitus AC with active ABD 7. Pain to palpation AC joint and ↓ length of pectoralis maj and lat dorsi mms 8. x-ray confirmed OA at the AC joint Summarized their major finding of ↓ passive internal rotation in left GH joint	internally rotated until the shoulder girdle could be felt by the stabilizing operator's arm/hand over the shoulder/AC joint	2. ↑ Internal rotation 25°, from initial 40 to 65° (at 5 month follow-up)
Lynch et al, 2008[104]	GHP under SCDP Flattened, shallow and deformed glenoid fossa with left shoulder pain 2 patients Patient 1 1. 27 yr ♀ athlete with gradual/insidious onset of left shoulder pain with overhead activities particularly with lifting weights. 10 yrs earlier hurt shoulder throwing javelin. Also previously hurt in football but resolved. 2. Aggravated with bench press and overhead throwing but with no pain if arms kept at side for bench press. 3. Shoulder ROM slightly ↓ in flexion, abd, add, int and ext rot in both shoulders; ↓ w/ post pain at abd 90° 4. + Apley's scratch, + Speed's test, Full and empty can +, Hawkin's Impingement +, Lift off + (= a tight post capsule and weak subscapularis), + Jobe's test, + apprehension and relocation tests bilat (= subtle instabililty), a sulcus sign + and Load and shift test + (all similar bilaterally) 5. VAS 9/10 when active Initial diagnosis: Secondary impingement Rotator cuff tendinosis with mild instability Biceps tendinosis Diagnosis changed after bilateral shoulder x-rays: GHP Outcome measures: VAS, ROM, orthopedic tests Patient 2 1. Left shoulder pain, 24 yr old ♂ chiropractic intern with pain after giving adjustive thrust manipulation. Originally injured in football collision 4 yrs prior. 2. 3-4/10 NRS at the worst 3. Exacerbated after overhead activities, ext rot or abduction & lifting weights 4. Exam demonstrated slight ↓ ROM in active and passive flex and ext rot. + Neer's, + Relocation, +Crank indicative of ant instability; + Apley's scratch, pain on Abbott-Saunder's ABD test with crepitus suggesting bicipital tenosynovitis. Diagnosis: Tendinitis After x-rays demonstrated GHP confirmed by MRI Diagnosis of GHP added	MT Patient 1: Manipulation of T3/4, T12/L1 Rehabilitation emphasized: 1. Proprioceptive stretching and strengthening of rotator cuff mms. 2. ART® and Nimmo for shoulder muscles with rhythmic stabilization 3. Later home exercise program with tubing for rot cuff mms and additional isotonic for int and ext rot and concentric and eccentric exercise included. Patient 2: 1. Mobilization of the AC and GH joints 2. ART® 3. Later home exercise program with tubing for rot cuff mms and additional isotonic for int and ext rot and concentric and eccentric exercise included 4. At 5 weeks additional 4 weeks of care	WSR (CR) 9 Outcomes and Treatment After 6 weeks: ROM at 6th and 7th week and 5 month follow-up: Patient 1: Patient tx 1x/week for 6 weeks 1. Full active and passive pain-free ROM restored 2. VAS 0 3. Orthopedic exam the same except Full and Empty Can and Speeds were less painful Patient 2: Patient tx 1x/week for 5 weeks. Total 9 txs 1. At 5 weeks still mod pain with + ortho tests 2. But at 7 weeks VAS 0 with no sxs 3. Moderate compliance with home exercise program GHP must be assessed later as commonly leads to OA. Mimics many disorders

ACOA, acromioclavicular osteoarthritis; *GHP*, glenoid hypoplasia.

Table 8. *Exercises for specific conditions*

Condition	Exercise
FS	Anterior capsule restriction
	Posterior capsule restriction
	Pendulum
Shoulder impingement syndrome RCIDs[a]	Shoulder serratus dynamic hug
	Shoulder depression
	Long-sitting row
	Serratus press
	Shoulder external rotation
	Shoulder flexion
	Shoulder extension
	Shoulder adduction
	Shoulder scaption
	Internal rotation
	Thoracic extension mobilization
	Dynamic stabilization of the entire kinetic chain including Scapular stabilization
	PNF patterns

http://www.thera-bandacademy.com/. Login-free access to exercise and research with free account. Click on circular area under category—drop-down box—click on condition.

[a] Most authors used Kinesiotape in conjunction with the above exercises for RCID.

easy access to personal computers and randomization software allowing use of these techniques particularly in the last 5 to 10 years.[16,65-68] Mechanical and manual randomization and concealed allocation derived from these procedures may in some circumstances be assigned a slightly decreased score or weight, although they will not be rejected, as similar and other significantly lower methodological studies have not been rejected in previous medical reviews, which of course calls for improvement in research methodology.[7,39,40]

Keeping the above in mind, these methods follow sound research methodology as published in the PEDro guidelines.[68] In particular, PEDro states that randomization is achieved if "a study is considered to have used random allocation if the report states that allocation was random. The precise method of randomization need not be specified. Procedures such as coin-tossing and dice-rolling should be considered random."

The PEDro guidelines consider concealed allocation successful if "the person who determined if a subject was eligible for inclusion in the trial was unaware, when this decision was made, of which group the subject would be allocated to." This study also considered intention-to-treat analysis (ITT) as per PEDro guidelines: "an intention to treat analysis means that, where subjects did not receive treatment (or the control condition) as allocated, and where measures of outcomes were available, the analysis was performed as if subjects received the treatment (or control condition) they were allocated to."[11] Furthermore, it is outlined in these guidelines that "this criterion is satisfied, even if there is no mention of analysis by intention to treat, if the report explicitly states that all subjects received treatment or control conditions as allocated." Although ITT appears to be moving toward becoming a requirement and has broad general acceptance, it is nevertheless true that this has not been so in the past.[69-71] Thus, randomization, concealed allocation, and ITT per the PEDro guidelines as outlined above were frequently accomplished in earlier chiropractic studies using admittedly older but what were formerly acceptable, commonly used methods, some of which are even now acceptable in smaller-sample-sized trials.[16,65-73]

After reviewing abstracts, research was placed into 3 broad categories. Category 1 included randomized controlled or clinical trials with MMT that may have included adjunctive or multimodal therapy such as modalities, exercise/rehabilitation, NSAIDS, and/or activity modification.[1,7,74] The Category 1 evidence table included (1) randomized controlled trials (RCTs) indicating studies that were placebo controlled; (2) randomized clinical trials (RCT^s) denoting a comparative study (treatment vs another treatment, usually either a "standard treatment" or a treatment with evidence superior to placebo); and/or (3) controlled or clinical trials (CTs) generally pseudo- or nonrandomized (with systematic assignment or purposive allocation), either an older study that used a now-unacceptable allocation methodology but was included because of prospectively controlled variables, accurate peripheral diagnosis, and usually a highly planned manipulative therapy protocol vs placebo, comparative treatment, or both; and also (4) studies that were prospective, measurable, and generally included valid and reliable outcome measures with appropriate statistical analyses[7] (Tables 2 and 3).

Category 2 included SGPPDs and case series including 3 or more patients per study. Single-group pretest posttest designs often use a significantly more rigorous methodology with innovation or improvements in design believed by some to produce a higher level of research hierarchy evidence due to strengthened evidentiary results[75-77] (Tables 4, 5, and 6).

Category 3 included case reports of 2 or less patients. However, only a few case reports (or other studies from any of the other categories) were included from the previous McHardy et al[1] upper extremity systematic review, as these studies (mostly case reports and series) were adequately analyzed and need not be repeated in this systematic review (Tables 4, 5, 6, and 7). In this sense, it is suggested that this study is as an expansion of that previous review but limited to the shoulder; and the reader is directed to the McHardy review.[1]

Within each of these categories, studies were further grouped according to the condition or conditions investigated in each article. This review used these diagnostic groupings: rotator cuff injuries, disorders, and/or diseases (RCIDs), which include partial tears, shoulder

impingement syndromes, subacromial bursitis, and tendinopathy of any of the rotator cuff tendons to include the bicipital tendon. Another diagnostic grouping was shoulder complaints, dysfunction, disorders, and/or pain (SCDP) per the Dutch Shoulder Guidelines and is defined as pain at rest or during movement of the upper arm in part or all of the area between the base of the neck and the elbow.[98] Frozen shoulder (FS) normally denoting adhesive capsulitis, is characterized by a painful shoulder with significantly limited range of motion (ROM) that may eventually cause muscle weakness and atrophy. Soft tissue disorders (STs) include any myofascial pain, disorder, dysfunction, disease, or syndrome. Neurogenic shoulder pain (NSP) includes any referred pain from the cervical and/or thoracic spine and ribs that must include a specific diagnosis for referred shoulder pain, neuralgia, or neuropathy that is of a minor peripheral neurogenic injury.

For evaluation of SGPPDs, case series and reports (Category 2 and 3 studies), WSR assessment and group consensus were used, placing more weight on the value of appraising "model validity (as described above)," that is, assessing whether there is alignment between the framework of the system being investigated and the research methodology being used, with a consensus-developed checklist and, for case series and reports, use of a slightly modified WSR instrument.[60,62] Many treatments delivered in private practice and CAM therapies combine a wide range of modalities to provide individualized treatment. The complexity of these interventions and their potential synergistic effects require innovative evaluative approaches, and the WSR attempts to accomplish this.[60-62,99]

After ranking each study by either PEDro or WSR, the SIGN document, Considered Judgment on Quality of Evidence, was applied to all reviewed materials by the primary author and reviewed, discussed, and agreed upon through author consensus.[7,57] The aggregate evidence for each condition was then given a score as level A, B, C, or I. I or "insufficient" was used in place of the earlier designation of D as outlined in the Handbook for the Preparation of Explicit Evidence-Based Clinical Practice Guidelines (Table 2).[1,12,74,100]

Results

Of 211 citations retrieved, 23 RCTs, 5 CTs, and 7 SGPPDs, case reports, and/or series were determined relevant (Fig 1). Of the RCTs, 4 were classified as RCID, 2 were classified as SCDP, 6 were listed as FS, and 2 were classified as ST. Of the RCT^s (clinical trials), 3 were labeled as RCID, 4 were labeled SCDP, 4 were classified as FS, 1 was listed as a ST, and 2 were newly labeled and called NSP. Of the CTs, 2 were classified as RCIDs, 2 were FS, and 1 was labeled as SCDP. Finally, also assessed were 2 case series, 3 case reports, and 3 SGPPDs. Some were labeled SCDPs, ST, FS, and osteoarthritis (OA).

Before listing levels of evidence, certain definitions will be given. For this article, the shoulder includes only the glenohumeral joint (GHJ); the shoulder girdle includes the GHJ, thoracic spine, cervical spine, upper ribs, and/or the acromioclavicular (AC) and sternoclavicular (SC) joints. Shoulder full kinetic chain (FKC) treatment includes all of the above and any indicated upper extremity joint.

Levels of Evidence

Rotator Cuff Injuries, Disorders, and/or Diseases

This study found a level of B or fair evidence for MMT of the shoulder, shoulder girdle, and/or FKC combined with multimodal or exercise therapy for RCIDs (Tables 2, 3, 5, 7).[25,26,43,44,78-83,101] Evidence was based on manual therapy studies of the shoulder, shoulder girdle, and/or FKC MMT combined with exercise and/or multimodal therapy.[25,26,43,44,78-83,102]

Of the 11 studies that looked at RCIDs, 4 were placebo-controlled RCTs, 4 were comparative treatment RCTs, 2 were clinical trials that used SGPPD, and 1 was a case report of 2 cases only[25,26,43,44,78-83,101] (Fig 1). Treatment varied between differing levels of mobilization (grades I-V) to the GHJ, shoulder girdle, or FKC. Some studies compared manipulation to no manipulation or exercise therapy. Some studies adequately detailed their exercise intervention, whereas others vaguely suggested general stretches and strengthening exercises.[25,26,43,78,81,101] Generally, treatments that included manipulation combined with soft tissue treatment and exercise therapy produced better outcomes than those that did not use multimodal methods. However, even if manipulation only was performed, usually there was a better outcome than no manipulation.

Of interest regarding an RCID is the Dickens et al[80] study that showed that 26% of patients in the multimodal treatment arm who were awaiting surgery were able to avoid surgery. Their population had been diagnosed with subacromial impingement and had failed after 3 steroid injections into the subacromial space. Of the control group, all had surgery. Treatment consisted of manipulation to the shoulder girdle and a supervised (moving to home care) exercise program.

Shoulder Complaints, Dysfunctions, Disorders, or Pain

There is a fair or B level of evidence for MMT of the shoulder/shoulder girdle and FKC combined with a multimodal treatment approach for SCDP (Tables 2, 5, 6, 7).[24,41,47,51,84-86,96,103,104] Evidence was assessed for MMT of the cervical and thoracic spines with and without upper

rib manipulation, or shoulder/shoulder girdle and/or FKC MMT combined with exercise or multimodal therapy (see individual studies).[24,41,47,51,84-86,103]

In 2009, Chen et al[24] published an RCT^ (n = 90) comparing mobilization and exercise therapy vs advice and exercise therapy only. They found no differences in outcome between the 2 groups and concluded that, in regard to mobilization (of the shoulder girdle), in this case meaning GH and AC joints—but not the SC or spinal joints, "the results of this study demonstrate conclusively that the addition of this commonly-used technique to advice and exercise is no more effective than advice and exercise alone." Yet Winters et al[51] in a fully powered RCT^ (n = 172) were able to demonstrate that manipulation was more effective than injection and physical therapy. Teys et al[86] in another RCT demonstrated that mobilization of the GHJ was superior in reducing algometry measured pain and increasing ROM as compared with a control/sham treatment group. In this category of SCDP, the studies by Chen et al,[24] Winters et al,[51] and Teys et al[86] are the only ones that specifically applied MMT to the GHJ (also to the cervical and thoracic spines and upper ribs in Winters et al). Chen et al however were the only ones that limited mobilizations to a grade II and III, whereas Winters et al specified mobilization technique up to a grade IV and V manipulation, and Teys et al performed Mulligan mobilizations with movement or MWM, but appears to have used the force required of a grade IV level delivering A-P and S-I pressure against the head of the humerus while the subjects flexed their arm.[24,51,86]

Of additional interest, in the SCDP category, there were 5 studies that found grades IV, IV+, and V MMT of the cervical spine, thoracic spine, and ribs only (no GH, AC, or SC joint MMT) to be efficacious in treatment of shoulder pain.[47,84,85,96,103] Whether the addition of GH (or AC or SC) joint MMT to these studies would have improved treatment is speculative.

Also reviewed in this category was a case report of 2 patients describing treatment of glenoid hypoplasia.[104] After MMT, both cases had a decrease in pain levels, one showed an increase in ROM, and both continued to respond positively with improving orthopedic test results. Lynch et al[104] concluded that shoulder pain patients that fail to respond to conservative care should be evaluated with advanced imaging for glenoid hypoplasia and that multimodal treatment should be used for management of these patients.

FS or Adhesive Capsulitis

There is a fair (B) level of evidence for MMT with exercise which included proprioceptive retraining, as helpful for FS or adhesive capsulitis (Tables 3 and 5).[27,42,83,87-89,95,105] Studies of FS included a variety of MMT, exercise, and/or rehabilitation treatments: HVLA manipulation, end-range mobilization (ERM), midrange mobilization (MRM), and mobilization with movement (MWM) of the shoulder only and/or of the shoulder girdle. A short-term significant difference in favor of using HVLA manipulation, ERM, or MWM MMT primarily increasing ROM, with a smaller effect for decreasing pain, was found as opposed to exercise alone. The studies included 4 RCT^s, 2 CTs, and 1 SGPPD.

Bulgen et al[42] looked at the difference between 4 groups: one received cortisone injections, another manipulation, a third ice and PNF, and a fourth was a control or "wait and see" group with no treatment. Initially, the injection group had the largest change in ROM; but by the end of the study (a 6-month trial), there were no significant differences in the increase in ROM between groups. This study used the Maitland mobilization (which commonly uses grades I-IV, although this was unspecified). Although MMT did not significantly produce changes, neither did the cortisone injections; however, repeated use of steroid injections (especially $\geq$3 or poorly placed injections) may carry significant risk.[106,107]

Although Bulgen et al did not find that MMT was of benefit, Nicholson,[27] Vermuelen et al,[87] Yang et al,[89] and Rainbow et al[105] all found significant benefit using MMT. Of these studies, only Nicholson[27] prescribed exercise beyond the common base exercise used for FS (below) described as "active and resisted exercises." Vermuelen et al[87] included the pendulum exercise only in the low-grade manipulation group, whereas Rainbow et al[105] included pendulum and wall walking exercises in both groups (one receiving mobilization, the other HVLA manipulation).

In a prospective case series, Vermuelen et al[95] followed 7 patients. Treatments included massage therapy, mobilization, active exercises, and physical modalities (ultrasound, short-wave diathermy, and electrotherapy); absence of pain posttreatment was observed in 5 of the 7 patients, and an increase in ROM was observed. As this was a case series, only descriptive and not inferential statistics were performed.[95]

Generally, the greatest change noted with MMT tended toward a change or increase in ROM and function rather than pain. The most common MMT was mobilization of the shoulder. The most common exercise prescribed appeared to be the pendulum, but other exercises (as described or similar to the above) were prescribed but often not well or specifically described.[42,87] Other differences between studies included inclusion of patients with diabetes mellitus in the Vermuelen et al[87] study. Three studies specifically excluded diabetes,[89,95,105] whereas another 3 did not mention diabetes at all.[27,42,88] Diabetes did not affect outcomes in the Vermuelen et al study,[87] but there are too few studies to state the effect of MMT for diabetic patients with FS; and how this disorder will affect

MMT outcomes is not known (co-management is therefore recommended).

Soft Tissue Disorders

There was a fair level of evidence (B) for MMT using soft tissue or myofascial treatments for soft tissue disorders of the shoulder (Tables 2, 3, 7). Three articles were reviewed: one was an RCT^, and 2 were RCTs with blind assessors. Treatment of these groups included the following techniques: soft tissue massage,[91] cryotherapy or heat application followed by passive stretching,[90] and ischemic compression.[92] Although 3 studies yielded a rating of fair for the level of evidence in the short-term treatment of ST disorders and pain of the shoulder, longer-term follow-up is needed; efficacy remains unresolved. Further long-term studies are needed to determine if these soft tissue procedures are associated with sustainable long-term efficacious change and relief of ST shoulder pain and disorders.

One study did track the experimental group (trigger point or ischemic compression of specific shoulder muscles) over a 6-month period and the application of experimental treatment in a crossover study applied to the placebo control repeating the 6-month period protocol; consequently, both groups were followed for 6 months.[92] The control group was treated with sham or placebo therapy 15 times (trigger point or ischemic pressure to muscles near the cervical and thoracic spines) and then later crossed over, offered, and given 15 experimental treatments.[92]

NSP or Minor NSP

There is a limited level of evidence (C) for cervical lateral glide mobilization (CLGM) and/or HVLA manipulation with soft tissue release and exercise in the treatment of minor NSP (Tables 2, 3 and 7).[93,94] Two RCT^s, an SGPPD, and a case study were reviewed for minor NSP. Both RCT^ studies compared to cervical lateral glide mobilization (CLGM) ultrasound and found that CLGM lowered pain scales and increased ROM,[93] as well as normalizing force curves during shoulder elevation.[94] Although both studies received PEDro ratings of 7, because of the small sample sizes, they were not fully powered. Both RCTs involved one visit with assessment pre- and posttreatment.

A single case report that described treatment of entrapment due to the pectoralis minor muscle was also included in this review of NSPs. Rimbey's[97] case report with a diagnosis of pectoralis minor entrapment with underlying cervical disk herniation, with neck, shoulder, arm, and digit pain and paresthesia on movement, was rated a 7 using WSR analysis. Treatment included soft tissue release, exercises, and HVLA manipulation to the cervical spine and upper ribs. This patient's complaints resolved with treatment. A decrease in pain perception (including changes in paresthesia), normalization of previous positive orthopedic test results, and an increase in ROM were the markers for improvement. One SGPPD study looked at 13 patients with cervical and/or referred shoulder and/or arm pain.[108] Patients had to have either weak external rotation or abduction strength due to a "facilitated segment" in the cervical spine. After a single CLGM treatment, the majority increased their shoulder external rotation strength immediately after (only) the first treatment, becoming stronger after treatment.[108] Treatment consisted of a grade III mobilization of the C5-6 level only. The authors hypothesized that cervical segmental sympathetic stimulation and central sensitization were causing an inhibitory effect on the muscles that caused muscle weakening. Wang and Meadows[108] posited that mobilization reversed the central phenomenon decreasing central sensitization and that the sympathetic stimulation allowed for an increase in the strength of the external rotators. The effect was diminished though within 20 minutes.

Shoulder OA

There is an insufficient level of evidence (I) for MMT with or without exercise or multimodal therapy in the treatment of OA of the shoulder (Tables 3 and 7). Although a separate category was not created for OA, 1 case report and 2 RCT^s reviewed MMT with exercise for an isolated or restricted number of patients (within these trials) with shoulder OA. However, there were no trials devoted solely to the treatment of shoulder OA; and this minimal evidence, combined, remains insufficient (I).[41,44,109]

Discussion

This systematic review of MMT for shoulder pain and disorders, in keeping with the intent of EBC, has presented a broader and more complete review of evidence. This intent is to cautiously provide practitioners, particularly in the context of clinical expertise and patient preference, with a more comprehensive picture of the existing evidence supporting a variety of MMT therapies (with and without rehabilitation or multimodal treatment) that may be useful. It is our position that the best approach to patient care is not informed by restricting one solely to the most stringently controlled randomized trials. Evidenced-based care was never meant to exclude all other study designs along the research hierarchy.

Multimodal treatment appears at this time to be the most efficacious approach for shoulder conditions (Tables 2-7). This review has shown that MMT, whether grade V HVLA thrust or grades III and IV mobilizations, should be considered for inclusion in the treatment of shoulder pain and disorders, applied appropriately for the benefit, effectiveness, and safety of the patient. Regarding MMT,

evaluation of the GH, AC, SC, spinal, upper ribs, and FKC (such as the elbow) joint should be assessed for ROM, accessory glide, and end-range play, feel, or accessory motions. High-velocity, low-amplitude or mobilization grades I to IV (or up to IV++) should then be applied, after an adequate diagnosis has been made and contraindications have been ruled out, in the direction of the restriction when appropriate.

From the results of this review, the clinician should be guided to additionally evaluate the cervicothoracic spine and ribs when treating the shoulder. A number of trials treated the cervicothoracic spine only and reported good outcomes without including GH (or AC or SC) joint manipulation. The segmental fixation of the cervicothoracic spine may refer pain to the shoulder area (from the neck to the arm) or may be partially responsible for inhibition of the lower scapular stabilizers that cause altered biomechanics of the shoulder eventually ending in shoulder pain.[108,110]

Rarely in clinical practice is there one diagnosis for a given shoulder condition. Often, myofascial soft tissue involvement will be accompanied with joint restrictions and neuromuscular movement dysfunction, which over time may cause tissue injury or failure resulting in a primary joint disorder. Travell and Simons[111] have revealed pain referral patterns into the shoulder area as a result of myofascial trigger points. One aspect this review did not address is the impact of myofascial adhesions and restrictions on shoulder function. This is a topic that needs more research, as there is some evidence that fascial disorders may have far-reaching effects on function and pain.[92,112] Treatment that addresses all of these dysfunctions as well as joint restrictions/fixations may be more efficacious in improving function and decreasing pain. For example, the work of Kibler and McMullen[110] suggests that scapular dyskinesis (an alteration in the normal position or motion of the scapula during coupled scapulohumeral movements) is very often present in the most painful shoulder conditions; rotator cuff injuries have scapular dyskinesis present in 68% of cases and labral tears in 94%, and there is scapular dyskinesis in GH instability in 100% of cases. Scapular stabilization exercise or rehabilitation may often then be the foundation of a shoulder rehabilitation program (requiring scapular MMT and/or shoulder girdle MMT) for success. This review found that scapular stabilization was one of the most common exercises prescribed in the studies reviewed. Please see Table 8 for a description of the most common exercises prescribed in the studies reviewed.

Limitations

One limitation is confusion surrounding and lack of standardization of the term *shoulder girdle*. *Shoulder girdle* has been defined variously by different authors at different times and in the past has been the combination of the GH, AC (including scapular glide), and SC joints and/or including the axial spine (cervical and thoracic spines). In this review, some authors described the *shoulder girdle* as the cervical and thoracic spines and upper ribs, whereas others used the (previously) more common definition given above. Some included it all. Others defined the shoulder as restricted to the GHJ. This confusion cannot be resolved in this article and may have led to different interpretations of findings in this review. The reader is directed to the particular article cited and Tables 2-7 for clarification.[113] It is also not clear when manipulation is indicated for the spine and not the GHJ, or the GHJ, spine, scapula, and upper ribs; this is explicated in a minor way in the Tables 3 to 7; and again, the reader is directed to the individual articles cited.

Another limitation is use of the WSR. The WSR is not yet demonstrated to be valid and reliable, and the number or WSR "score" that is given must be viewed with caution, should not be quoted as would a PEDro score, and is best seen as how this review deemed the importance and/or strength of the non-RCT study. Ultimately, the WSR score is this review's expert but consensus opinion. Finally, the literature base continues to grow. It is likely that some articles were published after submission and acceptance of this article and therefore were not able to be considered for this review.[114]

Conclusion

This study found a level of B or fair evidence for MMT of the shoulder, shoulder girdle, and/or FKC combined with multimodal or exercise therapy for RCIDs. There is a fair or B level of evidence for MMT of the shoulder/shoulder girdle and FKC combined with a multimodal treatment approach for SCDP. There is a fair (B) level of evidence for MMT with exercise that included proprioceptive retraining as helpful for FS or adhesive capsulitis. There was a fair level of evidence (B) for MMT using soft tissue or myofascial treatments for ST of the shoulder. There is a limited level of evidence (C) for CLGM and/or HVLA manipulation with soft tissue release and exercise in the treatment of minor NSP. There is an insufficient level of evidence (I) for MMT with or without exercise or multimodal therapy in the treatment of OA of the shoulder. In particular, MMT must be combined, when safe, appropriate, and including no contraindications, with commonly indicated exercise or rehabilitative therapy, as it remains the standard care. For clinicians, however, this study is intended to guide them in the appropriate use of MMT, soft tissue technique, exercise, and/or multimodal therapy for the treatment of a variety of shoulder complaints in the context of the entire hierarchy of available evidence.

Practical Applications

- This review allows a basic comparison of the diversity and commonalities of multiple manual therapy techniques used in the treatment shoulder disorders.
- This review, dating from the mid 1980s to 2010, gives a broad overview of the type and quality of previous manual therapy randomized controlled trials and other studies for the treatment of shoulder pain, allowing practitioners to have an increased choice of therapy.
- This review helps to elicit the best evidence along with lesser levels of evidence (which may still be useful in, or for, particular settings or patients) and to bring out the gaps in our understanding or literature.

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References

1. McHardy A, Hoskins W, Pollard H, Onley R, Windsham R. Chiropractic treatment of upper extremity conditions: a systematic review. J Manipulative Physiol Ther 2008;31:146-59.
2. Palmer B. Exposition of old moves illustrated. Davenport, IA: Plamer School of Chiropractic; 1911.
3. Wardwell W. Chiropractic history and the evolution of a new profession. St. Louis, MO: Mosby; 1992. p. 50-90.
4. Brantingham JW, Snyder WR. Old Dad Chiro and extravertebral manipulation. Chiropr Hist 1992;12:8-9.
5. Smith O, Langworthy S, Paxson M. Modernized chiropractic, Vol. 2. Cedar Rapids, IA: Laurence Press Company; 1906.
6. Christensen M, Kollasch M, Ward R, Kelly R, Day A, zumBrunnen J. Job analysis of chiropractic. Greeley, CO: National Board of Chiropractic Examiners; 2005. p. 2005.
7. Brantingham JW, Globe G, Pollard H, Hicks M, Korporaal C, Hoskins W. Manipulative therapy of lower extremity conditions: expansion of a literature review. J Manipulative Physiol Ther 2009;32:53-7.
8. Haldeman S, Chapman-Smith D, Petersen D. Guidelines for chiropractic quality assurance and practice parameters. Paper presented at: Proceedings of a consensus conference commissioned by the Congress of Chiropractic State Associations. Gaithersburg, MD: Mercy Conference Center; 1993. p. 103-77.
9. Peterson DH, Bergmann TF. Chiropractic technique: principles and procedures. 2nd ed. St. Louis, MO: Mosby; 2002. p. 39-501.
10. American Academy of Orthopaedic Manual Physical Therapists. [Internet]. Alexandria, VA; c 2008. Orthopaedic manual physical therapy description of advanced specialty practice. [Cited Jan 21, 2011]. Available from: www.aaompt.org.
11. American Physical Therapy Association. [Internet]. Alexandria, VA; c 2010. Manipulation education manual for physical therapist professional degree programs [Cited Jan 21, 2011]. Available from: www.apta.org.
12. Bronfort G, Haas M, Evans R, Leiniger B, Triano J. Effectiveness of manual therapies: the UK evidence report. Chiropr Osteopat 2010;18:1-112.
13. Haldeman S, Underwood M. Commentary on the United Kingdom evidence report about the effectiveness of manual therapies. Chiropr Osteopat 2010;18:4.
14. Sackett DL, Rosenberg WM, Gray JA, Haynes RB, Richardson WS. Evidence based medicine: what it is and what it isn't. BMJ 1996;312:71-2.
15. Smith BH. Evidence based medicine. Rich sources of evidence are ignored. BMJ 1996;313:169 [author reply 170-161].
16. Haneline M. Evidence-Based Chiropractic Practice. Sudbury, MA: Jones and Bartlett Publishers, Inc.; 2007. p. 1-175.
17. Dawes M, Summerskill W, Glasziou P, et al. Sicily statement on evidence-based practice. BMC Med Educ 2005;5:1.
18. Sege RD, De Vos E. Evidence-based health care for children: what are we missing? Boston Medical Center and Boston University School of Medicine, Boston, MA: The Commonwealth Fund; 2010.
19. Becker RE, Greig NH. Neuropsychiatric clinical trials: should they accommodate real-world practices or set standards for clinical practices? J Clin Psychopharmacol 2009;29:56-64.
20. Young G. Evidence-based medicine in podiatric residency training. Clin Podiatr Med Surg 2007;24:11-6, v.
21. Card SE, Snell L, O'Brien B. Are Canadian General Internal Medicine training program graduates well prepared for their future careers? BMC Med Educ 2006;6:56.
22. Johnson C. Evidence-based practice in 5 simple steps. J Manipulative Physiol Ther 2008;31:169-70.
23. Manchikanti L, Hirsch JA, Smith HS. Evidence-based medicine, systematic reviews, and guidelines in interventional pain management: part 2: randomized controlled trials. Pain Physician 2008;11:717-73.
24. Chen JF, Ginn KA, Herbert RD. Passive mobilisation of shoulder region joints plus advice and exercise does not reduce pain and disability more than advice and exercise alone: a randomised trial. Aust J Physiother 2009;55:17-23.
25. 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.
26. 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.
27. Nicholson G. The effects of passive joint mobilisation on pain andhypomobility associated with adhesive capsulitis of the shoulder. J Orthop Sports Phys Ther 1985;6:238-46.
28. Shacklock M. Neural mobilization: a systematic review of randomized controlled trials with an analysis of therapeutic efficacy. J Man Manip Ther 2008;16:23-4.

29. Gill P, Dowell AC, Neal RD, Smith N, Heywood P, Wilson AE. Evidence based general practice: a retrospective study of interventions in one training practice. BMJ 1996;312: 819-21.
30. Guirguis-Blake J, Calonge N, Miller T, Siu A, Teutsch S, Whitlock E. Current processes of the U.S. Preventive Services Task Force: refining evidence-based recommendation development. Ann Intern Med 2007;147:117-22.
31. Chikwe J. Evidence based general practice. Findings of study should prompt debate. BMJ 1996;313:114 [author reply 114-115].
32. Ernst E. Adverse effects of spinal manipulation: a systematic review. J R Soc Med 2007;100:330-8.
33. Cassidy JD, Boyle E, Cote P, et al. Risk of vertebrobasilar stroke and chiropractic care: results of a population-based case-control and case-crossover study. J Manipulative Physiol Ther 2009;32(2 Suppl):S201-8.
34. Murphy DR, Schneider MJ, Seaman DR, Perle SM, Nelson CF. How can chiropractic become a respected mainstream profession? The example of podiatry. Chiropr Osteopat 2008;16:10.
35. Moller HJ, Maier W. Evidence-based medicine in psychopharmacotherapy: possibilities, problems and limitations. Eur Arch Psychiatry Clin Neurosci 2010;260:25-39.
36. Walsh NE, Hurley MV. Evidence based guidelines and current practice for physiotherapy management of knee osteoarthritis. Musculoskeletal Care 2009;7:45-56.
37. Tilburt JC. Evidence-based medicine beyond the bedside: keeping an eye on context. J Eval Clin Pract 2008;14: 721-5.
38. Philadelphia Panel evidence-based clinical practice guidelines on selected rehabilitation interventions for shoulder pain: overview and methodology. Phys Ther 2001;81:1629-40.
39. Green S, Buchbinder R, Hetrick S. Physiotherapy interventions for shoulder pain. Cochrane Database Syst Rev 2003: CD004258, doi:10.1002/14651858.CD14004258.
40. Desmeules F, Cote CH, Fremont P. Therapeutic exercise and orthopedic manual therapy for impingement syndrome: a systematic review. Clin J Sport Med 2003;13:176-82.
41. Knebl JA, Shores JH, Gamber RG, Gray WT, Herron KM. Improving functional ability in the elderly via the Spencer technique, an osteopathic manipulative treatment: a randomized, controlled trial. J Am Osteopath Assoc 2002;102: 387-96.
42. Bulgen D, Binder A, Hazleman B, Dutton J, Roberts S. Frozen shoulder: prospective clinical study with an evaluation of three treatment regimens. Ann Rheum Dis 1984;43: 353-60.
43. Senbursa G, Baltaci G, Atay A. Comparison of conservative treatment with and without manual physical therapy for patients with shoulder impingement syndrome: a prospective, randomized clinical trial. Knee Surg Sports Traumatol Arthrosc 2007;15:915-21.
44. Pribicevic M, Pollard H, Bonello R. A randomized controlled clinical trial of multimodal manipulative treatment for shoulder pain: a report of findings. PhD Thesis, Macquarie University, Sydney, Australia; Forthcoming 2011.
45. Buchbinder R, Green S, Youd JM, Johnston RV. Oral steroids for adhesive capsulitis. Cochrane Database Syst Rev 2006:CD006189.
46. Ho CY, Sole G, Munn J. The effectiveness of manual therapy in the management of musculoskeletal disorders of the shoulder: a systematic review. Man Ther 2009;14:463-74.
47. Bergman GJ, Winters JC, Groenier KH, Meyboom-de Jong B, Postema K, van der Heijden GJ. Manipulative therapy in addition to usual care for patients with shoulder complaints: results of physical examination outcomes in a randomized controlled trial. J Manipulative Physiol Ther 2010;33: 96-101.
48. Christensen M, Kollasch M, Ward R, Kelly R, Day A, zumBrunnen J. Job analysis of chiropractic 2005. Greeley, CO: National Board of Chiropractic Examiners; 2005. p. 105.
49. Martinez DA, Rupert RL, Ndetan HT. A demographic and epidemiological study of a Mexican chiropractic college public clinic. Chiropr Osteopat 2009;17:4.
50. Lewis JS. Rotator cuff tendinopathy/subacromial impingement syndrome: is it time for a new method of assessment? Br J Sports Med 2009;43:259-64.
51. 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;314:1320-5.
52. Pribicevic M, Pollard H. A multi-modal treatment approach for the shoulder: a 4 patient case series. Chiropr Osteopat 2005;13:20.
53. Maher CG, Sherrington C, Herbert RD, Moseley AM, Elkins M. Reliability of the PEDro scale for rating quality of randomized controlled trials. Phys Ther 2003;83: 713-21.
54. Verhagen AP, de Vet HCW, de Bie RA, et al. The Delphi list: a criteria list for quality assessment of randomized clinical trials for conducting systematic reviews developed by Delphi consensus. J Clin Epidemiol 1998;51: 1235-41.
55. Teasell RW, Foley NC, Bhogal SK, Speechley MR. An evidence-based review of stroke rehabilitation. Top Stroke Rehabil 2003;10:29-58.
56. Harbour R, Miller JA. new system for grading recommendations in evidence based guidelines. Br Med J 2001;323: 334-6.
57. Scottish Intercollegiate Guidelines Network. A Guideline Developers' Handbook SIGN Edinburgh; 2001.
58. The Council on Chiropractic Guidelines and Practice Parameters [Internet]: Lexington, SC. CCGPP; c 2010. Chapter on the upper extremity. [cited Dec 8, 2007]. Available from: http://www.ccgpp.org/view.htm.
59. Scottish Intercollegiate Guidelines Network. A guideline developers' handbook. Edinburgh: SIGN; 2001.
60. Hawk C, Khorsan R, Lisi AJ, Ferrance RJ, Evans MW. Chiropractic care for nonmusculoskeletal conditions: a systematic review with implications for whole systems research. J Altern Complement Med 2007;13:491-512.
61. Ritenbaugh C, Verhoef M, Fleishman S, Boon H, Leis A. Whole systems research: a discipline for studying complementary and alternative medicine. Altern Ther Health Med 2003;9:32-6.
62. Verhoef MJ, Lewith G, Ritenbaugh C, Boon H, Fleishman S, Leis A. Complementary and alternative medicine whole systems research: beyond identification of inadequacies of the RCT. Complement Ther Med 2005;13: 206-12.
63. Verhoef MJ, Vanderheyden LC, Dryden T, Mallory D, Ware MA. Evaluating complementary and alternative medicine interventions: in search of appropriate patient-centered outcome measures. BMC Complement Altern Med 2006;6: 6-38.
64. Verhoef MJ, Mulkins A, Kania A, Findlay-Reece B, Mior S. Identifying the barriers to conducting outcomes research in integrative health care clinic settings–a qualitative study. BMC Health Serv Res 2010;10:14.

65. Neuhauser D, Diaz M. Shuffle the deck, flip that coin: randomization comes to medicine. Qual Saf Health Care 2004;13:315-6.
66. Domholdt E. Physical therapy research: principles and applications. 2nd ed. Philiadelphia: W. B Saunders Company; 2000. p. 83-299.
67. Portney L, Watkins P. Foundations of clinical research: applications to practice. 3rd ed. New Jersey: Pearson Prentice-Hall; 2009. p. 142-584.
68. Physiotherapy evidence database [homepage on the Internet]. Sydney: Sydney University; c1999-2006 [updated 2006 May 1; cited 2008, Feb 22]. Available from: http://wwwpedro www/pedro.fhs.usyd.edu.au/index.html.
69. Gravel J, Opatrny L, Shapiro S. The intention-to-treat approach in randomized controlled trials: are authors saying what they do and doing what they say? Clin Trials 2007;4: 350-6.
70. Porta N, Bonet C, Cobo E. Discordance between reported intention-to-treat and per protocol analyses. J Clin Epidemiol 2007;60:663-9.
71. Baron G, Boutron I, Giraudeau B, Ravaud P. Violation of the intent-to-treat principle and rate of missing data in superiority trials assessing structural outcomes in rheumatic diseases. Arthritis Rheum 2005;52:1858-65.
72. Eisenhart AW, Gaeta TJ, Yens DP. Osteopathic manipulative treatment in the emergency department for patients with acute ankle injuries. J Am Osteopath Assoc 2003;103: 417-21.
73. Hoeksma HL, Dekker J, Ronday HK, et al. Comparison of manual therapy and exercise therapy in osteoarthritis of the hip: a randomized clinical trial. Arthritis Rheum 2004;51: 722-9.
74. Hoskins W, McHardy A, Pollard H, Windsham R, Onley R. Chiropractic treatment of lower extremity conditions: a literature review. J Manipulative Physiol Ther 2006;29: 658-71.
75. Hawk C, Long C, Azad A. Chiropractic care for women with chronic pelvic pain: a prospective single-group intervention study. J Manipulative Physiol Ther 1997;20:73-9.
76. Hawk C, Rupert R, Colonvega M, Hall S, Boyd J, Hyland J. Chiropractic care for older adults at risk for falls: a preliminary assessment. J Am Chiropr Assoc 2005;42: 10-8.
77. Cable G. Enhancing causal interpretations of quality improvement interventions. Qual Health Care 2001;10: 179-86.
78. Bennell K, Wee E, Coburn S, et al. Efficacy of standardised manual therapy and home exercise programme for chronic rotator cuff disease: randomised placebo controlled trial. BMJ 2010;340:c2756.
79. Atkinson M, Matthews R, Brantingham JW, et al. A randomized controlled trial to assess the efficacy of shoulder manipulation vs. placebo in the treatment of shoulder pain due to rotator cuff tendinopathy. J Am Chiropr Assoc 2008; 45:11-26.
80. Dickens VA, Williams JL, Bhamra MS. Role of physiotherapy in the treatment of subacromial impingement syndrome: a prospective study. Physiotherapy 2005;91: 159-64.
81. Citaker S, Taskiran H, Akdur H, Onel Arabaci U. Comparison of the mobilization and proprioceptive neuromuscular facilitation methods in the treatment of shoulder impingement syndrome. Pain Clin 2005;17:197-202.
82. Munday S, Jones A, Brantingham J, Globe G, Jensen M, Price J. A randomized, single-blind, placebo controlled clinical trial to evaluate the efficacy of chiropractic shoulder girdle adjustment in the treatment of shoulder impingement syndrome. J Am Chiropr Assoc 2007;44: 6-15.
83. Surenkok O, Aytar A. G. B. Acute effects of scapular mobiliation in shoulder dysfunction: a double-blind randomized controlled trial. J Sport Rehabil 2009;18: 493-501.
84. Bergman GJD, Winters JC, Groenier KH, et al. Manipulative therapy in addition to usual medical care for patients with shoulder dysfunction and pain: a randomized, controlled trial. Ann Int Med 2004;141:432.
85. McClatchie L, Laprade J, Martin S, Jaglal SB, Richardson D, Agur A. Mobilizations of the asymptomatic cervical spine can reduce signs of shoulder dysfunction in adults. Man Ther 2009;14:369-74.
86. Teys P, Bisset L, Vicenzino B. The initial effects of a Mulligan's mobilization with movement technique on range of movement and pressure pain threshold in pain-limited shoulders. Man Ther 2008;13:37-42.
87. Vermeulen H, Rozing P, Obermann W, le Cessie S, Vliet VT. Comparison of high-grade and low-grade mobilization techniques in the management of adhesive capsulitis of the shoulder: randomized controlled trial. Phys Ther 2006;83: 355-68.
88. Buchbinder R, Youd JM, Green S, et al. Efficacy and cost-effectiveness of physiotherapy following glenohumeral joint distension for adhesive capsulitis: a randomized trial. Arthritis Rheum 2007;57:1027-37.
89. Yang JL, Chang CW, Chen SY, Wang SF, Lin JJ. Mobilization techniques in subjects with frozen shoulder syndrome: randomized multiple-treatment trial. Phys Ther 2007;87:1307-15.
90. Andersen MS, Parkin-Smith GF. A clinical trial investigating the possible effect of cryotherapy and moist heat on active myofascial trigger points of the shoulder girdle: a pilot study. Eur J Chiropr 2003;50:53-60.
91. van den Dolder PA, Roberts DL. A trial into the effectiveness of soft tissue massage in the treatment of shoulder pain. Aust J Physiother 2003;49:183-8.
92. Hains G, Descarreaux M, Hains F. Chronic shoulder pain of myofascial origin: a randomized clinical trial using ischemic compression therapy. J Manipulative Physiol Ther 2010;33: 362-9.
93. Coppieters MW, Stappaerts KH, Wouters LL, Janssens K. The immediate effects of a cervical lateral glide treatment technique in patients with neurogenic cervicobrachial pain. J Orthop Sports Phys Ther 2003;33:369-78.
94. Coppieters MW, Stappaerts KH, Wouters LL, Janssens K. Aberrant protective force generation during neural provocation testing and the effect of treatment in patients with neurogenic cervicobrachial pain. J Manipulative Physiol Ther 2003;26:99-106.
95. Vermeulen H, Obermann W, Burger B, Kok G, Rozing P, van Den Ende C. End-range mobilization techniques in adhesive capsulitis of the shoulder joint: a multiple-subject case report. Phys Ther 2000;80:1204-13.
96. Mintken PE, Cleland JA, Carpenter KJ, Bieniek ML, Keirns M, Whitman JM. Some factors predict successful short-term outcomes in individuals with shoulder pain receiving cervicothoracic manipulation: a single-arm trial. Phys Ther 2010;90:26-42.
97. Rimbey D. Diagnosis and treatment of pectoralis minor entrapment with underlying cervical disc herniation: a case study. J Am Chiropr Assoc 2005;42:14-9.
98. Geraets JJ, de Jongh AC, Boeke AJ, et al. Summary of the practice guideline for shoulder complaints from the Dutch

College of General Practitioners. Ned Tijdschr Geneeskd 2009;153:A164.
99. Verhoef M, Lewith G, Ritenbaugh C, et al. Complementary and alternative medicine whole systems research: beyond identification of inadequacies of the RCT. Complement Ther Med 2005;13:206-12.
100. Handbook for the Preparation of Explicit Evidence-Based Clinical Practice Guidelines; New Zealand Guidelines Group. Greer N MG, Logan A, Halaas G; A Practical Approach to Evidence Grading, Joint Commission Journal on Quality Improvement, 2001;26:700-12, 2000.
101. Krenner BJ, Fung JJF. Shoulder impingement syndrome: clinical overview and treatment approach utilizing Trigenics. J Am Chiropract Assoc 2005;42:16-24.
102. Krenner B. Case report: comprehensive management of medial tibial stress syndrome. J Chiropr Med 2002;1:121-4.
103. Strunce JB, Walker MJ, Boyles RE, Young BA. The immediate effects of thoracic spine and rib manipulation on subjects with primary complaints of shoulder pain. J Man Manip Ther 2009;17:230-6.
104. Lynch CJ, Taylor JA, Buchberger DJ. Glenoid hypoplasia: a report of 2 patients. J Manipulative Physiol Ther 2008;31: 381-8.
105. Rainbow DM, Weston JP, Brantingham JW, Globe G, Lee F. A prospective, clinical trial comparing chiropractic manipulation and exercise therapy vs. chiropractic mobilization and exercise therapy for treatment of patients suffering from adhesive capsulitis/frozen shoulder. J Am Chiropr Assoc 2008;45:12-28.
106. Nelson KH, Briner W, Cummins J. Corticosteroid injection therapy for overuse injuries. Am Fam Physician 1995;52: 1811-6.
107. van der Windt DA, Koes BW, Deville W, Boeke AJ, de Jong BA, Bouter LM. Effectiveness of corticosteroid injections versus physiotherapy for treatment of painful stiff shoulder in primary care: randomised trial. BMJ 1998;317:1292-6.
108. Wang SS, Meadows J. Immediate and carryover changes of C5-6 joint mobilization on shoulder external rotator muscle strength. J Manipulative Physiol Ther 2010;33: 102-8.
109. Cibulka MT, Hunter HC. Acromioclavicular joint arthritis treated by mobilizing the glenohumeral joint. A case report. Phys Ther 1985;65:1514-6.
110. Kibler WB, McMullen J. Scapular dyskinesis and its relation to shoulder pain. J Am Acad Orthop Surg 2003;11: 142-51.
111. Travell J, Simmons D. Myofascial pain and dysfunction: trigger point manual. Media, PA: Williams and Wilkins; 1983.
112. Schleip R, Zorn A, Lehmann-Horn F, Klingler W. The fascial network: an exploration of its load bearding capacity and its potential roles as a pain generator. Paper presented at: 7th Interdisciplinary World Congress on Low Back & Pelvic Pain; November 9-12, 2010; Los Angeles, CA; 2010.
113. Kuhn JE. A new classification system for shoulder instability. Br J Sports Med 2010;44:341-6.
114. Pribicevic M, Pollard H, Bonello R, de Luca K. A systematic review of manipulative therapy for the treatment of shoulder pain. J Manipulative Physiol Ther 2010;33:679-89.
115. Bennell K, Coburn S, Wee E, et al. Efficacy and cost-effectiveness of a physiotherapy program for chronic rotator cuff pathology: a protocol for a randomised, double-blind, placebo-controlled trial. BMC Musculoskelet Disord 2007; 8:86.