

Manual Therapy Combined with Therapeutic Exercise Vs Therapeutic Exercise Alone for Shoulder Impingement Syndrome: A Systematic Review and Meta-analysis

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ABSTRACT

Introduction: Shoulder complaints are the third most common musculoskeletal presentation, after back and neck disorders, in primary care. Among people with shoulder pain, Shoulder Impingement Syndrome (SIS) has the highest prevalence and accounts for 27% of shoulder disorders. Various treatment options are available for SIS. However, literature suggests the need of a review regarding the addition of Manual Therapy (MT) to the Therapeutic Exercise (TE) program.

Aim: To investigate the effectiveness of MT combined with TEs versus TEs alone for the management of SIS.

Materials and Methods: The study examined published randomised controlled trials and quasi-experimental studies. A comprehensive search of two electronic databases (PubMed and Physiotherapy Evidence Database (PEDro)) was performed from inception till the last week of August, 2020. The selected studies were assessed on methodological quality rating using the PEDro scale and the modified Downs and Black scale for

experimental and quasi-experimental studies, respectively. The extracted outcomes were pain levels, strength, Range of Motion (ROM) and Shoulder Pain and Disability Index (SPADI) scale score. The meta-analysis was done on continuous data and the data were summarised qualitatively and quantitatively.

Results: Seven trials were included (n=437) after evaluation. Standard Mean Difference (SMD) with 95% CI was used to denote summary effects of the outcome measures. Pain {SMD: -1.07; 95%CI: -1.85, -0.28; p<0.01} showed positive effect when managed with MT combined with TE while external rotation strength {SMD: 0.55; 95%CI 0.27, 0.84; p<0.01} improved with TE alone. The majority of the studies (six out of seven) had low risk of bias.

Conclusion: The results indicate that evidence exists for improvement in pain level and muscle strength with MT combined with TE and TE alone respectively. The qualitative evidence suggests that glenohumeral mobilisation and exercises are associated with best outcomes for SIS management.

Keywords: Exercise therapy, Joint mobilisation, Muscle strength, Pain, Rotator cuff disorders

INTRODUCTION

The Shoulder Impingement Syndrome (SIS) is considered to be an umbrella term for a cluster of signs and symptoms. The common clinical presentation of a SIS patient is localised pain around shoulder complex, functional disability, painful arc sign during elevation and weakness of external rotation [1]. SIS contributes 27% of the total shoulder injuries burden [2]. Since, the shoulder stabilises the upper quadrant, so it is considered to be a cornerstone for upper limb activities. SIS particularly generates significant impairment in function, so it has to be managed at early stages.

SIS is initially classified as subacromial space stenosis that results in compression of rotator cuff structures and gradual tendon attrition with potential chance of failure. Many of the recent literature also suggest that SIS is an end result of numerous pathologies of the shoulder [3,4]. Physiotherapy intervention usually comprise multimodal interventional strategies like exercise, MT, advice and patient education [3-5]. The goal of MT combined with TEs to accelerate reduction of pain, promote healing, restores pain free ROM and increase rotator cuff strength. Scapular exercises have also been reported to increase the activity of the middle trapezius, lower trapezius and serratus anterior muscles [6-8].

Manual Therapy (MT) or joint mobilisation is defined as skilled passive movement with therapeutic intent [8]. It uses low velocity, rhythmic oscillatory application applied in various grades. The mobilisation methodologies like Maitland approach are supposed to cause therapeutic effects either by structural or neurophysiological mechanisms [8].

A number of earlier published articles on conservative management of SIS have not been able to firmly come to a conclusion on the efficacy of the MT combined with TE. The paucity of clear guidelines on management of SIS is due to limitations in study designs and protocols in previous researches [9-11].

The aim of this study was to examine the overall effectiveness of the MT combined with TE in management of SIS and update the current state of knowledge with respect to pain, strength, active movement and SPADI scale.

MATERIALS AND METHODS

Searching strategy

This study was conducted as per Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines and Cochrane handbook for systematic reviews of intervention and the trial was registered at central trial registry CTRI/2018/05/013892. Medical and health science databases were searched electronically: PubMed and Physiotherapy Evidence Database (PEDro) from beginning till the date of search (i.e.,) August 2020. The search strategies used in both databases were same and the keywords and Boolean operators used (AND, OR) are given in [Table/Fig-1]. The study was approved by the Institutional Ethical Committee (IEC number: 01/04/JMI/SS/FNS).

Selection criteria

The study population was patients with SIS, intervention was MT combined with exercise therapy, comparator was exercise alone and outcomes were pain level, muscle strength, ROM, and SPADI score.

Search steps	Query (PubMed/PEDro)	Items found (PubMed/PEDro)
#1	Search Shoulder Impingement Syndrome (SIS) (Title/Abstract)	2422/164
#2	Search Shoulder Impingement Syndrome (SIS) (Title/Abstract) AND physiotherapy (Title/Abstract) OR physical therapy (Title/Abstract)	543/41
#3	Search Shoulder Impingement Syndrome (SIS) (Title/Abstract) AND Therapeutic Exercise (Title/Abstract)	308/72
#4	Search Shoulder Impingement Syndrome (SIS) (Title/Abstract) AND Manual Therapy Search Shoulder Impingement Syndrome (Title/Abstract) OR manipulative therapy (Title/Abstract)	146/36
#5	Search subacromial impingement syndrome (Title/Abstract) AND physiotherapy (Title/Abstract) OR physical therapy (Title/Abstract)	546/26
#6	Manual Therapy combined with Therapeutic Exercise (Title/Abstract) AND physiotherapy (Title/Abstract) OR physical therapy (Title/Abstract)	26/10

[Table/Fig-1]: Search strategy.

Two reviewers independently screened the articles from the two databases. The articles were screened according to the title and abstract after removing the duplicates from two sources.

Inclusion and Exclusion Criteria

English research publications that were randomised controlled trials and quasi-experimental trails, comparing physiotherapy interventions for management of SIS, were considered for the analysis. Full text version was retrieved if the title and abstract were unclear for deciding the inclusion of the study. Furthermore, the studies were included if the SIS was clinically diagnosed with shoulder physical examination tests. Only published full text studies were considered for the present review.

Studies were excluded if they had patients with prior or existing shoulder dislocation in the same or opposite shoulder, Acromio-Clavicular (AC) joint pathology, cervical spine radiculopathy, prior shoulder surgery on symptomatic side, positive drop arm test and patients who were on current medication like Nonsteroidal Anti Inflammatory Drugs (NSAIDs) or who had received steroid injection in past 12 months. The studies in which physiotherapy management were not used, case studies and case reports were excluded.

Cohens kappa coefficient expressed the strength of the selection of the studies and disagreements were resolved by third reviewer. There was main disagreement between the two authors on the point of number of included studies {one author wanted to include articles that were purely on SIS (n=5), another author wanted to include articles that were based on specific phenotypes (subcoracoid impingement, calcific tendinitis etc.) of impingement syndrome, including SIS (n=6). The third reviewer resolved this disagreement by only including articles having broad diagnosis of SIS rather than specific phenotypic diagnosis}.

Data extraction

Two reviewers extracted the data from the included studies by using a spreadsheet to record details of the study (author, year, journal, type of Physical Therapy (PT) intervention used, outcome measures and result of the study). Two reviewers reviewed the quality of the paper and also performed risk of bias assessment and disputes were resolved through discussion and consensus with the third author.

Outcome measure

The purpose of the present study was to summarise the effects of MT combined with TE vs TE alone for SIS on impairments like pain levels, functioning and strength of the shoulder girdle musculature.

Methodological quality of the study

Physiotherapy evidence database (PEDro) scale [12] was utilised to score the prospective experimental studies to be included in the review. Studies scoring high on the methodological quality (score $\geq 6/10$) were only considered for the review. For the

quasi-experimental controlled studies, the modified Downs and Black scale [13] was used for assessment of methodological quality. Studies scoring high on the methodological quality (score $\geq 17/28$) were only considered for the review. Agreement level between the two reviewers was evaluated using kappa coefficient. The normative values for agreement were <0.40 for poor, 0.40 to 0.75 for acceptable and >0.75 for excellent [14].

Data synthesis

The conclusion was drawn by compiling findings in the study. The findings include checking for the methodological quality and result of the outcomes were used to form the final conclusion. A meta-analysis was performed using the required statistics (mean, Standard Deviation (SD), Standardised Mean Difference (SMD), 95% Confidence Interval (CI)) using the review manager software.

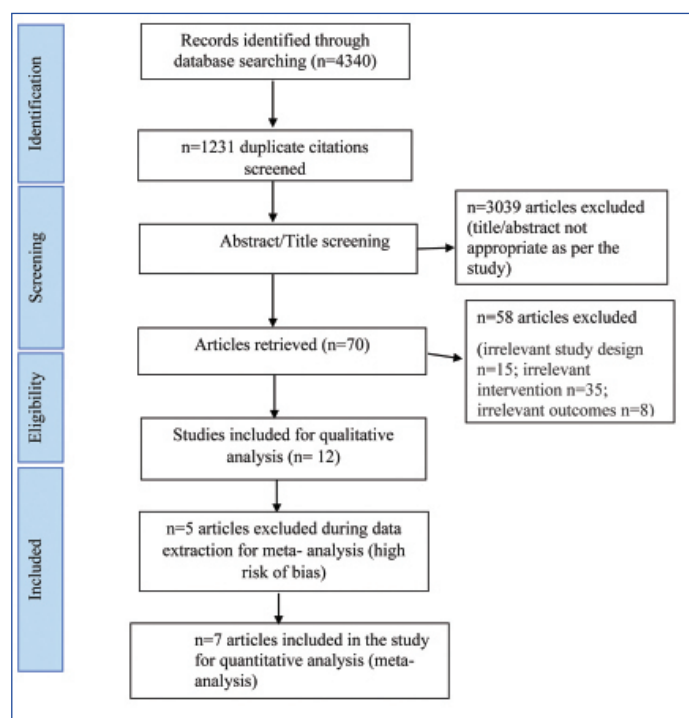
STATISTICAL ANALYSIS

The present study used the Rev Man version 5.3 (Cochrane collaboration) for meta-analysis and generating risk of bias charts. The readings from the outcome measures were obtained on a customised data filling form. The continuous data was evaluated for SMD with 95% CI at $p < 0.05$.

RESULTS

Selection of the Studies

The initial search of the two databases resulted in 4340 results, out of which 1231 were duplicates. After the screening of articles by title and abstract, 70 articles were further shortlisted and these were studied in detail through their full text. Their detailed evaluation was done on basis of the participants, clinical diagnosis of SIS, study design, intervention etc. Evaluation resulted in exclusion of 58 articles. Twelve articles were included for the systematic review (qualitative analysis) [5,15-25] whereas out of these twelve studies, five were not considered for the quantitative analysis due to high risk of bias and finally, 7 studies were considered for meta-analysis in the present study [5,15-19,24] [Table/Fig-2]. The studies have been summarised in the form of table [Table/Fig-3].



[Table/Fig-2]: PRISMA flowchart of search and screening process of studies.

Results of the Methodological Quality of the Study

Quality analysis of the studies [5,15-24,25] demonstrated score from 6 to 9 out of 10 on PEDro scale [Table/Fig-4a] and 11-19 out of 27

Study/PEDro/ MDS score	Participants/ Sessions	Diagnosis	Outcome measures	Interventions		Reported result			Results/ Conclusion
				MT+TE Group	TE. Group	Pain	Str.	ROM QoL/ FD	
Bang MD and Deyle GD 2000 [15] Score-6/10 Follow-up- 4 weeks and 8 weeks	Mean age±SD) 43.01±9.10 yrs Total participants: 52 MT+ET and ET: 6 sessions	a) Scapula fixed, passive internal rotation in scaption b) Active shoulder abduction. c) Resisted isometric test of abduction, IR and ER	a) Pain: VAS level b) Strength: Isometric str, for IR, ER and abductors. c) Functional assessment scale	MT: PA mobilisation Exercise therapy: Planar exercises, rowing, seated press up, elbow push up, anterior and posterior shoulder girdle muscle exercise	Exercise therapy: Planar exercises, rowing, seated press up, elbow push up, anterior and posterior shoulder girdle muscle exercise	+	+	+	4 weeks: no difference between groups 8 weeks: MT+TE group was more effective than group
Bennell K et al., 2010 [16] Score-9/10 Follow-up 12 weeks and 22 weeks	Mean age±SD: 60±10.21 years Total participant 120 MT+ET and ET: 1 st week-2 times a day. 2 nd week-once daily for 10 week	a) Painful active abduction/external rotation b) Positive "quick test" for impingement syndrome.	a) Pain: VAS scale b) Strength- abduction, external rotation, internal rotation c) SPADI scale	Manual therapy: Passive mobilisation of the shoulder complex, STM Exercise therapy: Scapular retraining, CBT, patient education. HEP maintained for further 10 weeks	Exercise therapy: Basic planar exercises, placebo ultrasonic, gentle local application of non-medical gel to the shoulder area for 10 min.	+	+	+	12 weeks: no difference in both groups. At 22 weeks: MT+ET group was more effective than TE group.
Kachingwe AF et al., 2008 [5] Score-7/10 Follow-up: 6 weeks	Mean age±SD: 46.40±8.70 years Total participant: 33 All groups received treatment once a week for 6 weeks	a) Supero-lateral shoulder pain b) Positive impingement tests c) Painful shoulder elevation d) Pain/restriction of functional movements.	a) Pain: VAS level b) ROM: measurement of flexion and scaption. c) SPADI scale	Exercise plus mobilisation group: Exercises: capsular stretches, PCT, strength tr. of scapular muscles Mobilisation group: shoulder joint distraction, AP, PA and inferior glides. Exercise plus MWM group: Exercise same as in Exercise plus mobilisation group	Exercise group: capsular stretches, PCT, strengthening of scapular muscles Control group: Only advise	+	NA	+	At 6 weeks: Pain level improved in exercise therapy and both Manual Therapy groups. At 6 weeks MWM group groups were most effective in improving function while mobilisation group was least.
Yiasemides R et al., 2011 [17] Score-9/10 Follow-up at 1, 3 and 6 months	Mean age±SD: 60.10±4.32 years Total participant: 98	a) Painful active shoulder uniplanar movements, b) Hypomobility and pain during accessory motion testing of the shoulder complex joints.	a) SPADI scale b) ROM c) Self-rated change in symptoms	Manual therapy: PA/AP glides, distraction Exercise therapy, PE	Exercise therapy, PE	+	NA	+	Improvement in both groups, no significant difference between the groups
Conroy DE and Hayes KW; 1998 [18] Score-8/10 Follow-up: 3 weeks	Mean age±SD: 52.90±3.45 years Total participant:14 MT+TE and TE: 3 sessions per week for 3 weeks.	a) Pain around superolateral shoulder region b) Decrease in AROM elevation c) Painful subacromial compression d) Limitation in functional elevated positions	a) Pain: VAS level b) ROM-elevation and rotation. c) Overhead function grading	Manual therapy: PA/AP glides, STM Exercise therapy: AROM: multiplanar active assisted exercise with stick and towel Strengthening exercise: press up, isometric rotations, stretching exercises, PE	Exercise therapy AROM- active assisted exercise with stick and towel in all three planes. Strengthening exercise-press up, isometric rotation, stretching exercises, PE.	+	NA	+	MT+TE group was effective to reduce pain level Improvement in both groups, no significant difference between the groups.
Lee DR and Kim LJ 2016 [21] Score-13/28 Follow-up 8 weeks	Mean age±SD: 18.2 years Total participant-23 ET: 3 times a week for 8 weeks.	Physician diagnosed subacromial impingement syndrome over preceding 6 months	a) Strength Internal rotation b) External rotation	NA	CKC shoulder multiplanar exercises in sling	NA	+	NA	Internal and external rotation strength improved after intervention
Merolla G et al., 2010 [22] Score-15/28 Follow-up 3 months 6 months	Mean age±SD: 22±2.50 years Total participant-31 ET: 2 sessions per week for 6 months	a) Negative for articular and muscular tears. b) Painful and weak infraspinatus	a) Pain: VAS scale b) Isometric strength of infra muscle (normal vs scapular retraction)	NA	Side lying horizontal flexion, side lying vertical abduction, side lying shoulder external rotation, forward punches, rowing exercise, side lying posterior capsular stretching	+	+	NA	Pain level improved at both 3- and 6-months interval. Strength improved in both positions at 3 and 6 mo. Follow-up.
Merolla G et al., 2010 [23] Score-11/28 Follow-up 3 and 6 months	Mean age±SD: 23±4.20 years Total participant-29	a) No articular and rotator cuff tears b) Kibler scapular dyskinesis pattern classification	a) Pain: VAS scale b) Strength: supr. and infra. c) ROM: IR	NA	Exercise for lower and middle trapezius, serratus anterior, Rhomboids and posterior capsular stretching	+	+	+	Pain level, strength and ROM improved at 3 and 6 months Follow-up.
De mey K et al., 2012 [25] score-15/28 Follow-up 6 weeks	Mean age±SD: 24.6±7.81 years Total participant-47 TE: 6 weeks	Two out of five to be positive- a) Neers test b) H K test c) Jobs test d) Apprehension e) Relocation test	a) SPADI scale b) MVIC activity of trapezius muscle group and serratus anterior.	NA	Side lying horizontal flexion, side lying vertical abduction, prone lying shoulder extension, side lying ER	+	-	+	Improvement in pain and function and reduction in trapezius muscle activity.

Cha JY et al., 2014 [24] Score-19/28 Follow-up 12 weeks	Mean age: 22 years. Total participant: 30 MT+TE: 3 sessions per week for 12 weeks	a) Postero-superior pain during ABER position. b) Positive apprehension and relocation test c) Positive impingement tests d) Positive Jobes test	a) Pain: VAS scale b) IR/ER torque-dynamometry	Manual therapy: soft tissue mobilisation Exercise therapy (Mon): scapular W, T and Y exercises (Wed) Rotations in scaption, Military press, "T" scapular exercise, triceps and biceps curls extension, rowing exercise (Fri) "T" scapular exercise	Group 2 (control group) No rehabilitation regime	+	+	NA	At 12 weeks MT+TE group showed better result.
Chen JF et al., 2009 [19] Score-8/10 Follow-up: 1 and 6 months	Mean age-65 years Total participants: 90 MT+TE and TE group: 6 to 10 sessions	a) Unilateral pain over the shoulder girdle b) Painful ROM c) Reduced AROM <110° d) Hypomobility	a) SPADI scale b) ROM c) Global perceived effect (GPE) scale	Manual therapy: GH, SC, and AC joints Exercises CKC NM exercise, PE	Exercise CKC exercises to develop NM control PE	+	NA	+	At 1- and 6-months improvement in both groups MT +TE is not superior to TE.
Senbursa G et al., 2007 [20] Score-4/10 Follow-up at 4 weeks	Mean age±SD: 48.8±7.7 years Total participants:30 MT+TE: 12 sessions (3 times a week × 4 weeks) TE: 7 days a week for 4 weeks (self-training)	a) Marked loss of AROM and PROM. b) Painful shoulder c) Painful isometric ER	a) Pain: VAS scale b) ROM c) Strength	Manual therapy: GH joint mobilisation, DTF Exercise therapy: stretching, PNF exercise, resistance band planar and scapular exercises	Active ROM exercises, stretching, PNF exercises, resistance band planar and scapular exercises	+	+	+	MT +TE is more effective in improving pain, ROM and strength improvement

[Table/Fig-3]: Overview of the included studies.

MT+TE: manual therapy combined with therapeutic exercise; TE: therapeutic exercise; VAS: visual analogue scale; ROM: range of motion; MDBS: the modified downs and black scale; FD: functional disability; QoL: quality of life; IR: internal rotation; ER: external rotation; STR: strength; STM: soft tissue mobilisation; CBT: cognitive behavioural therapy; MWM: mobilisation with movement; GH: glenohumeral; SC: sternoclavicular; ST: scapulothoracic; PE: patient education; PNF: proprioceptive neuromuscular technique; PCT: posture correction technique; HEP: home exercise program; DTF: deep transverse friction; AROM: active range of motion; PROM: passive range of motion; CKC NM: closed kinetic chain neuromuscular exercise; MVIC: maximum voluntary isometric contraction; HK: hawkins Kennedy test; ABER: abduction external rotation; PA glide: posteroanterior glide; AP glide: anteroposterior glide; +: Stands for improvement

on the modified downs and black scale [21-24,25] [Table/Fig-4b]. Treatment allocation was concealed in only three studies [16,17,19]. Blinding of the patient was done in two studies [16,18], assessor blinding in six studies [5,15-19] and only two studies blinded the therapist [17,18]. The mean sample size of the included studies was 48 patients (range=29 to 120 patients). The outcome measure for all studies comprised pain, disability and functioning level and strength evaluation although the measurement scales/tools differed in studies. The mean score for the PEDro scale was 7.28.

Some studies for which data was extracted were quasi-experimental studies [21-24,25]. While PEDro scale is specific for scoring in randomised control trials. Therefore, the modified downs and black scale was used for these studies. Inter-rater agreement for all items on each scale was examined and kappa coefficient with 95%CI was calculated to be 0.73 (95% CI 0.70-0.84, p<0.001) for the modified downs and black scale and 0.80 (95% CI 0.71-0.87, p<0.001) for PEDro scale which suggests acceptable to substantial agreement respectively. The criteria for evaluating grades of risk of bias for PEDro scale was a score of greater than equal to 6 out of 10. The modified downs and black scale classified studies as per score

obtained as high quality/low bias (>20), moderate quality (17-19) and low quality/high risk of bias (<16). Seven studies had low risk of bias i.e., scored 6 or more on PEDro scale and scored >16 on the modified downs and black scale [5,15-19,24]. Five trials obtained score in high risk of bias (PEDro score <6 and the modified downs and black score<16) [20-23,25] [Table/Fig-4a,b].

Risk of Bias Assessment Across Studies

Commonly scored methodological shortcomings were inadequate allocation concealment (n=4) [5,17,18,20], inadequate blinding Patients (n=5) [5,15,17,19,20] and inadequate therapist blinding (n=5) [5] [Table/Fig-5].

As far as the modified downs and black checklist is concerned the shortcomings were mainly in the external validity (n=4) [21,22,24,25], internal validity (n=4) [21-23,25] and confounding selection bias (n=3) [21-23] [Table/Fig-4b].

Risk of Bias Across Outcomes

a) Pain: Pain was reported by five studies at follow-up. All the five studies had low risk of bias [5,15,16,18,24]. All the studies reported

Articles	Adequate randomisation	Allocation concealment	Blinding patients	Baseline comparability	Blinding therapist	Blinding assessor	Outcome data >85%	Intention to treat	Between group results	Point measures/ measures of variability	PEDro score	Percentage
Bang MD and Deyle GD [15]	1	0	0	0	0	1	1	1	1	1	6	60%
Bennell K et al., [16]	1	1	1	1	0	1	1	1	1	1	9	90%
Chen JF et al., [19]	1	1	0	1	0	1	1	1	1	1	8	80%
Kachingwe AF et al., [5]	1	0	0	1	0	1	1	1	1	1	7	70%
Yiasemides R et al., [17]	1	1	0	1	1	1	1	1	1	1	9	90%
Conroy DE and Hayes KW [18]	1	0	1	1	1	1	1	0	1	1	8	80%
Senbursa G et al., [20]	0	0	0	1	0	0	1	0	1	1	4	40%

[Table/Fig-4a]: PEDro scale scoring for studies.

Article	Reporting										External validity		Internal validity (study bias)								Internal validity (confounding selection bias)						Power	Score (total)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26		
Cha JY et al., [24]	1	1	1	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	1	1	1	0	1	0	0	1	0	19
Merolla G et al., [22]	1	1	1	1	1	1	1	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	11
Merolla G et al., [23]	1	1	1	1	1	1	1	0	1	0	1	1	0	0	0	1	1	0	1	1	0	0	0	0	0	0	1	15
De mey K et al., [25]	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	0	0	1	0	0	0	0	15
Lee DR and Kim LJ [21]	1	1	1	1	1	1	1	0	1	1	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	13

Scoring: high quality/low bias (>20); moderate quality (17-19); low quality/high risk of bias (<16)

[Table/Fig-4b]: Modified downs and black scale scoring for studies.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Bang MD and Deyle GD, 2000 [15]	✓	✗	✗	✓	✓	✓	?
Bennell K et al., 2010 [16]	✓	✓	✓	✓	✓	✓	?
Cha JY et al., 2014 [24]	✓	✗	✓	✓	✓	✓	?
Chen JF et al., 2009 [19]	✓	✓	✗	✓	✓	✓	
Conroy DE and Hayes KW 1998 [18]	✓	✗	?	✓	✓	✓	✓
Kachingwe AF et al., 2008 [5]	✓	✗	✗	✓	✓	✓	?
Yiasemides R et al., 2011 [17]	✓	✓	✓	✓	✓	✓	?

✓ = low risk of bias; ✗ = high risk of bias; ? = unclear risk of bias.

[Table/Fig-5]: Risk of bias summary: review authors' judgements about each risk of bias item for each included study (Rev Man 5.3).

reduction in pain in the MT and TE group at follow-up. There was statistically significant difference in pain reduction in between groups also. The post intervention measurements were done from 3 week onwards to 22 weeks.

b) SPADI: This was measured by SPADI scale. Four studies were evaluated for effectiveness of MT and TE for SPADI scale. All the four articles had low risk of bias (n=4) [5,16,17,19]. Two studies reported statistically significant difference in SPADI score after intervention in favours of MT combined with TE group [5,16] whereas two trials reported no statistically significant improvement in SPADI score [17,19].

c) Strength: Three studies evaluated strength using a dynamometer. Three studies qualified the methodological criteria and had low risk of bias (n=2) [15,24]. Both the article reported statistically significant improvement (external rotation) in favour of the Therapeutic Exercise (TE) group.

d) Range of Motion (ROM) (elevation and abduction): Four studies evaluated the ROM (elevation and abduction) after interventions. All 4 studies had low risk of bias [5,17-19]. Two articles reported no significant differences in the elevation range [17,19]. However, 2 studies [5,18] reported improvement in elevation ROM.

Qualitative Summary of Strength of Evidence (Meta-analysis)

To construct the best evidence synthesis, five studies were rated to be of high quality [16-19,24], three were rated as medium quality [5,15,25] and four were low quality studies [20-23]. However, common exercise performed in the five high quality trials are glenohumeral mobilisations techniques, motor control exercises and scapular stabilisation and glenohumeral strengthening exercises.

Quantitative Analysis (Data Synthesis)

Seven studies were eligible for inclusion in the statistical pooling of data [5,15-19,24]. Reason for exclusion of other studies was score less than six on PEDro scale and four studies did not have any determinable control groups.

a) Pain: Five studies quantitatively assessed to analyse the effect of MT combined with TE when compared to TE alone [5,15,16,18,24]. Two hundred and thirty patients provided data related to effect of

interventions on pain. Figure demonstrated that there was significant effect of combined MT and exercise on pain reduction (SMD: -1.07 (95% CI: -1.85, -0.28, p< 0.01) I²=82% [Table/Fig-6a].

b) SPADI Scale: Four studies quantitatively assessed to analyse the effect of MT combined with TE when compared to TE alone [5,16,17,19]. A total of 315 patients provided data related to effect of intervention on SPADI scoring. Figure demonstrated that there was no significant effect of combined MT and exercise on SPADI scale scoring (SMD: - 0.10 (95% CI: -0.33, 0.14, p=0.41) I²=7% [Table/Fig-6b].

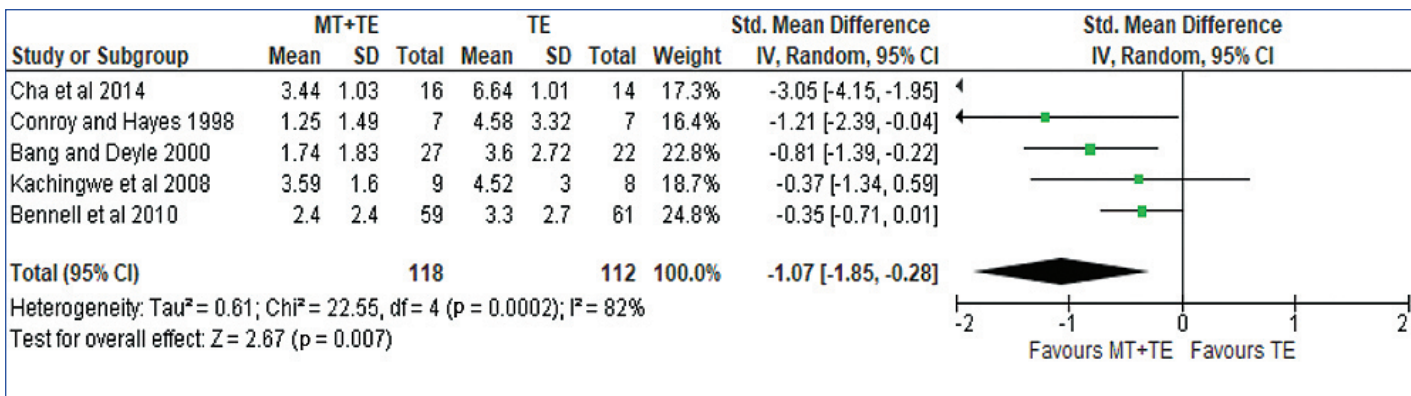
c) Strength: Three studies analysed the effect of intervention on strength of external rotators [15,16,24]. The total number of patients who provided data for the effect of intervention on external rotator strength was one hundred and ninety-nine. Figure demonstrated that there was a significant effect of TE intervention as compared to MT combined with TE (SMD: 0.55 (95% CI: 0.27, 0.84, p<0.01) I²=0% [Table/Fig-6c].

d) Range Of Motion (ROM) (elevation): Four studies analysed the effect of intervention on shoulder elevation range [5,17-19]. Two hundred and nine patients provided the data for the effect of intervention on shoulder elevation range. Figure demonstrated that there was a no significant effect of MT intervention when compared to TE (SMD:-0.03 (95% CI: -0.30, 0.24, p=0.84) I²=0% [Table/Fig-6d].

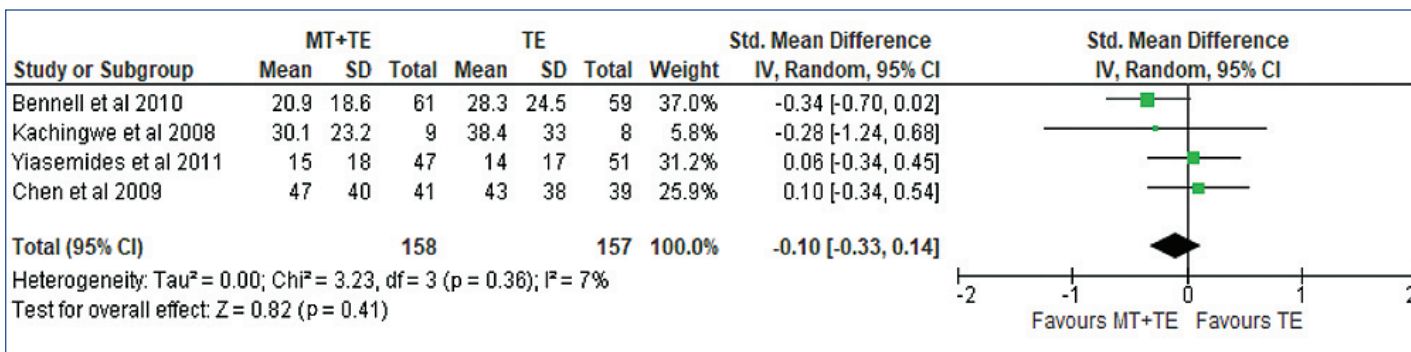
e) Range Of Motion (ROM) (abduction): Four studies analysed the effect of intervention on shoulder elevation range [5,17-19]. One hundred and ninety- four patients provided the data for the effect of intervention on shoulder elevation range. Figure demonstrated that there was a no significant effect of MT intervention when compared to TE (SMD: -0.11 (95% CI: -0.39, 0.18, p=0.46) I²=0% [Table/Fig-6e].

DISCUSSION

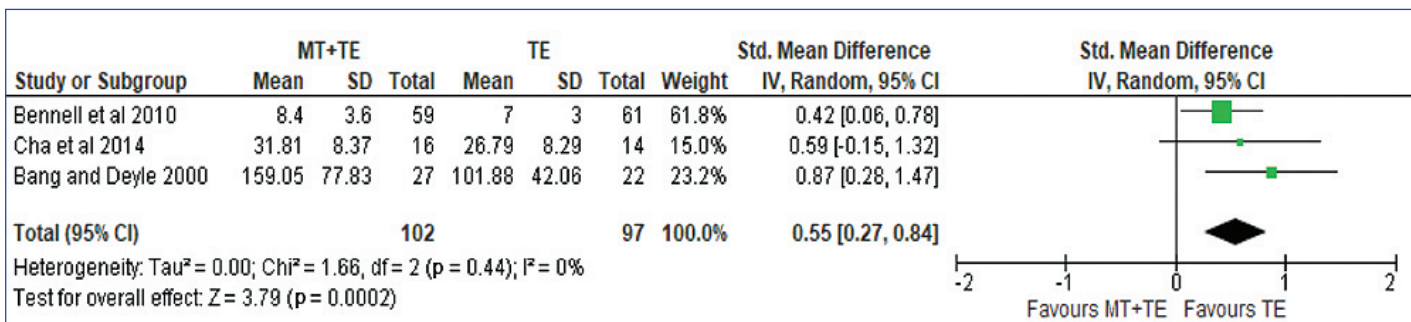
The purpose of this review was to examine the gross effects of MT combined with TE over TE alone in patients diagnosed with SIS. The results of the quantitative assessment summaries that MT combined with TE are effective in reducing pain following treatment. This assessment is supported by three high quality [16,18,24] and two moderate quality [5,15] researches. Secondly, the external rotation strength increase in the TE group was supported by two high quality [16,24] and one moderate quality studies [15]. Thirdly, SPADI scale



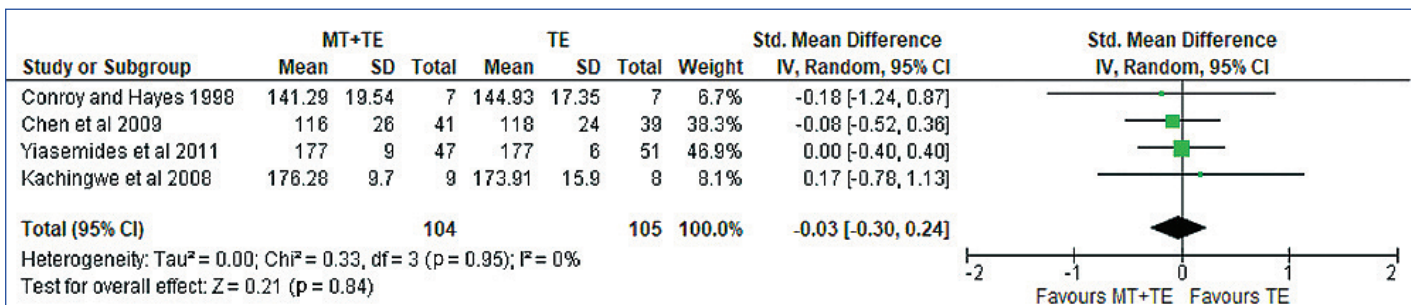
[Table/Fig-6a]: Forest plot showing results of Manual Therapy (MT) combined with TE vs TE alone for pain.



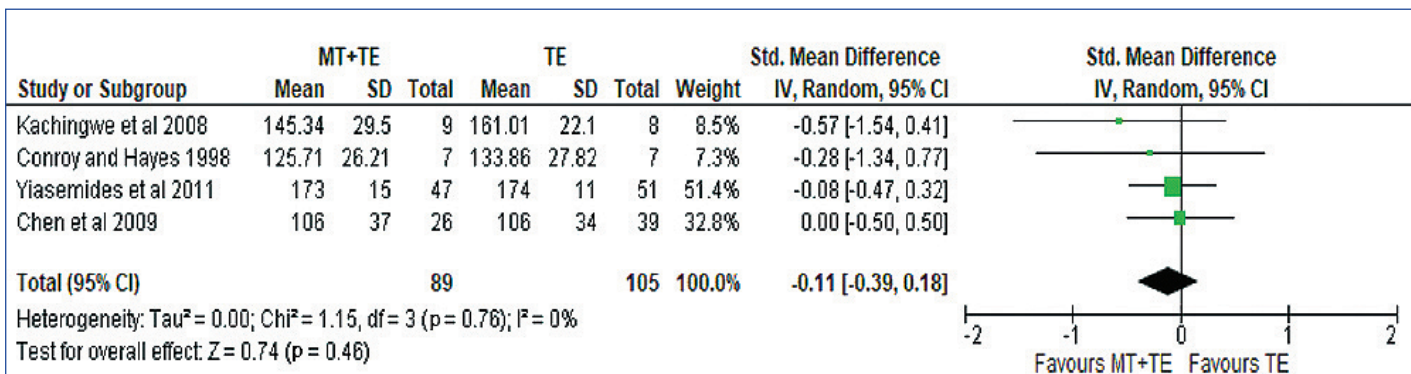
[Table/Fig-6b]: Forest plot showing results of Manual Therapy (MT) combined with TE vs TE alone for SPADI.



[Table/Fig-6c]: Forest plot showing results of Manual Therapy (MT) combined with TE vs TE alone for strength (external rotation).



[Table/Fig-6d]: Forest plot showing results of Manual Therapy (MT) combined with TE vs TE alone for ROM elevation.



[Table/Fig-6e]: Forest plot showing results of Manual Therapy (MT) combined with Therapeutic Exercise vs Therapeutic Exercise alone for ROM abduction.

score improvement showed a nonsignificant change between the two treatment protocols. SPADI scale result was supported by 3 high quality [16,17,19] and one moderate quality [5] studies. ROM (elevation) also showed nonsignificant change and the results were supported by three high quality [17-19] and one moderate quality [5] studies while nonsignificant change in ROM (abduction) was supported by four high-quality studies [5,17-19]. In terms of similarity of the exercise type usage in the medium and high-quality studies and its association with pain decrement and improved external rotation strength, the rotator cuff strengthening exercise, scapular muscle exercises with resistance bands, stretching's and mobilisation of the shoulder complex were a common denominator in these studies.

Twelve studies were qualitatively assessed. Five studies were found to have high quality/low risk of bias [16-19,24], two studies were having moderate quality [5,15] and five were found to have low quality/high risk of bias [20-23,25]. The largest risk of bias was due to inadequate allocation concealment and inadequate blinding of participants and assessors. In general, quantitative analysis was restricted to 7 trials due to the methodological quality of trials.

The literature review also indicates that there is limited meta-analysis studies comparing MT combined with TE. The current evidence is inconclusive with respect to beneficial effect of combine MT and TEs for reducing pain, improving function and limiting disability [26]. Another study performed systematic review and concluded no outcomes (pain, ROM, strength) in favour of combined MT and TE group [26]. Whereas, some studies demonstrated clinically important statistically significant effect on pain, ROM and functional improvement [27-33]. The present study also revealed strong evidence for pain reduction and external rotation strength improvement with a combination of MT and TE. There is moderate to strong evidence with regard to these two parameters which was previously not found to be the case.

There can be three plausible reasons for results obtained in the present review. Firstly, significant pain reduction with MT combined with TE occurred due to stimulation of the pain gate mechanism. The additive effect of MT and TE produced greater stimulation of the large diameter mechanoreceptors (A-delta fibres) located in the joint capsule and ligaments than TE alone. The A delta fibre stimulation blocks the ascending transmission of the pain carrying C-fibres at the spinal level itself and reduces the pain perception resulting in analgesia. Even Periaqueductal Grey Matter (PAG) can be stimulated resulting in activation of the descending pain suppression system using tolerable noxious stimulation. This has been reported to release natural pain-relieving chemicals known as endorphins at the level of stimulation [34].

Secondly, significant increase in strength of external rotation with TE alone occurred due to changes in the muscular apparatus after specified duration of training. The increase in strength of the muscle happens due to neural adaptations and muscular adaptations. Initially, 3 weeks of rehabilitation is dominated by neural changes and afterwards muscular changes follow in healthy subjects. The neural adaptations include, increase in motor unit recruitment and neural discharges while there are m RNA changes and satellite cells upregulation during muscular adaptations phase. Due to pre-existing dysfunctions or pathological conditions strength training usually require longer time than usual to exert its beneficial effects [35].

Thirdly, the main rationale behind nonsignificant findings for disability and ROM is nonoptimal duration of the treatment. Most of the studies in the present review had an average intervention length of 7 weeks. The existing dysfunction comprise tightness of the muscles, capsules and decreased accessory of motion. Research has found that minimum 8 weeks of static stretching is sufficient to increase muscle length in healthy subjects [36]. The duration of intervention in the studies taken in present review might not have

been enough in presence of pre-existing dysfunctions associated with SIS. In addition, patients with chronic musculoskeletal pain demonstrate an increased tolerance to stretch after 3 weeks of static stretching. The protocol of studies that were included didn't use progressive MT which could have led to plateauing of therapeutic effects. Hence, these might be the rationales for not observing significant improvement.

The risk of bias in this study was low which gives strength to its conclusions. No intervention linked adverse clinical events were reported in this study. The bias was reduced because independent reviewers searched and selected the relevant studies and also assessed the quality of the studies.

Limitation(s)

This study has some limitations as the present review was done using only two databases and the authors limited the search to English language publications only, therefore, some relevant publications might have been missed.

CONCLUSION(S)

Based on high to moderate quality, the present review concludes that physiotherapy interventions are effective in treatment of impairments seen in patients with SIS. A holistic approach comprising a combination of MT and TE (glenohumeral mobilisation techniques, motor control exercises and scapular stabilisation and glenohumeral strengthening exercises) is effective to combat the impairments caused by SIS. In future, adequately sampled, high-quality randomised controlled trials are needed to allow statistical pooling and quantitative confirmation of the results. In this review, studies which had used appropriate clinical criteria as a diagnostic measure for SIS were chosen. Since, clinical diagnostic method is reliable and valid but not a gold standard method, this could have led to outcomes being biased. Therefore, further studies utilising combined clinical and radiological diagnostic criteria are needed. In future, research on onset based (acute, subacute, chronic) and location based (subcoracoid, internal, subacromial) phenotypic classification should be done to investigate the effects of MT combined with TE.

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