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Review Article

Physiotherapy Section

Physical Therapy in Hemiplegic Shoulder Pain: A Systematic Review

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ABSTRACT

Introduction: Shoulder joint pain in hemiplegic patients is a common complication which interferes with the therapeutic exercises, influences activities of daily living, social participation and delays the recovery process. Various treatment methods have been given to prevent and manage the Hemiplegic Shoulder Pain (HSP). The purpose of present systematic review was to find the study which is most effective in HSP.

Aim: To determine the most effective method used in physical therapy for the management of HSP.

Materials and Methods: In the present systematic review, a search of PubMed, Physiotherapy Evidence Database (PEDro), CINHAL, Scopus database, Google Scholar, Cochrane Library Register of control trials and bibliography was conducted from January 2016 to March 2020. Randomised clinical trials were included in the review. The methodological quality of the identified Randomised Controlled Trials (RCTs) was assessed using the McMaster Critical Appraisal Tool. The RCTs which scored less than 9 out of 15 or below 64.2% on McMaster Critical Appraisal Tool were not included into the systematic review.

Results: A total of 1337 citations were identified, however, only six RCTs matched the eligibility criteria and were included in the review. The identified studies were similar in design. Investigated diverse physical therapy modalities that were applied for dissimilar periods, and outcome measures assessed at different periods which shown inconsistent results.

Conclusion: This systematic review found evidence for improvement in HSP in those treated with Kinesiotaping (KT) and Electromyography (EMG) triggered Neuromuscular Electrical Stimulaton (NMES) with bilateral arm training. However, more number of RCTs needed to substantiate the results.

Keywords: Conservative management, Motor impairment, Physiotherapy, Post stroke, Rehabilitation

INTRODUCTION

Pain in the shoulder joint in patients with hemiplegia after stroke is a common complication, with a prevalence of 16-84% worldwide [1-4]. The HSP, can inhibit contraction of muscles around shoulder complex, that interferes with exercises, delays the recovery in the motor function, influences activities of daily living and social participation [5,6]. Pain in acute stage following stroke prolongs hospitalisation, and negatively affects the patient's quality of life. The HSP adversely affects the recovery of arm function and independence in activities of daily living [7]. Hemiplegic shoulder pain is associated with a greater severity of motor impairment, however, no single aetiology has been found as a cause of HSP [8].The possible causes of HSP are shoulder subluxation, rotator cuff tears, rotator cuff tendinopathy and deltoid tendinopathy and bicipital and supraspinatus tendon tenderness [9]. The Glenohumeral Subluxation (GHS), is often identified as one of the major causes of HSP [10-12]. The shoulder subluxation in patients with HSP has been found to be associated with rotator cuff tears, thus it may be an indirect cause of HSP [1]. The presence of GHS is commonly accepted to be an important risk factor for developing a shoulder hand syndrome [13] or other complications such as decreased range of motion, plexus brachialis injuries, adhesive changes, and sub-acromial impingement [14,15]. Patients with severe arm weakness and/or shoulder subluxation within 72 hours of stroke are at significantly higher risk of HSP at 8-10 weeks [16].

Clinical observations suggest that shoulder pain does not occur until spasticity develops. In the later stage, when patient develops spasticity in the arm and shoulder girdle muscle, the shoulder exhibits adduction, internal rotation, limited range of motion with pain [17]. On the other hand, the stroke patients with a flaccid shoulder have a high incidence of shoulder subluxation that results in shoulder soft tissue injury and pain [18,19]. Muscle weakness after stroke is considered to be one of the major causes of the HSP as the muscles do not contract effectively against the gravity and fail to keep the head of humerus in the glenoid fossa. The soft tissues around the shoulder joint get stretched gradually and torn, that results in HSP.

It may be inferred from the abovementioned studies that, the aetiology of HSP is multifactorial. The stroke patients with flaccid shoulder in the acute stage have a high incidence of shoulder subluxation due to poor protective functions that results in soft tissue stretching, injury and pain. In the chronic stage, when patients develop spasticity in the arm and shoulder girdle muscles, the shoulder joint exhibits a particular synergistic pattern that leads to functional limitations and pain. Therefore, HSP may either be developed in the acute or in the chronic stage, if not given an appropriate intervention.

To decrease the incidence and to prevent and manage HSP, many therapeutic techniques have been proposed which include proper positioning, shoulder sling and strapping [20], functional electrical stimulation [21], kinesiology tapping [22], physical modalities [23], sub-acromial hyaluronic acid injections [24], and subcutaneous needling [25]. However, none of these studies have shown to be significantly superior to others. Therefore, the research question of the present review was to find out "Which treatment method of physiotherapy is more effective in patients with HSP?"

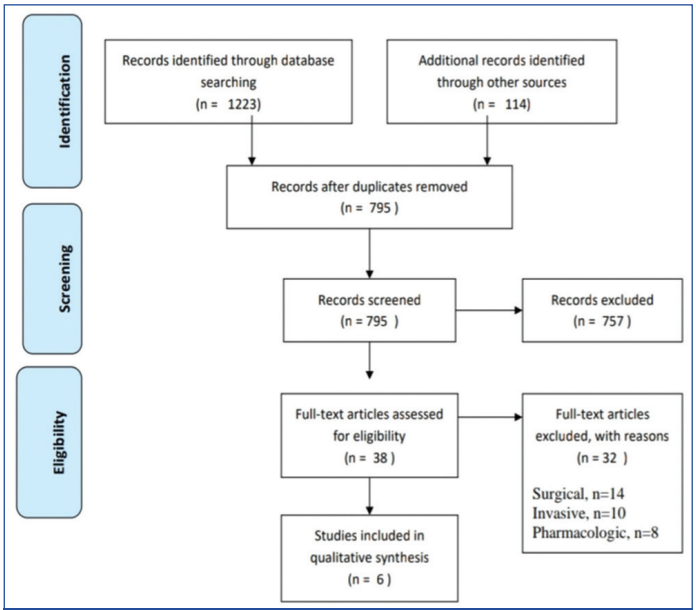
MATERIALS AND METHODS

The systematic review was reported in line with the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) statement to find out the more efficient physiotherapy methods in patients with HSP in the available RCTs. A medical

literature search was carried out in the following database Medline, CINAHL, PEDro, Scopus database, Google Scholar and Cochrane Library register of control trials from January 2016 to March 2020. The language of the studies was restricted to English. The search was performed using keywords- hemiplegic shoulder, HSP, HSP and subluxation, shoulder pain and shoulder sling, shoulder taping, exercise therapy, physical therapy and shoulder rehabilitation. The title and abstracts of the literatures were reviewed and the potential ones were chosen, then checked full texts of the selected articles according to the inclusion and exclusion criteria. A total of six RCTs met the inclusion criteria, were included in the present systematic review [9,26-30]. Studies included a total of 270 participants. Three studies observed the effectiveness of the therapeutic KT. The fourth study compared between the effects of actimove, shoulder lift and no shoulder sling, whereas fifth study compared the effects of modified wheel chair arm support and routine physiotherapy versus Ordinary wheel chair with ordinary armrest for assistance and, the sixth and last study compared the effects EMG-Triggered NMES, Transcutaneous Electrical Nerve Stimulation (TENS), and bilateral arm training to both the groups.

Literature Search and Identification of Relevant Studies

Following establishment of review protocol (design of the study, intervention, inclusion and exclusion criteria, outcome measures, adverse events and time frames), two authors allocated the database search and screened titles and abstracts of the studies. The studies published in the language other than the English were excluded. All the potential titles, abstracts and full texts were reviewed independently for inclusion and exclusion criteria. Disagreements were checked by the third reviewer regarding inclusion and was resolved through discussion. A total of 1337 articles were identified in the initial search. Out of 1337 articles, 542 were removed for duplication, 38 potentially relevant articles were selected and 757 were excluded from the study. The full text of 38 articles were obtained to check eligibility, in those, 32 were excluded because they failed to meet the inclusion criteria. Only six RCTs were included in the final systematic review [Table/Fig-1].



[Table/Fig-1]: Study flow diagram according to Preferred Reporting Items for Systematic reviews and Meta Analyses (PRISMA).

Study Design

The systematic review included the RCTs with the following inclusion and exclusion search criteria- RCTs, trials published in English, trials conducted on the patients with HSP and/or subluxation, which included any of the physiotherapeutic approach for the management of HSP such as physical therapy exercises, or electrotherapy modalities (electrical stimulation), or therapeutic KT, or shoulder sling. The RCTs which used a patient reported functional outcome measures for HSP were also included into the review. The RCTs that scored less than 9 out of 15 or below 64.2% on McMaster critical appraisal tool were not included into the systematic review. The systematic review excluded the following studies: non RCTs, literature reviews, pilot studies, duplicate studies, case studies, case reports, studies without integrated data [Table/Fig-2], outlines the inclusion and exclusion criteria. The studies that used any invasive interventions such as surgical interventions, acupuncture, and needling and injections for the management of hemiplegic shoulder have also been excluded.

S. No.	Inclusion criteria	Exclusion criteria
1.	Acute or subacute patients with stroke	History of shoulder dislocation
2.	Acute or subacute hemiplegic patients with shoulder pain or subluxation	History of humerus or glenoid fracture
3.	Acute or subacute hemiplegic patients with shoulder subluxation	History of tuberculosis/ infection in the shoulder
4.	Randomised Controlled Trials (RCT)	Non RCT, literature reviews, pilot studies, duplicate studies, case studies, case reports, studies without integrated data
5.	Studies scored at least 9 out of 14 or 64.2% on McMaster Critical Appraisal Tool	Studies scored less than 9 out of 14 or below 64.2% on McMaster Critical Appraisal Tool
6.	The studies used Visual Analogue Scale (VAS) or any other valid Pain Rating Scale (PRS) to measure the shoulder pain	Studies which did not use any pain rating scale to measure the pain
7.	Non Invasive physiotherapy intervention	

[Table/Fig-2]: Inclusion Criteria and Exclusion Criteria.

Outcome Measures

Studies which utilised patient reported measures such as Fugle-Meyer Assessment for Upper Extremity (FMA-UE), or Modified Barthel Index (MI), or Modified Ashworth Scale (MAS), pain rating scales such as Visual Analogue Scale (VAS), or, Numerical Rating Scale (NRS), or Shoulder Pain and Disability Index (SPADI); were included in the systematic review.

Time

The trials conducted on the patients with HSP for not less than three weeks with a maximum period of eight weeks including follow-up period were considered for the systematic review. The studies those did not collect the outcome data of all the subjects within the stipulated time frames were excluded from the review.

Methodological Quality

The methodological quality of the studies was assessed by using the McMaster critical Review Form for Quantitative studies [31]. The tool comprises of 15 items that assesses study purpose, design, sample, outcomes, interventions, results and clinical implications. Fourteen items of the tool assesses quantitative data with the response of yes or no, whereas, one item assesses qualitative data i.e., type of study design. The studies were awarded one point for each 'yes' and zero for 'no' or 'not addressed' response. The raw data (total quantitative score of the study out of 14) were calculated and expressed in percentage divided by 14 and multiplying by 100 [Table/Fig-3] [9,26-30].

RESULTS

Six studies were screened for the review which did trial on a total of 270 participants. Three studies saw the effectiveness of the therapeutic KT conducted by Huang YC et al., Huang YC et al., Yang L et al., reported p-value <0.05 [9,26,30]. The fourth study compared the effects of Actimove versus shoulder lift versus no shoulder sling. Actimove group reported more pain

Authors	Items (Mentioned below in the citation)															Scores	Scores in %
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
Huang YC et al., 2016 [26]	Y	Y	Y	Y	N	?	?	Y	?	?	Y	Y	?	Y	Y	9	64.2
Van Bladel A et al., 2017 [28]	Y	Y	Y	Y	N	?	?	Y	?	?	Y	Y	Y	Y	Y	10	71.4
Huang YC et al., 2017[9]	Y	Y	Y	Y	N	Y	Y	Y	?	?	Y	Y	?	?	Y	10	71.4
Chuang LL et al.,2017[27]	Y	Y	Y	Y	N	?	?	Y	?	?	Y	Y	?	Y	Y	9	64.2
Pan R et al., 2018 [29]	Y	Y	Y	Y	N	?	?	Y	?	?	Y	Y	?	Y	Y	9	64.2
Yang L et al., 2018 [30]	Y	Y	Y	Y	Y	?	?	Y	?	?	Y	Y	?	N	Y	9	64.2

[Table/Fig-3]: Outlines the methodological quality of studies based on the McMaster Critical Appraisal Tool [9,26-30].
Table.03: Methodological quality of studies based on the McMaster Critical Appraisal Tool: 1) Study purpose clearly stated; 2) Background literature reviewed; 3) Research design; 4) Sample described in detail; 5) Sample size justified; 6) Outcome measure reliability reported; 7) Outcome measure validity reported; 8) Intervention described; 9) Contamination avoided; 10) Co-intervention avoided; 11) Results reported in terms of statistical analysis; 12) Analysis methods appropriate; 13) Clinical significance reported; 14) Drop-outs reported; 15) Conclusions appropriate; Y=Yes N=No ?=not needed in the study

at rest (p=0.036). The shoulder subluxation remained unchanged in the Actimove group (-2.77% or 0.27 mm). The fifth study compared the effects of modified wheel chair arm support and routine physiotherapy versus ordinary wheel chair with ordinary armrest for assistance. The study showed improvement in shoulder pain (p<0.001) [Table/Fig-4] dd: [9,26-30]. The sixth and last study compared the effects of EMG-Triggered NMES TENS, and bilateral arm training to both the groups and found to lower the pain intensity during active and passive shoulder movement (p=0.007 and p=0.008), lower worst pain intensity (p=0.003), and greater pain-free passive shoulder abduction (p=0.001) and internal rotation (p=0.004) at follow-up.

Therapeutic Kinesiotaping (KT): Haung YC et al., used KT and sham taping on participants with HSP during the hospital stay. The therapeutic KT was aimed to provide proprioception, biofeedback, facilitation of muscle strength and to improve joint stability [26]. Both the therapeutic KT and sham KT was performed by the same physiotherapist; and the therapist was blind which KT was the therapeutic one. The KT was applied for three days followed by one day rest to avoid continuous tension on the shoulder. The authors found that the therapeutic KT may limit the development of HSP and improve pain free shoulder flexion in subacute stroke patients at risk during the rehabilitation (p=0.01 in experimental group and p=0.78 in the control group).

Huang YC et al., have applied KT to both the experimental and the control group. The application of KT to the experimental and control group was applied in the same manner, however; the KT was applied to the control group without the tension. Moreover, the KT in the control group did not cross the joint line. There was significant improvement in the pain and range of motion of the shoulder after three weeks of the KT application. Authors suggested, KT as an alternative treatment option for the patients with HSP [Table/Fig-5] [9,26-30].

Yang L et al., (2018) conducted RCT on HSP. The experimental and control group received therapeutic kinesiology taping and placebo taping respectively. The therapeutic KT was aimed to activate the neuromuscular functions and to produce mechanical support to the shoulder joint and also to facilitate the supraspinatus, deltoid, and teres minor muscles. The experimental group showed immediate improvement in terms of pain intensity, magnitude of subluxation, and muscle activity, whereas, no significant changes were observed in the control group. The study revealed that the effectiveness of kinesiology taping for HSP might be good alternative for relieving shoulder pain, improving the active range of motion, subluxation, and muscle activity of the shoulder [30].

Arm slings: Van Bladel A et al.,conducted RCT on patients with severe upper limb impairments. They used two devices actimove sling and the shoulder lift. The control group was not given any sling whereas, other two groups were given actimove sling and shoulder lift respectively for three weeks. The study stated that wearing a shoulder sling does not seem to prevent pain and shoulder subluxation. Contrary to that there was reduction in the acromio-humeral-distance in the control group who was not given any kind of sling during the study period.The study suggested that prescribing a sling might not be the preferred treatment approach since it may actually inhibit active correction [28].

Modified wheel chair arm-support: Pan R et al.,in their single blind trial have seen the effect of modified wheel chair arm support in decreasing HSP. The experimental group received the modified wheel chair whereas; the control group was given the ordinary wheel chair. The modified wheel chair included, the board designed to support the arm, with a thick handle equipped at the end of the board which could be held with the hand. Authors noted that both the groups showed improvements in shoulder pain, upper extremity movements, independence of daily living and quality of life during the four weeks of intervention and after the 12 weeks of follow-up, and the difference within groups were significant (p<0.001) the study stated that using the modified wheel chair arm support could lead to the mitigation of HSP and reduction in pain incidence in post stroke individuals [29].

EMG triggered neuromuscular electrical stimulation: Chuang LL et al., conducted a single blind RCT to see the effect of EMG-triggered NMES with bilateral arm training on HSP and arm function in post stroke hemiparetic patients. The study found that EMG-triggered NMES combined with the bilateral arm training was better than the TENS with bilateral arm training for reducing HSP during movement, lessening the worst shoulder pain, and improving pain free shoulder abduction and internal rotation for stroke patients with HSP [27].

Groups	Pretest/Post-test	Huang YC et al., 2016 [26]	Van Bladel A et al., 2017 [28]	Huang YC et al., 2017 [9]	Chuang LL et al., 2017 [27]	Pan R et al., 2018 [29]	Yang L et al., 2018 [30]
VAS/NRS	Pretest (control)	3.4±3.3	2.78±2.59	4.91±2.56	0.42±.90	3.50±7.0	5.0±0.7
	Post-test (control)	3.2±2.3	2.42±2.01	2.55±0.97	0.21±.54	3.0±5.75	3.4±0.8
	Pretest (Exp. Grp)	2.3±2.3	Experimental-I (Shoulder lift) 4.86±12.27 Experimental-II (Actimove) 5.75±2.12	3.90±1.37	0.68±1.46	3.0±6.0	4.3±1.2
	Post-test (Exp. Grp)	2.6±2.9	Experimental-I (Shoulderlift) 2.29±2.63 Experimental-II (Actimove) 4.38±2.39	2.60±1.35	0±0*	2.0±3.75	1.4±0.7

[Table/Fig-4]: Pain Rating Scales used in the trials: VAS and NRS and p-value [9,26-30].
*Significantly different from pretretment time point (p<0.05)

Authors	Study design	Participants	Interventions	Outcome measures	No. of treatment session	Program duration	p-value	Conclusion
Huang YC et al., 2016 [26]	RCT	44	Therapeutic Kinesiotaping and rehabilitation program versus Sham Taping	VAS, FMA (U/E), MBI, SSQOL, and shoulder subluxation-Finger Breadth	5 days/week	3 weeks	p=0.01	Therapeutic KT may limit the development of HSP and improve pain free shoulder flexion
Van Bladel A et al., 2017 [28]	RCT	28	1. Actimove versus 2. Shoulder lift versus 3. Balance exercise with motor learning programme	Sonography for acromio humeral distance measurement (AHD), Passive ROM, Fugl Meyer Assessment (U/E),	During day	6 weeks	p<0.05	Suggested that prescribing a sling might not be the preferred treatment approach since it may actually inhibit active correction
Huang YC et al., 2017 [9]	RCT	21	Therapeutic Kinesiotaping and rehabilitation program versus sham taping	NRS, SPADI, Ultrasonography, Sub-acromial distance for shoulder subluxation, PROM	5 days/week	3 weeks	p<0.01	Significant improvement in the pain and range of motion of the shoulder after three weeks of the KT application
Chuang LL et al.,2017 [27]	RCT	38	1. EMG-triggered NMES, 2. TENS, bilateral arm training to both the groups	NRS-FRS, BPI-SF, Fugl-Meyer Assessment	3 times/week	4 weeks	p<0.05	The study found that EMG-triggered NMES combined with the bilateral arm training was better than the TENS with bilateral arm training for reducing HSP during movement,
Pan R et al., 2018 [29]	RCT	120	3. Modified wheel chair arm support and routine physiotherapy versus ordinary wheel chair with ordinary armrest for assistance.	VAS, FM-A/U/E, Modified BI, Quality of Life Index	6 days/week	4 weeks	p<0.001	The study stated that using the modified wheel chair arm support could lead to the mitigation of HSP and reduction in pain incidence in stroke patients
Yang L et al., 2018 [30]	RCT	19	4. Therapeutic Kinesiotaping and conventional treatment versus Placebo Taping	NPRS, Magnitude of Shoulder subluxation, AROM, and EMG	10-12 hours/day	4 weeks	p<0.001	The study revealed that the effectiveness of kinesiology taping for HSP might be good alternative for relieving shoulder pain, improving the active range of motion, subluxation, and muscle activity of the shoulder

[Table/Fig-5]: Description of main aspect of studies, authors, year of publication, trials, interventions, outcome measures, interventions in a week and total duration of the studies [9,26-30].
RCT: Randomised control trial; FMA-UE: Fugle-Meyer assessment for upper extremity; MBI: Modified barthel index; MAS: Modified Ashworth scale; VAS: Visual analogue scale, NRS: Numerical rating scale; SPADI: Shoulder pain and disability index, AROM: Active range of motion; PROM: Passive active range of motion; HSP: Hemiplegic shoulder pain; KT: Kinesiotaping, SSQOL: Stroke specific quality of life scale

DISCUSSION

This review found that there was strong evidence for improvement in patient-reported functional outcomes in those who develop HSP. There was relative consistency between studies across multiple timeframes with sustained HSP after stroke. Nearly all studies that examined HSP reported statistically significant improvements in favour of shoulder pain after stroke, with moderate to large effect sizes in two studies. Conversely, there was an overall improvement in patient-reported functional outcomes in subjects with HSP developed after stroke who participated in any kind of intervention like therapeutic KT, arm sling, modified wheel chair arm support and EMG-electrical stimulation.

Given the above findings, it is reasonable to question the use of any kind of supportive intervention in the management of patients with stroke. Huang YC et al., (2016, 2017) reported that therapeutic KT is effective in HSP in both pain and functional outcome [9,26]. Yang L et al., also found that the KT is an effective measure for reducing shoulder pain and increasing Range of Motion (ROM) [30]. Pan R et al., concluded that modified wheel chair arm support for HSP after stroke found that using the modified wheel chair arm support could lead to the mitigation of HSP in stroke patients [29]. Chuang LL et al.,results revealed that EMG-triggered NMES combined with bilateral arm training was a better option for reducing HSP during movement [27]. Some issues within included studies may have influenced the results of this systematic review. Van Bladel A et al., concluded that reduction of acromio-humeral-distance in the hemiplegic individual with shoulder sling as compared to the hemiplegic individual without shoulder sling. However, this reduction did not prevent shoulder pain and subluxation since it may inhibit activation of muscle for active correction of subluxation [28]. The study conducted by Pan R et al., gave incomplete information regarding the control group [29]. The moderate methodological quality of included studies was also likely to affect the results of the present review.

Shoulder pain in patients with hemiplegia is a common problem.The HSP leads to gross disability and functional limitations in the upper extremity. The present systematic review has found numerous methods of treatment for an HSP. Therapeutic KT and EMG triggred NMES with bilateral trainer found to be more effective than the others for HSP.

The use of these techniques in the clinical practice would enable the clinicians to manage the patients with HSP in a more controlled and effective manner. The therapeutic KT and EMG triggered NMES could be an alternative treatment for the management of the HSP. Further research of interventions for HSP would benefit from more accurate descriptions of intervention and co-intervention including type, duration, and intensity. Future research should also continue, to embrace the use of reliable and valid outcome measures.

Limitation(s)

The RCTs reviewed for this systematic review had scored 9 out of 15 on McMaster Appraisal Tool however, high quality trails above 9/15 may be needed on the large-scaled sample size to see the effectiveness of therapeutic KT and EMG triggered NMES.

CONCLUSION(S)

The present systematic review found a strong evidence of improvement in HSP those treated with the KT. The EMG triggered NMES also showed significant improvement in the shoulder pain and abduction and internal rotation movements which can be an adjunct to the exercises. It can be summarised, that, therapeutic KT and EMG triggered NMES are beneficial in improving the shoulder pain and ranges. Shoulder sling might not be the preferred treatment approach for the management of HSP, as it may actually inhibit active correction.

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