Active versus Passive physiotherapy for chronic shoulder pain: a systematic review and meta-analysis

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Abstract

Objective

To explore the effects of active physiotherapy (AP) and passive physiotherapy (PP) on pain intensity and function in patients with chronic shoulder pain.
Design

Systematic review and meta-analysis.

Methods

Two independent researchers searched PubMed, Cochrane library, Embase, Web of science, CINAHL and PEDro from the beginning to September 7, 2022. All included studies were evaluated for risk of bias by the Cochrane risk-of-bias tool and the certainty of results was rated using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach.

Eligibility criteria

Randomized controlled trials (RCTs) involving patients with chronic shoulder pain were included. The treatment must be AP versus PP.

Results

Altogether 21 studies, including 1011 patients, were included. The primary result: Compared with passive manipulation, AP was superior in the pressure pain threshold (PPT) of shoulder (SMD-0.09, 95%CI: -0.42 to 0.24, P=0.59), pain intensity (SMD-0.37, 95%CI: -0.71 to -0.03, P=0.03) and function (SMD-0.22, 95%CI: -0.43 to -0.01, P=0.04). AP had an advantage over physical factor therapy in terms of pain intensity (SMD-1.32, 95%CI: -2.34 to -0.29, P=0.01) and function (SMD-0.64, 95%CI: -1.15 to -0.14, P=0.01). The secondary result: AP was superior to PP at short-term and medium-term follow-up, with no difference at long-term follow-up.
Conclusions

Evidence with moderate to very low certainty suggests AP was superior to PP in pain and functional improvement in patients with chronic shoulder pain at short-term and medium-term follow-up, but this advantage was not observed in the long-term follow-up.

**Keywords**: chronic shoulder pain; active; passive; physiotherapy; function; meta-analysis.
Introduction

Shoulder pain, second only to back and neck pain[1], is one of the most prevalent musculoskeletal pain in primary care[2], a quarter of people have experienced shoulder pain in their lifetime. Compared with other musculoskeletal pain, shoulder pain has a higher chronic rate, musculoskeletal shoulder pain persists beyond 6 months in 50% of individuals[3], poses tremendous economical pressure on social and patients. A Swedish survey of the cost of shoulder pain patients in primary health care estimated the mean annual costs at €4,139 per patients[4]. In addition to the high expenses losses, pain and functional limitations in the shoulder also seriously affect the patient's daily life and work[5].

Chronic shoulder pain (CSP) is defined as shoulder pain that persists or recurs for more than 3 months[6]. CSP is a complex syndrome that cannot be explained solely by a tissue defect or injury[7]. The International Association for the Study of Pain defined chronic pain as a complex phenomenon and is considered a disease of the nervous system[8].

Czech neurologist Dr. Vladimir Janda’s theory of muscle imbalance was supported this view. He considered that chronic musculoskeletal pain are Functional pathologies by the central nervous system (CNS), started with an injury or abnormal movement pattern that results in a deviation in proprioceptive input signals, causing muscle tension (hypertonicity) or weakness (inhibition). This is a characteristic response of the motor system to maintain homeostasis. Over time, this imbalance becomes centralized in the CNS as a new motor pattern, thus continuing a cycle of pain and dysfunction[9]. Therefore, the treatment of chronic musculoskeletal pain cannot be limited to the musculoskeletal system alone and also requires integration of the nervous system.

Physiotherapy is normally the preferred intervention for shoulder pain in the absence of evidence for its standard treatment[10]. Traditional physiotherapy for pain management is based on the "gate-control" theory: mechanical...
stimulation from physiotherapy could trigger the nerve impulses, the nerve impulses transmitted to and activate three
spinal cord systems: the cells of the substantia gelatinosa in the dorsal horn, the dorsal-column fibers that project
toward the brain, and the first central transmission (T) cells in the dorsal horn, this system cuts off and blocks some
pain signals from entering the brain so that the brain does not feel pain[11]. These treatments do not require the active
participate of the patient, such as Maitland therapy, Passive massage therapy, Passive stretching therapy, physical
factor treatment, etc.[12-15]. But in practice, this biomechanical and neuroanatomical-based approach seems
incapable of coping with the complex pain patterns and enormous psychological stress of the patient[16].

With increased understanding of Pain, researchers began to consider neurophysiology-based treatments. Initially,
researchers used language, vision, touch, and environmental stimuli to guide patients, and then, increasingly, they
began to emphasize patient’s active participate. The participate becomes an integral part of treatment so that
neuroplastic pathways and inhibitory mechanisms in the nervous system can be exploited to their fullest[16]. This
“Sensorimotor Training” can increase proprioceptive input into the CNS and output the normal motor pattern by the
patient’s active control, improve chronic pain[17]. For example, the structural integration (SI) therapy developed by
Ida Pauline Rolf in the Mid-20th century, and the Mulligan therapy created by Brain. R. Mulligan in 1984, etc., all
emphasize the biomechanics of the peripheral joint and the active movement of the patient[18, 19].

In 1987, Brown and Nicassio summarized coping strategies for chronic pain in the Vanderbilt Pain Management Scale,
namely, active coping strategies and passive coping strategies[20, 21]. Active coping strategies mean that patients try
to actively participate in pain control, while passive coping strategies are defined as relying on external force to relieve
pain[20-22]. Based on these above researches, we refer to physiotherapy based on biomechanical and neuroanatomical
mechanisms without active control and completed entirely by external forces as passive physiotherapy (PP) and
physiotherapy (include exercise training) based on neurophysiological mechanisms with active control as active physiotherapy (AP) [23-25].

Recently, the effect of traditional PP was questioned and labeled as “low-value care”. It is claimed that PP provided little or no help to patients with even greater risks than benefits[26]. A Randomized clinical trial (RCT) discussing the effects of AP and PP on 68 athletes with groin pain showed that more athletes in the AP group were able to return earlier to regular training, and active exercise significantly improved the athletes' physical coordination[27]. A meta-analysis revealed that active exercise intervention for external epicondyle pain seemed to have better effects than passive intervention, but the effect was not significant[28]. Although numerous studies confirm that active exercise contributes to the recovery of patients with shoulder pain, whether active exercise is superior to PP remains controversial[10, 29]. In 2014, a review indicated that therapeutic exercise for shoulder pain patients might not be as effective as corticosteroid injection, but the quality of the evidence is low and more high-quality studies are needed to confirm it[30]. In 2021, Michel et al[31]. reported that increasing active exercise in shoulder pain patients improved their active range of motion (AROM) compared to those without exercise. In contrast, employment of passive physical factor therapy appeared to have no additional benefit[31]. Besides, a systematic review found that active exercise alone (e.g., muscle flexibility and strength training) appeared to be as effective as corticosteroid injections in with shoulder pain patients[32]. Lately, Jeremy Lewis[33] suggested that the physical therapy profession was embracing an inflection point where active therapies and more patient self-reliance will move physical therapy away from an overreliance on passive therapies of the past[33].

Therefore, this review aims to compare the effects of AP and PP on pain intensity and function in patients with CSP in the hope of providing reference value in future clinical practice of physiotherapy.
Method

This study was conducted following Cochrane Handbook[34] and PRISMA guidelines[35] for systematic reviews. This review was registered in the International Prospective Register of Systematic Reviews (PROSPERO) under the identification number (CRD42022372213).

Search strategy

We searched the PubMed, Cochrane library, Embase, Web of science, CINAHL and PEDro from the beginning to September 7, 2022. All search strategies were completed by an experienced librarian (WRR) and are summarized in Appendix 1. Citation tracking was performed for the included literature and related systematic reviews. Grey literature searching included reference of included studies and conference proceedings of the following organizations: the American College of Sports Medicine from 2011 to 2022, the American Physical Therapy Association from 2012 to 2022, and the World Confederation for Physical Therapy from 2011 to 2022. For studies with no results, researchers contacted the original authors by email.

Inclusion and exclusion criteria

Inclusion and exclusion criteria followed the PICOS principle.

P (Patients): Over 18 years old with chronic shoulder pain. Pain in multiple regions (e.g., neck and shoulder pain or shoulder and elbow pain) were also included if the results for shoulder pain were presented separately. Patients with acute shoulder pain, a history of injury, surgery, dislocation, or fracture of the shoulder joint within three months or patients with stroke, cancer, rheumatoid arthritis, or rheumatic polymyositis were excluded[36].
I (Intervention): AP, including active manual therapy or exercise training, such as Mulligan therapy, Muscle energy technique, Proprioceptive neuromuscular facilitation (PNF), Biofeedback training, and exercise, etc. [27].

C (Control): PP, including passive manual therapy, such as massage, and tissue mobilization and manipulation, physical factor therapy, bracing, etc.[27].

O (Outcome): Shoulder pressure pain threshold (PPT), pain intensity and function. Follow-up was classified into immediate effect, short-term (≤3 months), mid-term (>3 to ≤12 months) and long-term (>12 months).

S (Study): Only RCTs.

**Selection of studies**

Two reviewers (WRR and WJL) performed independent searches and imported the results into EndNote 20. The title and abstract of the articles were reviewed first, and those that could not be judged by title and abstract were viewed in full text. All disagreements were decided by the discussion of two other reviewers (ZX and GXH). The kappa test was used to judge the consistency of the screening results[37]. A short checklist was used to guide the selection of relevant studies (Appendix 2).

**Data extraction**

Following a standardized procedure, two independent researchers (WRR and WJL) completed the data extraction and analysis, during which all discrepancies were resolved by discussion of two other researchers (ZX and GXH).

The mean difference (MD) and standard deviation (SD) between the baseline and post-intervention or follow-up results reported in the studies were extracted or converted into a standard format to ensure that our meta-analysis could
be performed successfully [34, 38]. Study characteristics, subject demographics, shoulder pain diagnostic labels, symptom duration, and intervention methods were extracted.

**Risk of bias**

Two researchers (WRR and WJL) independently assessed the risk of bias using the Cochrane risk-of-bias tool. The risk of bias was rated as low risk, high risk or uncertain from the following seven domains: (1) random-sequence generation (selection bias); (2) allocation concealment (selection bias); (3) blinding of participants and personnel (performance bias); (4) blinding of outcome assessment (detection bias); (5) incomplete outcome data (attrition bias); (6) selective reporting (reporting bias); (7) other bias[34]. The results were summarized using review manager 5.4 and all disagreements were settled by the discussion of two other reviewers (ZX and GXH).

**Data synthesis and analysis**

All outcome indicators were continuous variables and the data were pooled and analyzed using Review Manger 5.4. Researchers pooled MD if tools for assessing pain or function were consistent within groups, and pooled standardized mean difference (SMD) to eliminate the differences if tools or units were inconsistent within groups. Outcomes were expressed as MD or SMD between groups and 95% confidence interval (CIs)[34].

Clinical heterogeneity was determined by reviewing the participants, intervention and control therapies. Study heterogeneity was assessed using the inconsistency index (I2-statistic) with values of 25-50%, 50-75%, and 75-100%, indicating low, medium, and high heterogeneity, respectively [39]. A fixed-effects model was adopted to combine within-group data when I2 was less than 50%, and a random-effects model was considered otherwise[40]. We planned
to assess reporting bias using sensitivity analysis and publication bias using the Egger’s test and graphical aide funnel plot under the condition of sufficient studies[34].

For all outcomes, evidence for the benefits of AP compared with PP was examined using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach[41]. Risk of bias, inconsistency, imprecision, indirectness, and publication bias were assessed to determine whether these potential limitations affect the certainty of the results. GRADE approach was done on the GRADE work group website (https://www.gradeworkinggroup.org/).

**Result**

**Study selection and characteristics**

This study searched all databases and identified 19 articles[42-60]. Since the results of one research were repeatedly reported in two articles[56, 57], and three articles each included two research[46, 58, 60], actually there were 21 eligible research eventually. The inter-investigator agreement was calculated for the search result, which was considered good (K= 0.83, P<0.05, Appendix 3). Details of inclusion and exclusion can be viewed in Figure 1.
Altogether 1011 patients aged 48 on average with chronic shoulder pain were included, 502 in the AP group and 509 in the PP group, with males accounting for 36% and females 64%. There were 9 studies with the diagnosis of shoulder pain as subacromial impingement syndrome[43, 45, 50, 51, 54, 56, 57, 59, 60], and 5 studies as adhesive capsulitis[44, 48, 49, 52, 53]. For the rest 7 research, 4 included patients with work-related shoulder or neck and shoulder pain[42, 47, 58], and 3 included patients with nonspecific shoulder pain of unknown origin[46, 55]. Study characteristics can be viewed in Table 1.
<table>
<thead>
<tr>
<th>Trial author, year, Country</th>
<th>Diagnosis</th>
<th>Group allocation</th>
<th>Symptom duration, months</th>
<th>Number</th>
<th>Male (Female)</th>
<th>Age (mean ± SD)</th>
<th>Description of therapy</th>
<th>Outcomes available</th>
<th>Follow up periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kachingwe, 2008&lt;sup&gt;30&lt;/sup&gt; USA</td>
<td>Diagnosed with primary shoulder impingement</td>
<td>Intervention Group</td>
<td>9</td>
<td>5 (4)</td>
<td>48.9 (13.7)</td>
<td>Glenohumeral joint mobilization-with-movement (MWM) Technique Conventional treatment</td>
<td>VAS, SPADI</td>
<td>—</td>
<td>+</td>
</tr>
<tr>
<td>Control Group</td>
<td>9</td>
<td>4 (5)</td>
<td>43.4 (14.7)</td>
<td>Glenohumeral joint mobilization techniques Conventional treatment</td>
<td></td>
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<tr>
<td>Doner, 2013&lt;sup&gt;31&lt;/sup&gt; Turkey</td>
<td>Diagnosed as adhesive capsulitis</td>
<td>At least 3 months</td>
<td>Intervention Group</td>
<td>20</td>
<td>7 (13)</td>
<td>59.25 (6.17)</td>
<td>Mulligan’s technique Conventional treatment</td>
<td>VAS, SDQ</td>
<td>—</td>
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<tr>
<td>Control Group</td>
<td>20</td>
<td>2 (18)</td>
<td>58.55 (8.57)</td>
<td>Passive stretching exercises Conventional treatment</td>
<td></td>
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<tr>
<td>Ayta, 2015&lt;sup&gt;32&lt;/sup&gt; Turkey</td>
<td>Diagnosed with Subacromial Impingement Syndrome</td>
<td>—</td>
<td>Intervention Group</td>
<td>22</td>
<td>3 (19)</td>
<td>51 (4)</td>
<td>Supervised exercise Conventional treatment</td>
<td>VAS, Quick-DASH</td>
<td>—</td>
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<td>Control Group</td>
<td>22</td>
<td>8 (14)</td>
<td>52 (5)</td>
<td>Scapular mobilization Conventional treatment</td>
<td></td>
<td></td>
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<tr>
<td>Chandrasekaran, 2021&lt;sup&gt;23&lt;/sup&gt; India</td>
<td>Diagnosed with Unilateral adhesive capsulitis</td>
<td>—</td>
<td>Intervention Group</td>
<td>15</td>
<td>—</td>
<td>45-65 years old</td>
<td>Mulligan mobilization technique</td>
<td>—</td>
<td>SPADI</td>
</tr>
<tr>
<td>Control Group</td>
<td>15</td>
<td>—</td>
<td></td>
<td>Positional release therapy</td>
<td></td>
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<tr>
<td>Coronado, 2015&lt;sup&gt;33&lt;/sup&gt; USA</td>
<td>Patients with a general shoulder pain</td>
<td>Less than 6 months</td>
<td>Intervention Group</td>
<td>25</td>
<td>15 (10)</td>
<td>41 (14.1)</td>
<td>Home Exercise</td>
<td>PPT</td>
<td>—</td>
</tr>
<tr>
<td>Control Group</td>
<td>27</td>
<td>14 (13)</td>
<td>39.4 (13.6)</td>
<td>Shoulder Manipulation</td>
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<td>Coronado, 2015&lt;sup&gt;23&lt;/sup&gt; USA</td>
<td>Patients with a general shoulder pain</td>
<td>Less than 6 months</td>
<td>Intervention Group</td>
<td>25</td>
<td>15 (10)</td>
<td>41 (14.1)</td>
<td>Home Exercise</td>
<td>PPT</td>
<td>—</td>
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<tr>
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<td>26</td>
<td>13 (13)</td>
<td>36.7 (16.0)</td>
<td>Cervical Manipulation</td>
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<td>Go, 2016&lt;sup&gt;44&lt;/sup&gt; South Korea</td>
<td>Workers who are diagnosed with cervical and shoulder pain</td>
<td>—</td>
<td>Intervention Group</td>
<td>19</td>
<td>6 (13)</td>
<td>36.16 (5.53)</td>
<td>Stabilization exercises for the shoulder joint</td>
<td>PPT</td>
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<td>19</td>
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<td>35.79 (4.10)</td>
<td>Passive manual therapy</td>
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<tr>
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<td>Symptom duration, months</td>
<td>Group allocation</td>
<td>Number</td>
<td>Male (female)</td>
<td>Age (mean ± SD)</td>
<td>Description of therapy</td>
<td>Outcomes available</td>
<td>Follow up periods</td>
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<tr>
<td>Iqbal, 2020</td>
<td>Pakistan</td>
<td>Idiopathic frozen shoulder stages 1 and 2 or stiff painful shoulder joint</td>
<td>At least 3 months</td>
<td>Intervention Group</td>
<td>30</td>
<td>21 (39)</td>
<td>45.06 (6.46)</td>
<td>Spencer muscle energy technique Heating pack</td>
<td>NPRS SPADI</td>
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<td>30</td>
<td>46.63 (5.22)</td>
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<td>Kim, 2019</td>
<td>South Korea</td>
<td>Diagnosed with Subacromial Impingement Syndrome</td>
<td>Pain duration of at least 3 weeks</td>
<td>Intervention Group</td>
<td>13</td>
<td>0 (13)</td>
<td>46.38 (4.94)</td>
<td>Neurac technique</td>
<td>VAS SPADI</td>
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<td>13</td>
<td>45.92 (4.49)</td>
<td>Shoulder joint and scapular mobilizations</td>
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<tr>
<td>Lin, 2022</td>
<td>China</td>
<td>Shoulder joint pain and limited mobility</td>
<td>More than 4 weeks</td>
<td>Intervention Group</td>
<td>24</td>
<td>10 (14)</td>
<td>52.3 (5.2)</td>
<td>PNF technique under the ICF concept Upper limb flexion and extension exercises Conventional treatment</td>
<td>VAS</td>
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<td>24</td>
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<td>54.7 (6.5)</td>
<td>Manual therapy</td>
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<td>Pekgöz, 2020</td>
<td>Turkey</td>
<td>Diagnosed with Subacromial Impingement Syndrome</td>
<td>More than 6 weeks</td>
<td>Intervention Group</td>
<td>20</td>
<td>6 (14)</td>
<td>41.9 (9)</td>
<td>Exercise Neuromuscular electrical stimulation</td>
<td>VAS DASH</td>
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<td>12 (8)</td>
<td>45.2 (6.5)</td>
<td>Mobilization Neuromuscular electrical stimulation</td>
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<td>Rana, 2021</td>
<td>Pakistan</td>
<td>primary or secondary cause presenting with capsular Pattern</td>
<td>—</td>
<td>Intervention Group</td>
<td>20</td>
<td>4 (16)</td>
<td>53.6</td>
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<td>52.80</td>
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<td>Savolainen, 2004</td>
<td>Finland</td>
<td>Workers who have signs of neck muscle pain or tender thoracic Levels.</td>
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<td>17</td>
<td>7 (25)</td>
<td>54 (5)</td>
<td>Exercise</td>
<td>VAS/ PPT</td>
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<td>53 (6)</td>
<td>Thoracic manipulations</td>
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<td>Vijayan, 2019</td>
<td>India</td>
<td>Diagnosed as adhesive capsulitis</td>
<td></td>
<td>Intervention Group</td>
<td>15</td>
<td>—</td>
<td>40-60 years old</td>
<td>Muscle energy technique Conventional treatment</td>
<td>—</td>
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<td>Control Group</td>
<td>15</td>
<td>—</td>
<td></td>
<td>Cyrian deep friction technique Conventional treatment</td>
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<tr>
<td>Trial author, Country</td>
<td>Population</td>
<td>Symptom duration, months</td>
<td>Group allocation</td>
<td>Number</td>
<td>Male (Female)</td>
<td>Age (mean ± SD)</td>
<td>Description of therapy</td>
<td>Outcomes available</td>
<td>Follow up periods</td>
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<tr>
<td>Igrek, 2022³¹ Turkey</td>
<td>Shoulder pain for at least 2 month</td>
<td>Intervention Group</td>
<td>15</td>
<td>6 (9)</td>
<td>47.6 (12.4)</td>
<td>Proprioceptive Neuromuscular Facilitation (PNF) exercises Conventional treatment</td>
<td>VAS</td>
<td>— + + —</td>
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<tr>
<td></td>
<td>Control Group</td>
<td>15</td>
<td>5 (10)</td>
<td>44.4 (11)</td>
<td>Shoulder mobilization Conventional treatment</td>
<td></td>
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<tr>
<td>Engdbroten, Norway ²⁰⁰⁶, 201⁰³⁶</td>
<td>Subacromial shoulder pain</td>
<td>At least 3 months</td>
<td>Intervention Group</td>
<td>52</td>
<td>26 (26)</td>
<td>49 (9.3)</td>
<td>Supervised exercise</td>
<td>9 point Likert Scale, SPADI</td>
<td>— + + +</td>
</tr>
<tr>
<td></td>
<td>Control Group</td>
<td>52</td>
<td>26 (26)</td>
<td>47 (11.7)</td>
<td>Radial extracorporeal shock-wave</td>
<td></td>
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</tr>
<tr>
<td>ma2011³⁵ China</td>
<td>Neck and shoulder pain related to computer use</td>
<td>At least 3 months</td>
<td>Intervention Group</td>
<td>15</td>
<td>4 (11)</td>
<td>34.2 (10.3) 35.3 (9.4)</td>
<td>Active exercise</td>
<td>VAS</td>
<td>NDI</td>
</tr>
<tr>
<td></td>
<td>Control Group</td>
<td>15</td>
<td>5 (10)</td>
<td>35.4 (9.4)</td>
<td>Interferential therapy Hot packs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ma2011³⁶ China</td>
<td>Neck and shoulder pain related to computer use</td>
<td>At least 3 months</td>
<td>Intervention Group</td>
<td>15</td>
<td>5 (10)</td>
<td>31.3 (8.6)</td>
<td>35.3 (9.4)</td>
<td>Biofeedback training</td>
<td>VAS</td>
</tr>
<tr>
<td></td>
<td>Control Group</td>
<td>15</td>
<td>5 (10)</td>
<td>35.3 (9.4)</td>
<td>Interferential therapy Hot packs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alfredo, 20²⁰³³ Brazil</td>
<td>Diagnosed with Subacromial Impingement Syndrome</td>
<td>—</td>
<td>Intervention Group</td>
<td>42</td>
<td>—</td>
<td>56.0 (10.4)</td>
<td>Exercise</td>
<td>NPRS, SPADI</td>
<td>— + + —</td>
</tr>
<tr>
<td></td>
<td>Control Group</td>
<td>36</td>
<td>—</td>
<td>54.2 (7.1)</td>
<td>Laser</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>walker2004⁴⁷ Germany</td>
<td>Painful disabling impingement syndrome of the shoulder</td>
<td>—</td>
<td>Intervention Group</td>
<td>20</td>
<td>9 (11)</td>
<td>52.1</td>
<td>Standardized self-training</td>
<td>VAS</td>
<td>CS</td>
</tr>
<tr>
<td></td>
<td>Control Group</td>
<td>20</td>
<td>14 (6)</td>
<td>48.6</td>
<td>Functional brace</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>walker2004⁴⁷ Germany</td>
<td>Painful disabling impingement syndrome of the shoulder</td>
<td>—</td>
<td>Intervention Group</td>
<td>20</td>
<td>11 (9)</td>
<td>51.5</td>
<td>Centering training for the rotator cuff</td>
<td>VAS</td>
<td>CS</td>
</tr>
<tr>
<td></td>
<td>Control Group</td>
<td>20</td>
<td>14 (6)</td>
<td>48.6</td>
<td>Functional brace</td>
<td></td>
<td></td>
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</tbody>
</table>

VAS: Visual Analogue Scale  NPRS: Numeric Pain Rating Scale  SPADI: Shoulder Pain and Disability Index  CS: Constant (Merle) Score  PPT: Pressure pain thresholds  SDQ: Shoulder Disability Questionnaire  DASH: Disability of Arm, Shoulder and Hand Scores  Immediate: immediately outcome after treatment  Short: Follow-up within three months  Moderate: Three months (not included) to six months follow-up  Long: Six months (not included) or longer follow-up
In the AP group, the intervention in 8 research [43, 44, 48-50, 52-54] were active therapy, including Mulligan therapy, Spencer muscle energy technique, PNF and Neurac technique. 12 studies [42, 45-47, 51, 56-60] adopted exercise training; only 1 study [55] combined active therapy technique with exercise. In the PP group, patients were treated with passive manual therapy (manipulation) in 15 studies [42-55], with physical factor treatment in 4 studies [56-59], and with shoulder brace in 2 research [60]. Treatment details can be viewed in Appendix 4.

**Risk of bias assessment**

The risk of bias in the included studies can be viewed in Figure 2. The primary risk of bias in the studies was concentrated on the performance bias and detection bias. 15 studies [44, 46-49, 52-54, 56-59] failed to blind participants and personnel, and 12 studies [44, 47-50, 52-55, 58, 60] failed to blind outcome assessors. 5 studies [47, 48, 52, 58] failed to allocate concealment. 7 studies [47, 48, 52, 53, 58, 60] had 3 or more high-risk items and were considered to be at high risk of bias.

![Figure 2. Risk of bias summary](image-url)
Primary comparisons

The result of primary comparisons was viewed in Table 2.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Primary outcome</th>
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</thead>
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<tr>
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<td>Outcome</td>
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<tr>
<td>AP versus Passive Manipulation</td>
<td>PPT*</td>
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<tr>
<td></td>
<td>Pain Intensity*</td>
</tr>
<tr>
<td></td>
<td>function*</td>
</tr>
<tr>
<td>AP versus Physical factor therapy</td>
<td>Pain Intensity*</td>
</tr>
<tr>
<td></td>
<td>function*</td>
</tr>
</tbody>
</table>

*No significant difference between groups.
*Favor of experimental group.
PPT: Pressure pain threshold
SMD: Standardized mean difference
GRADE: Grading of Recommendations Assessment

Primary comparisons

Active physiotherapy versus passive manipulation

A total of 15 studies[42-55], which involved 588 patients (42% males and 58% females) with a mean age of 48, compared AP with passive manipulation. Shoulder pain was diagnosed as Subacromial Impingement Syndrome or Subacromial Pain Syndrome in 5 studies[43, 45, 50, 51, 54] and as adhesive capsulitis in 5 studies[44, 48, 49, 52, 53]. In the rest 5e studies, 2 included patients with work-related shoulder or neck pain, and 3 included patients with nonspecific shoulder pain for no apparent cause.

4 research reported changes in PPT after AP and passive manipulation intervention [42, 46, 47], 1 of which could not be pooled for statistical reasons. The pooled results showed no significant difference between AP and passive
manipulation (SMD -0.09, 95%CI: -0.42 to 0.24, I²=0%). In a descriptive analysis of uncombined outcomes, both
groups showed statistically significant improvement in PPT after treatment, but there were no statistical differences
between the two groups.

9 research [42-45, 49-51, 54, 55] assessed pain intensity using either the Visual Analogue pain Scale (VAS) or
Numerical Pain Rating Scale (NPRS). The pooled results showed that the AP group was better at relieving pain than
the PP group, but the effect was small (SMD-0.37, 95%CI: -0.71 to -0.03, I²=58%).

Function was rated in 10 research[43-45, 48-54] and the pooled results showed that AP was more effective with a
small effect (SMD-0.22, 95%CI: -0.43 to -0.01, I²=0%). The funnel diagram was symmetrical, no publication bias
detected. (Egger's test, P = 0.77, Appendix5).

**Active physiotherapy versus Physical factor therapy**

4 research[56-59] compared AP with physical factor therapy. 298 patients with an average age of 46 were included,
among which 30% are males and 70% are females. The patient in 2 research[56, 57, 59] diagnosed as Subacromial
Impingement Syndrome or Subacromial Pain Syndrome. 2 research[58] included patients with work-related shoulder
or neck pain.

4 research[57-59] using the VAS or NPRS to assess pain intensity. The pooled results showed AP was more effective
than physical factor therapy (SMD-1.32, 95%CI: -2.34 to -0.29, I²=91%). Sensitivity analysis was performed due to
high heterogeneity, and after removing one study[57], the heterogeneity was reduced (SMD-1.72, 95%CI: -2.33 to -
1.12, I²=51%).

4 research[57-59] used the SPADI, NDI to evaluate function, and the pooled results showed that AP produced more
improvement with a moderate effect (SMD-0.64, 95%CI: -1.15 to -0.14, \(I^2=61\%\)).

**Active physiotherapy versus brace treatment**

2 research [60] compared AP with brace treatment, but the data could not be pooled. 1 study found that both standard self-training and shoulder brace treatment contributed to pain relief and function improvement with the latter being more effective on pain relief, and no significant difference found between their effects on function improvement. Another study showed that shoulder brace treatment was more effective in pain relief than centering training for the rotator cuff, but no significant difference was found in function.

**Secondary comparisons**

Subgroup analyses for all outcome measures were performed according to different follow-up times (See Table 3).
Pressure pain thresholds (PPT)

4 research[42, 46, 47] reported the change of PPT in the comparison of AP and passive manipulation, with 2 studies[46] reported immediate effects, 1[47] reported short-term follow-up outcomes, and one reported Mid and long-term effects.

Mid and long-term results were difficult to pool for high heterogeneity, and we performed descriptive analyses. The pooled results showed that there was no significant difference between the two groups in terms of immediate effect (SMD-0.10, 95%CI: -0.48 to 0.29, I²=0%), and at short-term follow-up, only 1 group showed no significant difference
20

(MD-0.31, 95%CI: -2.83 to 2.21). At long-term and mid-term follow-up, there were no significant differences between
the two groups at either follow-up.

**Pain intensity**

9 studies reported the changes in pain intensity between AP and passive manipulation. 7 studies[43-45, 49-51,
55] reported short-term follow-up, and pooled results showed AP was more effective in pain relief (SMD-0.48, 95%CI:
-0.88 to -0.09, I^2=60%). 2 studies[42, 54] reported no significant difference between two groups (Mid-term follow-up:
MD1.10, 95%CI: -0.01 to 2.21; Long-term follow-up: MD0.10, 95%CI: -1.42 to 1.62).

4 studies[56-59] reported AP versus physical factor therapy in reducing pain intensity. The pooled results showed AP
was more effective in short and mid-term follow up. (Short-term: SMD-0.58, 95%CI: -1.02 to -0.14, I^2=60%; Mid-
term: SMD-1.35, 95%CI: -2.30 to -0.39, I^2=90%). Only 1 study[57] had a long-term follow-up, with results of no
significant difference between exercise and shock-wave therapy (MD-0.40, 95%CI: -1.23 to 0.43).

**Function**

10 studies[43-45, 48-54] compared AP and passive manipulation in function. 9 studies[43-45, 48-53] reporting short-
term follow-up found that AP was more effective (SMD-0.27, 95%CI: -0.49 to -0.05, I^2=0%). 1 study[54] showed that
there was no significant difference between two groups (MD3.70, 95%CI: -6.78 to 14.18) in mid-term follow-up.

4 studies[56-59] introduced the effect of AP versus physical factor treatment in function. The pooled results revealed
AP was more effective in short and mid-term follow up. (Short-term follow-up: SMD-0.61, 95%CI: -0.89 to -0.34,
I^2=0%; Mid-term follow-up: SMD-0.65, 95%CI: -1.15 to -0.15, I^2=60%). 1 study[57] reporting long-term follow-up
showed no significant difference between the two groups (MD-7.60, 95%CI: -16.69 to 1.49).

**Discussion**

**Main findings and comparison with other reviews**

AP has been shown better efficacy in both pain and function than PP, although the differences between groups were small. In the subgroup analysis, AP showed advantages only in the short-term. At mid-term follow-up, AP stood out only when patients were treated with physical factor therapy. At long-term follow-up, all outcomes were not significantly different.

**AP outperforms passive manipulation for pain intensity and function**

AP surpassed passive manipulation in terms of pain intensity (SMD-0.37, 95%CI: -0.71 to -0.03) and function (SMD-0.22, 95 %CI: -0.43 to -0.01), but with only small effects. This result is similar to the agreed views on physiotherapy for shoulder pain published in 2015 that active exercise should be the primary approach[10].

The fundamental difference between the AP and the passive manipulation was the degree of active participation and exercise of patients. Previous studies have demonstrated the importance of exercise for pain relief[61-64]. As early as 1987, when developing the Vanderbilt Pain Management Scale, Brown and Nicassio[64] proposed that active coping strategies were associated with less pain, less depression, less dysfunction and higher self-efficacy, while passive coping strategies were opposite. Although the definitions of active coping strategies and active physical therapy are not identical, both describe the patient's willingness and determination to actively participate in pain control.

A cross-sectional study revealed that problems reported by 87.7% of patients fell under the activity and participation
component of the International Classification of Functioning, Disability and Health (ICF)[65]. Different from passive manipulation, the AP group had more training related to activity and participation (such as exercise in the home environment and normal movement pattern training[45-47, 51, 56-60]) in addition to active therapy technique, which are more closely linked to daily life, and this may partly account for the better results in the AP group.

Pain intensity and function showed small changes in both groups, possibly due to the fact that the majority of the included studies[43-51, 53-56, 58-60] (78%) had a short follow-up period. Moreover, some studies required both the intervention and control group to perform exercise at home after the intervention to maintain the treatment effect [44, 45, 48, 54], which may also lead to the small differences between groups.

**AP outperforms physical factor therapy for pain intensity and function**

Four studies compared the effectiveness of AP and physical factor therapy in patients with shoulder pain. The result found that AP was superior in both pain and function.

In terms of pain intensity, the pooled results of the 4 studies presented a high effect (SMD: -1.32, 95%CI: -2.34 to -0.29) in the AP group, with high heterogeneity (I²=91%). In clinical practice, physical factor therapy has been widely used for pain relief. The Greenberg et al.[29]. review reported that heat and cold therapy, electrical stimulation, and ultrasound could be used to alleviate shoulder pain, but did not elaborate on their effectiveness. At present, physical factor therapy seems to be more likely to be combined with other therapies, and studies solely exploring its efficacy for musculoskeletal diseases are few and of low quality[29]. In 2016, Jessica et al[66]. questioned the effectiveness of physical factor therapy (heat, cold, diathermy, hydrotherapy, ultrasound) in patients with neck and shoulder pain in a high-quality systematic review. Therefore, at present, the efficacy of traditional passive physical factor therapy needs
to be reconsidered[67]. Clinical heterogeneity may have contributed to the statistical heterogeneity. One study, in which extracorporeal shock-wave therapy was used as the physical factor therapy, presented significant heterogeneity in the statistical synthesis of results. A review mentioned that extracorporeal shock wave therapy was far superior to other treatments in terms of easing shoulder and neck pain[68]. Nevertheless, this result was finally judged as low certainty and should be interpreted with caution.

In terms of function, the pooled results of the 4 studies presented a moderate effect (SMD: -0.64, 95%CI: -1.15 to -0.14) in the AP group, with moderate heterogeneity ($I^2=61\%$). It is not difficult to explain why the effect of physical factor therapy on functional improvement is worse than that of AP. Patients are always in a state of rest when receiving physical factor therapy and rely on machines and equipment or therapists to complete the treatment. Shoulder joint related activities and functions are not carried out in the treatment process. From the level of neuromuscular control, it is not conducive to functional recovery in patients with chronic shoulder pain. A network meta-analysis indirectly supporting our results pointed out that active exercise should be the first-line treatment to improve pain and function; manual therapy technique combined with exercises may accelerate pain relief in the short term. Low-level laser therapy, pulsed electromagnetic field (PEMF) and taping should not be recommended[69].

**AP may outperform shoulder brace for pain intensity and function**

Two research from one article compared the effect of AP and brace, which results could not be pooled for statistical reasons. In terms of pain, there were no significant differences between the two treatments, and in terms of function, both studies presented shoulder brace had better effect. Due to methodological quality limitations, the results were ultimately judged to be of very low quality. Unfortunately, there are very few studies on the comparison between AP
and brace with a limited number of patients being covered. In 2016, a Cochrane systematic review suggested that exercise therapy and brace treatment didn’t show a significant difference in pain and function improvement in patients with shoulder pain, but the AP in this review is only exercise[70].

**AP treatment showed an advantage over PP treatment in short-term follow-up**

In short-term follow-up, AP showed favorable outcomes compared to PP (77% of the studies reported short-term follow-up). At mid-term follow-up, AP stood out only when patients were treated with physical factor therapy and there were no significant differences between the two groups when AP was compared to passive manipulation. At long-term follow-up, all outcomes were not significantly different. A systematic review supporting this result suggested that the addition of exercise during manipulation accelerated symptom improvement in patients with subacromial pain in the short term, but no medium- or long-term effects were observed [69]. Similarly, Haik’s study also encountered a lack of medium- and long-term follow-up studies. Besides, the intervention phase of all but one study[42] ends within three months, and after intervention, researchers often develop a home training program and instruct patients to actively exercise which may cause statistical underestimation of the AP group.

**Strengths and limitations**

Physiotherapy is at an inflection point. The current debate over "active" versus "passive" therapies once again highlights the extent to which physical therapy reflects changing cultural and social attitudes[26, 33]. In contrast to previous studies, the "active physiotherapy" described in this review includes active manual therapy techniques in addition to exercise. Human connection through touch is one of the most unique aspects of physiotherapy practice.
From the patient's perspective, when people think about treating their injury again, they may just want to be “passive” for a while and then start active exercise. During this "passive" period, therapists should adopt manual therapies which allow patients to actively participate in the treatment process as much as possible.

This study is the first systematic review comparing the effects of AP and PP in musculoskeletal pain disorders. Strictly following the requirements of the Cochrane handbook and PRISMA guidelines, we conducted a comprehensive search based on clear and targeted inclusion and exclusion criteria, and performed rigorous data extraction and analysis. Data in this study is relatively representative since 52% of the research sources are from developed countries and 48% from developing countries, and detailed demographic data are provided.

However, some included studies are of low quality and have a high risk of bias, which may affect the certainty of results in this review. Another limitation that possibly affects the quality of this study is that some included studies have incomplete data, and we cannot contact the original authors to obtain these data. In addition, due to the unclear description of active intervention methods in some studies, we cannot judge whether the dose of AP intervention (duration, intervention method, degree of active participation) has an impact on the final results.

**Future directions**

Traditional passive physical therapy is being questioned, while "active health" is the new trend. In addition to expanding sample sizes and improving trial design, future efficacy trials for musculoskeletal disorders should further explore the impact of "active participation" on patients (such as the relationship between the degree of active participation and treatment effects, for instance, whether the dose (time, frequency, method) of active intervention is related to the outcome). Moreover, rather than constantly developing new interventions, it is worth looking at the
interventions that are already in place. By adapting or improving existing interventions, they can be made more feasible and cost-effective, thus benefiting patients as well.

**Conclusion**

In sum, Medium and low evidence suggests that AP was superior to PP in terms of pain relief and functional improvement in patients with chronic shoulder pain but this advantage was not observed in the long-term follow-up. In the future treatment of chronic shoulder pain, physiotherapy with active participation may lead to better results, whether it is active manipulation or exercise therapy.

**Declarations**

**Ethical Approval**

Not applicable.

**Competing interests**

The authors of this article have no financial affiliations (including research funding) or involvement with any commercial organization to disclose.

**Authors’ contributions**

Ruirui Wang and Jialin Wang served as principal author, had full access to all the data in the study, and took
responsibility for the accuracy of the data analysis and its integrity. Peng Zhao contributed to the conception and
design. Xiao Zhou, Xuanhui Guo contributed to data acquisition and interpretation. Ruirui Wang and Jialin Wang
prepared the initial draft of the manuscript and revised the article, and gave final approval. All authors reviewed the
manuscript.

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15–33.

Availability of data and materials

Some or all data generated or analyzed during this study are included in this published article or the data repositories
listed in References.

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Legends for Figures

FIGURE 1. PRISMA Flow Diagram. PRISMA flow diagram showing the process of study selection. 19399 articles were retrieved from the bibliographic search, and seven were found by manual search. 19 articles were included in the meta-analysis. PRISMA, Preferred Reporting Items of Systematic Reviews and Meta-Analysis.

FIGURE 2. Risk of bias summary. Review authors' judgements about each risk of bias item for each included study (Risk of Bias scale).

TABLES

TABLE 1. Demographic characteristics of included studies.

TABLE 2. Results of primary outcomes.

TABLE 3. Results of secondary outcomes.

Appendices. Supplementary Information

Appendix 1. The detailed search strategies for all databases.

Appendix 2. A short checklist was used to guide the selection of relevant studies.

Appendix 3. The result of kappa test (K= 0.83, P<0.05).

Appendix 4. Detailed intervention content of active and passive physiotherapy in each study.
Appendix 5. Publication bias heterogeneity funnel plot for function (active physiotherapy versus passive manipulation). A funnel plot was used to assess the risk of publication bias. The diagonal lines represent the 95% confidence limits. Se: standard error, SMD: standardized mean difference. A random-effects model was used.
Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Appendix1.docx
- Appendix2.docx
- Appendix3.docx
- Appendix4.docx
- Appendix5.pdf