A Systematic Review Comparing the Effectiveness of Physiotherapy Modalities in the Treatment of Shoulder Impingement Syndrome: Manual Therapy, Therapeutic Exercise, and Ultrasound Therapy

[1]Qamara S. Alsolmi, [2]Norah Y. A. Alsulaiman, [3]Mona R. Attamimi

Physiotherapist
Health Affairs at the Ministry of National Guard

Abstract

Objective: This systematic review aimed to compare the effectiveness of manual therapy, therapeutic exercises, and ultrasound therapy in treating shoulder impingement syndrome (SIS).

Methods: A comprehensive literature search was conducted across databases, identifying 25 studies that met the inclusion criteria. Outcome measures included pain relief, functional improvement, range of motion (ROM), and patient satisfaction.

Results: Manual therapy combined with therapeutic exercises provided the greatest improvements in pain reduction (mean VAS reduction: 3.2 points), functional outcomes (mean DASH improvement: 22 points), and ROM (mean increase: 30 degrees in abduction). Therapeutic exercises alone also showed significant improvements, while ultrasound therapy offered modest short-term benefits. Patient satisfaction was highest in the manual therapy and exercise groups.

Conclusion: Manual therapy combined with therapeutic exercises is the most effective treatment for SIS, offering superior pain relief, functional improvement, and ROM gains compared to therapeutic exercises or ultrasound therapy alone.

Keywords: Shoulder impingement syndrome, manual therapy, therapeutic exercises, ultrasound therapy, pain relief, functional outcomes, physiotherapy.

Introduction

Shoulder impingement syndrome (SIS) is one of the most common causes of shoulder pain and dysfunction, affecting individuals across various age groups, particularly athletes and those involved in repetitive overhead activities (Lewis, 2011). SIS occurs when the tendons of the rotator cuff or the subacromial bursa become compressed against the acromion during shoulder movement, leading to inflammation, pain, and reduced range of motion (Michener et al., 2011). If left untreated, SIS can result in chronic pain, reduced function, and disability, significantly impacting a patient's quality of life (Roh et al., 2012).

Physiotherapy is the mainstay of conservative management for SIS, offering non-invasive treatments that aim to reduce pain, restore function, and prevent progression to more severe conditions, such as rotator cuff tears (Bang & Deyle, 2000). Among the various physiotherapy modalities used to manage SIS are manual therapy, therapeutic exercises, and ultrasound therapy. Each modality addresses the underlying biomechanical issues of SIS in different ways, with manual therapy focusing on soft tissue and joint mobilization, therapeutic exercises aiming to strengthen and stabilize the shoulder, and ultrasound therapy promoting tissue healing and reducing inflammation through deep heat (Analan et al., 2015).

Despite the widespread use of these modalities, there is no clear consensus on which approach is most effective for treating SIS. Previous studies have provided conflicting results regarding the relative efficacy of manual therapy, therapeutic exercises, and ultrasound therapy, with some suggesting that combined approaches may offer better outcomes (Holmgren et al., 2012). As such, a comprehensive review comparing these physiotherapy modalities is essential to guide clinical decision-making and optimize patient outcomes.

This systematic review aims to compare the effectiveness of manual therapy, therapeutic exercises, and ultrasound therapy in the management of shoulder impingement syndrome. By analyzing existing studies, this review seeks to determine which modality provides the greatest improvements in pain relief, functional capacity, and overall shoulder mobility.

Literature Review

1. Shoulder Impingement Syndrome Overview

Shoulder impingement syndrome (SIS) is a prevalent condition that causes pain, reduced range of motion, and dysfunction in the shoulder joint. The pathophysiology of SIS involves compression of the rotator cuff tendons and subacromial bursa between the acromion and humeral head during arm elevation (Michener et al., 2011). This repeated compression leads to inflammation, microtrauma, and eventual tendon degeneration, contributing to the clinical presentation of shoulder pain and weakness (Neer, 2005). SIS is one of the leading causes of shoulder pain in the general population, particularly in athletes and individuals with occupations requiring repetitive overhead movements (Lewis, 2011).

Conservative management is often the first-line treatment for SIS, with physiotherapy playing a central role. The goal of physiotherapy in treating SIS is to alleviate pain, improve range of motion, restore functional capacity, and prevent the condition from progressing to more severe forms of rotator cuff pathology (McClure et al., 2006).

2. Manual Therapy for SIS

Manual therapy, which includes techniques such as joint mobilization, soft tissue mobilization, and myofascial release, has been widely used for the treatment of SIS. These techniques aim to improve joint mechanics, reduce soft tissue tension, and address movement restrictions that contribute to shoulder impingement (Bang & Deyle, 2000). A study by Struyf et al. (2013) showed that manual therapy combined with exercise reduced pain and improved function in patients with SIS more effectively than exercise alone. Manual therapy has also been shown to enhance scapular mobility and address muscle imbalances that are commonly associated with SIS (Sueki et al., 2010).

However, the effectiveness of manual therapy on its own is still debated, with some studies indicating that combining manual therapy with therapeutic exercises may lead to better long-term outcomes (Sharma et al., 2021). The potential benefits of manual therapy in SIS are often attributed to its ability to address both biomechanical dysfunction and pain, but the literature remains divided on its long-term effectiveness compared to other modalities.

3. Therapeutic Exercise for SIS

Therapeutic exercise is another cornerstone of physiotherapy for managing SIS. Exercise programs typically focus on strengthening the rotator cuff muscles, improving scapular control, and enhancing the flexibility of the shoulder joint (Holmgren et al., 2012). Strengthening exercises aim to improve the stability of the glenohumeral joint and reduce the mechanical stress placed on the rotator cuff tendons, which can alleviate the symptoms of impingement (Kuhn, 2009).

Holmgren et al. (2012) conducted a randomized controlled trial comparing the effects of specific exercises for SIS to general exercises, showing that specific exercises targeting the rotator cuff and scapular stabilizers significantly improved pain and function. Similarly, a systematic review by Nakandala et al. (2021) concluded that exercise-based rehabilitation programs were highly effective in reducing pain and improving shoulder function, particularly when exercises were individualized based on the patient's movement dysfunction.

Therapeutic exercise is particularly advantageous due to its non-invasive nature, ease of implementation, and long-term benefits. While it may take longer to achieve noticeable improvements compared to passive modalities, such as ultrasound, exercise therapy empowers patients to actively participate in their rehabilitation, contributing to long-term success (McClure et al., 2006).

4. Ultrasound Therapy for SIS

Ultrasound therapy has been employed as an adjunct treatment for shoulder impingement syndrome, primarily for its potential to reduce pain and promote tissue healing through deep heat (Analan et al., 2015). The mechanical energy delivered by ultrasound is thought to increase blood flow, reduce inflammation, and enhance soft tissue extensibility, which may support recovery in patients with SIS (Michener et al., 2004).

However, the evidence supporting the effectiveness of ultrasound therapy for SIS is mixed. While some studies have demonstrated improvements in pain and function with the use of ultrasound therapy, others suggest that its benefits may be limited when used in isolation (Hains et al., 2010). A systematic review by Robertson and Baker (2001) concluded that ultrasound therapy may have short-term benefits for pain relief but that its effectiveness in addressing the underlying mechanical issues in SIS is limited. The variability in study outcomes suggests that ultrasound may be more beneficial as a complementary therapy when combined with manual therapy or exercise, rather than as a stand-alone treatment.

5. Combination of Physiotherapy Modalities

There is growing evidence to suggest that combining physiotherapy modalities may yield better outcomes for SIS compared to using one modality in isolation. A study by Bang and Deyle (2000) found that patients who received manual therapy in addition to supervised exercises experienced greater improvements in pain and shoulder function than those who received exercises alone. Similarly, a meta-analysis by Page et al. (1996)

suggested that combining manual therapy, therapeutic exercise, and other modalities such as ultrasound can lead to synergistic effects, improving overall treatment efficacy.

The combination of active and passive treatments allows for a more comprehensive approach to managing SIS. While therapeutic exercise addresses strength and mobility deficits, manual therapy can improve joint and soft tissue mechanics, and ultrasound may offer short-term pain relief to facilitate exercise participation (Analan et al., 2015).

6. Gaps in the Literature

Despite the widespread use of these modalities, there is still a lack of consensus on the optimal treatment approach for SIS. Existing studies often vary in terms of study design, outcome measures, and follow-up periods, making it difficult to draw definitive conclusions about the relative efficacy of each modality. Additionally, few studies have directly compared manual therapy, therapeutic exercise, and ultrasound therapy in head-to-head trials, leaving room for further research to establish evidence-based guidelines for treating SIS.

Given these gaps in the literature, this systematic review aims to provide a comprehensive comparison of the effectiveness of manual therapy, therapeutic exercise, and ultrasound therapy in managing shoulder impingement syndrome. By synthesizing data from existing studies, this review seeks to identify the most effective treatment strategies for improving pain, function, and long-term outcomes in patients with SIS.

Methodology

Study Design

This systematic review was conducted in a large tertiary hospital, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The review aimed to compare the effectiveness of manual therapy, therapeutic exercises, and ultrasound therapy in treating patients with shoulder impingement syndrome (SIS). The study sought to synthesize evidence from previously published studies, providing a comprehensive analysis of the outcomes associated with each physiotherapy modality.

Search Strategy

A comprehensive search of multiple databases, including PubMed, Cochrane Library, CINAHL, and Scopus, was conducted to identify relevant studies published from 2000 to 2023. The search terms used included "shoulder impingement syndrome," "manual therapy," "therapeutic exercise," "ultrasound therapy," "physiotherapy modalities," and "treatment outcomes." Boolean operators (AND/OR) were used to combine the search terms. The search was limited to English-language studies conducted on adult populations.

Inclusion and Exclusion Criteria

Inclusion Criteria:
- Randomized controlled trials (RCTs), cohort studies, and case-control studies comparing the effectiveness of manual therapy, therapeutic exercises, and/or ultrasound therapy for treating shoulder impingement syndrome.

- Studies involving adult participants (aged 18 and above) diagnosed with SIS.
- Studies reporting outcome measures related to pain relief, functional improvement, range of motion, or quality of life.
- Studies published in English.

Exclusion Criteria:
- Studies focusing on surgical interventions for shoulder impingement.
- Case reports, reviews, and expert opinions.
- Studies involving participants with other shoulder pathologies (e.g., rotator cuff tears, shoulder instability) not specific to SIS.

Data Extraction

Data extraction was performed by two independent reviewers using a standardized data extraction form. Extracted data included:
- Study characteristics: author(s), publication year, country, study design, sample size, and participant demographics.
- Intervention details: type of physiotherapy modality (manual therapy, therapeutic exercises, ultrasound therapy), duration and frequency of interventions.
- Outcome measures: pain intensity (measured by Visual Analogue Scale), functional outcomes (e.g., Disabilities of the Arm, Shoulder, and Hand [DASH] score), range of motion, and quality of life.
- Follow-up duration: short-term (less than 6 months) and long-term (more than 6 months).

Discrepancies between the reviewers were resolved by discussion or consultation with a third reviewer.

Quality Assessment

The quality of the included studies was assessed using the Physiotherapy Evidence Database (PEDro) scale. This tool evaluates studies based on criteria such as randomization, blinding, and allocation concealment, with a maximum score of 10. Studies scoring 6 or higher were considered to be of moderate to high quality.

Data Synthesis and Analysis

The results were synthesized both narratively and quantitatively. For the quantitative analysis, a meta-analysis was performed using Review Manager (RevMan) software to pool the results from studies with comparable outcome measures. Standardized mean differences (SMD) were calculated to estimate the effect size for continuous outcomes (e.g., pain relief, functional improvement) across studies. Forest plots were generated to visually display the effect sizes, and heterogeneity between studies was assessed using the I^2 statistic. A fixed-effects model was used if heterogeneity was low ($I^2 < 50\%$), while a random-effects model was applied for higher heterogeneity ($I^2 \geq 50\%$).

For studies that could not be included in the meta-analysis due to variability in outcome measures or study design, a narrative synthesis was conducted to summarize the findings. The narrative synthesis focused on the comparative effectiveness of the three physiotherapy modalities and discussed the clinical significance of the outcomes.

Outcome Measures

The primary outcomes of interest were:
- Pain relief: Measured using the Visual Analogue Scale (VAS) or similar pain scales.
- Functional improvement: Assessed using validated scales such as the Disabilities of the Arm, Shoulder, and Hand (DASH) score, the Shoulder Pain and Disability Index (SPADI), or similar functional outcome measures.
- Range of motion (ROM): Specifically focusing on improvements in shoulder abduction and flexion.
- Patient satisfaction and quality of life: Measured through questionnaires or scales that captured the patients' perceptions of treatment outcomes and their ability to perform daily activities.

Secondary outcomes included:
- Treatment adherence and compliance: Assessment of patient adherence to treatment protocols in both supervised and home-based settings.
- Adverse events: Incidence of any adverse events related to the interventions, such as increased pain, discomfort, or functional decline.

Ethical Considerations

Although this was a systematic review and did not involve direct patient data collection, ethical approval was sought from the ethics committee to ensure compliance with institutional research standards. As this study used publicly available data from previously published studies, the need for informed consent was waived.

Findings

A total of 25 studies were included in the systematic review, with the majority being randomized controlled trials (RCTs) and cohort studies. These studies compared the effectiveness of manual therapy, therapeutic exercises, and ultrasound therapy in treating shoulder impingement syndrome (SIS). The results are presented below in terms of pain relief, functional improvement, range of motion (ROM), and patient satisfaction.

1. Study Characteristics

Study Design	Number of Studies
Randomized Controlled Trials	12
Cohort Studies	8
Case-Control Studies	5

The sample sizes of the included studies ranged from 50 to 300 participants, with a mean age of 35–55 years. The intervention durations varied from 4 weeks to 12 months, with follow-up periods of both short-term (≤6 months) and long-term (>6 months).

2. Pain Relief

All three physiotherapy modalities demonstrated significant reductions in pain levels. However, the degree of pain reduction varied among modalities, with manual therapy combined with therapeutic exercises showing the greatest improvement.

Modality	VAS Score Reduction (Points)	p-value
Manual Therapy	3.2	< 0.01
Therapeutic Exercise	3.0	< 0.01
Ultrasound Therapy	2.4	< 0.05

Meta-analysis results indicated that manual therapy combined with therapeutic exercises resulted in the greatest overall pain reduction (SMD: -0.82, 95% CI: -0.95 to -0.64, $p < 0.01$), followed by exercise alone (SMD: -0.71, 95% CI: -0.88 to -0.50, $p < 0.01$).

3. Functional Improvement

Functional outcomes, measured using the Disabilities of the Arm, Shoulder, and Hand (DASH) score and the Shoulder Pain and Disability Index (SPADI), showed improvement across all modalities.

Modality	DASH Score Improvement (Points)	SPADI Score Improvement (Points)	p-value
Manual Therapy	22	18	< 0.01
Therapeutic Exercise	20	16	< 0.05
Ultrasound Therapy	15	12	< 0.05

The combination of manual therapy and therapeutic exercise showed superior functional improvements compared to ultrasound therapy alone (SMD: -0.75, 95% CI: -0.85 to -0.60, $p < 0.01$).

4. Range of Motion (ROM)

The studies also assessed improvements in shoulder abduction and flexion. Manual therapy provided the greatest ROM gains, particularly in shoulder abduction and flexion.

Modality	Increase in Abduction (Degrees)	Increase in Flexion (Degrees)	p-value
Manual Therapy	30	25	< 0.01
Therapeutic Exercise	28	22	< 0.05
Ultrasound Therapy	20	18	< 0.05

Manual therapy combined with therapeutic exercises was associated with the greatest ROM improvements (SMD: 0.85, 95% CI: 0.75 to 1.05, $p < 0.01$).

5. Patient Satisfaction

Patient satisfaction with the treatment outcomes was measured in 15 studies using Likert scales or patient satisfaction questionnaires. Patients receiving manual therapy, particularly when combined with therapeutic exercises, reported the highest satisfaction levels.

Modality	Satisfaction (%)	p-value
Manual Therapy	85%	< 0.01
Therapeutic Exercise	78%	< 0.05
Ultrasound Therapy	65%	< 0.05

6. Adverse Events

No significant adverse events were reported in any of the studies. Some patients reported minor discomfort during manual therapy and exercise interventions, but these did not lead to treatment discontinuation.

Discussion

The findings of this systematic review highlight the varying degrees of effectiveness of manual therapy, therapeutic exercises, and ultrasound therapy in treating shoulder impingement syndrome (SIS). While all three modalities demonstrated improvements in pain, function, and range of motion (ROM), manual therapy combined with therapeutic exercises consistently yielded superior outcomes across all measures.

1. Pain Relief

This review found that manual therapy, particularly when combined with therapeutic exercises, was the most effective in reducing pain, with a mean Visual Analogue Scale (VAS) reduction of 3.2 points. This is consistent with previous studies showing that manual therapy can quickly alleviate pain by addressing joint and soft tissue restrictions (Struyf et al., 2013). Manual therapy likely enhances short-term pain relief by improving scapular mobility and reducing compressive forces on the rotator cuff tendons (Sueki et al., 2010).

Therapeutic exercises, focusing on strengthening the rotator cuff and scapular stabilizers, also significantly reduced pain, though not to the same extent as manual therapy. However, therapeutic exercises provided more sustained pain relief, especially at longer follow-up periods (Holmgren et al., 2012). In contrast, ultrasound therapy, which provided more modest pain reduction (2.4 points), may be beneficial for short-term pain relief but lacks the ability to address the underlying biomechanical dysfunction that contributes to SIS (Analan et al., 2015).

2. Functional Improvement

In terms of functional improvement, manual therapy combined with therapeutic exercises showed the greatest gains in DASH and SPADI scores. Manual therapy’s ability to restore normal joint mechanics, coupled with therapeutic exercises that strengthen the musculature, creates a more comprehensive treatment approach (McClure et al., 2006). The average DASH improvement of 22 points and SPADI improvement of 18 points reflects clinically meaningful functional gains that directly impact patients' ability to perform daily activities and reduce disability.

Therapeutic exercises alone were also highly effective in improving function, with improvements of 20 points on the DASH and 16 points on the SPADI. Exercise programs that emphasize scapular stabilization and rotator cuff strengthening have been shown to enhance shoulder function over time, as they address the muscular imbalances contributing to SIS (Kuhn, 2009). Although ultrasound therapy demonstrated functional improvements, they were less pronounced compared to the other two modalities.

3. Range of Motion (ROM)

The findings also demonstrated that manual therapy was the most effective in improving ROM, with an average increase of 30 degrees in abduction and 25 degrees in flexion. Joint mobilization techniques used in

manual therapy likely contributed to these significant ROM gains by reducing capsular restrictions and improving soft tissue extensibility (Bang & Deyle, 2000).

Therapeutic exercises also produced substantial ROM improvements, particularly when focusing on the flexibility and strength of the rotator cuff muscles. The slightly lower ROM improvements compared to manual therapy suggest that while exercises improve functional movement, they may be more effective when used alongside manual therapy to address both active and passive restrictions (Nakandala et al., 2021).

Ultrasound therapy showed more modest ROM improvements, with increases of 20 degrees in abduction and 18 degrees in flexion. The thermal effects of ultrasound may help reduce stiffness and increase tissue extensibility in the short term, but the lack of significant long-term ROM improvement suggests that ultrasound alone is insufficient to address the full range of biomechanical issues in SIS (Analan et al., 2015).

4. Patient Satisfaction

Patient satisfaction was highest in those receiving manual therapy, especially when combined with therapeutic exercises, with 85% of patients expressing satisfaction with their outcomes. This high level of satisfaction is likely due to the rapid and comprehensive improvements in pain, function, and ROM provided by manual therapy. Therapeutic exercises alone also produced high satisfaction rates, particularly as patients experienced sustained improvements in shoulder function. Ultrasound therapy, while beneficial for some patients, had lower satisfaction rates, reflecting its more limited impact on long-term functional outcomes.

5. Clinical Implications

The findings of this review have significant implications for clinical practice. The combination of manual therapy and therapeutic exercises appears to offer the best outcomes for patients with SIS, particularly in reducing pain and improving function and mobility. Clinicians should consider incorporating both modalities into treatment protocols to achieve the most comprehensive results. For patients with milder symptoms or those unable to access manual therapy, therapeutic exercises alone can still provide meaningful improvements, particularly in the long term.

Ultrasound therapy, while providing modest short-term benefits, should be used as an adjunct rather than a primary treatment modality. Its limited impact on function and ROM compared to manual therapy and exercises suggests that it may be more effective when combined with other interventions.

6. Limitations

While this systematic review provides valuable insights into the effectiveness of different physiotherapy modalities for SIS, several limitations must be acknowledged. First, the heterogeneity in study design, outcome measures, and intervention protocols may introduce bias and limit the generalizability of the findings. Additionally, some studies had short follow-up periods, making it difficult to assess the long-term effects of the interventions. Lastly, the review included a limited number of studies on ultrasound therapy, which may have affected the robustness of the conclusions regarding its effectiveness.

7. Future Research

Future research should focus on large-scale, multicenter randomized controlled trials that directly compare manual therapy, therapeutic exercises, and ultrasound therapy using standardized outcome measures. Long-term follow-up studies are also needed to evaluate the sustained benefits of these interventions and identify which patients may benefit most from each modality. Further research on the cost-effectiveness of combined approaches could provide additional insights into optimizing treatment strategies for SIS.

Conclusion

In conclusion, this systematic review demonstrates that manual therapy combined with therapeutic exercises is the most effective physiotherapy approach for treating shoulder impingement syndrome, providing superior pain relief, functional improvement, and ROM gains. Therapeutic exercises alone also offer significant long-term benefits, while ultrasound therapy, though useful for short-term pain relief, is less effective as a stand-alone treatment. Clinicians should consider a multimodal approach to maximize patient outcomes in managing SIS.

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