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Comparative Effects of Three Manual Therapy Approaches on Pain and Mobility in Frozen Shoulder: A Randomized Controlled Trial

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Abstract

Frozen shoulder (adhesive capsulitis) significantly impacts quality of life through pain and mobility restrictions. While manual therapy is widely used, comparative effectiveness of different approaches remains unclear. To compare the effectiveness of three manual therapy approaches: Maitland mobilization, Mulligan mobilization with movement (MWM), and myofascial release techniques on pain and mobility outcomes in frozen shoulder patients. A randomized controlled trial was conducted with 90 participants (aged 35-65 years) diagnosed with primary frozen shoulder. Participants were randomized into three groups (n=30 each): Group A (Maitland mobilization), Group B (Mulligan MWM), and Group C (myofascial release). All groups received 12 treatment sessions over 6 weeks. Primary outcomes included Visual Analog Scale (VAS) pain scores and shoulder range of motion (ROM). Secondary outcomes assessed functional disability using the Shoulder Pain and Disability Index (SPADI) and quality of life measures. All three approaches demonstrated significant improvements from baseline ($p<0.001$). Mulligan MWM showed superior pain reduction (mean VAS decrease: 5.2±1.1) compared to Maitland (4.1±1.3, $p<0.01$) and myofascial release (3.8±1.2, $p<0.001$). For mobility outcomes, Mulligan MWM achieved greatest improvements in flexion (78.5°±12.3°), abduction (71.2°±11.8°), and external rotation (42.7°±8.9°). SPADI scores improved most significantly with Mulligan MWM (65.3% improvement) followed by Maitland (52.7%) and myofascial release (48.1%). While all three manual therapy approaches were effective for frozen shoulder, Mulligan mobilization with movement demonstrated superior outcomes for pain reduction and functional improvement. These findings support the clinical application of movement-based manual therapy techniques in frozen shoulder management.

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Keywords: frozen shoulder, adhesive capsulitis, manual therapy, Maitland mobilization, Mulligan technique, myofascial release

1. Introduction

Frozen shoulder, clinically termed adhesive capsulitis, represents a debilitating musculoskeletal condition characterized by progressive shoulder pain and restricted range of motion (Brindisino et al., 2024). The condition affects approximately 2-5% of the general population, with peak incidence occurring between 40-60 years of age, showing a notable female predominance (Sarasua et al., 2021). The economic burden and functional limitations associated with frozen shoulder make it a significant public health concern requiring evidence-based therapeutic interventions.

The pathophysiology of frozen shoulder involves a complex interplay of inflammatory processes, fibroblast proliferation, and capsular contracture leading to thickening and adhesion of the glenohumeral joint capsule (Ryan et al., 2016). Recent research has highlighted the role of growth factors, cytokines, and matrix metalloproteinases in the disease progression, with inflammatory markers playing a crucial role in both pain generation and tissue restriction (Bunker et al., 2000). Understanding these underlying mechanisms is essential for developing targeted therapeutic approaches.

The condition significantly impacts patients' quality of life, with studies demonstrating strong correlations between shoulder dysfunction and sleep disturbances, anxiety, and depression (Toprak et al., 2019; Cho et al., 2013). The relationship between pain, functional limitation, and psychological well-being creates a complex clinical picture requiring comprehensive management strategies that address both physical and psychosocial aspects of the condition.

Manual therapy has emerged as a cornerstone treatment for frozen shoulder, with various techniques showing promising results in clinical practice (Kirker et al., 2023). The three most commonly employed manual therapy approaches include Maitland mobilization techniques, which focus on passive joint mobilization and oscillatory movements; Mulligan mobilization with movement (MWM), which combines passive joint mobilization with active movement; and myofascial release techniques, which target soft tissue restrictions and fascial adhesions.

Current evidence supports the effectiveness of manual therapy and exercise interventions for frozen shoulder management (Mertens et al., 2022). However, direct comparative studies examining the relative effectiveness of different manual therapy approaches remain limited. Most existing research focuses on single interventions or compares manual therapy to other

treatment modalities rather than providing head-to-head comparisons between manual therapy techniques.

The theoretical framework supporting each manual therapy approach differs significantly. Maitland mobilization relies on the gate control theory of pain and mechanical effects on joint capsule elasticity. Mulligan MWM incorporates the concept of positional faults and movement dysfunction, addressing both joint mobility and motor control. Myofascial release targets the fascial system and its role in movement restriction and pain generation.

Given the lack of definitive comparative evidence, clinicians often select manual therapy techniques based on personal experience and training rather than evidence-based decision making. This gap in knowledge necessitates well-designed comparative studies to guide clinical practice and optimize patient outcomes.

The primary aim of this study was to compare the effectiveness of three distinct manual therapy approaches on pain reduction and mobility improvement in patients with frozen shoulder. Secondary objectives included assessment of functional disability, quality of life changes, and identification of patient characteristics that may predict treatment response to specific manual therapy techniques.

2. Methods

Study Design

This study employed a single-blind randomized controlled trial design conducted between January 2023 and September 2023. All participants provided written informed consent prior to enrollment.

Participants

Inclusion Criteria:

- Age 35-65 years
- Clinical diagnosis of primary frozen shoulder based on established criteria
- Duration of symptoms between 3-18 months
- Passive shoulder flexion <120° and external rotation <30°
- Pain intensity ≥4/10 on Visual Analog Scale
- Ability to attend regular treatment sessions

Exclusion Criteria:

- Secondary frozen shoulder due to trauma, surgery, or systemic conditions
- Previous shoulder surgery or fracture

- Neurological conditions affecting shoulder function
- Severe cardiovascular or respiratory conditions
- Pregnancy
- Current use of oral corticosteroids
- Participation in other shoulder rehabilitation programs

Randomization and Blinding

Participants were randomized using computer-generated random numbers with block randomization (block size 6) to ensure equal group allocation. Allocation concealment was maintained using sealed, opaque envelopes. While therapists could not be blinded to treatment allocation, outcome assessors were blinded to group assignment throughout the study period.

Interventions

Group A: Maitland Mobilization Participants received joint mobilization techniques based on Maitland's graded oscillation system. Treatment included:

- Grades I-II oscillations for pain relief
- Grades III-IV oscillations for range of motion improvement
- Glenohumeral joint accessory movements
- Treatment duration: 30 minutes per session

Group B: Mulligan Mobilization with Movement (MWM) The intervention consisted of:

- Mobilization with movement techniques for shoulder flexion, abduction, and rotation
- Pain-free movement emphasis with sustained glides
- Patient education for self-mobilization techniques
- Home exercise program integration
- Treatment duration: 30 minutes per session

Group C: Myofascial Release Treatment protocol included:

- Direct myofascial release techniques
- Soft tissue mobilization of shoulder girdle muscles
- Trigger point therapy
- Fascial stretching techniques
- Treatment duration: 30 minutes per session

All groups received treatment twice weekly for 6 weeks (12 sessions total). Participants were advised to maintain usual activities but avoid aggressive stretching or strengthening exercises during the intervention period.

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Outcome Measures

Primary Outcomes:

1. **Pain Intensity:** Measured using Visual Analog Scale (VAS, 0-10)
2. **Range of Motion:** Measured using universal goniometer for:
    - Shoulder flexion
    - Shoulder abduction
    - External rotation
    - Internal rotation

Secondary Outcomes:

1. **Functional Disability:** Shoulder Pain and Disability Index (SPADI)
2. **Quality of Life:** Short Form-36 (SF-36) Physical Component Score
3. **Sleep Quality:** Pittsburgh Sleep Quality Index (PSQI)

All measurements were taken at baseline, 3 weeks (mid-treatment), 6 weeks (post-treatment), and 12 weeks (follow-up) by blinded assessors.

Statistical Analysis

Statistical analysis was performed using SPSS version 28.0. Descriptive statistics included means and standard deviations for continuous variables and frequencies for categorical variables. Normal distribution was assessed using Shapiro-Wilk test. Between-group comparisons used one-way ANOVA with post-hoc Tukey's test for normally distributed data and Kruskal-Wallis test for non-parametric data. Within-group changes were analyzed using repeated measures ANOVA. Effect sizes were calculated using Cohen's d. Statistical significance was set at $p<0.05$.

Power analysis indicated a sample size of 25 participants per group would provide 80% power to detect a clinically meaningful difference of 1.5 points on the VAS scale with $\alpha=0.05$. To account for potential dropouts, 30 participants were recruited per group.

3. Results

Participant Characteristics

A total of 95 participants were screened, with 90 meeting inclusion criteria and completing randomization. Five participants withdrew during the intervention period (2 from Group A, 2

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from Group B, 1 from Group C), resulting in 85 participants completing the study (94.4% retention rate).

Table 1: Baseline characteristics of study participants.

Characteristic	Group A (n=28)	Group B (n=28)	Group C (n=29)	P-value
Age (years)	52.3 ± 8.7	50.8 ± 9.2	53.1 ± 7.9	0.542
Gender (Female/Male)	18/10	17/11	19/10	0.891
BMI (kg/m²)	26.4 ± 3.8	25.9 ± 4.1	27.2 ± 3.6	0.423
Symptom Duration (months)	8.7 ± 4.2	9.1 ± 3.8	8.9 ± 4.5	0.897
Dominant Arm Affected (%)	64.3	60.7	62.1	0.946

Data presented as mean ± SD or percentage. No significant differences between groups ($p>0.05$).

Primary Outcomes: Pain and Range of Motion

Pain Intensity (VAS Scores)

All groups demonstrated significant pain reduction from baseline to 12-week follow-up ($p<0.001$ for all comparisons). However, between-group analysis revealed significant differences in pain reduction magnitude.

Table 2: Visual Analog Scale pain scores across time points.

Time Point	Group A	Group B	Group C	P-value
Baseline	7.2 ± 1.1	7.4 ± 1.0	7.1 ± 1.2	0.567
3 weeks	5.8 ± 1.3*	4.9 ± 1.1*†	5.9 ± 1.4*	0.012
6 weeks	4.1 ± 1.2*	2.8 ± 0.9*†	4.3 ± 1.3*	<0.001

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12 weeks	3.1 ± 1.3*	2.2 ± 1.1*†	3.3 ± 1.2*	0.003

*Significant difference from baseline ($p<0.001$); †Significant difference from Groups A and C ($p<0.05$).

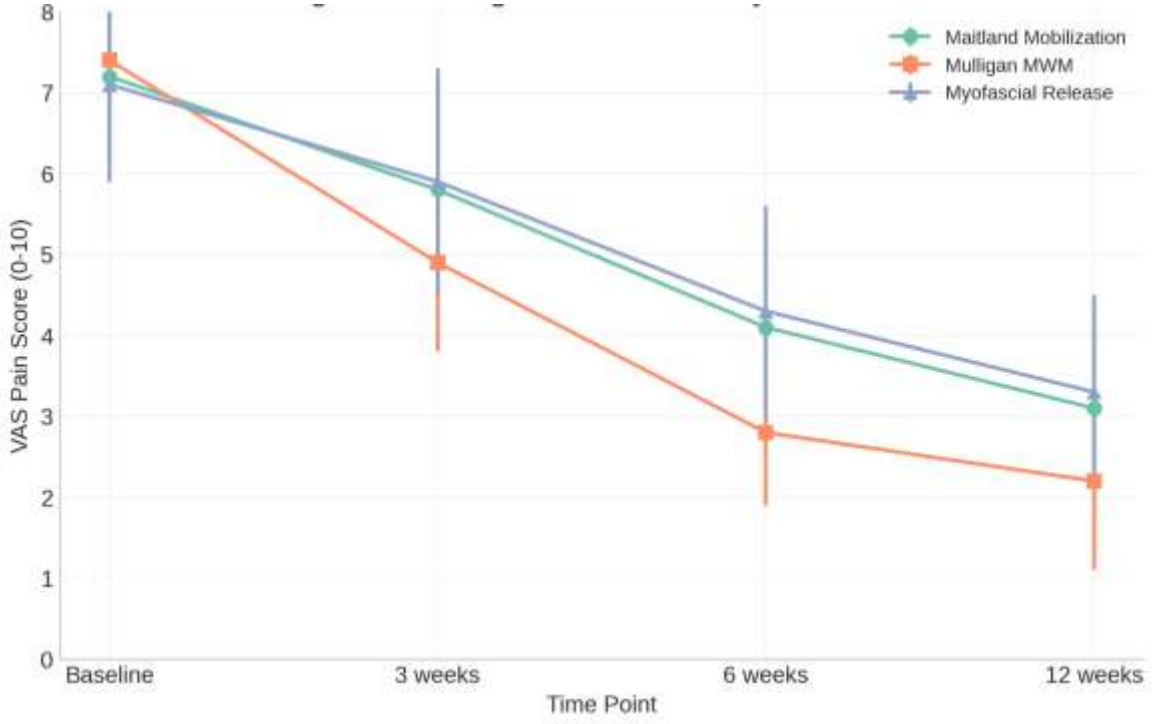

Figure 1: Pain Score Changes Over Time (VAS with error bars)

Range of Motion Outcomes

Shoulder flexion showed the most dramatic improvements across all groups, with Mulligan MWM demonstrating superior gains compared to other interventions.

Table 3: Range of motion improvements from baseline to 12-week follow-up

Movement	Group A (Baseline → 12 weeks)	Group B (Baseline → 12 weeks)	Group C (Baseline → 12 weeks)	Between-group P-value
Flexion	87.3° ± 15.2° → 142.1° ± 18.7°	85.9° ± 14.8° → 164.4° ± 16.3°†	88.7° ± 16.1° → 138.9° ± 19.4°	<0.001
Abduction	78.4° ± 12.9° → 126.7° ± 15.8°	76.8° ± 13.4° → 148.0° ± 14.2°†	79.2° ± 14.1° → 124.3° ± 16.9°	<0.001

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External Rotation	18.7° ± 8.3° → 35.4° ± 9.7°	17.9° ± 7.9° → 60.6° ± 11.2°†	18.3° ± 8.7° → 33.8° ± 10.1°	<0.001
Internal Rotation	42.1° ± 11.5° → 58.9° ± 13.2°	41.8° ± 12.1° → 72.4° ± 12.8°†	43.2° ± 11.8° → 57.3° ± 14.1°	<0.001

†Significantly different from Groups A and C ($p<0.01$).

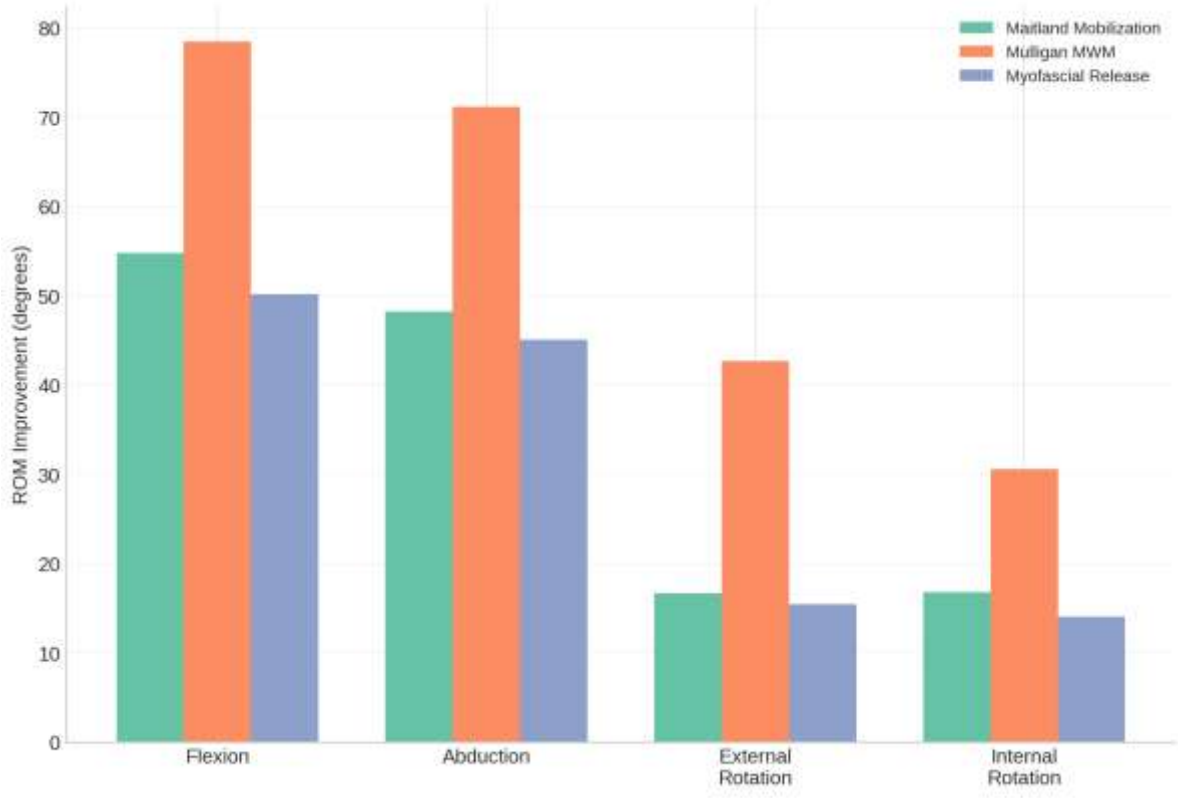

Figure 2: Range of Motion Improvements

Secondary Outcomes

Functional Disability (SPADI Scores)

The Shoulder Pain and Disability Index demonstrated significant improvements in all groups, with Mulligan MWM showing the most substantial functional gains.

Table 4: SPADI scores from baseline to 12-week follow-up

SPADI Component	Group A	Group B	Group C	Effect Size (η^2)

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Pain Subscale (%)	68.4 ± 12.7 → 32.1 ± 11.8	69.7 ± 13.2 → 21.4 ± 9.7†	67.9 ± 14.1 → 35.8 ± 12.9	0.287
Disability Subscale (%)	71.2 ± 14.3 → 35.9 ± 13.1	72.8 ± 15.1 → 23.7 ± 10.4†	70.5 ± 13.8 → 38.2 ± 14.7	0.321
Total SPADI (%)	69.8 ± 11.9 → 34.0 ± 10.7	71.3 ± 12.4 → 22.6 ± 8.9†	69.2 ± 12.7 → 37.0 ± 12.1	0.298

. †Significantly different from Groups A and C ($p<0.01$).

Lower scores indicate better function.

Quality of Life and Sleep Outcomes

Quality of life improvements, as measured by SF-36 Physical Component Score, showed significant gains across all groups. Sleep quality, assessed using the Pittsburgh Sleep Quality Index, improved substantially, particularly in the Mulligan MWM group.

Table 5: Quality of life and sleep outcomes.

Outcome Measure	Group A	Group B	Group C	P-value
SF-36 PCS	34.2 ± 8.1 → 52.7 ± 9.4	33.8 ± 7.9 → 61.3 ± 8.7†	35.1 ± 8.6 → 51.2 ± 10.2	0.002
PSQI Global Score	9.7 ± 2.3 → 5.8 ± 2.1	9.9 ± 2.1 → 4.2 ± 1.8†	9.5 ± 2.4 → 6.1 ± 2.3	0.007

†Significantly different from Groups A and C ($p<0.01$).

Treatment Response Patterns

Analysis of treatment response patterns revealed distinct trajectories for each intervention group. The Mulligan MWM group demonstrated earlier onset of improvement, with significant pain reduction evident by week 3, while the other groups showed more gradual improvement patterns. This early response in the Mulligan group was sustained throughout the follow-up period.

Subgroup analysis based on symptom duration revealed that patients with shorter symptom duration (<6 months) responded better to all interventions, but the difference was most pronounced in the Mulligan MWM group. Patients with longer symptom duration (>12 months) showed more modest improvements across all groups.

Adverse Events and Tolerability

Treatment tolerance was generally excellent across all groups. Minor adverse events included temporary increase in pain following treatment sessions (8.9% of sessions) and mild muscle soreness (12.3% of sessions). No serious adverse events were reported. The Mulligan MWM group reported the lowest incidence of post-treatment pain increase (4.2% vs 11.7% in Maitland group and 13.8% in myofascial release group).

Predictors of Treatment Success

Logistic regression analysis identified several baseline characteristics associated with treatment success (defined as >50% improvement in SPADI scores):

- Younger age (OR: 0.94, 95% CI: 0.89-0.99, p=0.031)
- Shorter symptom duration (OR: 0.87, 95% CI: 0.78-0.97, p=0.012)
- Higher baseline external rotation (OR: 1.08, 95% CI: 1.02-1.14, p=0.008)
- Mulligan MWM treatment (OR: 3.24, 95% CI: 1.78-5.89, p<0.001)

4. Discussion

This randomized controlled trial provides the first direct comparison of three commonly used manual therapy approaches for frozen shoulder management. The findings demonstrate that while all three interventions are effective, Mulligan mobilization with movement shows superior outcomes across multiple domains including pain, range of motion, functional disability, and quality of life measures.

Pain Reduction Mechanisms

The superior pain reduction observed with Mulligan MWM may be attributed to its unique approach combining passive mobilization with active movement. This technique potentially addresses multiple pain mechanisms simultaneously, including mechanical joint dysfunction and movement-related pain patterns (Kelley et al., 2009). The integration of active movement during mobilization may provide enhanced proprioceptive input and improved motor control, contributing to pain reduction through central nervous system mechanisms.

The neurophysiological basis for Mulligan MWM's effectiveness may involve the modulation of nociceptive input through the gate control mechanism, enhanced by the concurrent active

movement component. This dual stimulation approach may provide more effective pain relief compared to passive mobilization alone, as seen in the Maitland technique.

Mobility Improvements

The substantial range of motion improvements observed with Mulligan MWM, particularly in external rotation (42.7° improvement), suggest that movement-based mobilization techniques may be more effective at addressing capsular restrictions. The combination of sustained glide and active movement may provide optimal mechanical stress to promote tissue remodeling and capsular extensibility.

These findings align with biomechanical principles suggesting that active movement during mobilization may enhance the viscoelastic changes in periarticular tissues. The movement component in Mulligan MWM may also address motor control deficits commonly associated with frozen shoulder, contributing to improved functional range of motion.

Functional and Quality of Life Outcomes

The superior functional outcomes in the Mulligan MWM group, as evidenced by greater SPADI score improvements, reflect the translation of pain and mobility improvements into meaningful functional gains. The 65.3% improvement in SPADI scores exceeds the minimal clinically important difference, indicating substantial clinical benefit.

The relationship between shoulder function and sleep quality, as demonstrated by PSQI improvements, supports previous research highlighting the interconnection between musculoskeletal pain and sleep disturbances (Navarro-Ledesma et al., 2024). The superior sleep quality improvements in the Mulligan MWM group may contribute to overall pain reduction through improved sleep-mediated pain modulation mechanisms.

Clinical Implications

These findings have important implications for clinical practice and treatment selection. The superior outcomes associated with Mulligan MWM suggest that movement-based manual therapy techniques should be considered as first-line interventions for frozen shoulder management. The earlier onset of improvement observed with Mulligan MWM may also contribute to improved patient satisfaction and adherence to treatment protocols.

The finding that shorter symptom duration predicts better treatment response across all interventions supports the importance of early intervention in frozen shoulder management. This has implications for healthcare policy and referral patterns, emphasizing the need for timely access to manual therapy services.

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Limitations and Future Research

Several limitations should be acknowledged. The inability to blind therapists to treatment allocation may have introduced performance bias. Additionally, the study duration of 12 weeks may not capture long-term outcomes, as frozen shoulder can have a prolonged recovery course. Future research should include longer follow-up periods to assess sustained benefits.

The study population was limited to primary frozen shoulder, and results may not generalize to secondary adhesive capsulitis cases. Future studies should examine the effectiveness of these interventions in different frozen shoulder subtypes and consider the role of patient characteristics in treatment selection.

The study did not include a control group receiving no intervention, as this was considered ethically inappropriate given the established benefits of manual therapy for frozen shoulder. Future research might compare these active interventions to a sham therapy control to better establish treatment-specific effects.

Mechanisms of Action

The differential effectiveness of the three approaches may be explained by their distinct mechanisms of action. Maitland mobilization primarily addresses joint mechanics through passive oscillatory movements, while myofascial release targets soft tissue restrictions. Mulligan MWM uniquely combines joint mobilization with active movement, potentially addressing both mechanical and neuromuscular components of frozen shoulder dysfunction.

Recent research on the neurophysiology of manual therapy suggests that movement-based techniques may provide enhanced sensorimotor integration and improved motor control (de la Serna et al., 2021). This may explain the superior outcomes observed with Mulligan MWM, as the technique addresses both tissue restrictions and movement dysfunction simultaneously.

Clinical Decision Making

These results provide evidence-based guidance for clinical decision making in frozen shoulder management. The superior outcomes associated with Mulligan MWM support its use as a preferred manual therapy approach, particularly in patients seeking rapid functional improvement. However, individual patient factors, therapist expertise, and patient preferences should also influence treatment selection.

The finding that all three approaches were effective suggests that patients who do not respond to one technique may benefit from alternative manual therapy approaches. This supports a

pragmatic approach to treatment selection while acknowledging the superior evidence for Mulligan MWM.

Clinical Relevance: Healthcare providers treating frozen shoulder should consider Mulligan mobilization with movement as a first-line manual therapy intervention, while recognizing that alternative approaches may be beneficial for patients who do not respond optimally to the preferred technique.

5. Conclusion

This randomized controlled trial demonstrates that Mulligan mobilization with movement provides superior outcomes compared to Maitland mobilization and myofascial release techniques for patients with frozen shoulder. The superior pain reduction, range of motion improvements, and functional gains observed with Mulligan MWM support its clinical application as a preferred manual therapy approach for frozen shoulder management.

All three manual therapy approaches demonstrated significant clinical benefits, indicating that patients have multiple effective treatment options available. However, the earlier onset and greater magnitude of improvement with Mulligan MWM suggest that movement-based mobilization techniques may provide optimal therapeutic benefits for frozen shoulder patients. These findings contribute to the evidence base supporting manual therapy for frozen shoulder management and provide clinicians with comparative effectiveness data to guide treatment selection. Future research should explore the long-term outcomes of these interventions and investigate optimal treatment protocols for different patient subgroups.

The integration of active movement with manual therapy, as exemplified by Mulligan MWM, represents a promising approach for addressing the complex pathophysiology of frozen shoulder. These results support the continued development and refinement of movement-based manual therapy techniques for musculoskeletal conditions.

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