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EFFECTS OF TELE REHABILITATION WITH AND WITHOUT MULLIGAN TECHNIQUE ON PAIN, RANGE OF MOTION AND FUNCTIONAL DISABILITY IN PATIENTS OF SUBACROMIAL PAIN SYNDROME.

Original Research (ID: 1688)

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ABSTRACT

Background: Subacromial pain syndrome is a common cause of shoulder pain and activity limitation, frequently affecting shoulder mobility, daily function and quality of life. Conservative rehabilitation remains the preferred management approach, while telerehabilitation has increased access to supervised care through remote platforms. The Mulligan technique may provide additional benefit by promoting pain-free movement and improving joint mechanics. Evidence comparing telerehabilitation with and without self-Mulligan technique in subacromial pain syndrome remains limited.

Objective: To compare the effects of telerehabilitation combined with self-Mulligan technique versus telerehabilitation alone on pain intensity, shoulder range of motion and functional disability in patients with subacromial pain syndrome.

Methods: A randomized controlled trial was conducted at Pakistan Rugby Academy, Lahore, over nine months. A sample size of 58 was calculated, and 52 participants completed the study. Participants were recruited through purposive sampling and randomly allocated into two equal groups using a computer-generated sequence with allocation concealment. Group A received telerehabilitation with self-Mulligan technique, while Group B received telerehabilitation alone. Pain was assessed using the Visual Analogue Scale, shoulder range of motion using a digital goniometer, and functional disability using SPADI and QuickDASH. Data were analyzed using appropriate non-parametric tests, with $p < 0.05$ considered significant.

Results: The study included 52 participants, with 26 in each group. Baseline gender distribution ($p = 0.248$) and affected side ($p = 0.510$) were comparable. Mean age was 34.08 ± 9.299 years. Overall VAS decreased from 7.56 ± 1.195 to 4.58 ± 1.775. Flexion improved from 114.25 ± 17.266° to 143.44 ± 21.685°, extension from 29.00 ± 6.023° to 40.13 ± 7.170°, abduction from 106.38 ± 15.017° to 135.13 ± 20.026°, internal rotation from 44.71 ± 9.187° to 60.10 ± 11.328°, and external rotation from 42.40 ± 9.179° to 57.10 ± 11.323°. SPADI reduced from 74.10 ± 9.910 to 50.94 ± 13.068, and QuickDASH from 63.27 ± 8.997 to 43.10 ± 11.776. Group A showed significantly better post-intervention outcomes than Group B for all variables.

Conclusion: Telerehabilitation was effective in improving pain, shoulder mobility and functional disability in patients with subacromial pain syndrome. However, adding self-Mulligan technique produced superior clinical outcomes, supporting its use as an accessible and patient-centered rehabilitation strategy.

Keywords: Disability Evaluation; Exercise Therapy; Musculoskeletal Pain; Range of Motion, Articular; Shoulder Impingement Syndrome; Telerehabilitation; Visual Analog Scale.

INTRODUCTION

Subacromial pain syndrome is one of the most frequent causes of shoulder pain and functional limitation, particularly among adults who perform repetitive overhead activities or sustained upper-limb tasks. It represents a broad clinical condition involving painful structures within the subacromial space, including the rotator cuff tendons, subacromial bursa and long head of the biceps tendon. Although it has traditionally been described as subacromial impingement, current understanding suggests that the condition is not limited to simple mechanical compression. Instead, it develops through an interaction of tendon degeneration, altered shoulder biomechanics, inflammatory changes, muscle imbalance and impaired neuromuscular control. Clinically, patients commonly present with pain during arm elevation, reduced shoulder range of motion, difficulty in overhead movements and progressive limitation in daily, occupational and recreational activities (1). The burden of subacromial pain syndrome extends beyond local shoulder symptoms because persistent pain often interferes with sleep, work productivity, self-care, household tasks and overall quality of life. In many patients, restricted movement and fear of pain lead to reduced shoulder use, which may further promote stiffness, muscle weakness and functional disability. These factors create a cycle in which pain limits movement, limited movement worsens physical capacity and reduced capacity increases disability. Therefore, effective rehabilitation should not only aim to reduce pain but should also restore movement, improve shoulder mechanics and enable patients to return safely to meaningful activities (2).

Conservative physiotherapy remains the preferred first-line management for subacromial pain syndrome because it is non-invasive, cost-effective and clinically relevant for improving pain and shoulder function. Common rehabilitation strategies include therapeutic exercises, stretching, strengthening of the rotator cuff and scapular stabilizers, postural correction, patient education and activity modification. However, exercise-based rehabilitation alone may not fully address the joint-related mechanical restrictions and painful movement patterns seen in some patients. This has encouraged the integration of manual therapy techniques into shoulder rehabilitation, particularly methods that can improve pain-free movement, joint mobility and functional performance (3-5). The Mulligan concept, especially Mobilization with Movement, has gained considerable attention in the management of shoulder disorders. This technique involves the application of a sustained accessory glide while the patient actively performs the restricted or painful movement. The clinical purpose is to restore pain-free movement by correcting minor positional faults, improving joint mechanics and stimulating neurophysiological pain-modulating mechanisms. In patients with subacromial pain syndrome, Mulligan mobilization may help improve glenohumeral movement, reduce pain during elevation and enhance functional shoulder use. Previous studies have reported that Mulligan techniques can improve pain intensity, range of motion and disability outcomes in shoulder impingement and related rotator cuff conditions, particularly when combined with therapeutic exercise (6-8).

At the same time, telerehabilitation has emerged as an important development in modern physiotherapy practice. It allows rehabilitation services to be delivered through digital communication platforms, enabling patients to receive guidance, monitoring and exercise progression without attending frequent in-person sessions. This approach is especially valuable for individuals who face barriers such as distance, time limitations, transport difficulty, cost, work commitments or limited access to specialized physiotherapy services. Evidence suggests that structured telerehabilitation can improve pain, shoulder range of motion and functional outcomes in non-surgical shoulder disorders when the program is well supervised and patient engagement is maintained (2, 9, 10). Despite its advantages, telerehabilitation may have certain limitations when used as a standalone approach. Remote exercise programs can improve strength, flexibility and self-management, but they may not fully replicate the immediate mechanical and pain-relieving effects of hands-on manual therapy. Conversely, Mulligan mobilization is traditionally delivered in face-to-face settings and requires therapist guidance, but modified self-mobilization techniques may be taught and supervised remotely. This creates a practical opportunity to combine the accessibility of telerehabilitation with the therapeutic principles of Mulligan mobilization. Such an approach may help patients perform guided self-assisted mobilization and corrective exercises under virtual supervision, potentially improving adherence, confidence and clinical outcomes (8, 11).

The rationale for combining telerehabilitation with Mulligan technique lies in the need to address both functional and biomechanical components of subacromial pain syndrome. Telerehabilitation can support regular exercise performance, education, activity modification and continuity of care, while Mulligan-based mobilization may provide additional benefits through pain reduction, improved arthrokinematics and enhanced movement confidence. This combined model may be particularly meaningful in healthcare systems where access to repeated face-to-face physiotherapy is limited. It also supports a patient-centered approach by encouraging active participation, self-management and regular therapist-patient interaction through digital platforms (9, 12). Although separate evidence supports the use of telerehabilitation and Mulligan mobilization in shoulder rehabilitation, limited research has directly compared telerehabilitation with Mulligan technique against telerehabilitation alone in patients with subacromial pain syndrome. This gap is clinically important because it remains unclear whether adding Mulligan-based mobilization to a remote rehabilitation program provides superior improvements in pain, shoulder range of motion and functional disability. Addressing this question may help physiotherapists design more effective, accessible and evidence-based treatment protocols for patients who cannot attend regular in-person rehabilitation

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sessions (13, 14). Therefore, the present study is designed to compare the effects of telerehabilitation with and without Mulligan technique on pain, range of motion and functional disability in patients with subacromial pain syndrome. It is hypothesized that telerehabilitation combined with Mulligan mobilization will produce greater improvement in pain intensity, shoulder mobility and functional ability than telerehabilitation alone. The objective of this study is to determine whether the addition of Mulligan technique provides an added therapeutic benefit within a telerehabilitation-based rehabilitation model for patients with subacromial pain syndrome (15-17).

METHODS

This study was conducted as a randomized controlled trial to compare the effects of telerehabilitation with and without Mulligan technique on pain, shoulder range of motion and functional disability in patients with subacromial pain syndrome. The trial was registered under clinical trial registration number NCT07610954. The study was carried out at Ali Fatima Hospital, Lahore, and Pakistan Rugby Academy, Lahore, Pakistan, over a period of nine months after approval of the research synopsis. The methodological details were developed from the provided study protocol and CONSORT flow diagram . The sample size was calculated for comparison of two means using a 95% confidence level, 80% power, an expected mean difference of 0.9 and a pooled standard deviation of approximately 1.15, based on the findings reported by Deniz Kıvrak et al. (18). The calculated minimum sample size was 26 participants in each group. According to the CONSORT flow, 58 participants were assessed for eligibility, of whom four were excluded because two did not meet the inclusion criteria and two declined participation. A total of 54 eligible participants were randomized, with 27 participants allocated to Group A and 27 participants allocated to Group B. During follow-up, one participant from each group was lost, and final analysis was performed on 52 participants, with 26 participants analyzed in each group.

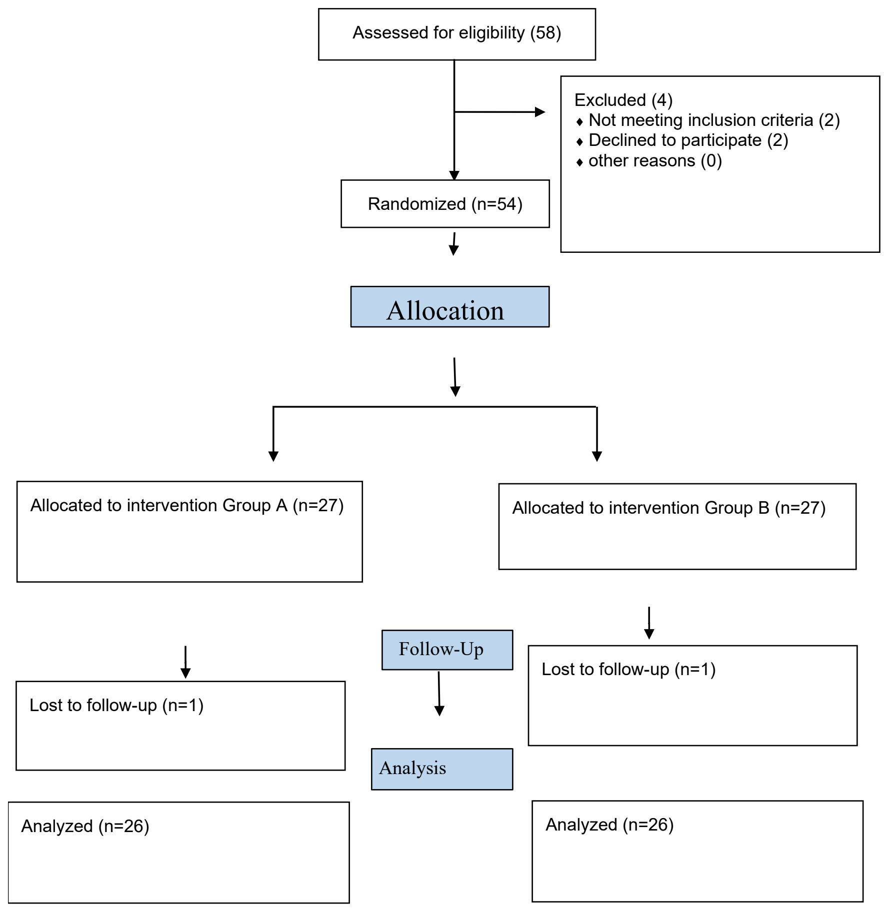
Participants were recruited through non-probability purposive sampling after clinical screening for subacromial pain syndrome. After eligibility confirmation and baseline assessment, participants were randomly allocated into two equal groups through a computer-generated randomization sequence. Allocation concealment was maintained using sealed opaque envelopes that were opened only at the time of intervention assignment. This process was used to reduce selection bias and ensure that group allocation was not influenced by the investigators or participants. The study included individuals aged 25–55 years who had been clinically diagnosed with subacromial pain syndrome or subacromial impingement through orthopedic assessment, had symptoms for at least three months, reported pain of 4 or more on the Visual Analogue Scale, and demonstrated limited active shoulder range of motion in flexion, abduction or external rotation compared with the opposite side (3, 4, 19, 20). Participants were also required to be willing and able to attend telerehabilitation sessions and follow home-based instructions (15). Individuals were excluded if they had a previous shoulder fracture, dislocation or surgery, neurological disorders affecting shoulder function such as cervical radiculopathy, rheumatologic or systemic inflammatory disease, severe adhesive capsulitis, full-thickness rotator cuff tear diagnosed on imaging, ongoing physiotherapy for the same condition, or inability to use the required telerehabilitation technology (21-24).

The independent variable was the type of rehabilitation provided. Group A received telerehabilitation combined with Mulligan mobilization principles, while Group B received telerehabilitation without Mulligan technique. Both groups participated in three supervised online rehabilitation sessions per week for six weeks. The experimental group performed shoulder exercises integrated with Mulligan Mobilization with Movement principles under virtual therapist supervision, whereas the control group followed a standard tele-guided shoulder rehabilitation program without mobilization. The telerehabilitation sessions were delivered through a secure digital platform, and weekly online consultations were conducted to monitor adherence, correct exercise performance, address difficulties and ensure participant safety. Data were collected using a structured data collection proforma that recorded demographic characteristics, clinical details, baseline values and follow-up outcomes. Pain intensity was assessed using the Visual Analogue Scale, shoulder range of motion was measured with a digital goniometer, and functional disability was evaluated using the Shoulder Pain and Disability Index and Quick Disabilities of the Arm, Shoulder and Hand questionnaire. Outcome measurements were recorded at baseline, after six weeks of intervention and at week twelve to assess the persistence of treatment effects. Pain reduction was considered the primary outcome, while shoulder range of motion and functional disability were treated as secondary outcomes.

The study used standard physiotherapy and telerehabilitation equipment, including a digital goniometer, Visual Analogue Scale, Shoulder Pain and Disability Index questionnaire, QuickDASH questionnaire, elastic resistance bands, shoulder pulleys, light dumbbells and a secure online rehabilitation platform. All assessments were performed by a trained assessor, and outcome recording was planned to be blinded where possible to minimize measurement bias. Ethical approval was obtained from the Ethical Review Committee of Green International University, Lahore, Pakistan, before the start of data collection. The study followed the ethical principles of the Declaration of Helsinki for research involving human participants. Written informed consent was obtained from all participants after explaining the purpose of the study, intervention procedures, expected duration, possible risks, expected benefits and right to withdraw. Participation was voluntary, and participants were informed that refusal or withdrawal would not affect their routine medical care.

Participant confidentiality was maintained throughout the study. Each participant was assigned a unique identification code, and personal information was not used in analysis, reporting or publication. Electronic data were stored in password-protected files, while any hard copies were kept in secure storage accessible only to the research team. The interventions were non-invasive and were expected to carry minimal risk. Mild temporary soreness or fatigue after exercise was considered possible and was managed through appropriate exercise progression, warm-up, cool-down and therapist supervision. Data were entered and analyzed using SPSS version 26.0. Descriptive statistics were used to summarize demographic and baseline clinical characteristics. Continuous variables, including age, pain score, range of motion and functional disability scores, were presented as mean and standard deviation, while categorical variables such as gender and affected side were presented as frequencies and percentages. Data normality was assessed using the Shapiro–Wilk test along with visual inspection of histograms and Q-Q plots. Within-group comparisons were performed using the paired sample t-test for normally distributed data and the Wilcoxon signed-rank test for non-normally distributed data. Between-group comparisons were analyzed using the independent sample t-test or Mann–Whitney U test according to data distribution. For outcomes measured across three time points, repeated-measures ANOVA was used to assess time, group and time-by-group effects, with Greenhouse–Geisser correction applied where required. Pearson or Spearman correlation was used to assess the relationship between pain reduction and functional improvement, and Cohen's d was calculated to estimate effect size. The level of significance was set at $p < 0.05$, and 95% confidence intervals were reported for key outcomes.

CONSORT DIAGRAM



RESULTS

The study included 52 participants, with 26 participants analyzed in Group A and 26 participants analyzed in Group B. Group A received telerehabilitation with self-Mulligan technique, while Group B received telerehabilitation alone. The mean age of the participants was 34.08 ± 9.29 years. The overall sample included 34 males and 18 females. In Group A, 15 participants were male and 11 were female, while in Group B, 19 participants were male and 7 were female. The gender distribution did not differ significantly between the groups ($p = 0.248$). Right shoulder involvement was more common overall, affecting 40 participants, while 12 participants had left shoulder involvement. In Group A, the right shoulder was affected in 21 participants and the left shoulder in 5 participants. In Group B, the right shoulder was affected in 19 participants and the left shoulder in 7 participants. The distribution of affected shoulder side was also comparable between the groups ($p = 0.510$). These findings showed that both groups were similar at baseline for the recorded demographic and clinical side-related variables . Pain intensity showed a reduction after intervention. The mean VAS score decreased from 7.56 ± 1.19 before intervention to 4.58 ± 1.77 after intervention. Shoulder range of motion also improved across all measured movements. Mean shoulder flexion increased from 114.25 ± 17.26° to 143.44 ± 21.68°, extension increased from 29.00 ± 6.02° to 40.13 ± 7.17°, and abduction increased from 106.38 ± 15.01° to 135.13 ± 20.02°. Internal rotation improved from 44.71 ± 9.18° to 60.10 ± 11.32°, while external rotation improved from 42.40 ± 9.17° to 57.10 ± 11.32°. Functional disability scores also decreased after treatment. The mean SPADI score reduced from 74.10 ± 9.91 to 50.94 ± 13.06, and the mean QuickDASH score reduced from 63.27 ± 8.99 to 43.10 ± 11.77.

The Shapiro–Wilk test showed that the pre-intervention variables were not normally distributed, as all p-values were less than 0.05. VAS, flexion, extension, abduction, internal rotation, external rotation, SPADI and QuickDASH all demonstrated non-normal distribution at baseline. Therefore, non-parametric statistical testing was applied for further analysis. Within-group comparison using the Wilcoxon signed-rank test showed statistically significant pre- to post-intervention changes in all outcome variables. Pain intensity significantly decreased after intervention (Z = -6.314, p < 0.01). Shoulder flexion significantly improved (Z = -6.276, p < 0.01), extension increased significantly (Z = -6.282, p < 0.01), and abduction also showed significant improvement (Z = -6.276, p < 0.01). Internal rotation improved significantly (Z = -6.279, p < 0.01), and external rotation also increased significantly after intervention (Z = -6.278, p < 0.01). Functional disability decreased significantly, with improvement in SPADI score (Z = -6.278, p < 0.01) and QuickDASH score (Z = -6.277, p < 0.01).

Between-group analysis using the Mann–Whitney U test showed no statistically significant difference between Group A and Group B at baseline. Baseline VAS score was comparable between the groups (p = 0.940). Baseline shoulder range of motion was also similar for flexion (p = 0.876), extension (p = 0.927), abduction (p = 0.194), internal rotation (p = 0.583), and external rotation (p = 0.640). Baseline functional disability was comparable between the groups for SPADI (p = 0.245) and QuickDASH (p = 0.551). After intervention, Group A showed significantly better post-treatment outcomes than Group B across the measured clinical variables. Post-intervention pain intensity was significantly lower in Group A compared with Group B (Z = -4.027, p < 0.01). Post-intervention shoulder range of motion was significantly greater in Group A for flexion (Z = -3.699, p < 0.01), extension (Z = -3.688, p < 0.01), abduction (Z = -4.650, p = 0.01), internal rotation (Z = -3.407, p < 0.01), and external rotation (Z = -4.167, p < 0.01). Functional disability scores were also significantly lower in Group A after intervention, with better post-treatment SPADI and QuickDASH scores compared with Group B (p < 0.01). Overall, telerehabilitation combined with self-Mulligan technique produced greater improvement in pain, shoulder range of motion and functional disability than telerehabilitation alone.

Table 1. Baseline Demographic and Clinical Characteristics of Participants

Variable	Group A n = 26	Group B n = 26	Total N = 52	p-value
Age, years	Not provided group-wise	Not provided group-wise	34.08 ± 9.29	—
Male	15 (57.7%)	19 (73.1%)	34 (65.4%)	0.248
Female	11 (42.3%)	7 (26.9%)	18 (34.6%)	0.248
Right shoulder affected	21 (80.8%)	19 (73.1%)	40 (76.9%)	0.510
Left shoulder affected	5 (19.2%)	7 (26.9%)	12 (23.1%)	0.510

Abbreviations: Group A = telerehabilitation with self-Mulligan technique; Group B = telerehabilitation alone.

Table 2. Overall Pre- and Post-intervention Changes in Pain, Range of Motion and Functional Disability

Outcome Variable	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	Mean Change	Percentage Change	Z-value	p-value
VAS score	7.56 ± 1.19	4.58 ± 1.77	-2.98	39.4% reduction	-6.314	<0.01
Shoulder flexion	114.25 ± 17.26°	143.44 ± 21.68°	+29.19°	25.5% increase	-6.276	<0.01
Shoulder extension	29.00 ± 6.02°	40.13 ± 7.17°	+11.13°	38.4% increase	-6.282	<0.01
Shoulder abduction	106.38 ± 15.01°	135.13 ± 20.02°	+28.75°	27.0% increase	-6.276	<0.01
Internal rotation	44.71 ± 9.18°	60.10 ± 11.32°	+15.39°	34.4% increase	-6.279	<0.01
External rotation	42.40 ± 9.17°	57.10 ± 11.32°	+14.70°	34.7% increase	-6.278	<0.01
SPADI score	74.10 ± 9.91	50.94 ± 13.06	-23.16	31.3% reduction	-6.278	<0.01
QuickDASH score	63.27 ± 8.99	43.10 ± 11.77	-20.17	31.9% reduction	-6.277	<0.01

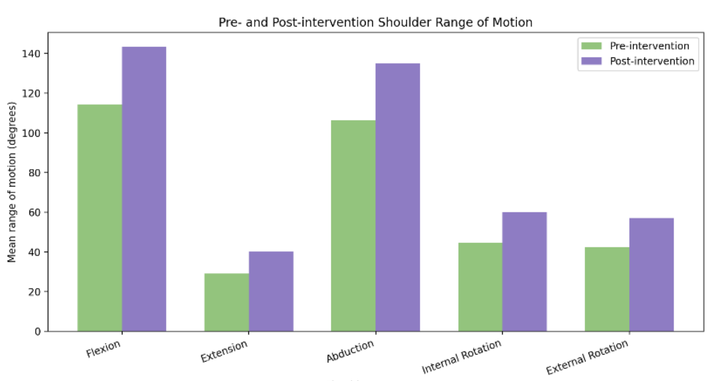
Abbreviations: VAS = Visual Analogue Scale; SPADI = Shoulder Pain and Disability Index; QuickDASH = Quick Disabilities of the Arm, Shoulder and Hand.

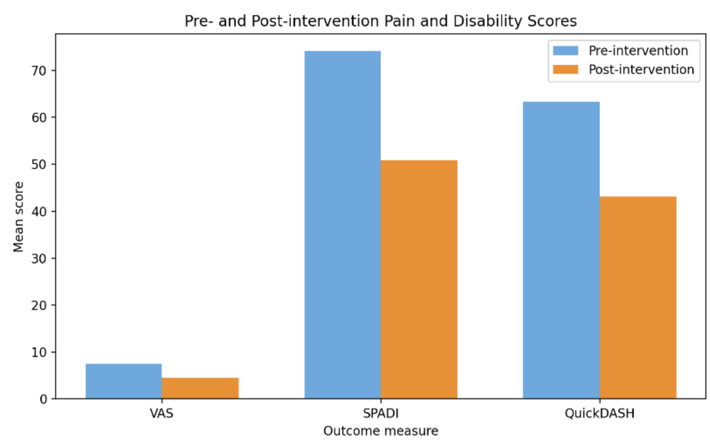
Test applied: Wilcoxon signed-rank test.

Table 3. Between-group Comparison of Pain, Range of Motion and Functional Disability

Outcome Variable	Time Point	Group A Mean Rank	Group B Mean Rank	Z-value	p-value
VAS score	Baseline	26.35	26.65	-0.076	0.940
VAS score	Post-intervention	18.17	34.83	-4.027	<0.01
Shoulder flexion	Baseline	26.17	26.83	-0.156	0.876
Shoulder flexion	Post-intervention	34.27	18.73	-3.699	<0.01
Shoulder extension	Baseline	26.69	26.31	-0.092	0.927
Shoulder extension	Post-intervention	34.23	18.77	-3.688	<0.01
Shoulder abduction	Baseline	29.23	23.77	-1.300	0.194
Shoulder abduction	Post-intervention	36.27	16.73	-4.650	0.010
Internal rotation	Baseline	27.65	25.35	-0.549	0.583
Internal rotation	Post-intervention	33.65	19.35	-3.407	<0.01
External rotation	Baseline	27.48	25.52	-0.467	0.640
External rotation	Post-intervention	35.25	17.75	-4.167	<0.01
SPADI score	Baseline	28.17	24.83	-0.797	0.245
SPADI score	Post-intervention	17.98	35.02	-0.761	<0.01
QuickDASH score	Baseline	27.75	25.25	-4.058	0.551
QuickDASH score	Post-intervention	17.10	35.90	-4.480	<0.01

Test applied: Mann–Whitney U test.





DISCUSSION

The present study showed that telerehabilitation with self-Mulligan technique produced greater improvement in pain, shoulder range of motion and functional disability than telerehabilitation alone in patients with subacromial pain syndrome. Both groups improved significantly after intervention, which indicated that structured remote rehabilitation had a positive effect on shoulder recovery. However, the group receiving self-Mulligan technique demonstrated superior post-intervention outcomes across pain, flexion, extension, abduction, internal rotation, external rotation, SPADI and QuickDASH scores. Pain intensity decreased from 7.56 ± 1.19 to 4.58 ± 1.77, while SPADI reduced from 74.10 ± 9.91 to 50.94 ± 13.06 and QuickDASH decreased from 63.27 ± 8.99 to 43.10 ± 11.77. Shoulder mobility also improved meaningfully, with flexion increasing from 114.25 ± 17.26° to 143.44 ± 21.68°, abduction from 106.38 ± 15.01° to 135.13 ± 20.02°, internal rotation from 44.71 ± 9.18° to 60.10 ± 11.32°, and external rotation from 42.40 ± 9.17° to 57.10 ± 11.32°.

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These findings suggested that the addition of self-Mulligan technique provided an added therapeutic benefit beyond exercise-based telerehabilitation alone (25). The greater reduction in pain observed in the self-Mulligan group may be explained through both biomechanical and neurophysiological mechanisms. Subacromial pain syndrome is commonly associated with altered glenohumeral movement, reduced subacromial space, rotator cuff overload, scapular dyskinesis and pain-related movement avoidance. Mulligan Mobilization with Movement is based on the concept of applying a corrective accessory glide during active movement, which may help restore pain-free arthrokinematics and reduce abnormal mechanical stress around the shoulder complex. Repeated pain-free movement during self-application may also stimulate mechanoreceptors, reduce nociceptive input and improve confidence in shoulder use. When this approach was combined with supervised telerehabilitation exercises, the intervention appeared to address both joint-related movement restriction and muscle-based functional impairment (26, 22).

The improvement in shoulder range of motion was clinically relevant because limitation of arm elevation and rotation is a common source of disability in subacromial pain syndrome. Greater gains in flexion, abduction and rotation in the self-Mulligan group indicated that corrected movement practice may have helped restore smoother glenohumeral motion. Exercise alone can improve strength, flexibility and endurance, but it may not always correct painful movement patterns or minor positional faults. The combined intervention likely allowed patients to perform therapeutic exercises with less pain and better movement quality, which may have contributed to greater functional recovery over time (27-29). The reduction in SPADI and QuickDASH scores further supported the functional value of the combined approach. Disability in subacromial pain syndrome is closely linked with pain, weakness, restricted movement and reduced ability to perform overhead or daily tasks. Patients who experienced earlier pain relief may have been able to participate more actively in rehabilitation and daily activities. This relationship between pain reduction and functional restoration has been emphasized in previous rehabilitation research, where improvement in movement confidence and task performance was considered essential for meaningful recovery rather than pain relief alone (30-34).

The findings were generally consistent with previous studies reporting that Mulligan Mobilization with Movement, when added to exercise therapy, produced greater improvement in pain, shoulder mobility and function than exercise alone. Previous randomized trials and systematic evidence have suggested that manual therapy combined with active rehabilitation can enhance short-term outcomes in patients with shoulder impingement or rotator cuff-related shoulder pain. Similar improvements in SPADI and range of motion have also been reported when Mulligan-based techniques were incorporated into shoulder rehabilitation programs. The present findings extended this evidence by showing that a self-applied or remotely supervised Mulligan approach could also be beneficial within a telerehabilitation model (26). The results also supported the growing role of telerehabilitation in musculoskeletal physiotherapy. Significant within-group improvement in the telerehabilitation-only group showed that remote exercise supervision, education and progression were able to improve pain and function. This finding was aligned with previous evidence showing that telerehabilitation can provide meaningful outcomes for musculoskeletal conditions when programs are structured, monitored and supported by regular therapist communication. Telerehabilitation may be especially useful for patients with limited access to in-person physiotherapy, transport difficulty, work-related barriers or geographical restrictions (27).

However, the superiority of Mulligan-based rehabilitation should be interpreted carefully. Some previous studies have reported that manual therapy may provide faster or short-term pain relief, while long-term differences compared with exercise therapy alone may become smaller over time. This variation may be related to differences in treatment duration, severity of shoulder pathology, therapist expertise, patient adherence, follow-up period and whether the mobilization was therapist-applied or self-applied. Therefore, the present findings supported the short-term added value of self-Mulligan technique within telerehabilitation, but they did not establish long-term superiority without extended follow-up (28). The active nature of self-Mulligan technique may have contributed to better outcomes in this study. In remote rehabilitation, patients are not passive recipients of treatment; they must understand, perform and repeat the prescribed movements correctly. This active involvement may improve self-efficacy, proprioception, motor learning and adherence. Repeated practice of corrected shoulder movement under virtual supervision may help reduce compensatory patterns and reinforce more efficient scapulohumeral rhythm. This patient-centered element is important because modern rehabilitation increasingly emphasizes self-management, education and active participation rather than dependence on passive treatment alone (29, 35).

A methodological strength of the study was the randomized controlled design with comparable baseline characteristics between groups. No significant baseline differences were reported for gender, affected shoulder side, pre-intervention pain, range of motion or disability outcomes, which strengthened the internal validity of post-intervention comparisons. The use of validated clinical tools, including VAS, digital goniometry, SPADI and QuickDASH, also supported standardized measurement of pain, mobility and function. The application of non-parametric tests was appropriate because Shapiro–Wilk testing showed non-normal distribution of the data. This strengthened the statistical handling of the findings and reduced the risk of inappropriate parametric analysis (30, 35). The study had some limitations that should be considered while interpreting the results. The sample size was relatively small, with 52 participants analyzed, which may limit generalizability to a broader population. The study was conducted in limited clinical settings, so the findings may not fully represent patients from different regions, age groups, occupations or levels of disease severity. The intervention duration was also relatively short, and long-term follow-up was not adequately reported, which limited the ability to determine whether improvements in pain, range of motion and disability were sustained over time. In addition, telerehabilitation depends on internet access, device quality, digital literacy and the patient's ability to correctly perform exercises at home. These factors may have influenced treatment consistency and adherence (36).

Another limitation was the potential variability in self-Mulligan application. Although remote supervision was provided, the therapist's ability to physically correct technique was limited compared with face-to-face sessions. The accuracy of mobilization direction, amount of force, exercise posture and repetition quality may have varied among participants. Confounding factors such as occupation, activity level, posture, sleep disturbance, psychosocial status, fear avoidance and severity of subacromial pathology were not deeply analyzed. These factors may influence pain perception, adherence and functional recovery and should be included in future studies to provide a more complete understanding of treatment response. The findings had practical implications for physiotherapy practice. Telerehabilitation with self-Mulligan technique may provide a useful hybrid model for patients who cannot attend frequent in-person sessions but still require guided movement correction and structured shoulder rehabilitation. This model may reduce barriers to care, support patient independence and improve continuity of rehabilitation. However, clinical implementation should include careful patient selection, clear instruction, video demonstration, safety monitoring and regular feedback to ensure correct technique and reduce the risk of ineffective self-application (37).

Future research should include larger multicenter randomized trials with longer follow-up periods to assess the durability of treatment effects. Group-wise change scores, effect sizes and minimally clinically important differences should be reported to strengthen clinical interpretation. Future studies should also monitor adherence through digital logs, wearable sensors or app-based tracking. Objective measures such as shoulder strength, scapular kinematics, dynamometry, motion analysis and patient satisfaction may further clarify how telerehabilitation with self-Mulligan technique affects recovery. Comparative studies involving other manual therapy methods, supervised in-person therapy and cost-effectiveness analysis would also help determine the most practical and efficient rehabilitation model for subacromial pain syndrome. Overall, the present study suggested that telerehabilitation was beneficial for patients with subacromial pain syndrome, while the addition of self-Mulligan technique produced greater improvements in pain, shoulder mobility and functional disability. The combined approach appeared to address mechanical, neuromuscular and functional components of the condition more effectively than telerehabilitation alone. These results supported the integration of manual therapy principles into remote rehabilitation programs, although larger and longer-term studies are needed before broad clinical recommendations can be made.

CONCLUSION

The present study concluded that telerehabilitation was an effective approach for reducing pain, improving shoulder mobility and minimizing functional disability in patients with subacromial pain syndrome. However, the addition of self-Mulligan technique provided greater clinical benefit than telerehabilitation alone, suggesting that combining guided remote rehabilitation with active self-mobilization can better address both movement restriction and functional limitation. These findings support the use of a structured, patient-centered telerehabilitation model with self-Mulligan technique as a practical and accessible rehabilitation strategy for improving recovery and daily functional performance in patients with subacromial pain syndrome.

AUTHOR CONTRIBUTION

Author	Contribution
Dr. Bisma Saleem	Conceptualization, Methodology, Formal Analysis, Writing - Original Draft, Validation, Supervision
Dr. Komal Tehzeeb	Methodology, Investigation, Data Curation, Writing - Review & Editing
Prof Dr Fahad Tanveer	Investigation, Data Curation, Formal Analysis, Software
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