

Article

Effects of Mulligan's Mobilization with and Without Clamshell Exercise on Pain, Disability, and Quality of Life in Patients with Sacroiliac Joint Dysfunction

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ABSTRACT

Background: Sacroiliac joint dysfunction (SIJD) is a prevalent yet underdiagnosed contributor to low back pain, especially among women. Despite the growing use of manual therapies like Mulligan Mobilization, the additive effect of targeted muscle strengthening such as clamshell exercises remains underexplored in anterior innominate dysfunction.

Objective: To compare the effects of Mulligan Mobilization with and without clamshell exercises on pain, disability, and quality of life in patients with anterior innominate sacroiliac joint dysfunction, hypothesizing superior outcomes with the combined intervention. **Methods:** A single-blinded randomized controlled trial was conducted involving 38 participants aged 20–50 years diagnosed with hypomobile anterior innominate SIJD, recruited from Fatima Memorial Hospital and Boston Physiotherapy and Wellness Clinic. Inclusion required positive Leslett's criteria and moderate NPRS and ODI scores. Participants were randomized into two equal groups (n = 19), receiving either Mulligan Mobilization alone or combined with clamshell exercises, for 18 sessions over six weeks. Outcomes were assessed at baseline and post-intervention using the Numeric Pain Rating Scale (NPRS), Oswestry Disability Index (ODI), and EQ-5D for quality of life. Ethical approval was granted by Riphah International University, following the Declaration of Helsinki. Statistical analyses, including paired and independent t-tests, were conducted using SPSS v25. **Results:** Both groups showed statistically significant improvements (p < 0.001) across all outcomes, with Group B (Mulligan + clamshell) demonstrating greater reductions in NPRS (mean difference = 4.68 vs. 2.47), ODI (18.47 vs. 10.47), and superior improvement in EQ-5D scores (mean difference = 20.31 vs. 17.89). These results were both statistically and clinically meaningful. **Conclusion:** Mulligan Mobilization significantly reduces pain and disability in anterior innominate SIJD; however, the addition of clamshell exercises enhances these effects, offering a clinically relevant, cost-effective intervention for improving function and quality of life. These findings support integrating targeted gluteal strengthening with manual therapy in routine rehabilitation.

Keywords: Sacroiliac Joint Dysfunction, Anterior Innominate Dysfunction, Mulligan Mobilization, Clamshell Exercise, Low Back Pain, Manual Therapy, Physical Therapy Modalities

INTRODUCTION

Sacroiliac joint dysfunction (SIJD) is a prevalent but frequently misdiagnosed condition that significantly contributes to low back pain, especially among the female population. The sacroiliac joint (SIJ), a diarthrodial synovial joint, serves as the key connection between the spine and the pelvis, effectively transmitting forces between the upper body and lower extremities(1). With its capacity to bear up to 60% of body weight, the SIJ is vulnerable to

dysfunction, primarily due to hypomobility or hypermobility induced by trauma, repetitive stress, ligamentous laxity, or pregnancy-related hormonal changes (2, 3). The joint's stability relies heavily on form and force closure mechanisms provided by bone congruency and soft tissue structures like ligaments and stabilizing muscles, notably the gluteus maximus, piriformis, and hamstrings(4, 5).

Epidemiological studies have reported that 15–30% of patients with idiopathic low back pain suffer from SIJD (6). The dysfunction often presents with dull, aching pain radiating to the groin or buttock, exacerbated by transitional movements, prolonged postures, and weight-bearing activities (7, 8). Diagnostic challenges persist due to overlapping symptoms with other musculoskeletal disorders. However, the use of standardized provocation tests, such as those defined in Leslett's criteria, improves diagnostic accuracy when at least three of five tests are positive (13, 14). Among the various subtypes of SIJD, anterior innominate dysfunction is characterized by an anterior and inferior shift of the ASIS, with a compensatory posterior sacral motion, leading to altered pelvic mechanics and asymmetrical gait patterns (15, 16, 17). This dysfunction often results in inhibited gluteus maximus activation and tight hip flexors, compromising postural alignment and dynamic stability (17).

In clinical practice, manual therapy and therapeutic exercises remain cornerstones in managing SIJD. Mulligan Mobilization with Movement (MWM) is a widely used technique that corrects joint positional faults by applying a sustained accessory glide combined with patient-initiated physiological movements, ideally resulting in pain-free mobility (21, 22). It has shown immediate and long-term benefits in reducing pain and improving joint function. Parallely, clamshell exercises are emphasized for strengthening the gluteus medius and maximus, particularly beneficial in stabilizing the SIJ and preventing recurrent dysfunction (18, 19). Despite the known benefits of both interventions independently, limited research exists on their combined effect, particularly on anterior innominate dysfunction. This presents a crucial gap in the literature, as synergistic integration of mobilization and targeted muscle strengthening may provide a more comprehensive rehabilitation strategy.

The current study aims to bridge this gap by examining whether combining Mulligan's MWM with clamshell exercises yields superior outcomes in reducing pain, improving function, and enhancing quality of life compared to MWM alone. Addressing this question is clinically significant as it can influence physical therapy protocols for SIJD. Therefore, the research question posed is: Does the combination of Mulligan Mobilization with clamshell exercises result in greater improvement in pain, disability, and quality of life in patients with anterior innominate SIJD compared to Mulligan Mobilization alone?

MATERIALS AND METHODS

The present study was designed as a single-blinded, randomized controlled trial conducted over a duration of six months to investigate the comparative effects of Mulligan Mobilization with and without clamshell exercises on pain, disability, and quality of life in patients diagnosed with anterior innominate sacroiliac joint dysfunction. A total of 45 patients were initially assessed for eligibility at two clinical settings: Fatima Memorial Hospital and Boston Physiotherapy and Wellness Clinic, Lahore. After screening, 38 participants who fulfilled the inclusion criteria were enrolled. Eligible participants included both males and females between the ages of 20 and 50 years, with a clinical diagnosis of hypomobile sacroiliac joint, subacute sacroiliac pain persisting for at least four weeks, and a positive result on at least three out of

five pain provocation tests described in Leslett's criteria—namely the compression, distraction, thigh thrust, Gaenslen, and Patrick tests. Additional eligibility criteria included an NPRS score of less than 8 and an ODI score ranging from 20–40%. Exclusion criteria encompassed patients with a history of spinal surgery, lumbar canal stenosis, spondylosis, spondylolisthesis, congenital postural deformities, pelvic bone fractures, disc herniation, and pregnancy.

CONSORT Flow Diagram

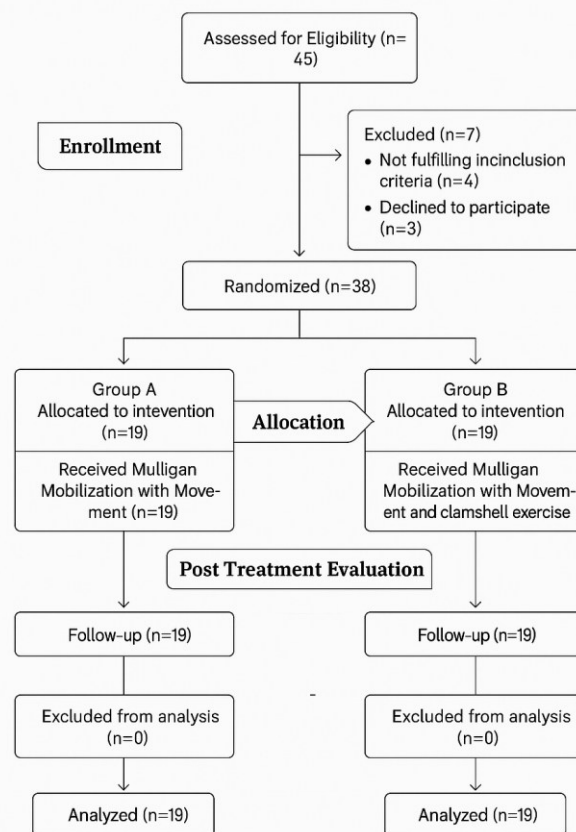


Figure 1 CONSORT Flow Diagram

Participants were recruited using a non-probability consecutive sampling technique and were randomly allocated into two groups (Group A and Group B) using computer-generated randomization through www.randomizer.org. Allocation concealment was achieved using sealed opaque envelopes. Group A received Mulligan Mobilization with Movement (MWM) alone, while Group B received the same mobilization technique combined with clamshell exercises. Written informed consent was obtained from all participants prior to enrollment. The study protocol was reviewed and approved by the Ethics Committee of Riphah International University, Lahore, and all procedures were conducted in accordance with the Declaration of Helsinki. The primary outcomes were pain, functional disability, and quality of life, assessed using the Numeric Pain Rating Scale (NPRS), the Oswestry Disability Index (ODI), and the EQ-5D questionnaire, respectively. All assessments were conducted at baseline and after six weeks of intervention. NPRS is a validated 0–10 scale where 0 indicates no pain and 10 indicates worst imaginable pain

(33, 34). ODI consists of 10 items covering activities of daily living and pain, with higher scores indicating greater disability and is widely recognized as a reliable tool in low back pain assessment (35, 36). The EQ-5D instrument evaluates five domains: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression, serving as a validated tool to assess health-related quality of life (37, 38).

Each participant received 18 treatment sessions over six weeks, with a frequency of three sessions per week. Both groups received a standard baseline treatment that included continuous ultrasound therapy (1 MHz frequency, 1.5 W/cm² intensity for 5 minutes), isometric hip abduction and adduction exercises, and stretching of the quadratus lumborum muscle. For MWM, participants were positioned prone with hands under their shoulders; the therapist applied posterior translational and rotational glides to the anterior superior iliac spine while stabilizing the sacrum, and the patient simultaneously performed active trunk extension. The mobilization was delivered in 3 sets of 10 repetitions per session with a 3-minute rest interval between sets. For Group B, clamshell exercises were added to the same mobilization protocol. Participants lay in a side-lying position with hips flexed to 45° and knees at 90°, lifting the top knee while keeping feet together, performing 3 sets of 10 repetitions with visual monitoring. Data analysis was performed using SPSS version 25. Descriptive statistics such as frequencies, percentages, means, and standard deviations were used to

Table 1. Descriptive Statistics of Participant Demographics

Parameter	Group A (Mean ± SD)	Group B (Mean ± SD)
Age (years)	26.78 ± 4.41	31.10 ± 7.51
Height (cm)	171.10 ± 5.84	167.15 ± 6.74
Weight (kg)	75.68 ± 12.73	70.42 ± 12.21
BMI (kg/m ²)	25.88 ± 4.01	25.10 ± 3.41

Table 2. NPRS Comparison Within and Between Groups

Group	Time Point	Mean ± SD	Mean Difference	p-value
Group A	Pre	7.15 ± 0.68	2.47	0.00
	Post	4.68 ± 0.94		
Group B	Pre	7.52 ± 0.77	4.68	0.00
	Post	2.84 ± 0.76		
Between Groups (Post)	—	Group A: 4.68 ± 0.94 Group B: 2.84 ± 0.76	1.84	0.00

Table 3. ODI Comparison Within and Between Groups

Group	Time Point	Mean ± SD	Mean Difference	p-value
Group A	Pre	29.92 ± 5.00	14.48	0.00
	Post	15.44 ± 4.07		
Group B	Pre	31.31 ± 4.26	18.47	0.00
	Post	12.84 ± 2.60		
Between Groups (Post)	—	Group A: 15.44 ± 4.07 Group B: 12.84 ± 2.60	2.60	0.00

Both groups showed statistically significant within-group reductions in Numeric Pain Rating Scale (NPRS) scores after six weeks of intervention. Group A demonstrated a mean reduction from 7.15 ± 0.68 to 4.68 ± 0.94 ($p = 0.00$), while Group B showed a greater reduction from 7.52 ± 0.77 to 2.84 ± 0.76 ($p = 0.00$). Between-group analysis revealed a significant difference in post-

summarize demographic characteristics. The Shapiro-Wilk test assessed the normality of data distribution. Paired t-tests were used to evaluate within-group differences before and after the intervention, while independent t-tests were used for between-group comparisons. Statistical significance was defined as a p-value less than 0.05. The study did not encounter any missing data, as all 38 participants completed the full course of the intervention and assessments.

RESULTS

A total of 45 participants were assessed for eligibility, of whom 7 were excluded (4 did not meet the inclusion criteria, and 3 declined to participate). Ultimately, 38 participants with clinically diagnosed anterior innominate sacroiliac joint dysfunction were enrolled and randomized equally into two groups: Group A (Mulligan Mobilization only) and Group B (Mulligan Mobilization with Clamshell Exercises). Each group consisted of 19 participants, and all completed the intervention and were included in the final analysis, with no dropouts reported.

The mean age in Group A was 26.78 ± 4.41 years, and in Group B was 31.10 ± 7.51 years. The overall gender distribution was 31.5% males and 68.4% females. BMI distribution showed that 47.37% of participants had a normal weight, 31.58% were overweight, and 18.42% were obese. Only 2.63% were underweight. Detailed anthropometric data are presented in Table 1.

treatment NPRS scores ($p = 0.00$), favoring Group B. Oswestry Disability Index (ODI) scores significantly improved in both groups post-treatment. Group A's ODI decreased from 29.92 ± 5.00 to 15.44 ± 4.07 ($p = 0.00$), while Group B improved from 31.31 ± 4.26 to 12.84 ± 2.60 ($p = 0.00$). The between-group comparison of post-intervention ODI scores showed a statistically significant

difference favoring Group B ($p = 0.00$), with a greater reduction in disability level. EQ-5D scores improved significantly in both groups, with Group A improving from 47.26 ± 8.19 to 65.15 ± 4.42 ($p = 0.000$) and Group B from 56.26 ± 6.30 to 76.57 ± 5.65 ($p = 0.000$).

Table 4. EQ-5D Comparison Within and Between Groups

Group	Time Point	Mean \pm SD	Mean Difference	p-value
Group A	Pre	47.26 ± 8.19	17.89	0.000
	Post	65.15 ± 4.42		
Group B	Pre	56.26 ± 6.30	20.31	0.000
	Post	76.57 ± 5.65		
Between Groups (Post)	—	Group A: 65.15 ± 4.42	11.42	0.000
		Group B: 76.57 ± 5.65		

All three outcome domains—pain, disability, and quality of life—showed significant improvement in both intervention groups, with greater improvements consistently observed in the group receiving Mulligan Mobilization in combination with clamshell exercises. Notably, the effect size appears to be clinically meaningful, especially in NPRS and EQ-5D outcomes, suggesting that the inclusion of targeted hip abductor strengthening via clamshell exercise augments the therapeutic efficacy of joint mobilization. Given the p-values across all between-group comparisons are <0.001 for NPRS and EQ-5D, and <0.05 for ODI, the results support the superiority of the combined intervention in managing anterior innominate SIJ dysfunction.

DISCUSSION

The findings of the present randomized controlled trial demonstrate that both Mulligan Mobilization alone and Mulligan Mobilization combined with clamshell exercises significantly reduce pain and disability while improving quality of life in patients with anterior innominate sacroiliac joint dysfunction. However, the group receiving the combined intervention showed greater improvement across all outcome measures, suggesting a synergistic effect when manual therapy is integrated with targeted gluteal strengthening exercises. These findings align with the biomechanical understanding of sacroiliac joint (SIJ) stability, where both passive structures (ligaments and joint surfaces) and active muscular contributions are essential for maintaining alignment and distributing forces during load-bearing activities (4, 5, 17).

The improvement in Numeric Pain Rating Scale (NPRS) scores observed in this study mirrors outcomes reported in earlier trials evaluating the efficacy of Mulligan Mobilization techniques for various spinal and pelvic dysfunctions (21, 22). The inclusion of clamshell exercises likely contributed to a greater reduction in pain by enhancing neuromuscular control of the gluteus medius and maximus, which are integral to lumbopelvic stability. Previous EMG-based studies have confirmed that clamshell exercises effectively activate the gluteus medius while minimizing compensation from the anterior hip flexors, thereby correcting muscle imbalances often observed in SIJ dysfunction (18, 19). This reinforces the theoretical framework suggesting that muscle inhibition and asymmetry contribute to altered force closure mechanisms, perpetuating pain and dysfunction in the SIJ (5).

The post-treatment intergroup difference was also statistically significant ($p = 0.000$), indicating a superior improvement in quality of life in the group receiving clamshell exercises.

Our results also align with a study conducted by Varghese *et al.*, which showed that Mulligan Mobilization in combination with conventional exercise resulted in superior functional improvements compared to mobilization alone in SIJ dysfunction (40). Similarly, Jeong *et al.* demonstrated the utility of modified clamshell exercises in selectively strengthening the gluteus medius and quadratus lumborum, muscles that play a pivotal role in pelvic stability (18). This current study builds upon those findings by not only confirming the individual efficacy of both interventions but also quantifying their enhanced effect when applied concurrently. In contrast, some trials, such as that by Farooq and Zahid, highlighted kinesio taping as an adjunct to manual therapy, showing benefits in pain reduction but without exploring muscular activation or long-term stabilization (25). The current research advances the literature by focusing on functionally significant muscular rehabilitation, which may promote sustained improvements and reduce recurrence.

The clinical implications of these findings are considerable. Manual therapy alone may offer short-term pain relief through correction of positional faults and stimulation of mechanoreceptors (21, 22), but incorporating active rehabilitation through gluteal strengthening addresses the underlying neuromuscular deficits responsible for joint instability. This dual-approach model can be particularly valuable in rehabilitation protocols for patients experiencing recurrent low back or pelvic girdle pain, especially those with anterior innominate dysfunction, a condition known to compromise gait mechanics and load transfer (17). In clinical settings, the practicality of clamshell exercises—requiring no equipment and minimal space—makes them an ideal adjunct to manual therapy.

Nevertheless, the study has limitations that should be acknowledged. The sample size, though statistically justified, was modest and may not reflect the broader population, limiting the generalizability of the findings. Additionally, the study focused on a single subtype of SIJ dysfunction and excluded patients with comorbid lumbar pathologies or pregnancy-related pain, which constrains the applicability to more complex clinical presentations.

The absence of long-term follow-up also prevents conclusions regarding the durability of treatment effects. Another limitation is the reliance on subjective outcome measures, which, while validated and reliable (33, 35, 37), may be complemented in future research by objective biomechanical assessments or imaging.

Future studies should aim to include larger, more diverse populations and assess the long-term efficacy and recurrence rates following combined interventions. Additionally, exploring modified versions of clamshell exercises and integrating them into comprehensive kinetic chain rehabilitation may further enhance outcomes. Investigating the role of other stabilizing muscle groups, such as the transverse abdominis and pelvic floor muscles, in conjunction with SIJ mobilization may offer a more holistic understanding of lumbopelvic rehabilitation. Lastly, mechanistic studies exploring neuromuscular adaptations to combined manual and exercise-based therapies could deepen theoretical insights and inform clinical decision-making.

In conclusion, this study reinforces the clinical value of integrating Mulligan Mobilization with clamshell exercises in treating anterior innominate sacroiliac joint dysfunction. The combined approach not only alleviates pain but also enhances function and quality of life by addressing both the biomechanical and neuromuscular dimensions of SIJ dysfunction. These findings support the adoption of multi-modal rehabilitation protocols for optimal management and long-term patient outcomes.

CONCLUSION

This randomized controlled trial concluded that Mulligan's Mobilization, both with and without clamshell exercises, significantly reduces pain and disability while improving quality of life in patients with anterior innominate sacroiliac joint dysfunction. However, the addition of clamshell exercises yielded superior outcomes, emphasizing the importance of integrating targeted gluteal strengthening into manual therapy protocols. These findings have important clinical implications, suggesting that combining mobilization with focused rehabilitation enhances neuromuscular control and functional recovery. For human healthcare, this approach offers an effective, non-invasive strategy for managing sacroiliac joint dysfunction. Future research should explore long-term benefits and applicability across broader populations to optimize evidence-based rehabilitation strategies.

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