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EFFECTS OF CONCENTRIC EXERCISES WITH AND WITHOUT MULLIGAN WRIST MOBILIZATION ON PAIN, GRIP STRENGTH, RANGE OF MOTION AND FUNCTION AFTER DISTAL RADIUS FRACTURE

Original Research

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ABSTRACT

Background: Distal radius fractures are among the most common orthopedic injuries, often requiring effective rehabilitation strategies to restore function and mobility. Mulligan's mobilization with movement (MWM) is widely used in musculoskeletal rehabilitation but requires further investigation to understand its effectiveness in improving outcomes following distal radius fractures. This study aimed to evaluate the effects of adding MWM to a conventional concentric exercise regimen on pain, grip strength, range of motion (ROM), and wrist function in patients with distal radius fractures.

Objective: To determine the impact of Mulligan's mobilization with movement combined with concentric exercises on pain, ROM, grip strength, and wrist function compared to concentric exercises alone in patients with distal radius fractures.

Methods: A single-blinded randomized controlled trial was conducted at DHQ Hospital Sheikhupura. Twenty patients with distal radius fractures were randomly divided into two groups: Group A (n=10) received concentric exercises combined with MWM, and Group B (n=10) received concentric exercises alone. Treatment was administered three times a week for one month. Pain, wrist function, grip strength, and ROM were assessed using the Numeric Pain Rating Scale (NPRS), Patient-Rated Wrist Evaluation (PRWE), dynamometer, and goniometer, respectively. Assessments were conducted pre- and post-intervention. Statistical analysis was performed using SPSS, with significance set at $p<0.05$.

Results: Group A showed significantly better improvements in all variables except ulnar deviation. NPRS scores improved from 5.40±1.42 to 1.50±0.52 in Group A compared to 6.50±1.35 to 2.50±1.08 in Group B ($p<0.05$). PRWE scores decreased from 54.6±9.53 to 30.6±7.18 in Group A and from 63.10±14.75 to 44.40±13.85 in Group B ($p<0.05$). Grip strength increased from 3.30±0.94 to 11.20±1.39 in Group A versus 2.10±0.73 to 4.20±1.22 in Group B ($p<0.05$). ROM significantly improved in Group A for flexion, extension, radial deviation, pronation, and supination ($p<0.05$), while ulnar deviation showed no significant difference between groups ($p>0.05$).

Conclusion: Adding Mulligan's mobilization with movement to a conventional concentric exercise regimen significantly improved pain reduction, wrist function, grip strength, and most ROM measures compared to concentric exercises alone, except for ulnar deviation. This approach can be an effective rehabilitation strategy for patients with distal radius fractures.

Keywords: Exercise therapy, Fracture rehabilitation, Grip strength, Mobilization, Pain management, Range of motion, Wrist injuries.

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INTRODUCTION

Distal radius fractures are among the most commonly encountered injuries in orthopedic practice, constituting approximately 8% to 15% of all bony injuries in adults. These fractures are frequently reported in emergency departments and are particularly prevalent in the upper extremity. Epidemiological surveys on traumatic fractures have shown that distal radius fractures account for 4% of all fractures in adults and 12% in elderly populations. The predominant cause of these injuries is a fall on an outstretched hand (FOOSH), often resulting in intra-articular and comminuted fractures that do not always conform to traditional classification systems (1, 2). Despite their prevalence, the specific criteria for initiating physiotherapy following the immobilization period remain undefined, yet physiotherapy plays an essential role in recovery by improving muscle strength and restoring functionality (3).

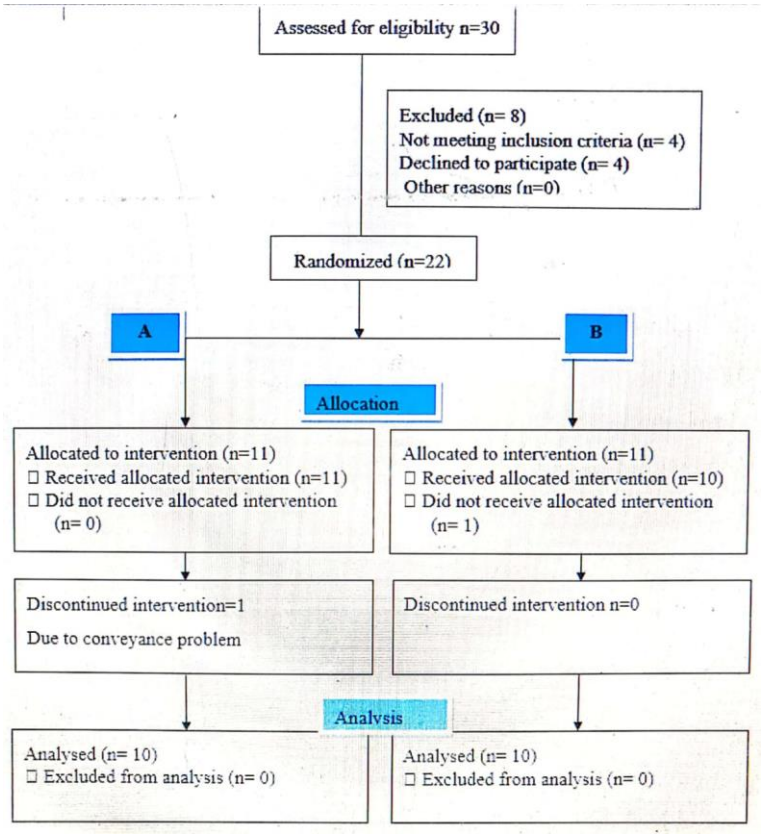
Emerging evidence suggests that incorporating manual therapy alongside standard physiotherapy enhances functional outcomes. In particular, early manual therapy, such as mobilization with movement (Mulligan techniques), has shown promise in improving wrist flexion in patients treated with volar plating for distal radius fractures (4). This manual approach, widely utilized in musculoskeletal pain management, involves the simultaneous application of passive sustained joint gliding by the therapist and active joint movement by the patient. Its effectiveness has been documented in several studies, highlighting its role in optimizing recovery following distal radius fractures (5, 4, 6, 7).

Recovery following these injuries often requires the integration of wrist exercises and manual therapy techniques to maximize rehabilitation outcomes, facilitate a return to normal function, and enable individuals to resume daily activities or work. While many interventions have been suggested for these purposes, concentric exercises combined with Mulligan wrist mobilization remain underexplored in terms of their comprehensive impact on pain relief, grip strength, range of motion, and functional improvement (8). The objective of this study was to evaluate the effects of concentric exercises with and without Mulligan wrist mobilization, with the aim of providing evidence-based recommendations for optimizing recovery in patients with distal radius fractures.

METHODS

A single-blinded randomized controlled trial was conducted to evaluate the effects of concentric exercises with and without Mulligan's mobilization with movement (MWM) on individuals with distal radius fractures. The study was registered on ClinicalTrials.gov with ID NCT05405023. Patient recruitment began in June 2022, and the study concluded in March 2023. The research was conducted at District Head Quarters Hospital, Sheikhupura, Pakistan.

Participants were recruited using a consecutive sampling technique. Twenty participants were randomly assigned to the experimental group (n=10) or control group (n=10) through a lottery method, where participants drew numbered chits. Odd numbers indicated assignment to the experimental group, and even numbers indicated assignment to the control group. The allocation process ensured equal chances for group assignment. The outcome assessor was blinded to participant allocation and did not perform any intervention. Sample size estimation was performed using the online Epitool sample size calculator, referencing supination range of motion (ROM) values from a prior study, with a confidence level of 0.95 and a power of 0.8 (6). Accounting for a 10% attrition rate, 22 participants were required. After the dropout of two participants from each group, 20 individuals completed the study, and their data were analyzed. A CONSORT flow diagram was used to illustrate the participant recruitment process.



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Inclusion criteria required participants to be aged 45 to 65 years, of either gender, with at least six weeks post distal radius fracture, orthopedic clearance for participation, and extra-articular distal radius fractures (9). Exclusion criteria included neurological conditions affecting the upper limb, polyarthritis, bleeding disorders, tumors, local infections, peripheral vascular disease, contraindications to physiotherapy, concurrent upper limb fractures, and proximal radial, radial shaft, or ulnar fractures (6).

After obtaining informed consent, participants in the experimental group underwent a combined intervention comprising concentric exercises and Mulligan's MWM. Concentric exercises included wrist flexion, extension, abduction, adduction, supination, and pronation, as well as elbow flexion and extension, and shoulder abduction and forward flexion, performed for 5 to 10 repetitions in 3 sets. Mulligan's MWM was applied for wrist supination and extension, consisting of 1 to 3 sets of 10 repetitions, with modifications to glide direction and location to ensure pain-free mobilization (6). The control group performed only the concentric exercises outlined above for the same frequency and intensity. Participants were provided with instructional sheets and videos to support proper exercise execution at home.

Pain was assessed using the Numeric Pain Rating Scale (NPRS) (11), grip strength was measured with a manual dynamometer (12), and wrist function was evaluated using the Patient-Rated Wrist Evaluation (PRWE) score (13). A goniometer was employed to measure range of motion (ROM) for pronation, supination, wrist flexion, extension, radial deviation, and ulnar deviation (14). Baseline data were collected before the intervention, and outcomes were reassessed after four weeks of treatment.

Data analysis was performed using SPSS version 25. For normally distributed variables (NPRS, PRWE, pronation, supination ROM, and grip strength), independent sample t-tests were used for between-group comparisons, and paired sample t-tests were used for within-group comparisons. For non-normally distributed variables (flexion, extension, radial deviation, and ulnar deviation ROM), between-group comparisons were analyzed using the Mann-Whitney U test, while within-group differences were assessed using the Wilcoxon signed-rank test.

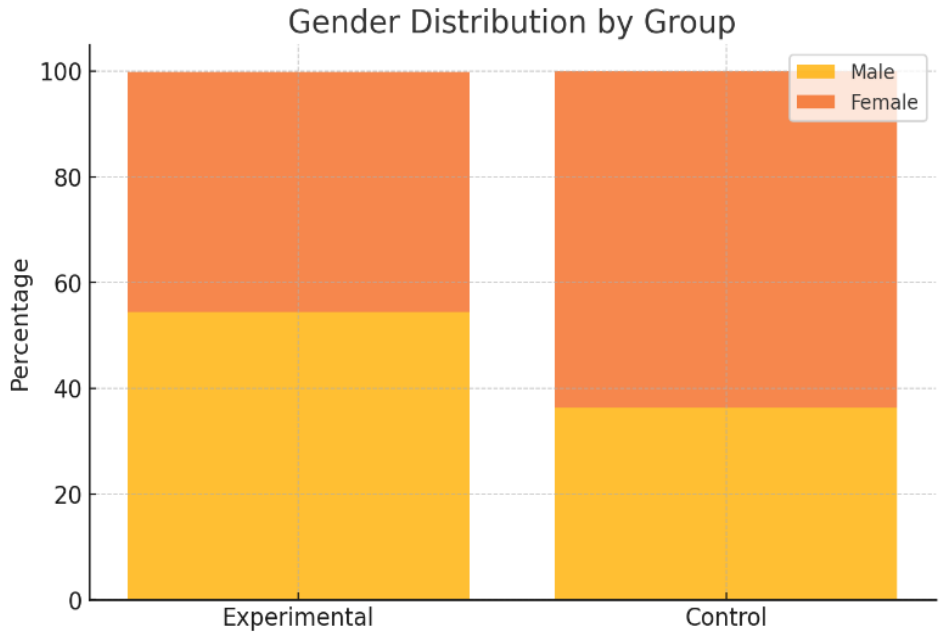
The study adhered to ethical guidelines and received approval from the Research and Ethics Committee of Riphah College of Rehabilitation and Allied Health Sciences, Riphah International University (Ref. No. REC/RCR&AHS/22/0128). All participants provided written informed consent before participation in the study, in accordance with the Declaration of Helsinki.

RESULTS

The results of the study included data from 20 participants, equally divided between the experimental and control groups (n=10 each). The demographic characteristics of participants showed no significant differences between the groups. The mean age of participants in the experimental group was 50.00±2.26 years, while the control group had a mean age of 50.90±2.60 years (P=0.29). Height, weight, and BMI were comparable across groups with no significant differences ($P > 0.05$). The gender distribution indicated a slightly higher proportion of males (54.44%) in the experimental group compared to the control group (36.36%), but this difference was also not statistically significant (P=0.53).

Within-group analysis revealed significant improvements in range of motion (ROM), pain scores, grip strength, and wrist function following the intervention in both groups. For wrist flexion, the median score improved from 60.00 to 70.00 in the experimental group and from 52.50 to 60.00 in the control group ($P < 0.05$). Similarly, wrist extension increased from 59.00 to 74.00 in the experimental group and from 40.00 to 47.50 in the control group ($P < 0.05$). Radial deviation showed improvements from 10.00 to 20.50 in the experimental group and from 10.50 to 15.00 in the control group ($P < 0.05$). Ulnar deviation also improved significantly in both groups, although the between-group analysis showed no statistically significant difference for this variable (P=0.579). Pain levels, measured by the Numeric Pain Rating Scale (NPRS), decreased significantly in both groups, with greater reductions observed in the experimental group ($P < 0.001$).

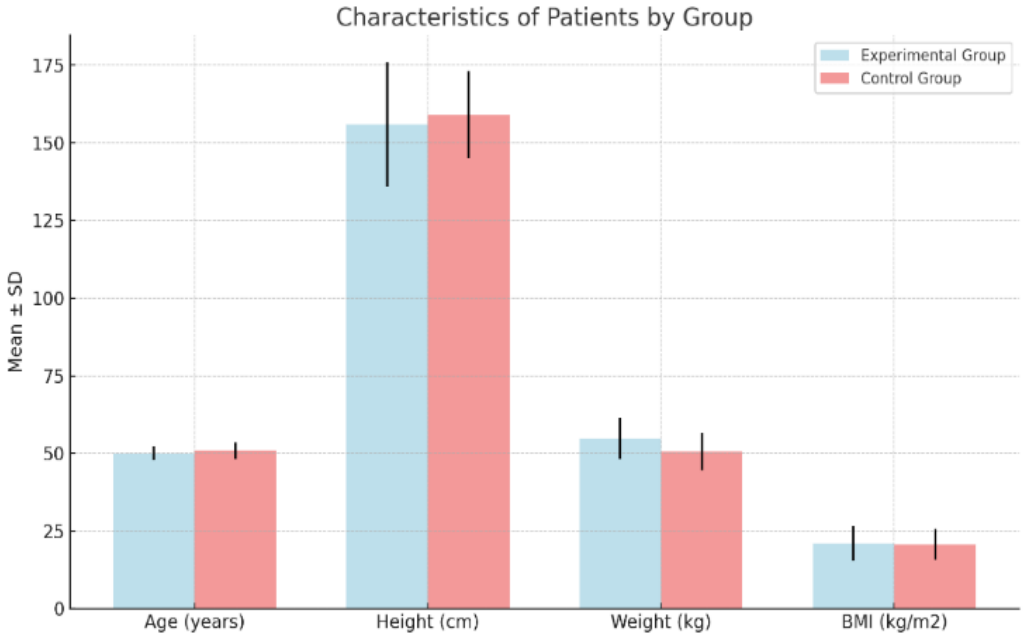
Between-group analysis indicated that the experimental group showed greater improvements in NPRS, Patient-Rated Wrist Evaluation (PRWE), grip strength, pronation, and supination compared to the control group ($P < 0.05$). For grip strength, the experimental group improved from 3.30±0.94 kg to 11.20±1.39 kg, whereas the control group improved from 2.10±0.73 kg to 4.20±1.22 kg ($P < 0.001$). Supination improved more significantly in the experimental group, increasing from 61.50±13.34° to 82.60±2.11°, compared to the control group, which increased from 61.50±10.55° to 74.50±7.97° (P=0.001). Flexion, extension, and radial deviation also showed significantly greater improvements in the experimental group compared to the control group. Overall, the experimental group demonstrated superior outcomes, highlighting the effectiveness of concentric exercises combined with Mulligan's mobilization with movement.



This chart shows data Of the 20 participants, 10(50%) were in group A and 10(50%) were in group B. By profession, in group A (experimental group), 40% were sports-person, 30% were housewives, and 30% were labourers. In group B (control), 40% were sports-person, 20% were housewives, and 40% were labourers. Demographic data is presented in Table 1.

Figure 1 Gender Distribution by Group

The chart illustrates the demographic characteristics of patients in the experimental and control groups, highlighting mean values with standard deviations. The experimental group had a mean age of 50.00±2.26 years, compared to 50.90±2.60 years in the control group.



Mean height was slightly lower in the experimental group (156±20 cm) than in the control group (159±14 cm). Similarly, mean weight was higher in the experimental group (54.80±6.51 kg) than in the control group (50.60±6.00 kg). BMI was comparable between the groups, with 20.98±5.52 kg/m² in the experimental group and 20.69±4.99 kg/m² in the control group. None of these differences were statistically significant ($P > 0.05$). The error bars represent the variability within each group.

Figure 2 Characteristics Of Patients By Group

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Table 1: Within group analysis of group A and B

Variable	Group	Pre-intervention Mean±SD	Post intervention Mean±SD	P-value
NPRS	A	5.40±1.42	1.50±0.52	0.000
	B	6.50±1.35	2.50±1.08	0.000
PRWE	A	54.6±9.53	30.6±7.18	0.000
	B	63.10±14.75	44.40±13.85	0.000
Pronation	A	67.50±7.07	79.00±4.69	0.001
	B	56.00±10.48	69.10±7.47	0.001
Grip strength	A	3.30±0.94	11.20±1.39	0.000
	B	2.10±0.73	4.20±1.22	0.000
Supination	A	61.50±13.34	82.60±2.11	0.000
	B	61.50±10.55	74.50±7.97	0.001
Flexion	A	58.70±5.88	70.30±5.85	0.04
	B	50.50±7.70	59.30±7.70	0.04
Extension	A	56.80±7.46	71.80±5.67	0.05
	B	42.50±8.57	51.00±8.09	0.04
Radial deviation	A	9.80±1.47	20.50±3.02	0.05
	B	10.80±1.87	16.80±2.57	0.05
Ulnar deviation	A	19.40±3.50	27.70±4.76	0.05
	B	21.10±1.28	26.90±2.68	0.04

Wilcoxin test showed significant difference in flexion before and after treatment with (Z=-2.877, P <0.05) in group A, and (Z=-2.913, P <0.05) in group B. The median score was 60.00 and 52.50 before treatment and 70.00 and 60.00 after treatment in group A and B respectively. Similarly, extension was also improved significantly for both groups with (Z=-2.812, P =0.05), median score before treatment 59.00 and post treatment 74.00 for A group and (Z=-2.919, P <0.05) and pre-treatment median score was 40.00 and post treatment was 47.50 for group B. Radial deviation in group A (Z=,-2.814 P=0.05), median score before treatment 10.00 and after treatment 20.50 and group B (Z=-2.814, P=0.05) median score before treatment was 10.50 and post treatment 15.00 was also improved significantly. Ulnar deviation (Z=-2.82, P=0.05.) in group A with median score 9.50 before and 29.50 after treatment and (Z=-2.844, P<0.05) in group B with median score 20.50 pre treatment and 25.00 post treatment also showed significant improvement. In addition to this, NPRS (P=0.000) , PRWE (P=0.000), grip strength (P=0.000), pronation (P=0.001) and supination (P=0.000) ranges were also improved significantly in both groups.

Table 2: Between group analysis of NPRS, PRWE, Pronation, grip strength, supination

Variable	Group	Mean±SD	P-value
NPRS	A	6.50±1.35	<0.001
	B	4.20±1.22	
PRWE	A	30.6±7.18	0.001
	B	44.40±13.85	

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Variable	Group	Mean±SD	P-value
Pronation	A	79.00±4.69	<0.001
	B	69.10±7.47	
Grip Strength	A	11.20±1.39	<0.001
	B	8.10±2.33	
Supination	A	82.60±2.11	0.001
	B	74.50±7.97	

The table compares outcomes between the experimental (A) and control (B) groups, showing significantly better results in the experimental group across all variables ($P < 0.05$). The experimental group demonstrated lower NPRS scores (6.50±1.35 vs. 4.20±1.22), better wrist function with lower PRWE scores (30.6±7.18 vs. 44.40±13.85), greater pronation (79.00±4.69° vs. 69.10±7.47°), higher grip strength (11.20±1.39 kg vs. 8.10±2.33 kg), and greater supination (82.60±2.11° vs. 74.50±7.97°). These findings indicate superior improvements in the experimental group compared to the control group.

Table 3: Between group analysis of flexion, extension, Radial and Ulnar deviation

ROM	Group	Mean Rank	Z score	P value
Pre-Flexion	A	13.45	-2.30	0.23
	B	7.55		
Post-Flexion	A	14.25	-2.86	0.003
	B	6.75		
Pre-Extension	A	14.25	-2.87	0.003
	B	6.75		
Post-Extension	A	15.20	-3.59	<0.001
	B	5.80		
Pre- Radial deviation	A	8.90	-1.23	0.247
	B	12.10		
Post- Radial deviation	A	13.75	-2.52	0.011
	B	7.25		
Pre- Ulnar deviation	A	7.10	-2.60	0.009
	B	13.90		
Post- Ulnar deviation	A	11.25	-0.57	0.579
	B	9.75		

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The table presents between-group analysis of wrist range of motion (ROM), showing significant improvements in the experimental group (A) compared to the control group (B) for post-treatment flexion (Mean Rank 14.25 vs. 6.75, P=0.003), post-extension (15.20 vs. 5.80, P<0.001), and post-radial deviation (13.75 vs. 7.25, P=0.011). Pre-treatment differences for these variables were not statistically significant. Ulnar deviation showed no significant difference between groups post-treatment (P=0.579), indicating comparable outcomes for this parameter. These results highlight the experimental group's greater gains in ROM for most movements.

DISCUSSION

The study evaluated the effects of concentric exercises with and without Mulligan wrist mobilization (MWM) on pain, grip strength, range of motion, and functional outcomes following distal radius fracture. Both groups demonstrated significant improvements across all measured variables after four weeks of treatment, with p-values less than 0.05. However, the experimental group, which received MWM in addition to concentric exercises, showed superior outcomes in pain reduction, grip strength, wrist flexion, extension, radial deviation, and functional scores compared to the control group, as evidenced by p-values <0.001. Notably, ulnar deviation showed no significant difference between the groups, highlighting a consistent response to both interventions for this variable.

The results align with previous research supporting the addition of manual therapy to standard physiotherapy in improving functional outcomes. A study by Tomruk et al. (2019) demonstrated that early manual therapy significantly enhanced wrist flexion and functional outcomes in patients with volar plating after a distal radius fracture ($p < 0.05$) (4). Similarly, Stephan (2020) reported improved grip strength and wrist function using PRWE scores, consistent with the findings of this study (15). The current study's inclusion of radial and ulnar deviations expands upon previous studies, such as Reid et al. (2020), which primarily focused on wrist flexion and extension. While both studies report improvements in flexion and extension, the additional evaluation of radial deviation in the current study underscores the enhanced efficacy of MWM in promoting joint mobility, though ulnar deviation improvements remained comparable between groups (6).

The greater improvement observed in the experimental group could be attributed to the repetitive passive gliding and movement provided by the therapist, which may have promoted joint mobilization, reduced stiffness, and enhanced neurophysiological responses. The mechanical hypoalgesia induced by MWM likely contributed to the reduction in pain and improved overall outcomes (16). Furthermore, the inclusion of a home exercise plan with video and pictorial guidance proved beneficial, as evidenced by significant improvements in functional and ROM measures. This approach is consistent with the findings of Nathan Hunting et al. (2019), who emphasized the role of self-management strategies in addressing persistent musculoskeletal disorders and supporting rehabilitation efforts (17).

One of the strengths of this study was its comprehensive assessment of various outcome measures, including pain, grip strength, wrist ROM in multiple directions, and functional scores. The randomized controlled trial design and blinding of outcome assessors minimized bias and increased the validity of the results. However, the small sample size and single-center setting may limit the generalizability of findings. Additionally, adherence to the home exercise program was not objectively monitored, which could introduce variability in the outcomes. Future research should consider larger sample sizes, multicenter trials, and strategies to ensure compliance with home exercise regimens.

Overall, the study highlights the importance of incorporating Mulligan's mobilization with movement into rehabilitation protocols following distal radius fractures. By demonstrating superior reductions in pain and PRWE scores, enhanced grip strength, and improved range of motion compared to concentric exercises alone, this study provides evidence supporting the integration of MWM into physiotherapy regimens to optimize recovery and functional outcomes, particularly in enhancing radial deviation and wrist flexion. Ulnar deviation, while improved across both groups, requires further exploration to identify potential interventions for greater improvement.

CONCLUSION

The study concluded that incorporating Mulligan's mobilization with movement into a concentric exercise regimen was more effective in reducing pain, improving range of motion (except ulnar deviation), enhancing wrist functionality, and increasing grip strength in patients recovering from distal radius fractures. This combination demonstrated superior outcomes compared to concentric exercises alone, highlighting its potential as an integral component of physiotherapy protocols aimed at optimizing recovery and functional restoration.

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AUTHOR CONTRIBUTIONS

Author	Contribution
Iqra Shehzadi	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Tahreem Raza	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Muneeba Najeeb	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Nimra Mehmood	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Aqsa Iftikhar	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Fizza Shafi	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Ammara Irshad	Contributed to study concept and Data collection Has given Final Approval of the version to be published
Urooj Mazoor	Writing - Review & Editing, Assistance with Data Curation

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