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Role Of Gluteus Medius Strengthening On Function In Individuals With Chronic Ankle Instability.

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Abstract:
Background*: Ankle sprains are among the most prevalent musculoskeletal injuries, often resulting in recurrent instability and the development of Chronic Ankle Instability (CAI). CAI is characterized by impaired proprioception, reduced dorsiflexion range of motion (ROM), compromised neuromuscular control, and diminished postural stability. While conventional rehabilitation protocols primarily emphasize local ankle joint interventions, emerging evidence underscores the role of proximal musculature—particularly the gluteus medius—in enhancing dynamic balance and postural control.*
Materials and Methods*: A randomized controlled trial was conducted on 54 participants (aged 18–40 years) with a history of lateral ankle sprain and a positive Cumberland Ankle Instability Tool (CAIT) score. Participants were randomly assigned into two groups: Group A received conventional ankle rehabilitation, and Group B received ankle rehabilitation plus targeted gluteus medius strengthening exercises. Both groups completed 12 supervised physiotherapy sessions over four weeks. Outcome measures included: Dorsiflexion ROM measured using a goniometer and Foot and Ankle Ability Measure – Activities of Daily Living (FAAM-ADL). Statistical analysis was performed using SPSS v29, with independent t-tests to evaluate between-group differences, respectively.*
Results*: Both groups demonstrated statistically significant improvements in all outcome measures ($p < 0.05$). However, Group B showed superior gains in dorsiflexion ROM and FAAM-ADL scores, indicating enhanced functional performance.*
Conclusion: *The integration of gluteus medius strengthening with ankle rehabilitation yielded superior improvements in dorsiflexion ROM and functional outcomes in individuals with CAI. These findings support the inclusion of proximal muscle training—specifically hip abductor strengthening—as a vital component of comprehensive ankle rehabilitation protocols.*
Key Words: *Ankle Sprain, Chronic Ankle Instability, Functional Rehabilitation, Gluteus Medius, Range of Motion, Postural Stability, Hip Strengthening.*

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I. Introduction

Chronic Ankle Instability (CAI) is a common and often debilitating musculoskeletal condition that develops following a lateral ankle sprain, particularly when the injury is recurrent or inadequately rehabilitated. It is clinically defined by persistent symptoms such as recurrent ankle sprains, a subjective feeling of "giving way", pain, swelling, and functional limitations lasting for more than six months after the initial injury.[1]

Following an acute sprain, up to 40% of individuals develop persistent symptoms such as pain, swelling, and instability lasting over a year.[2] Chronic Ankle Instability (CAI) affects approximately 20% of those with previous sprains and is associated with mechanical laxity and functional deficits, including impaired proprioception, neuromuscular control, and postural stability.[3,4] Mechanical instability arises from ligamentous insufficiency and altered arthrokinematics, while functional instability is linked to sensorimotor deficits and compensatory motor strategies.[5]

Limited ankle dorsiflexion range of motion (ROM) is commonly observed post-sprain and is considered a significant risk factor for recurrent injuries.[6] Dorsiflexion deficits impair gait mechanics, shock absorption, and dynamic movements such as landing and squatting, often resulting in compensatory strategies that increase stress on adjacent joints.[7]

Traditionally, rehabilitation protocols for LAS and CAI have focused on restoring ankle strength, ROM, and proprioception. However, recent studies suggest that proximal muscle groups, particularly the gluteus medius, play a critical role in maintaining lower limb alignment and postural control.[8,9] Individuals with CAI frequently display reduced gluteus medius activation and delayed muscle recruitment, contributing to balance impairments

and altered dynamic stability.[10] Weakness or delayed activation of the gluteus medius has been linked to increased medial knee collapse, altered ankle joint loading, and compensatory movements that predispose individuals to recurrent ankle sprains.

Hip abductor weakness has been linked to increased lateral sway and reliance on distal compensations, which may further predispose the ankle to reinjury.[11] The interdependence between proximal stability and distal joint control underscores the need for a more holistic approach to rehabilitation. Despite this, there is limited research evaluating the impact of integrating gluteus medius strengthening into conventional ankle rehabilitation.

II. Material And Methods

This randomized interventional study was conducted over a one-year period at the Physiotherapy Outpatient Department of Nanavati Max Super Specialty Hospital, Mumbai. A total of 54 participants with a history of ankle sprain were recruited through simple random sampling. Participants were randomly allocated into two groups: Group A (n = 27) Received Ankle rehabilitation only, and Group B (n = 27) Received Ankle rehabilitation combined with gluteus medius strengthening.

Study Design: Interventional study

Study Setting: Physiotherapy Outpatient Department of Nanavati Max Super Specialty Hospital, Mumbai

Study Duration: 1 year

Sample size: 54

Subjects & selection method: A total of 54 individuals with a history of ankle sprain and a positive score on the Cumberland Ankle Instability Tool (CAIT) were recruited for the study. Participants were randomly assigned into two groups: Group A (ankle rehabilitation only) and Group B (ankle rehabilitation with gluteus medius strengthening).

Inclusion criteria:
1) Individuals aged between 18–40 years (both males and females)
2) History of ankle sprain
3) Positive score on the Cumberland Ankle Instability Tool (CAIT)

Exclusion criteria:
1) Recent trauma to the lower limb other than ankle sprain
2) Any medical or surgical pathology involving the hip joint
3) Professional athletes
4) Non-consenting individuals

Procedure methodology

Ethical approval for the study was obtained from the Institutional Ethics Committee of Nanavati Max Super Specialty Hospital, Mumbai. Participants were screened for eligibility, and those meeting the inclusion criteria were recruited and randomized into two groups. Informed consent was obtained from all participants before their inclusion in the study. Demographic details were recorded, and baseline assessments were conducted. Each participant underwent 12 supervised intervention sessions according to their group allocation. Post-intervention assessments were done after all the sessions were completed, followed by statistical analysis of the collected data.

a. Outcome Measures

1. Dorsiflexion Range of Motion (ROM):
   The reliability of goniometric measurement for dorsiflexion has an ICC range of 0.80–0.98.[12] The subject was seated with the knee flexed at 90° and foot in neutral (90° at the ankle). Dorsiflexion ROM was measured using a goniometer aligned with the lateral malleolus, fibula, and fifth metatarsal. The subject dorsiflexed actively without compensatory movements. Three readings were taken, and the average was recorded.
2. Foot and Ankle Ability Measure – ADL Subscale (FAAM-ADL):
   A validated 21-item questionnaire evaluating limitations in activities of daily living, scored on a 0–100% scale. Reported Cronbach's alpha = 0.92–0.98.[13] It measures performance in daily activities such as walking, climbing stairs, and standing for prolonged periods. Each item is scored on a 5-point Likert scale ranging from 4 (no difficulty) to 0 (unable to do), with higher scores indicating better functional ability.

b. Interventional protocol

The exercises progressed across three phases (Sessions 1–4, 5–8, and 9–12) for both groups as detailed in Tables 1 and 2.

Group A: Ankle Rehabilitation		
➢ Tendo-Achilles Stretch ➢ Pain-Free Isometrics for all 4 muscle groups: Dorsiflexors, Plantarflexors, Invertors, Evertors ➢ Ankle Range of Motion Exercises ➢ Ankle Alphabets ➢ Towel Curls/Marble Pick-Up ➢ Walking on foam ➢ Toe Raises/Heel Raises (With Support) ➢ Ultrasound(Dosage-1.5W/cm^2 for 7 minutes)	➢ Ankle ROM with Resistance ➢ Toe Raises/Heel Raises (No Support, Eyes Open) ➢ Wobble Board (Forward/Backward,Sideways - Eyes Open) ➢ Tandem Stand (Eyes Open) ➢ Single-Leg Stand (Eyes Open) ➢ Walking Backward ➢ Perturbations (Eyes Open) ➢ Tandem Walk (Eyes Open)	➢ Bosu Ball Spot Marching ➢ Heel Raises/Toe Raises (Eyes Closed) ➢ Single-Leg Stand (Eyes Closed) ➢ Tandem Stand (Eyes Closed) ➢ Tandem Walk (Eyes Closed) ➢ Perturbations (Eyes Closed)

Table 1: Intervention protocol for Group A

Group B: Ankle Rehabilitation + Gluteus medius strengthening		
➢ Hip Abduction with Ankle Weights (Standing) ➢ Clamshell Exercises ➢ Prone Knee Bending with Hip Extension ➢ Prone Knee Bending with Hip Abduction ➢ Bridging with Holds ➢ Bridging with Lower Extremity Extension	➢ Hip Abduction in Standing with Resistance Band ➢ Squats ➢ Forward Lunges ➢ Lateral Lunges ➢ Lateral Step-Up	➢ Banded Glute Bridge ➢ Banded quadruped donkey kicks ➢ Banded lateral squat walks ➢ Lateral lunge to balance

Table 2: Intervention protocol for Group B

Statistical analysis

The data analysis was done using the Statistical Package for Social Science version 29 (SPSS-29). Results were concluded to be statistically significant with a p-value <0.05. No statistically significant differences were observed between the two groups at baseline ($p > 0.05$ for all measures), confirming the homogeneity of the sample before intervention. An Independent T-test was used to compare the means between the two groups.

III. Results

A total of 54 participants (Group A: n=27; Group B: n=27) completed the study protocol without any dropouts. The mean age for Group A was 24.56 ± 3.34 years, and for Group B was 24.22 ± 2.53 years. The groups were homogenous at baseline across all outcome variables ($P > 0.05$). Gender distribution included 21 females and 6 males in Group A, and 22 females and 5 males in Group B. Based on BMI, 23 participants had normal weight, 15 were overweight, 11 were obese, and 5 were underweight. Regarding injury recurrence, 30 participants had two episodes, 21 had a single episode, and 3 reported three episodes. Pre-values followed normality; hence, post-values were analyzed using an independent t-test. The table below (Table 3) shows that Group B performed better than Group A by increasing the dorsiflexion range and by improving FAAM-ADL components.

	A -GROUP	B- GROUP	P-VALUE
DORSIFLEXION	24.93 ± 2.61	26.41 ± 2.43	0.036
FAAM- ADL	68.34 ± 4.92	70.85 ± 6.21	0.053

Table 3: Comparison of all outcome measures between Group A and Group B post 12 intervention sessions. There is a significant improvement in clinical and statistical values for dorsiflexion (P=0.036) and Foot and Ankle Ability Measure - Activities of Daily Living (FAAM-ADL) (P=0.053).

IV. Discussion

This study examined the effectiveness of combining gluteus medius strengthening with ankle rehabilitation compared to ankle rehabilitation alone in individuals with Chronic ankle instability. The findings demonstrate that participants receiving the combined intervention (Group B) showed greater clinical improvements in dorsiflexion range of motion and functional outcomes, highlighting the value of proximal muscle training in lower limb rehabilitation. Proximal muscle activation has been demonstrated to improve weight distribution and prevent excessive ankle joint stresses.[14]

One of the key observations was the superior dorsiflexion ROM gain in the group receiving gluteus medius strengthening. Restricted dorsiflexion is a well-documented risk factor for recurrent ankle sprains, altered

gait mechanics, and reduced shock absorption during functional activities.[12,15] When dorsiflexion is restricted, individuals often develop compensatory movement patterns such as excessive foot pronation or hip rotation to achieve functional mobility. These compensations not only reduce efficiency but also place undue stress on adjacent joints, including the knee and hip, increasing the risk of further injuries. This finding aligns with previous research that emphasized the importance of restoring dorsiflexion to enhance weight-bearing function and minimize compensatory movements.[7] Enhanced strength in the hip abductor muscles leads to improved control of the lumbopelvic region, which reduces compensatory movements that restrict ankle dorsiflexion during walking and weight-bearing activities. Moreover, increased stability in the proximal area decreases excessive stress on the ankle joint, enabling a natural and unrestricted movement pattern. This supports the idea that proximal control, especially through the hip abductors, plays a foundational role in regulating distal joint motion. Improved neuromuscular control at the hip may also lead to better muscle recruitment patterns and improved joint loading strategies, which collectively reduce stress at the ankle joint and promote more efficient movement.

The improvement in FAAM-ADL scores- a reliable indicator of a person's ability to perform daily functional tasks observed in this study can be closely linked to the inclusion of targeted gluteus medius strengthening exercises, which likely contributed to enhanced balance and postural control in individuals with chronic ankle instability (CAI). The gluteus medius plays a pivotal role in frontal plane pelvic stability during single-leg stance -and dynamic activities such as walking, stair climbing, walking on uneven terrain and transitioning from sitting to standing — all of which are core components of daily function assessed in the FAAM-ADL subscale. These tasks are commonly impaired in individuals with CAI due to instability and fear of reinjury. By incorporating exercises specifically aimed at activating and strengthening the gluteus medius, the intervention in this study likely led to improved neuromuscular control and alignment of the lower kinetic chain, which in turn enhanced postural stability during functional tasks, enabling participants to complete these functional tasks with greater ease and confidence.

The exercises used—such as lateral band walks, clamshells, and hip abduction in standing—are designed to activate the gluteus medius both isometrically and dynamically, enhancing its ability to stabilize the pelvis during movement. Over time, this leads to better motor control, improved joint alignment, and reduced postural sway, all of which are critical in individuals with CAI. As the hip muscles grow stronger, participants likely experienced less reliance on compensatory ankle strategies, allowing for improved performance in tasks assessed by FAAM-ADL. This functional improvement is reflected in daily scenarios, such as walking longer distances, turning quickly, or standing on unstable ground—actions that typically challenge individuals with chronic instability.

Improved balance resulted in reduced compensatory strategies and inefficient movement patterns, thereby allowing individuals to perform activities of daily living with greater confidence, efficiency, and less discomfort. This mechanistic improvement is reflected in the increased FAAM-ADL scores, as participants were better able to perform basic tasks such as walking on uneven surfaces, turning quickly, or standing for extended periods — activities commonly hindered in those with CAI. Thus, the additional focus on gluteus medius strengthening not only addressed proximal weakness but also contributed to functional gains at the ankle joint, as evidenced by improved FAAM-ADL outcomes. The results align with previous studies suggesting that weakness or delayed activation of hip abductors may lead to increased lateral sway, knee valgus, and altered loading at the ankle, compromising neuromuscular control and postural adjustments, all of which increase the likelihood of reinjury. Therefore, rehabilitation strategies that ignore hip function may fall short in preventing the recurrence of ankle instability.[16] Therefore, our study suggests that addressing isolated ankle impairments alone may be insufficient, and that including gluteus medius training is both biomechanically sound and clinically effective in optimizing functional outcomes.

V. Conclusion

This study demonstrates that incorporating gluteus medius strengthening into a conventional ankle rehabilitation program significantly enhances functional recovery in individuals with ankle sprain. The combined intervention resulted in superior improvements in ankle dorsiflexion range of motion and functional performance. These findings emphasize the importance of addressing both distal and proximal deficits in rehabilitation to optimize recovery and reduce the risk of recurrence.

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