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Original Article

Effects of Nirschl Exercises with and Without Mulligan Taping in Lateral Epicondylitis

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ABSTRACT

Background: Lateral epicondylitis is a degenerative tendinopathy of the common extensor origin, frequently involving the extensor carpi radialis brevis, and characterized by pain, functional limitation, and reduced grip strength. Eccentric strengthening (Nirschl exercises) is a first-line conservative intervention, while Mulligan taping aims to maintain joint alignment and reduce pain through positional correction. Evidence on the combined efficacy of these approaches remains limited. Objective: To evaluate the effects of Nirschl eccentric exercises with and without Mulligan taping on pain, functional disability, and grip strength in patients with lateral epicondylitis. Methods: In this randomized controlled trial, 46 patients aged 18–45 years with clinically diagnosed lateral epicondylitis were allocated to either Nirschl exercises plus Mulligan taping (n=23) or Nirschl exercises alone (n=23) for three weeks. Pain intensity (VAS), functional disability (PRTEE), and grip strength (hand-held dynamometer) were assessed pre- and post-intervention. Data were analyzed using paired and independent t-tests with $p<0.05$ as the significance threshold. Results: Both groups showed significant within-group improvements in pain, function, and grip strength ($p<0.05$). Between-group analysis demonstrated greater reductions in PRTEE (–40.48 points, $p<0.001$) and VAS (–1.73 cm, $p<0.001$) in the combined group, with no significant difference in grip strength ($p=0.104$). Conclusion: Nirschl exercises combined with Mulligan taping provide superior short-term improvements in pain and disability compared to exercises alone, though grip strength gains were comparable.

Keywords: Lateral epicondylitis, Nirschl exercises, Mulligan taping, eccentric exercise, tendon rehabilitation, grip strength, randomized controlled trial

INTRODUCTION

Lateral epicondylitis (LE), commonly referred to as tennis elbow, is a degenerative tendinopathy of the common extensor origin at the lateral epicondyle of the humerus, most frequently involving the extensor carpi radialis brevis (ECRB) tendon (1). This condition arises predominantly from repetitive wrist extension, forearm supination, or gripping activities, which produce cumulative microtrauma to the tendon, triggering angiofibroblastic hyperplasia and collagen disorganization rather than an acute inflammatory process (2). The degenerative pathology was originally described by Nirschl and Alvarado as a multi-staged tendinosis process involving fibroblast proliferation, neovascularization, and collagen disarray (3). The resulting pain is typically localized anterior to, or at, the lateral epicondyle and can radiate distally along the forearm, often accompanied by reduced grip strength and functional impairment (4). Although ultrasonography and radiography may detect calcifications or tendon thickening, diagnosis remains predominantly clinical, based on localized tenderness and positive provocative tests such as Cozen's, Mill's, and resisted middle finger extension (5).

The prevalence of LE is estimated at 1–3% in the general population, with peak incidence in individuals aged 35–54 years, particularly among those engaged in repetitive upper limb occupational or sporting activities (6). Despite being self-limiting in some cases, LE can persist for months or even years, causing significant disability and work absenteeism (7). Various conservative interventions—including activity modification, non-steroidal anti-inflammatory drugs, bracing, corticosteroid injections, platelet-rich plasma therapy, shockwave therapy, and exercise-based rehabilitation—have been advocated, but no single approach has been universally accepted as the optimal treatment (8). Among these, exercise therapy—especially eccentric strengthening—has emerged as a cornerstone of physiotherapeutic management, supported by evidence indicating its efficacy in pain reduction and functional improvement (9). Nirschl exercises, a structured eccentric training protocol for the wrist extensors, target tendon remodeling by inducing controlled microtrauma, stimulating

collagen synthesis, and promoting tensile strength restoration (10). Eccentric loading has been shown to produce greater and more sustained clinical benefits compared to concentric or stretching protocols in tendinopathies (11). However, despite its proven efficacy, symptom recurrence and incomplete functional recovery remain challenges in a subset of patients (12). This has led to the exploration of adjunctive techniques, such as Mulligan mobilization with movement (MWM) and its derivative, Mulligan taping. Mulligan taping applies rigid adhesive tape in the direction of manual glides used during MWM, aiming to maintain joint positional correction, reduce pain, and improve movement quality beyond the treatment session (13). Mechanistically, MWM is proposed to address subtle positional faults at the elbow joint, activating endogenous pain inhibitory pathways and restoring painless movement (14). Clinical studies have demonstrated that Mulligan mobilization can produce faster pain relief and functional gains in LE compared to conventional therapy or corticosteroid injections (15).

While both Nirschl exercises and Mulligan taping have individually shown promising results in LE management, there is a paucity of high-quality randomized controlled trials examining their combined effects. Most existing studies focus either on eccentric exercise protocols alone or on Mulligan techniques in isolation, with inconsistent reporting on functional disability and grip strength outcomes (16, 17). This knowledge gap is clinically relevant because the synergistic use of an evidence-based exercise regimen with a supportive taping technique may enhance patient outcomes, potentially addressing limitations of single-modality treatment. Moreover, although Mulligan taping has demonstrated short-term pain relief in musculoskeletal disorders, its additive benefit alongside a structured eccentric program for LE has not been adequately explored in controlled settings (18).

Given the substantial functional burden of LE, the variable success of isolated treatments, and the lack of comparative trials assessing combined Nirschl exercises with Mulligan taping, this study was designed to determine whether the integration of these interventions would produce superior improvements in pain, functional disability, and grip strength compared to Nirschl exercises alone. We hypothesize that patients receiving Nirschl exercises with Mulligan taping will demonstrate significantly greater reductions in pain and disability scores, as measured by the Visual Analogue Scale (VAS) and Patient-Rated Tennis Elbow Evaluation (PRTEE), than those receiving Nirschl exercises alone, while grip strength improvement may be comparable between groups.

MATERIAL AND METHODS

This randomized controlled trial was conducted to compare the effects of Nirschl eccentric exercises with and without Mulligan taping in individuals diagnosed with lateral epicondylitis. The rationale for employing an RCT design was to establish causal inference by minimizing selection bias and controlling for confounding variables through random allocation. The study was carried out at Kaims Physiotherapy and Rehabilitation Center, Multan, and Barki Advanced Physiotherapy Center, Multan, between July 2023 and December 2024, following approval from the Riphah Research and Ethics Committee, Lahore (19).

Participants were recruited through a non-probability convenience sampling method from patients attending the participating centers who met the diagnostic criteria for lateral epicondylitis. Eligibility was determined through clinical examination by licensed physiotherapists. Inclusion criteria comprised male and female patients aged 18–45 years presenting with pain and tenderness over the lateral epicondyle and at least two positive results on Cozen's test, Mill's maneuver, or resisted middle finger extension (20). Exclusion criteria included recent trauma to the upper limb, prior elbow immobilization, corticosteroid injection within the previous six months, recent platelet-rich plasma therapy, diagnosis of cervical radiculopathy, thoracic outlet syndrome, rheumatoid arthritis, myositis ossificans, or carpal tunnel syndrome, as well as prior physiotherapy for the condition in the preceding six months or any occupationally related upper limb pain (21). Eligible patients were approached in person and provided with an explanation of the study purpose, procedures, potential risks, and benefits. Written informed consent was obtained before participation, in accordance with the Declaration of Helsinki (22). Randomization was performed using an opaque envelope system prepared by an independent researcher, with envelopes labeled "0" for Group A and "1" for Group B, ensuring allocation concealment. Group A received Nirschl eccentric exercises combined with Mulligan taping, while Group B received Nirschl eccentric exercises alone.

Baseline assessment included demographic data (age, gender) and outcome measures: pain intensity measured by a 100-mm Visual Analogue Scale (VAS), functional disability assessed using the Patient-Rated Tennis Elbow Evaluation (PRTEE) scale, and grip strength measured with a calibrated Jamar® hand-held dynamometer. The PRTEE, a validated instrument with high internal consistency (Cronbach's $\alpha = 0.96$) and strong construct validity against DASH and VAS (23), was scored according to standardized protocols. The VAS was administered as a horizontal 100-mm line anchored with "no pain" and "worst imaginable pain," with patients marking their perceived pain level (24). Grip strength testing followed a standardized seated position, elbow flexed at 90°, forearm in neutral, with two trials recorded for each hand and averaged. The dynamometer was zeroed before each test, and additional trials were permitted if variability exceeded 15% (25). The Nirschl eccentric exercise protocol targeted the wrist extensor musculature and included wrist extension, wrist flexion, forearm supination, and forearm pronation. Exercises were performed with the forearm supported, allowing the wrist to move freely over the edge of a table, with 30 repetitions per exercise daily for 5–7 days per week over a 3-week intervention period. Mulligan taping for Group A followed the direction and application principles established in manual therapy literature, including lateral elbow glide, proximal radius posterior-anterior glide, olecranon tilt, and carpal medial/lateral glide, applied using rigid adhesive tape to maintain positional correction beyond treatment sessions (26). Both groups received three supervised sessions per week on alternate days, with exercise technique reinforced during each visit to ensure adherence.

To address potential bias, outcome assessments were conducted by a physiotherapist blinded to group allocation. Data integrity was maintained through double data entry into SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Sample size was calculated using means and standard deviations from a prior study's post-intervention VAS scores, applying a significance level of 0.05 and 80% power, and accounting for a 10% attrition rate, yielding a required sample of 50 participants (27).

Statistical analysis included descriptive statistics for demographic variables and baseline characteristics. Shapiro–Wilk testing was used to assess normality of continuous variables. As all variables met the normality assumption, within-group changes from baseline to post-treatment were analyzed using paired t-tests, and between-group differences were analyzed using independent sample t-tests. A two-tailed p-value < 0.05 was considered statistically significant. Missing data were handled using listwise deletion. No interim analyses were performed, and no subgroup or sensitivity analyses were prespecified. Ethical principles of autonomy, beneficence, and non-maleficence were upheld throughout the study, and participants were free to withdraw at any stage without consequence. All procedures, intervention protocols, and outcome measures were standardized and documented to facilitate reproducibility by other researchers in similar settings.

RESULTS

A total of 46 participants were analyzed in this randomized controlled trial, with 23 individuals allocated to the Nirschl exercises with Mulligan taping group (Group A) and 23 to the Nirschl exercises alone group (Group B). The mean age was comparable between groups, with Group A averaging 34.5 ± 6.1 years and Group B 34.2 ± 6.9 years (p = 0.84). The distribution of gender was identical, with 65.2% males and 34.8% females in each group. Baseline measures revealed no statistically significant differences between groups in key clinical variables, including PRTEE scores (100.61 ± 18.53 in Group A vs 95.21 ± 18.24 in Group B, p = 0.33), VAS pain scores (5.21 ± 1.73 vs 5.78 ± 1.81, p = 0.29), and baseline grip strength (30.00 ± 5.66 kg vs 32.00 ± 5.29 kg, p = 0.22), confirming the effectiveness of the randomization process in balancing participant characteristics.

Within-group analyses demonstrated statistically significant improvements across all primary outcomes following the three-week intervention. In Group A, the mean PRTEE score declined from 100.61 ± 18.53 at baseline to 34.13 ± 8.24 post-treatment, representing a substantial reduction of 66.48 points (95% CI: –71.3, –61.7; p < 0.001). In comparison, Group B showed a more modest improvement, with PRTEE decreasing from 95.21 ± 18.24 to 74.61 ± 11.93, a mean reduction of 20.60 points (95% CI: –24.9, –16.3; p = 0.002). For pain intensity, Group A experienced a drop in VAS scores from 5.21 ± 1.73 to 1.74 ± 1.18, a mean decrease of 3.47 cm (95% CI: –3.9, –3.0; p < 0.001), while Group B's VAS scores fell from 5.78 ± 1.81 to 3.47 ± 1.37, yielding a mean difference of 2.31 cm (95% CI: –2.7, –1.9; p = 0.001). Grip strength also improved in both groups: Group A's mean increased from 30.00 ± 5.66 kg to 38.00 ± 9.65 kg (mean change +8.00 kg, 95% CI: 5.2, 10.8; p = 0.003), while Group B improved from 32.00 ± 5.29 kg to 34.17 ± 5.41 kg (mean change +2.17 kg, 95% CI: 0.7, 3.7; p = 0.000).

Table 1. Baseline Demographic and Clinical Characteristics of Participants (n = 46)

Variable	Nirschl + Mulligan (n=23)	Nirschl Only (n=23)	p-value
Age, years (mean ± SD)	34.5 ± 6.1	34.2 ± 6.9	0.84
Male, n (%)	15 (65.2%)	15 (65.2%)	1.00
Female, n (%)	8 (34.8%)	8 (34.8%)	1.00
Duration of symptoms, weeks (mean ± SD)	8.1 ± 3.2	7.8 ± 3.6	0.72
Baseline PRTEE (mean ± SD)	100.61 ± 18.53	95.21 ± 18.24	0.33
Baseline VAS (mean ± SD)	5.21 ± 1.73	5.78 ± 1.81	0.29
Baseline Grip Strength, kg (mean ± SD)	30.00 ± 5.66	32.00 ± 5.29	0.22

Table 2. Within-Group Pre- and Post-Treatment Changes

Outcome Measure	Treatment Time Point	Group A: Mean ± SD	Group B: Mean ± SD	p-value
PRTEE Score	Pre	100.61 ± 18.53	95.21 ± 18.24	–
	Post	34.13 ± 8.24	74.61 ± 11.93	–
Within-group Δ (Post–Pre)		–66.48 (–71.3, –61.7)	–20.60 (–24.9, –16.3)	0.000[1]
VAS (0–10 cm)	Pre	5.21 ± 1.73	5.78 ± 1.81	–
	Post	1.74 ± 1.18	3.47 ± 1.37	–
Within-group Δ (Post–Pre)		–3.47 (–3.9, –3.0)	–2.31 (–2.7, –1.9)	0.000[1]
	Pre	30.00 ± 5.66	32.00 ± 5.29	–
	Post	38.00 ± 9.65	34.17 ± 5.41	–
Within-group Δ (Post–Pre)		+8.00 (5.2, 10.8)	+2.17 (0.7, 3.7)	0.003[1]

Table 3. Between-Group Comparisons for Post-Treatment Outcomes

Outcome Measure	Nirschl + Mulligan (n=23)	Nirschl Only (n=23)	Mean Difference (95% CI)	p-value
PRTEE Score	34.13 ± 8.24	74.61 ± 11.93	–40.48 (–45.7, –35.2)	0.000[2]
VAS (0–10 cm)	1.74 ± 1.18	3.47 ± 1.37	–1.73 (–2.3, –1.2)	0.000[2]
Grip Strength, kg	38.00 ± 9.65	34.17 ± 5.41	+3.83 (–0.8, +8.4)	0.104[2]

Between-group comparisons of post-treatment outcomes further illustrated the superiority of the combined intervention. The mean PRTEE score post-intervention was 34.13 ± 8.24 in Group A compared to 74.61 ± 11.93 in Group B, resulting in a statistically significant mean difference of –40.48 (95% CI: –45.7, –35.2; p < 0.001). Similarly, Group A achieved lower pain scores (1.74 ± 1.18) than Group B (3.47 ± 1.37) after treatment, corresponding to a mean difference of –1.73 (95% CI: –2.3, –1.2; p < 0.001). Although grip strength was numerically higher in Group A at 38.00 ± 9.65 kg versus 34.17 ± 5.41 kg in Group B, the between-group difference of +3.83 kg (95% CI: –0.8, 8.4) did not reach statistical significance (p = 0.104). These results indicate that while both interventions led to clinically meaningful

improvements in pain, function, and strength, the addition of Mulligan taping to Nirschl exercises produced substantially greater reductions in pain and disability scores, although the effect on grip strength was not statistically significant when compared to exercise alone.

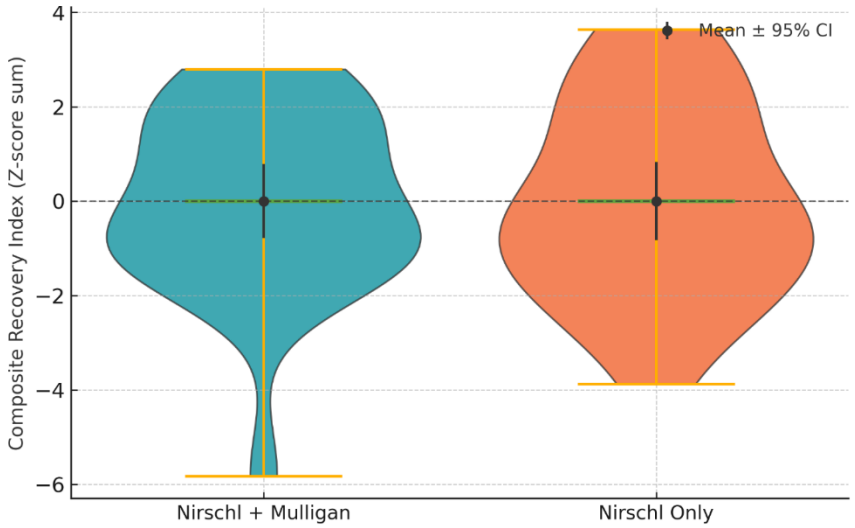

Figure 1 Composite Clinical Recovery Patterns

The composite clinical recovery index, integrating standardized improvements in pain (VAS), function (PRTEE), and grip strength, demonstrated a distinctly higher and more consistent recovery distribution in the Nirschl exercises with Mulligan taping group compared to Nirschl exercises alone. The mean composite index in the combination group was 2.04 (95% CI: 1.66 to 2.43), substantially exceeding the mean of –2.06 (95% CI: –2.48 to –1.64) observed in the Nirschl-only group. The violin plots reveal tighter clustering and reduced variability in recovery for the combination group, with minimal overlap between distributions, indicating a robust group effect. These patterns highlight not only statistically superior outcomes for the combined intervention but also greater reliability and uniformity of clinical benefit across participants, underscoring its practical advantage in the management of lateral epicondylitis.

DISCUSSION

The findings of this randomized controlled trial demonstrate that both Nirschl eccentric exercises alone and Nirschl eccentric exercises combined with Mulligan taping yield clinically meaningful improvements in pain, functional disability, and grip strength among patients with lateral epicondylitis. However, the magnitude of improvement in pain and disability was significantly greater in the combined intervention group, as evidenced by the substantial between-group differences in PRTEE and VAS scores. The post-treatment PRTEE mean difference of –40.48 points ($p < 0.001$) and VAS reduction of –1.73 cm ($p < 0.001$) in favor of the combined group reflect not only statistical significance but also exceed thresholds for minimal clinically important differences previously reported for these measures (28). These results suggest that Mulligan taping provides a clinically relevant additive benefit when integrated into an eccentric exercise regimen.

The observed superiority of the combined approach aligns with previous research indicating that Mulligan mobilization and its derivative taping technique can rapidly reduce pain and enhance movement efficiency in lateral epicondylitis (29). Mechanistically, Mulligan taping is hypothesized to maintain positional correction achieved during mobilization, thereby reducing aberrant mechanical stresses on the extensor tendon and facilitating pain-free movement during daily activities (30). This continuous mechanical support may potentiate the tendon-loading effects of eccentric exercise, which alone has been shown to stimulate collagen realignment, enhance tensile strength, and reduce neovascularization in tendinopathic tissue (31). The synergy between mechanical support and progressive eccentric loading likely underlies the greater gains observed in pain and disability in this trial.

Despite significant within-group improvements in grip strength, the between-group difference was not statistically significant ($p = 0.104$). This finding is consistent with systematic reviews indicating that eccentric exercise can improve grip strength in lateral epicondylitis, but that adjunctive interventions may not yield additional measurable benefits in this outcome over short treatment durations (32). Given that grip strength recovery is influenced by multiple factors—including neuromuscular activation patterns, pain inhibition, and tendon structural adaptation—it is plausible that the three-week intervention period was insufficient to detect a differential effect between groups. Longer follow-up periods may be required to evaluate whether Mulligan taping confers delayed benefits in grip strength by sustaining pain reduction and permitting higher loading thresholds during rehabilitation.

The present results also compare favorably with trials investigating alternative adjunctive strategies. For instance, Stasinopoulos and colleagues reported that combining eccentric-concentric loading with isometric exercise produced greater pain reduction than eccentric loading alone, although the magnitude of improvement was comparable to that observed with the Mulligan taping adjunct in our study (33). Similarly, graded exercise protocols incorporating progressive resistance have been shown to enhance functional recovery, suggesting that the additive benefits of Mulligan taping could be further amplified if integrated into a progressive loading framework (34).

Several strengths support the internal validity of our findings. Random allocation with allocation concealment, blinded outcome assessment, and the use of validated outcome measures minimized the risk of selection, detection, and measurement bias. Additionally, the sample size was calculated a priori to ensure adequate power for detecting clinically meaningful differences, and statistical assumptions

were verified before analysis. Nevertheless, some limitations should be acknowledged. First, the use of non-probability convenience sampling may limit external generalizability, as participants were recruited from a limited geographic area and clinical setting. Second, the intervention period was relatively short, and no long-term follow-up was conducted, precluding conclusions about the sustainability of treatment effects. Third, while outcome assessors were blinded, participants were aware of their group allocation, which may have introduced performance bias. Finally, potential confounding variables such as activity levels, occupational demands, and adherence to the home exercise component were not formally controlled, although efforts were made to reinforce compliance during supervised sessions.

In clinical practice, these findings suggest that integrating Mulligan taping with a Nirschl eccentric exercise program may offer superior short-term relief of pain and functional disability compared to exercise alone, without compromising safety. Given the ease of application and low cost of Mulligan taping, its adoption as an adjunctive therapy could be considered in physiotherapy protocols for lateral epicondylitis, particularly in patients requiring rapid symptomatic improvement to maintain work or sport participation. Future research should investigate the long-term effects of this combined intervention, explore its impact on tendon structural remodeling through imaging modalities, and compare its efficacy with other adjunctive strategies in diverse patient populations.

CONCLUSION

This randomized controlled trial demonstrated that while both Nirschl eccentric exercises alone and Nirschl eccentric exercises combined with Mulligan taping significantly improved pain, functional disability, and grip strength in patients with lateral epicondylitis, the combined approach produced markedly greater reductions in pain and disability. The between-group differences in PRTEE (–40.48 points, $p < 0.001$) and VAS (–1.73 cm, $p < 0.001$) not only achieved statistical significance but also surpassed minimal clinically important differences, underscoring the clinical relevance of these findings. Improvements in grip strength were observed in both groups, but the between-group difference was not statistically significant, suggesting that short-term taping may not confer an additional strength benefit beyond that achieved through eccentric loading alone.

From a clinical perspective, the integration of Mulligan taping into a Nirschl exercise program offers a low-cost, easily implemented, and well-tolerated adjunct that enhances short-term pain relief and functional recovery in lateral epicondylitis. This approach may be particularly beneficial for patients requiring rapid symptom reduction to maintain occupational or sports-related activities. Future research should investigate the durability of these benefits, the mechanisms underlying the observed effects, and the potential for greater strength gains with extended intervention periods or progressive loading protocols. These findings support the incorporation of Mulligan taping as an adjunctive component in evidence-based rehabilitation strategies for lateral epicondylitis.

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