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Effectiveness of Mcconnell Taping Combined with Electrical Stimulation and Quadriceps Strengthening in Patellofemoral Instability Among Female Runners: A Randomized Controlled Trial

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Abstract:

- ***Background***

Patellofemoral instability is a multifactorial condition resulting from abnormal patellar tracking, soft-tissue imbalance, and neuromuscular dysfunction, often leading to pain and functional limitations in athletes, particularly female runners. While patellar taping, electrical stimulation, and quadriceps strengthening have individually shown benefits, their combined effectiveness has not been adequately studied.

- ***Objective***

To evaluate the effectiveness of McConnell taping combined with electrical stimulation and quadriceps strengthening compared with electrical stimulation and strengthening alone in female runners with patellofemoral instability.

- ***Methods***

A randomized controlled trial was conducted on 30 female runners (aged 18–30 years) diagnosed with recurrent patellofemoral instability. Participants were randomly allocated into two groups: Group A (McConnell taping + electrical stimulation + quadriceps strengthening) and Group B (electrical stimulation + quadriceps strengthening). Interventions were delivered over 4 weeks. Outcomes assessed at baseline, 2 weeks, and 4 weeks included pain (Visual Analogue Scale, VAS), function (Kujala questionnaire), and Q-angle. Statistical analysis was performed using paired and unpaired t-tests, with $p < 0.01$ considered significant.

- ***Results***

Both groups showed significant within-group improvements in pain, function, and Q-angle over 4 weeks ($p < 0.0001$). Between-group comparisons revealed significantly greater improvements in Group A across all outcomes. At 4 weeks, mean VAS reduced to 1.33 in Group A versus 2.87 in Group B ($p = 0.0001$), Kujala scores improved to 86.33 in Group A versus 73.73 in Group B ($p = 0.0001$), and Q-angle reduced to 18.33° in Group A versus 19.20° in Group B ($p = 0.0001$).

- ***Conclusion***

McConnell taping combined with electrical stimulation and quadriceps strengthening is more effective than electrical stimulation and strengthening alone in reducing pain, improving knee function, and correcting Q-angle in female runners with patellofemoral instability. These findings support incorporating patellar taping into rehabilitation programs for this population.

Keywords: *Patellofemoral Instability, McConnell Taping, Electrical Stimulation, Quadriceps Strengthening, Female Runners, Randomized Controlled Trial.*

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I. INTRODUCTION

Patellofemoral instability is defined as the inability of the patella to remain centered within the trochlea during knee motion, particularly between 0°–30° of flexion, where passive stability is lowest (Jenny McConnell, 2007). This condition results from a complex interplay of bony architecture, soft-tissue integrity, and neuromuscular control. Several factors predispose to patellofemoral instability, including increased femoral anteversion, tibial torsion, patella alta, excessive Q-angle and insufficiency of the medial patellofemoral ligament (J.S. Mulford, 2007). The imbalance between vastus medialis obliquus (VMO) and vastus lateralis (VL) activity has been strongly implicated in lateral patellar subluxation (Christopher M Powers, 2000). Patients often present with a sensation of patellar slipping, giving way, pain, swelling and apprehension during knee movements such as stair ascent or descent. Clinical parameters frequently assessed include Q-angle measurement, Kujala questionnaire scoring and Visual Analogue Scale (VAS) for pain (Michael James Callaghan, 2001; Bhawna Verma, 2007). Although patellar taping, electrical stimulation, and physical therapy have each shown beneficial effects in improving VMO activation, quadriceps strength, and reducing pain, no study has comprehensively assessed their combined effect in patellofemoral instability. Hence, there is a need to evaluate the integrated role of these rehabilitation techniques in improving function, reducing pain, and decreasing Q-angle in affected individuals.

II. METHODOLOGY

A. Design and Participants

➢ *Study Design*

Randomized controlled trial (parallel group design, 1:1 allocation ratio).

The study included 30 female runners aged 18–30 years, diagnosed with recurrent patellofemoral instability for at least 2 months. Participants were recruited from the Orthopaedic Department of Guru Gobind Singh Medical College & Hospital (GGSMC&H), Faridkot, and referred to the Physiotherapy Outpatient Department of University College of Physiotherapy, Faridkot. After obtaining informed consent, eligible participants were screened and enrolled. The sample size was limited to 30 due to strict eligibility criteria, limited patient availability during the study period, and feasibility constraints. As an academic randomized controlled trial, the primary aim was to generate preliminary evidence on the effectiveness of the interventions rather than large-scale generalization.

➢ *Inclusion Criteria:*

- Female runners aged 18–30 years
- Diagnosed with recurrent patellofemoral instability for at least 2 months

➢ *Exclusion Criteria:*

- Undergoing any medical treatment
- Patellar tendinopathy
- Any defined pathological knee condition
- Previous knee injury
- Recent knee surgery or arthroscopy
- History of fracture of lower limb

B. Randomization and Allocation Concealment

Randomization was performed using a random number table. Allocation concealment was maintained by opaque, sequentially numbered, sealed envelopes. No blinding was performed for either patients or therapists due to the nature of the interventions.

➢ *Group Allocation*

Participants were divided into two groups:

- Group A (Experimental Group): McConnell taping + Electrical stimulation + Quadriceps strengthening exercises
- Group B (Control Group): Electrical stimulation + Quadriceps strengthening exercises

➢ *Assessments*

Baseline and follow-up assessments were conducted at 0 week, 2 weeks, and 4 weeks. The following outcome measures were used:

- Visual Analogue Scale (VAS): To assess pain intensity (0 = no pain, 10 = severe pain).
- Kujala Functional Scoring System: 13-item questionnaire assessing knee function and symptoms.
- Q-angle Measurement: Angle formed between ASIS, patella midpoint, and tibial tuberosity (measured with goniometer).

Additional clinical tests included the patellar apprehension test, evaluation for patella alta, tenderness over the medial patellofemoral ligament, and the patellar grind test (Jenny McConnell, 2007).

C. Interventions

➢ *Group A: Experimental Group*

- *Electrical Stimulation (EMS):*
- Frequency: 65 Hz, Pulse width: 2.0 ms, Intensity: maximal comfortable contraction
- Protocol: 10:50:10 format (10 sec contraction, 50 sec rest, 10 repetitions)

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- Electrodes placed at proximal and distal aspects of vastus medialis
- Sessions: 3 times per week for 4 weeks (Parker et al., 2003; H.D. Hartsell, 1996)

- *McConnell Taping:*
- Applied after EMS, using medial glide technique (Noako Aminaka, 2008)
- Tape applied for 4 days, removed for 3 days, then reapplied (Cushnaghan et al., 1994)
- Continued for 4 weeks

- *Quadriceps Strengthening Exercises (Mark G. Kowall et al., 1996):*
- Quadriceps isometrics: Supine, pressing knee into floor, 10 sec hold × 10 reps × 3 sets
- Straight leg raises: Affected leg lifted 6 inches, held 10 sec × 10 reps × 3 sets
- Short arc terminal extension: Supine with pillow under knee, extend knee to full, hold briefly × 10 reps × 3 sets
- Frequency: Twice weekly, 4 weeks

➢ *Group B: Control Group*
- Electrical Stimulation (Same as Group A):
✓ Parameters: 65 Hz, 2.0 ms pulse width, 10:50:10 format, 3 times/week for 4 weeks
- Quadriceps Strengthening Exercises (Same as Group A):
✓ Quadriceps isometrics, straight leg raises, and short arc terminal extensions
✓ Frequency: Twice weekly, 4 weeks

III. STATISTICAL ANALYSIS

Data analysis was performed using SPSS version 21.0. Within-group comparisons (pre-, mid, and post-intervention) were analyzed using the paired t-test, while between-group comparisons were assessed using the unpaired t-test. A p-value of <0.01 was considered statistically significant.

IV. RESULTS

➢ *Baseline Characteristics*

The study included 30 female participants (15 in each group). The mean age of Group A and Group B was identical (22.80 ± 3.59 years), with no significant difference between the groups (p = 1.000).

➢ *Visual Analogue Scale (VAS)*
- *Within-group analysis*: Both groups demonstrated significant reductions in pain across 0, 2nd, and 4th weeks (p < 0.0001). In Group A, mean VAS decreased from 8.40 to 1.33, while in Group B it decreased from 8.40 to 2.87.
- *Between-group analysis*: No difference was observed at baseline (p = 1.000). However, Group A showed significantly greater pain reduction than Group B at both 2nd and 4th weeks (p < 0.01) (Table 1).

Table 1. Comparison of VAS Scores within and Between Groups

Timepoint	Group A Mean ± SD (95% CI)	Group B Mean ± SD (95% CI)	p-value
Pre-test	8.40 ± 0.63 (8.05–8.75)	8.40 ± 0.63 (8.05–8.75)	1.000 (NS)
2 weeks	5.60 ± 0.99 (5.04–6.16)	6.67 ± 0.90 (6.16–7.18)	0.004 (S)
4 weeks	1.33 ± 0.49 (1.07–1.59)	2.87 ± 0.99 (2.31–3.43)	0.0001 (S)

*NS= Not Significant
*S= Significant

➢ *Kujala Questionnaire*
- *Within-group analysis*: Both groups showed significant functional improvement over time (p < 0.0001). In Group A, scores improved from 67.87 to 86.33, while in Group B they improved from 62.60 to 73.73.
- *Between-group analysis*: No baseline difference was observed (p = 0.128). At the 2nd and 4th weeks, Group A had significantly higher Kujala scores than Group B (p < 0.01), reflecting greater functional improvement (Table 2).

Table 2. Comparison of Kujala Scores within and Between Groups

Timepoint	Group A Mean ± SD (95% CI)	Group B Mean ± SD (95% CI)	p-value
Pre-test	67.87 ± 4.61 (65.24–70.50)	62.60 ± 6.13 (59.16–66.04)	0.128 (NS)
2 weeks	77.07 ± 3.37 (75.17–78.97)	67.33 ± 5.21 (64.36–70.30)	0.0001 (S)
4 weeks	86.33 ± 4.95 (83.68–88.98)	73.73 ± 4.35 (71.23–76.23)	0.0001 (S)

*NS= Not Significant
*S= Significant

➢ *Q-angle Measurement*
- *Within-group analysis*: Both groups demonstrated a significant reduction in Q-angle over time. Group A reduced from 19.73° to 18.33° (p < 0.0001), while Group B reduced from 19.53° to 19.20° (p < 0.01).
- *Between-group analysis*: No difference at baseline (p = 0.253). At 2nd and 4th weeks, Group A showed significantly greater reduction compared to Group B (p < 0.01) (Tables 3).

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Table 3. Comparison of Q-Angle within and Between Groups

Timepoint	Group A Mean ± SD (95% CI)	Group B Mean ± SD (95% CI)	p-value
Pre-test	19.73 ± 0.50 (19.46–20.00)	19.53 ± 0.44 (19.29–19.77)	0.253 (NS)
2 weeks	19.10 ± 0.28 (18.95–19.25)	19.47 ± 0.40 (19.26–19.68)	0.007 (S)
4 weeks	18.33 ± 0.41 (18.11–18.55)	19.20 ± 0.32 (19.02–19.38)	0.0001 (S)

*NS= Not Significant
*S= Significant

V. DISCUSSION

The principal findings of the present study were that both groups showed significant improvements in pain, Q-angle, and function following four weeks of intervention. However, the group that received McConnell taping in addition to electrical stimulation and physical therapy (Group A) demonstrated significantly greater improvements than the group that feedback, promoting better VMO activation and contributing to patellar stability and recovery received electrical stimulation and physical therapy alone (Group B). These findings suggest that McConnell taping provides additional clinical benefits in reducing pain, correcting patellar alignment, and improving functional outcomes. The superior results in Group A can be attributed to medial patellar taping, which realigns the patella, reduces lateral tracking and joint stress, and thereby lessens pain and improves function. It may also enhance sensory.

The findings of the present study are consistent with earlier work. McConnell (2007) emphasized that patellar taping minimizes excessive patellar motion and helps stabilize hypermobile patellae in recurrent instability. Similarly, Whittingham (2004) reported that four weeks of daily patellar taping combined with exercises significantly improved pain and function compared with exercise alone. Kowal et al. (1996) also highlighted the effectiveness of a four-week quadriceps rehabilitation program in improving outcomes in patellofemoral disorders, aligning with the physical therapy component of the current study.

Pfeiffer et al. (2004) demonstrated that McConnell taping produces a significant medial glide of the patella, supporting its role in improving patellofemoral tracking. Kaya et al. (2010) also found that combining patellar taping with an exercise program enhanced quadriceps activation and pain reduction, further validating our findings. Regarding the role of electrical stimulation, Parker et al. (2003) reported significant improvements in quadriceps strength with neuromuscular electrical stimulation, which is consistent with the improvements observed in both groups in this study. Similarly, Callaghan (2001) confirmed the usefulness of VAS and Kujala scores as reliable outcome measures in patellofemoral pain, which were also employed in the present study.

VI. CONCLUSION

This study concluded that patellar taping combined with electrical stimulation and physiotherapy was more effective than physiotherapy with electrical stimulation alone in reducing pain, correcting Q-angle, and improving function. Patients receiving taping showed greater improvements in VAS, Kujala scores, and Q-angle at both the 2nd and 4th weeks, confirming its added clinical benefit.

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