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Comparing the effects of progressive tendon loading exercises versus eccentric training and static stretching exercises on patellar tendinopathy among college recreational players

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Abstract
The study compares the effectiveness of Progressive Tendon Loading Exercises (PTLE) with eccentric training combined with static stretching in managing patellar tendinopathy among college recreational players. Thirty participants were divided into two groups and treated over 24 weeks. Outcomes were measured using the VISA-P questionnaire assessing pain, function, and sports ability. Results showed that PTLE produced greater improvements in pain relief, functional performance, and tendon strength than the traditional eccentric and stretching approach, indicating that PTLE is a more effective rehabilitation method for patellar tendinopathy.

Keywords: Progressive tendon loading exercises, eccentric training, static stretching exercises, patellar tendinopathy

1. Introduction
Patellar tendinopathy, also known as jumper's knee, is a condition causing activity-related pain at the distal pole of the patella or proximal patellar tendon, commonly affecting athletes involved in jumping and high-impact sports. It results from repetitive stress on the knee's extensor mechanism and can lead to significant functional impairment. The prevalence is high in volleyball (45%), basketball (14%), and present even in soccer (2.4%) players.
The pathophysiology involves both extrinsic factors (like mechanical overload) and intrinsic factors (such as malalignment, muscle tightness, and imbalance), leading to tendinosis a degenerative process marked by mucoid degeneration and neovascularization associated with pain.
Common symptoms include localized pain, swelling, stiffness, reduced strength, and gradual onset of discomfort during activity.
Treatment options include eccentric training combined with static stretching, which addresses muscle tightness but may provoke pain during competitive phases. A newer approach, Progressive Tendon Loading Exercise (PTLE), emphasizes a gradual increase in load from isometric to isotonic and energy-storage exercises promoting tendon remodeling and improved pain management.

2. Materials and Methodology
2.1 Materials used
- Bench
- Dumbbell's
- Consent form
- Leg press machine
- Note
- Pen

2.2 Study design and setting
This study employed a quasi-experimental pre- and post-test design and was conducted at

department of physiotherapy of Sri Ramakrishna college of paramedical science, under supervision of staff in charge, SRIPMS, Coimbatore, over a period of 3 months.

2.3 Participants and sampling

- Based on following criteria 30 individuals with patellar tendinopathy were assigned for comparative study.
- Progressive tendon loading exercises Group A (n=15).
- Eccentric training and static stretching Group B (n=15).

2.4 Inclusion criteria

- Age group between 18 to 30 years.
- College athletes with diagnosed patellar tendinopathy.
- Only male players were included
- Tenderness on palpitation of the corresponding area on the proximal patellar tendon.

2.5 Exclusion criteria

- Subjects with any diagnosed deformities of hip and knee.
- Recent fracture of knee.
- Lower limb ligament injuries.
- Previous surgery of knee.
- Inflammatory joint disease.
- Familial hypercholesterolemia

2.6 Variables

- **Independent variables:** Patellar tendon loading exercises, Eccentric training and static stretching.
- **Dependent variables:** Pain and functional improvement.

2.7 Assessment tool

- Victorian institute of sports assessment for patellar tendon (VISA-P) was used to assess the pain and functional movement.

1. For how many minutes can you sit pain free?

0 minutes ☐0 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10 100 minutes

2. Do you have pain walking downstairs with a normal gait cycle?

Strong severe pain ☐0 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10 No pain

3. Do you have pain at the knee with full active non-weightbearing knee extension?

Strong severe pain ☐0 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10 No pain

4. Do you have pain when doing a full weight bearing lunge?

Strong severe pain ☐0 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10 No pain

5. Do you have problems squatting?

Unable to do ☐0 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10 No problems

6. Do you have pain during or immediately after doing 10 single leg hops?

Strong severe pain ☐0 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10 No pain

7. Are you currently undertaking sport or other physical activity?

0	Not at all
4	Modified training ± modified competition
7	Full training ± competition but not at same level as when symptoms began
10	Competing at the same or higher level as when symptoms began

8. Please complete EITHER A, B or C in this question.

- If you have **no pain** while undertaking sport please complete **Q8a only.**
- If you have **pain while undertaking sport but it does not stop you** from completing the activity, please complete **Q8b only.**
- If you have **pain that stops you from completing sporting activities**, please complete **Q8c only.**

A. If you have no pain while undertaking sport, for how long can you train/practise?

NIL	1-5 minutes	6-10 minutes	7-15 minutes	>15 minutes
0	7	14	21	30

B. If you have some pain while undertaking sport, but it does not stop you from completing your training/practice for how long can you train/practise?

NIL	1-5 minutes	6-10 minutes	7-15 minutes	>15 minutes
0	4	10	14	20

C. If you have pain which stops you from completing your training/practice for how long can you train/practise?

NIL	1-5 minutes	6-10 minutes	7-15 minutes	>15 minutes
0	2	5	7	10

TOTAL SCORE (_____ /100) = _____%

Fig 1: Victorian Institute of Sports Assessment for Patellar Tendon (VISA-P)

2.8 Treatment procedure

Progressive Tendon Loading Exercises (PTLE)

The PTLE program was divided into four progressive stages to promote tendon healing and strength:

- **Stage 1 - Isometric (Static) exercises:** Daily single-leg leg-press or leg-extension holds (5 reps × 45 seconds) at mid-range (60° knee flexion) and 70% maximal effort to reduce pain and initiate tendon activation.
- **Stage 2 - Isotonic (Dynamic) exercises:** Combined with stage 1, performed on alternate days with progressive single-leg movements (4 sets × 15 reps to 4 sets × 6 reps) increasing load and range (10°-90° knee flexion).
- **Stage 3 - Energy storage (Plyometric) exercises:** Introduced jump squats, box jumps, and cutting maneuvers every third day (progressing from double-leg to single-leg). Isometric and isotonic training continued on other days.
- **Stage 4 - Sport-specific exercises:** Gradual return to sport activities (e.g., basketball, volleyball) every 2-3 days, with continued isometric exercises on alternate days to maintain tendon strength and recovery.

Eccentric training and static stretching

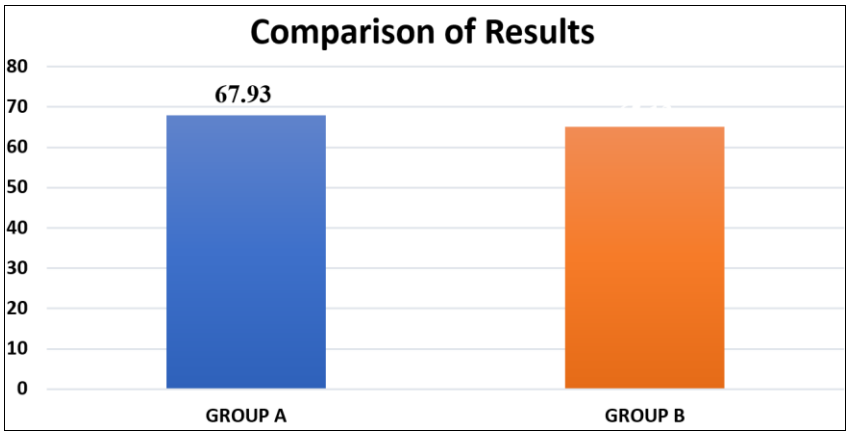
Participants performed unilateral squats on a 25° decline board (3 sets × 15 reps) slowly to load the quadriceps and patellar tendon eccentrically. The non-injured leg assisted the return to start position.

- Training was done once daily, three times per week for 12 weeks.
- Mild pain was acceptable, but exercises were stopped if pain became severe.
- Load increased gradually by adding hand-held weights once pain-free.

- Static stretching of the hamstrings and quadriceps was performed before and after training, with each stretch held for 30 seconds and a 1-minute rest between stretches.

3. Result

Pre-test and post-test values of the study were collected and assessed for variations in improvement and their results were analysed using independent t test and parried t test. The statically analysis of the study showed that there is a significant difference between the groups with a t value of VISA-P Scale was 2.048.



Graph 1: Comparing the post test of group A & B: The Victorian Institute of Sport Assessment - Patella (VISA- P)

4. Discussion

This study compared the effectiveness of Progressive Tendon Loading Exercises (PTLE) and Eccentric Training with Static Stretching in improving pain reduction and functional movement among 30 patients with patellar tendinopathy. Both groups showed statistically significant improvements based on VISA-P scores, with Group A (PTLE) demonstrating superior outcomes ($t = 18.75$, $p<0.05$) compared to Group B ($t = 16.00$, $p<0.05$). The mean improvement was also greater in Group A (67.93) than Group B (65.13).

The findings align with Robert-Jan de Vos's study, which reported significant pain reduction and improved function following PTLE, and Stasinopoulos Dimitrios's research, which highlighted the benefits of combining eccentric training with static stretching. However, PTLE proved to be more effective, less painful, and associated with a higher return-to-sport rate (43% vs 27%) and greater patient satisfaction (38% vs 10%).

The superiority of PTLE is attributed to its progressive design, starting with isometric exercises that reduce pain and enhance muscle activation, followed by isotonic and sport-specific phases promoting tendon adaptation and strength.

5. Conclusion

This study demonstrates that Progressive Tendon Loading Exercise (PTLE) is more effective than eccentric training combined with static stretching in managing patellar tendinopathy among college recreational players. PTLE yielded significant improvements in pain reduction, functional performance and tendon strength compared to the traditional eccentric training approach.

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