

**ANALYSIS OF ELECTROMYOGRAPHY OF QUADRICEPS
MUSCLE OF VOLLEYBALL PLAYERS WITH PATELLAR
TENDINOPATHY - AN OBSERVATIONAL STUDY**

By

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In

SPORTS



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Thank you.

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LIST OF ABBREVIATIONS USED

1. ABSMARI - Abhinav Bindra Sports Medicine and Research Institute.
2. sEMG – Electromyography
3. SD - Standard Deviation.
4. SPSS - Statistical Package for social science.
5. MPT- Master of physiotherapy
6. OUHS- Odisha university of health science
7. RF- Rectus Femoris
8. SPSS- Stastical package of the social science
9. VL- Vastus lateralis
10. VM- Vastus medialis

ABSTRACT

Background: Patellar tendinopathy (PT) is a common overuse injury among volleyball players, caused by chronic repetitive jumping and landing that places high mechanical stresses on the knee. Abnormal activation patterns of the quadriceps muscle can be responsible for aberrant tendon stress and PT pathology.

Purpose: The purpose of this study was to explore quadriceps muscle activation differences, as assessed using surface electromyography (EMG), between volleyball athletes with PT and healthy controls, and to explore the correlation between changed activation and PT severity.

Methods: Twenty competitive volleyball players were enlisted and categorized into a PT group (n = 20) and a healthy control group (n = 20). Demographic and anthropometric measures were similar between groups ($p > 0.20$). Surface EMG captured peak and mean activity of rectus femoris (RF), vastus lateralis (VL), and vastus medialis (VM) during countermovement jumps. In-group muscle activation patterns were compared using two-way repeated measures ANOVA, whereas between-groups were compared using independent samples t-tests with Welch's correction if necessary.

Results: PT group revealed significant decreases in RF and VL activation. RF peak ($368.35 \pm 82.17 \mu\text{V}$) and mean ($61.75 \pm 16.46 \mu\text{V}$) values were significantly reduced in healthy controls ($643.05 \pm 371.52 \mu\text{V}$ and $103.50 \pm 44.74 \mu\text{V}$, respectively; $p = 0.003$ – 0.001). VL peak and mean activation were also decreased ($p = 0.025$ and $p = 0.023$). No differences were noted for VM activation ($p > 0.23$). Peak values systematically surpassed mean values in all muscles, and the muscle \times measure interaction was near significance ($p \approx 0.049$), indicating differential peak–mean separations across muscles.

Conclusion: Patellar tendinopathy volleyball players display selectively decreased activation of rectus femoris and vastus lateralis during sport-movement patterns, with preservation of vastus medialis activation. These results suggest that PT changes neuromuscular recruitment patterns, emphasizing the need for specific rehabilitation maneuvers targeting RF and VL activation to reestablish quadriceps balance function, enhance performance, and minimize reinjury risk.

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INTRODUCTION

Sports injuries remain a major concern for athletes, coaches, and healthcare professionals. The knee joint, as a complex hinge joint that supports high loads and allows extensive movement, is commonly subjected to acute as well as overuse injuries among athletes. Volleyball, a sport that is famous for having intense episodes of jumping, landing, and quick direction change, imposes severe repeated stress on the knee joint. The repeated movements, combined with dynamic force development from muscles surrounding the knee, render volleyball players highly susceptible to overuse pathologies ^(1,2).

The quadriceps femoris, consisting of four individual muscles vastus medialis, vastus lateralis, vastus intermedius, and rectus femoris is a crucial component of knee biomechanics. They are effective in extending the knee and dynamic stabilization during movement, essentially managing the transmitted forces through the knee during jumping and landing movements ⁽²¹⁾. Correct neuromuscular coordination and sufficient strength in the quadriceps are both necessary for safe and effective force absorption. Any impairment or imbalance of this muscle group can enhance mechanical stress on the structures of the knee, particularly the patellar tendon, and make athletes susceptible to tendinopathy and other overuse injuries ⁽³⁾.

Patellar tendinopathy which is commonly known as jumper's knee, is a degenerative injury involving pain and dysfunction of the patellar tendon, typically involving the inferior pole of the patella. Despite its classic description as an inflammatory tendonitis, current evidence supports PT as a chronic tendinosis characterized by collagen disruption, increased ground substance, neovascularization, and cellular alterations within the tendon tissue ^(8,11). These pathologic changes decrease elasticity and tensile strength of the tendon, compromising load tolerance and causing pain with dynamic sport-related activities.

Epidemiological research shows that PT is more common in sport participants who engage in sports with frequent jumping and explosive lower limb movements. Volleyball, for example, shows some of the highest PT rates among sports. A complete meta-analysis of over 28,000 sport participants reported a general PT prevalence of 18.3% among sport-active populations. Particularly, the prevalence was 24.8% in basketball players, 20.8% in volleyball players, and 6.1% in soccer players ⁽⁴⁾. These data are supported by several studies showing that volleyball players, particularly those at the professional level, have PT prevalence rates up to 45% ^(10,19)

Age, sex, and competitive level strongly influence PT risk. For example, athletes 18 years and above bear more than twice the prevalence rate than younger athletes (21.3% vs. 10.1%), highlighting the cumulative nature of the effects of chronic repetitive loading over time ^(4,11). With respect to sex-based differences, the prevalence of PT among male volleyball players is relatively higher (approximately 25.3%) than that for females (13.1%), which might be due to increased quadriceps strength and jumping ability among men, leading to higher tendon loading forces ^(12,19). The differences are multifactorial, however, and may be determined by hormonal, biomechanical, and training-related factors.

Position-specific needs in volleyball also have implications for the risk profile. Playing positions involving repeated aggressive jumping, e.g., outside hitters and middle blockers, exhibit higher PT risk compared with less jump-prone positions such as setters and liberos ⁽¹⁹⁾. Such risk stratification implies that specific preventive strategies may prove beneficial by adjusting training loads according to playing position.

From a functional perspective, patellar tendinopathy (PT) typically presents with localized swelling and pain that worsen during landing and jumping activities, accompanied by notable declines in muscular strength, proprioception, and neuromuscular coordination ⁽⁵⁾. These impairments can reduce key performance indicators such as jump height and agility and may prompt athletes to adopt compensatory movement strategies, thereby increasing the likelihood of secondary injuries.

Surface electromyography (EMG) is widely recognized in sports science and clinical practice as a critical method for evaluating muscle performance. By measuring electrical signals generated during muscular contraction, EMG reveals recruitment patterns and coordination details that are difficult to detect through routine clinical assessments ⁽³⁾. Evidence indicates that individuals with PT often exhibit delayed firing or lower amplitude activation in their quadriceps muscles compared to healthy peers ⁽¹³⁾. Such neuromuscular alterations may either exacerbate tendon loading or serve as protective responses, ultimately sustaining abnormal stress on the patellar tendon.

Although considerable research exists on tendon overload and general biomechanics, only a limited number of investigations have specifically targeted volleyball athletes performing volleyball-related tasks. Most EMG studies have involved broader populations or movements that are not sport-specific, leaving an important knowledge gap regarding the neuromuscular function of volleyball players under authentic performance conditions ⁽¹³⁾. Given the fast-paced and dynamic characteristics of volleyball, reassessing jumping and landing mechanics within sport-specific contexts is essential for clarifying how mechanical loads contribute to tendon injury.

Filling this knowledge gap offers valuable direction for developing prevention strategies and rehabilitation programs tailored to volleyball players. Understanding distinctive quadriceps activation patterns in athletes with PT can help coaches and clinicians optimize training volumes, design targeted neuromuscular retraining protocols, and ultimately lower the risk of reinjury while supporting sustained athletic performance.

NEED OF THE STUDY

Considering how common and impactful patellar tendinopathy is among volleyball players, this research seeks to better clarify the neuromuscular disturbances involved by using electromyography. Examining quadriceps activation during movements specific to volleyball may reveal functional weaknesses that lead to injury and ongoing symptoms.

Findings can directly influence injury prevention programs by pointing to at-risk athletes based on different muscle activity profiles. They also inform rehabilitation by targeting retraining individual muscles to restore optimal activation patterns, enhance biomechanical functioning, and decrease recurrence risk. Such targeted care improves performance durability, extends athletic careers, and decreases healthcare costs.

AIM AND OBJECTIVE

AIM OF THE STUDY

To investigate the differences in lower extremity neuromuscular activity, measured by Electromyography (EMG), between volleyball players with patellar tendinopathy and healthy volleyball players, and to assess its association with the severity of patellar tendinopathy.

STUDY OBJECTIVES

To compare the muscle activation patterns in the lower extremity of volleyball players with patellar tendinopathy to those of healthy volleyball players using Electromyography (EMG).

HYPOTHESIS OF THE STUDY

Null Hypothesis

- There will be no alteration in the muscle activation pattern during jumping and landing activities in volleyball players with patellar tendinopathy compared to asymptomatic controls.

Alternate Hypothesis

- There will be altered muscle activation patterns during jumping and landing activities in volleyball players with patellar tendinopathy compared to asymptomatic controls.

REVIEW OF LITERATURE

1. van der Worp et al. (2011) – Risk factors for patellar tendinopathy: a prospective study among volleyball players

This large prospective study of more than 200 volleyball players had a prevalence of around 40% for patellar tendinopathy. The highest-risk groups were male athletes, those playing at national or elite levels, and players in jumping-specific positions (outside hitters, middle blockers). Resulting factors were listed as repetitive high-load jumping with inadequate recovery.

2. De Vries et al. (2017) – Prevalence of patellar tendinopathy and its effect on sports participation

Surveying athletes in a range of sports, it was found that 18–25% of volleyball players experienced symptomatic patellar tendinopathy, higher than rates in soccer or basketball. Notably, more than half of symptomatic athletes reported decreased participation, with some being forced to abandon competitive sports. PT's profound effect on career duration was highlighted by the authors.

3. Walton et al. (2023) – Clinical burden and management of patellar tendinopathy in elite volleyball athletes

Walton and co-authors reported a 40% incidence of PT in elite volleyball players, with competitive season peak intensity of symptoms. Most players experienced persistent or chronic pain despite rehabilitation. The authors concluded that PT is a chronic burden with partial treatment success and persistent performance impact.

4. Christina Frese et al. (2022) – Decreased Vastus Medialis/Lateralis EMG Ratio in Volleyballers with Chronic Knee Pain

This pilot study examined quadriceps muscle activation in volleyball players with chronic knee pain, including PT, by surface EMG during countermovement and spike jumps on indoor and beach surfaces. Six injured and nine control subjects took part. Results indicated that injured athletes exhibited significantly lower VM/VL activation ratios than controls, regardless of surface or task. This disproportion suggests compromised neuromuscular control and that decreased VM activation compared to VL might contribute to patellar maltracking and tendon overload. The research lends evidence to EMG biofeedback and specific neuromuscular retraining in rehabilitation.

5. Rob W. Bisseling et al. (2007) – Relationship between landing strategy and patellar tendinopathy in volleyball

Bisseling et al. investigated if drop jump landing dynamics were different between healthy volleyball players (CON), asymptomatic volleyball players with a past history of patellar tendinopathy (PJK), and symptomatic volleyball players with a recent diagnosis (RJK). Inverse dynamics analyses of 30, 50, and 70 cm drop jumps were used, with repeated measures ANOVA comparing joint dynamics. Findings indicated that the PJK group exhibited greater knee angular velocities and greater ankle plantar flexion moment loading rates than controls. There were also significant tendencies for increased loading rates of vertical

ground reaction force and greater knee extensor moment loading. The authors concluded that changing landing patterns, specifically stiffer landing in previously injured athletes, can lead to tendon overloading and be a cause of perpetuating patellar tendinopathy.

6. Shawn C. Sorenson et al. (2010) – Knee Extensor Dynamics in the Volleyball Approach Jump: The Influence of Patellar Tendinopathy

The objective of Sorenson et al. was to compare knee joint dynamics in elite volleyball players with and without patellar tendinopathy, with a focus on energy absorption and generation. Thirteen elite male volleyball players executed maximal approach jumps, and sagittal plane kinematics and kinetics were measured using motion capture and force platforms. Vertical ground reaction forces and pelvis velocity at take-off were also quantified. Results demonstrated that players with patellar tendinopathy exhibited significantly lower net joint work and power, by about 30%, during the eccentric phase but not the concentric phase. These findings highlighted that eccentric loading upon landing is the key phase responsible for tendon stress and pathology in volleyball players.

7. Christian Helland et al. (2013) – Mechanical properties of the patellar tendon in elite volleyball players with and without patellar tendinopathy

Helland et al. examined whether flexibility and strength varied between healthy controls and athletes with patellar tendinopathy. Fourteen male volleyball, handball, and basketball players were classified into a control and a tendinopathy group. Hip, knee, and ankle isometric torques were measured with a handheld dynamometer, while ankle dorsiflexion, hamstring, and quadriceps flexibility were assessed using a gravity inclinometer. The study found that athletes with tendinopathy displayed strength and flexibility deficits compared with controls, which could increase knee extensor loading. The authors concluded that such impairments could contribute to the formation and maintenance of patellar tendinopathy, with a need to include flexibility and strength training as part of rehabilitation.

8. Adam B. Rosen et al. (2015) – Lower Extremity Kinematics During a Drop Jump in Individuals With Patellar Tendinopathy

Rosen and others aimed to identify whether patellar tendinopathy athletes have altered kinematics upon landing compared to healthy participants. Sixty recreationally active subjects (30 with tendinopathy and 30 controls matched for age, sex, and activity level) completed drop jumps with subsequent vertical jumps, and joint angles and displacements at the hip, knee, and ankle in three planes were recorded. The results indicated that patellar tendinopathy athletes had lower maximum flexion and angular displacement in the sagittal plane at both hip and knee. These observations are consistent with the possibility that stiffer landing patterns are leading to tendon overload and symptom perpetuation, which might be modulated by the contributions of the rectus femoris during dynamic activities.

9. Van der Worp H, Malliaras P, et al. (2015) – Patellar Tendinopathy: Clinical Diagnosis, Load, and Movement Patterns

This observational research reviewed movement strategies and mechanical loading patterns in athletes with patellar tendinopathy. Van der Worp, Malliaras, and colleagues identified a characteristic stiff-knee landing pattern combined with reduced hip flexion among symptomatic athletes compared with healthy peers. These biomechanical features increase patellar tendon strain during dynamic movements such as jumps and

landings. The study emphasized that altered landing mechanics are both a marker and a potential contributor to tendon pathology. The authors highlighted the clinical importance of load management, movement retraining, and strength conditioning as central components of PT prevention and rehabilitation strategies in jumping athletes.

10. Malliaras et al., (2015) – Clinical Diagnosis and Load Characteristics of Patellar Tendinopathy in Athletes

Malliaras and colleagues examined biomechanical and clinical features associated with patellar tendinopathy (PT), focusing on how tendon loading and movement patterns contribute to injury risk and progression. Their review and observational data highlighted that athletes with PT often adopt altered landing strategies, including reduced knee flexion angles and increased lower-limb stiffness during jump landings. These changes increase patellar tendon stress and may perpetuate tendon degeneration over time. The authors further suggested that such mechanical adaptations likely influence neuromuscular control, potentially altering electromyographic (EMG) activation patterns of the quadriceps. Recognizing these movement and loading differences is crucial for clinicians when diagnosing PT and developing rehabilitation strategies aimed at restoring normal kinematics and balanced muscle activation.

11. Z. J. Zhang et al. (2016) – Increase in passive muscle tension of the quadriceps muscle heads in jumping athletes with patellar tendinopathy

Zhang and others examined quadriceps passive muscle tension and tendon stiffness in 66 male jumping athletes and contrasted them with healthy controls. Supersonic shear wave imaging technology was employed to measure passive tension of the rectus femoris (RF) and vastus lateralis (VL) muscles, as well as patellar tendon stiffness. A 26.5% elevation of shear elastic modulus of the VL muscle in tendinopathic athletes was observed compared with controls, and increased tendon stiffness was associated with greater passive tension. The authors concluded that affected athletes have increased passive muscle tension in the vastus lateralis, which is potentially responsible for modifying tendon mechanics and contributing to pathology.

12. A.B. Rosen et al. (2017) – Patellar Tendon Straps Alter Pre-Landing Quadriceps Activation During Jumping Tasks

Rosen and co-authors examined whether using patellar tendon straps influences quadriceps muscle activity during jump-landing tasks. In this controlled laboratory study, competitive volleyball players performed standardized jumps both with and without tendon strapping while surface EMG measured quadriceps activation. Results revealed that wearing the strap significantly reduced pre-landing activation of the vastus lateralis and, to a lesser degree, the rectus femoris. This suggests that external patellar support can modulate neuromuscular control before ground contact, potentially reducing tendon loading and discomfort. The authors proposed that patellar straps may provide a valuable adjunct for athletes managing PT, particularly during high-impact training or competition.

13. Christina Frese et al. (2022) – Decreased Vastus Medialis/Lateralis EMG Ratio in Volleyballers with Chronic Knee Pain on Sports-Specific Surfaces: A Pilot Study

Frese et al. carried out a pilot study examining neuromuscular control in volleyball athletes with chronic knee pain, such as patellar tendinopathy, versus healthy controls. Six participants with knee pain and nine controls were tested, with surface electromyography on the vastus medialis (VM) and vastus lateralis (VL) during countermovement jumps and volleyball spike tasks performed on both indoor and beach surfaces. Results indicated that injured athletes consistently had lower VM/VL activation ratios than controls, independent of movement task or surface. Authors concluded that decreased VM activation compared with VL might compromise neuromuscular control and tendinous stress, indicating EMG-guided rehabilitation may be advantageous.

14. M. Chantrelle et al. (2022) – Consequences of Patellar Tendinopathy on Isokinetic Strength in Professional Volleyball Players

Chantrelle and colleagues examined the impact of patellar tendinopathy on isokinetic knee extensor strength in professional volleyball athletes. Isokinetic dynamometry was used to evaluate quadriceps performance, revealing significant strength deficits in players with PT compared to healthy teammates. The researchers noted that these strength losses were linked to reduced jump performance and could compromise overall playing ability and career longevity. By demonstrating the direct effect of PT on muscle function, the study emphasizes the importance of early detection, progressive loading strategies, and individualized strength training during rehabilitation to preserve athletic performance and minimize the long-term burden of PT on professional volleyball players.

15. S. Garcia et al. (2022) – Patellar Tendon Force Differs Depending on Jump Type in Volleyball Players

Garcia and collaborators explored how jump style influences patellar tendon forces in competitive volleyball players. Vertical and forward jump landings were analyzed using force platforms and musculoskeletal modeling. Results revealed that forward jump-landings produced markedly higher patellar tendon loads compared to standard vertical jumps. The authors suggested that volleyball movements involving forward propulsion, such as approach jumps and spike landings, may present greater risks for tendon overload and injury. These insights are critical for coaches and physiotherapists, as they point to specific movement patterns that may need modification or additional strengthening drills to distribute forces more evenly across the lower limb and reduce PT risk.

16. T. Fendri et al., (2022) – Patellar Tendinopathy Impairs Postural Control and Quadriceps Strength in Athletes

Fendri and colleagues conducted a case-control study comparing athletes diagnosed with patellar tendinopathy to matched healthy controls. Using balance platforms and isokinetic testing, they assessed static and dynamic postural control along with quadriceps strength. Athletes with PT demonstrated poorer balance performance and reduced quadriceps torque, suggesting compromised neuromuscular stability and strength deficits. These findings indicate that PT not only affects tendon health but also impairs overall functional stability, which could increase the risk of further injury. The authors recommended integrating proprioceptive training and quadriceps strengthening into rehabilitation programs to restore function and reduce reinjury risk.

17. Tayfur et al. (2022) – Are Landing Patterns in Jumping Athletes Associated With Patellar Tendinopathy? A Systematic Review and Meta-Analysis

Tayfur and co-authors synthesized findings from multiple studies examining the relationship between landing mechanics and patellar tendinopathy in jumping athletes. Their systematic review and meta-analysis revealed that restricted ankle dorsiflexion during drop and spike landings is strongly associated with PT. Furthermore, affected athletes often demonstrated reduced knee joint power and work, alongside altered joint moments and ground reaction forces. These biomechanical differences suggest that inadequate energy absorption and altered lower-limb alignment contribute to tendon overload. The authors concluded that screening for landing mechanics and implementing corrective training may be key strategies in PT prevention and management among athletes in jumping sports.

18. Acaröz Candan et al. (2023) – Electromyographic Activity of Quadriceps Muscles During Eccentric Decline Squats Versus Traditional Squats in Volleyball Athletes

Acaröz Candan and colleagues explored how different squat variations influence quadriceps muscle activation in volleyball players, particularly in the context of patellar tendinopathy rehabilitation. Using surface electromyography (EMG), they compared eccentric decline squats—a commonly recommended exercise for tendinopathy—with traditional flat squats. Preliminary findings indicated that eccentric decline squats elicited higher EMG amplitudes in the quadriceps, especially the vastus medialis, compared to traditional squats. This suggests that decline squats may provide a more targeted stimulus for strengthening and neuromuscular re-education of the patellar tendon unit. Although the full dataset has not yet been widely published, the study supports incorporating decline squats into rehabilitation protocols to enhance quadriceps recruitment and optimize tendon loading in volleyball players recovering from patellar tendinopathy.

19. C. De Bleecker et al. (2024) – Higher Knee Joint Work as a Risk Factor for Patellar Tendinopathy in Volleyball Players

This prospective investigation followed volleyball athletes over a competitive season to identify biomechanical risk factors for patellar tendinopathy development. Using motion analysis and force plate measurements, De Bleecker and colleagues observed that players who later developed PT displayed significantly higher knee joint work during jump take-offs and landings compared to those who remained injury-free. The authors proposed that excessive energy absorption and transfer through the knee joint places heightened stress on the patellar tendon. These findings highlight the importance of screening knee joint workload in athletes and incorporating technique modifications or conditioning strategies to manage tendon stress during high-impact movements like spiking and blocking.

20. Benjamin Ben Zaki et al.(2025) – Altered Landing Strategy During Vertical Jump Tasks in Elite Volleyball Players With Patellar Tendinopathy

This cross-sectional, field-based study evaluated 23 elite volleyball players, nine of whom were symptomatic for patellar tendinopathy (PT). Using countermovement jumps without arm swing and drop-jump tasks, the researchers analysed knee kinematics and landing strategies. Athletes with PT exhibited greater peak knee flexion angles and larger sagittal plane knee ranges of motion compared to asymptomatic peers. They also showed greater rates of velocity reduction during certain jump types, suggesting altered neuromuscular control and energy absorption strategies. The findings indicate that PT is associated with

compensatory movement adjustments during explosive jumping, which may both reflect and exacerbate tendon stress. Recognizing these changes can inform targeted neuromuscular retraining and load-management interventions to prevent injury progression or recurrence.

Gaps in Research

Even with considerable insight, there are significant gaps. Whereas biomechanics and landing patterns have been extensively researched (Bisseling et al., 2007; Rosen et al., 2015), there is limited research that has integrated EMG muscle activation analysis with sport-specific movements in volleyball. Neuromuscular research tends to comprise small sample sizes or heterogeneous knee conditions, thus restricting extrapolation. In addition, passive mechanical adaptations such as elevated quadriceps stiffness (Zhang et al., 2016) need further investigation within volleyball populations only. Longitudinal EMG studies tracking athletes across onset, rehabilitation, and return to sport are lacking. Finally, rehabilitation protocols often neglect neuromuscular coordination deficits revealed by EMG, leaving residual risk for reinjury.

METHODOLOGY AND PROCEDURE

METHODOLOGY

- **STUDY POPULATION:** Volleyball players diagnosed with patellar tendinopathy and asymptomatic controls
- **STUDY SETTING:** ABSMARI
- **SAMPLING DESIGN:** Purposive sampling
- **SAMPLING CRITERIA:**

- **INCLUSION:**

Competitive volleyball players aged 18–30 years.

Clinical signs of patellar tendinopathy (tenderness on palpation and pain during SLDS).

VISA-P score between 50 and 80.

Minimum of 3 years of volleyball training.

- **EXCLUSION:**

Previous history of knee surgery, ligament injury, or fracture.

Neuromuscular disorders or other lower-limb pathologies.

Inability to execute counter-movement jump safely.

Control Group (Asymptomatic):

A control group consisting of volleyball players with no history of anterior knee pain, negative SLDS test, and VISA-P score ≥ 90 were recruited. The control group was matched with the symptomatic group in age, sex, training level, and playing position to minimize potential confounding effects.

- **SAMPLE SIZE: 40**

- **DURATION:** 1 Year

- **MATERIALS TO BE USED:**

~ Pen

~ Paper

~ Inclined board

~ VISA-P questionnaire

- **Outcome Measures:**

EMG – muscle activation: For each muscle, two outcome variables were calculated:
EMG Amplitude (PEAK) and Average EMG Amplitude (AVG)

Peak

Peak EMG Amplitude (PEAK)

Peak EMG amplitude is the greatest electrical signal recorded from a muscle during a specific contraction or movement phase. It represents the point of maximum motor unit recruitment, as the indicator of the highest instantaneous activation of the muscle. PEAK is used by researchers and clinicians to assess the capacity of a muscle to generate strong, high-intensity contractions. It is especially useful for comparing the strength of activation among various muscles, movement patterns, or experimental conditions. In sports and rehabilitation settings, an increased peak value can indicate more effective neuromuscular response or better force production at critical phases of a movement.

Average EMG Amplitude (AVG)

Average EMG amplitude defines the average level of electrical activity over the duration of an entire contraction phase or movement cycle. In contrast to PEAK, which defines a single maximum value, AVG gives the average muscle activation maintained over time. This measure is particularly relevant for muscle endurance evaluation, for checking activation consistency, and for estimating the effort needed for repeating or maintaining actions. By taking an average, occasional spikes or interference in the signal are eliminated, and a more consistent indication of overall muscular function and energy expenditure is provided.

- **INSTRUMENTS TO BE USED FOR OUTCOME MEASURES**

EMG- Surface electromyography (EMG) is a non-invasive technique for recording the electrical activity produced by skeletal muscles during their activation. It reflects the integrated activity of motor units that are in line with the recording electrodes and is typically used to measure muscle activation features, such as intensity, timing, and coordination, for functional movements or clinical examinations.

In the current research, EMG was used to explore the performance of volleyball players' quadriceps muscle with patellar tendinopathy. Three particular muscles rectus femoris (RF), vastus lateralis (VL), and vastus medialis (VM) were recorded using bipolar Ag/AgCl electrodes positioned according to SENIAM guidelines to ensure accurate location and stable quality of data. Signals were recorded at 1000 Hz and filtered with a state band-pass filter range 10–500 Hz filter in order to minimize noise and movement artifacts.

PROCEDURE

The current research was done adhering to ethical procedures and research guidelines necessary for human participants. The study was approved by the Institutional Ethical Committee of ABSMARI before the study was conducted. The participants were made aware of the study procedures, risks, and benefits prior to participation. Written informed consent was sought before recruitment.

Participant Recruitment and Screening

Recruitment of participants took place from competitive volleyball teams, training facilities, and university-level sports clubs. Both male and female athletes actively training and competing at the time of recruitment were considered.

Screening for patellar tendinopathy was performed through a series of clinical assessments:

Clinical Examination

Palpation of the patellar tendon at its proximal attachment to the inferior pole of the patella was used as a primary diagnostic indicator. Localized pain during palpation was taken as evidence of patellar tendinopathy.

Single-Leg Decline Squat Test

Conducted on a 25° decline board to preferentially load the patellar tendon. Athletes performed a slow squat to approximately 60° knee flexion while maintaining balance. The test has been reported to be highly sensitive in detecting symptomatic patellar tendinopathy ⁽⁵⁾.

VISA-P Questionnaire

All athletes completed the Victorian Institute of Sport Assessment for Patellar Tendinopathy (VISA-P) questionnaire. The VISA-P is a confirmed self-administered measure of pain, function, and capacity to play sport in athletes with patellar tendon pathology ⁽²⁴⁾. The scores range from 0 to 100 and lower the scores, more serious the symptoms. Athletes with VISA-P scores between 50 and 80 were considered to have clinically significant patellar tendinopathy and were included in the symptomatic group.

Preparation for Electromyographic (EMG) Testing

Surface electromyography (sEMG) was employed to record quadriceps muscle activation during a counter-movement jump (CMJ). Testing took place in the sports science laboratory under controlled conditions.

Skin Preparation

The skin surface over the quadriceps muscles was shaved, lightly abraded, and cleaned with 70% isopropyl alcohol to minimize skin impedance.

Electrode Placement

Bipolar Ag/AgCl surface electrodes were applied following SENIAM guidelines ⁽³²⁾:

Rectus Femoris (RF): Halfway between anterior superior iliac spine and superior border of patella.

Vastus Lateralis (VL): Two-thirds along the line from the anterior superior iliac spine to the lateral patella.

Vastus Medialis (VM): 80% along the line from the anterior superior iliac spine to the joint space in front of the anterior border of the medial collateral ligament.

Inter-electrode distance was kept at 20 mm. A reference electrode was put over the tibial shaft.

Signal Acquisition

EMG signals were recorded with Freeze EMG, at 1000 Hz sampling rates, with band-pass filtering 10–500 Hz and full-wave rectification. The raw signals were subsequently processed to derive peak (μV) and average activation values.

Counter-Movement Jump (CMJ) Protocol

The CMJ was chosen as the task because it mimics explosive knee extensor activity common in volleyball (e.g., blocking, spiking).

Warm-Up: Participants completed a standardized warm-up that included 5 minutes of jogging at light intensity, dynamic stretching, and 3 practice submaximal jumps.

Task Execution: Participants were asked to execute 3 maximal CMJs with hands on hips to remove arm swing contribution.

Rest Interval: A 30s rest was given between trials to avoid fatigue.

Recording: EMG activity was recorded throughout the movement phases.

PROCEDURE FLOWCHART

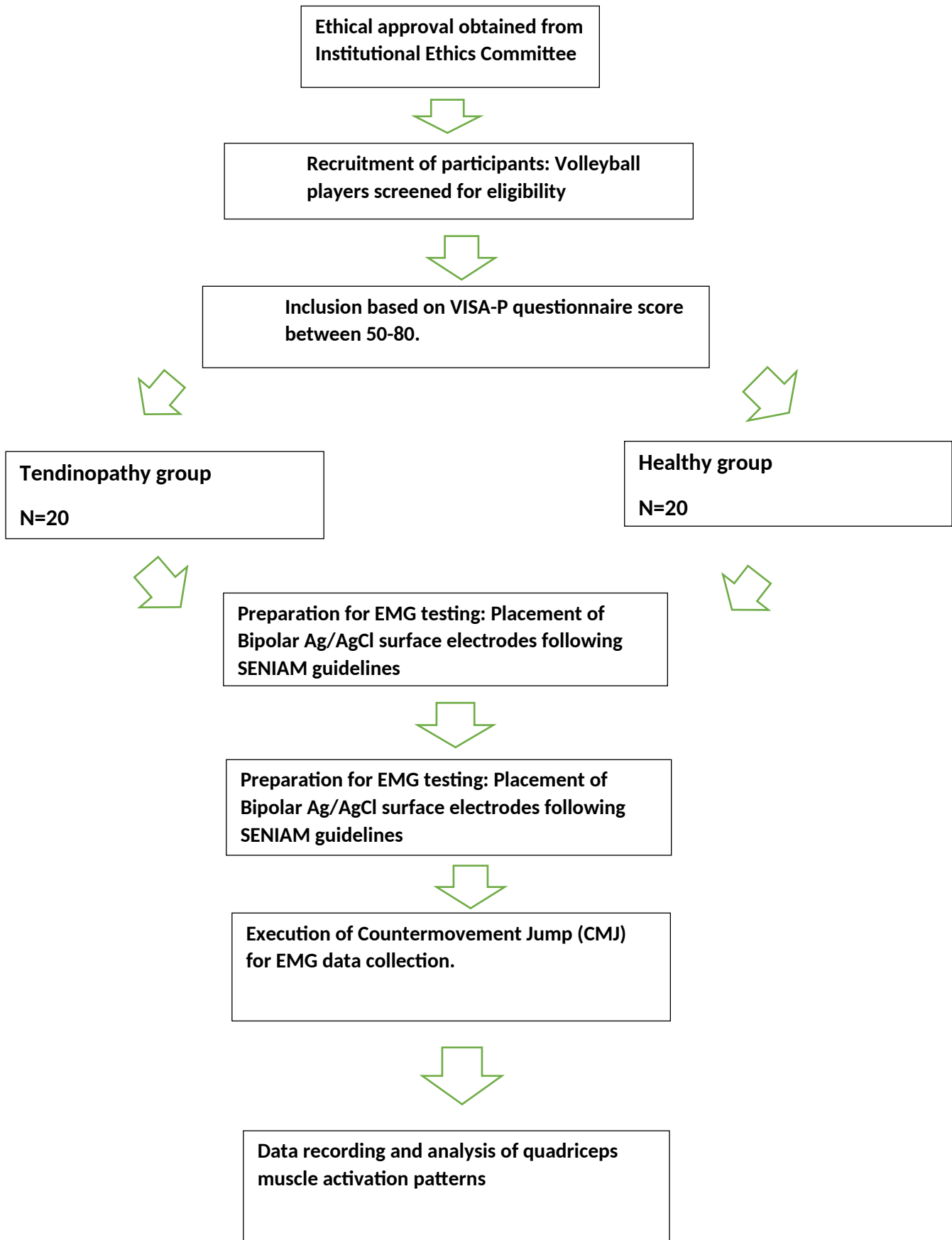




Fig:1 Clinical Assessment In Supine



Fig:2 Clinical Assessment With Knee Flexion



Fig:3 Single Leg Decline Squat In Inclined Board



Fig:4 Emg Testing Of Quadriceps Muscle

STATISTICAL ANALYSIS

Data Processing and Analysis

Primary Variables:

Peak EMG activation (μV) for RF, VL, and VM during concentric phase.

Average EMG activation (μV) for entire CMJ cycle.

Data Handling

Muscle signals were normalized to each participant's maximal voluntary isometric contraction (MVIC), obtained using a consistent manual resistance protocol at 60° of knee flexion. This normalization allowed for reliable comparisons across individuals and groups.

Statistical Analysis:

Descriptive measures, including mean and standard deviation, were calculated. Differences between the tendinopathy and healthy groups were analyzed using appropriate parametric tests, such as two-way ANOVA and t-tests, depending on the distribution of the data. A significance level of $p < 0.05$ was adopted.

RESULTS

1. Demographic information

Forty participants were recruited and randomized to two groups: tendinopathy (n = 20) and healthy control (n = 20). The sample was male skewed (80%); the tendinopathy group consisted of 15 males and 5 females and the healthy group consisted of 17 males and 3 females. The sex distribution between groups was not statistically significantly different.

2. Anthropometric measures

Anthropometrics at baseline were similar between groups. Mean age in tendinopathy group was 23.95 ± 2.91 years while that of the healthy group was 24.40 ± 2.22 years ($t = -1.295$; $p = 0.207$). Mean body weight was 79.45 ± 10.27 kg in the tendinopathy group and 82.15 ± 9.41 kg in the healthy group ($t = -0.866$; $p = 0.392$). Mean height was 189.90 ± 9.24 cm in the tendinopathy group and 190.35 ± 7.58 cm in the healthy group ($t = -0.168$; $p = 0.867$). Since none of these differences are statistically significant, demographic or anthropometric differences would be unlikely to explain between-group differences in muscle activity.

Table 1. Demographic and anthropometric characteristics

Variable	Tendinopathy (n=20)	Healthy (n=20)	p
Age (years)	23.95 ± 2.91	24.40 ± 2.22	0.207
Weight (kg)	79.45 ± 10.27	82.15 ± 9.41	0.392
Height (cm)	189.90 ± 9.24	190.35 ± 7.58	0.867
Sex (M / F)	15/5	17/3	0.442

Graph:1-demographic and anthropometric variables



Graph:2- normality graph of age, weight, height

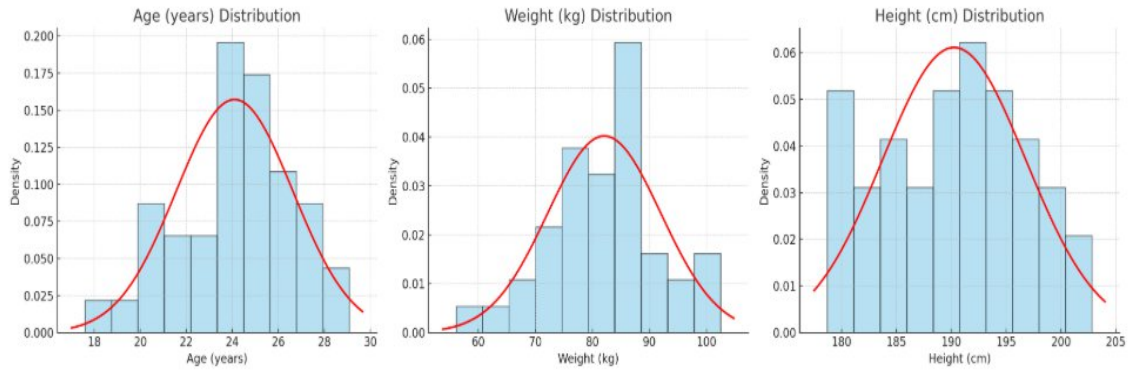
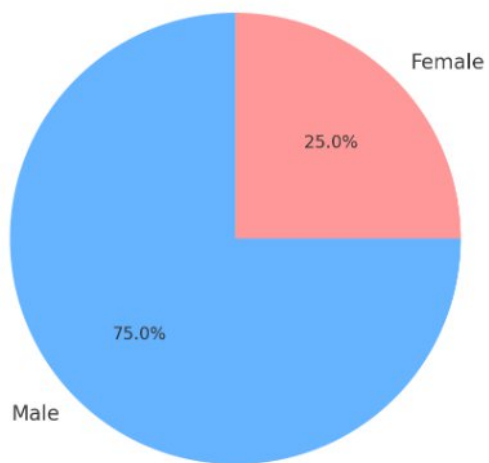
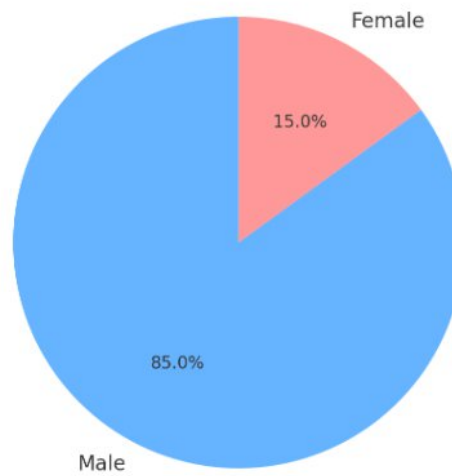


Chart:1- Sex Distribution

Sex Distribution - Tendinopathy Group (G1)



Sex Distribution - Healthy Group (G2)



3. EMG activity of the quadriceps muscles (descriptive)

EMG results present clear profiles for peak and mean activation by muscles and groups:

Rectus femoris (RF): RF peak in tendinopathy group = $368.35 \pm 82.17 \mu\text{V}$ and RF mean = $61.75 \pm 16.46 \mu\text{V}$. RF peak in healthy group = $643.05 \pm 371.52 \mu\text{V}$ and RF mean = $103.50 \pm 44.74 \mu\text{V}$. RF peak in the tendinopathy group was significantly lower compared to the healthy group (mean difference $\approx -274.7 \mu\text{V}$), and RF mean was significantly lower as well (mean difference $\approx -41.8 \mu\text{V}$). RF peak distribution had some skew in the healthy group (greater variability and positive skew).

Vastus lateralis (VL): Tendinopathy: VL peak = $396.05 \pm 148.09 \mu\text{V}$, VL mean = $85.95 \pm 36.65 \mu\text{V}$. Healthy: VL peak = $524.80 \pm 197.76 \mu\text{V}$, VL mean = $119.45 \pm 51.42 \mu\text{V}$. Both VL peak and mean were lower in the tendinopathy group (mean differences $\approx -128.8 \mu\text{V}$ and $-33.5 \mu\text{V}$ respectively).

Vastus medialis (VM): Tendinopathy: VM peak = $308.55 \pm 115.16 \mu\text{V}$, VM mean = $79.80 \pm 54.18 \mu\text{V}$. Healthy: VM peak = $361.25 \pm 156.18 \mu\text{V}$, VM mean = $80.75 \pm 41.05 \mu\text{V}$. VM had the lowest between-group differences and in most comparisons was roughly equal across groups.

For all muscles, peak amplitudes were larger than mean amplitudes, and peak measures had higher between-subject variability (larger SDs) than mean measures.

Table 2. EMG descriptives by group (mean \pm SD)

Muscle	Measure	Tendinopathy (mean \pm SD)	Healthy (mean \pm SD)
Rectus femoris (RF)	Peak (μ V)	368.35 \pm 82.17	643.05 \pm 371.52
RF	Mean (μ V)	61.75 \pm 16.46	103.50 \pm 44.74
Vastus lateralis (VL)	Peak (μ V)	396.05 \pm 148.09	524.80 \pm 197.76
VL	Mean (μ V)	85.95 \pm 36.65	119.45 \pm 51.42
Vastus medialis (VM)	Peak (μ V)	308.55 \pm 115.16	361.25 \pm 156.18
VM	Mean (μ V)	79.80 \pm 54.18	80.75 \pm 41.05

4. Muscle activation pattern (within-subject analysis)

A two-way repeated measures ANOVA with factors Muscle (RF, VL, VM) and Measure (Peak vs Mean) tested within-subject patterns:

No significant main effect of muscle was found ($F(2,38) = 2.057$, $p = 0.142$), suggesting that, averaged across peak and mean, the three muscles were not significantly different from one another in overall magnitude of activation.

The muscle \times measure interaction became statistically significant under the sphericity-assumed analysis ($F(2,38) = 3.400$, $p = 0.044$) and under the Huynh–Feldt-corrected analysis ($p \approx 0.049$) but was close to it with the more conservative Greenhouse–Geisser correction ($p \approx 0.053$). This pattern suggests that the peak-minus-mean difference amplitude differed across muscle (i.e., that the peak/mean separation is not the same for RF, VL and VM). In application this implies some of the muscles (e.g., RF and VL) had greater peak–mean separations and/or greater between-subject variation than others.

5. Between-group comparisons (t-tests) and interpreted effect sizes

Independent-samples t-tests were conducted to compare EMG measures between players with patellar tendinopathy and healthy controls, with effect sizes interpreted alongside statistical significance. Levene's test indicated unequal variances for some measures (RF peak, RF mean, and VM peak), so Welch's correction was applied where equal variances could not be assumed.

For the rectus femoris, both peak and mean activation were significantly lower in the tendinopathy group: RF peak, $t = -3.229$ (Welch $df \approx 20.86$), $p = 0.003$; RF mean, $t = -3.917$ (Welch $df \approx 24.05$), $p = 0.001$. The absolute mean differences were substantial, with RF peak approximately $274.7 \mu\text{V}$ lower ($\approx 43\%$ reduction relative to healthy players) and RF mean about $41.8 \mu\text{V}$ lower ($\approx 40\%$ reduction). These differences are statistically significant and represent a clinically relevant decrease in muscle activation.

For the vastus lateralis, both peak and mean values were also significantly reduced in the tendinopathy group (VL peak, $t = -2.331$, $p = 0.025$; VL mean, $t = -2.372$, $p = 0.023$), with mean differences of $\sim 128.8 \mu\text{V}$ ($\approx 24.6\%$ reduction in peak) and $\sim 33.5 \mu\text{V}$ ($\approx 28\%$ reduction in mean).

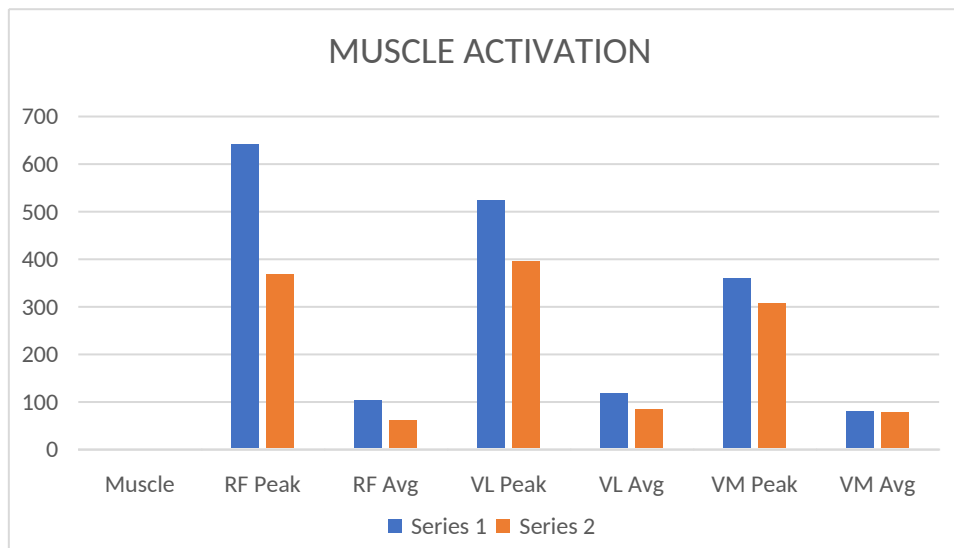
In contrast, the vastus medialis showed no significant differences between groups (VM peak, $p = 0.233$; VM mean, $p = 0.950$), with negligible mean differences (VM mean difference $\approx 0.95 \mu\text{V}$).

These results indicate a selective reduction in activation of the rectus femoris and vastus lateralis in athletes with patellar tendinopathy, while vastus medialis activation remains largely unaffected.

Table 3. Between-Group Comparisons — Independent Samples T-Tests

Variable	t	p (2-tailed)	Mean difference (Tend. - Healthy)	95% CI
RFPEAK	-3.229	0.004	-274.70 μ V	-451.71 to -97.69
RFAVG	-3.917	0.001	-41.75 μ V	-63.75 to -19.75
VLPEAK	-2.331	0.025	-128.75 μ V	-240.59 to -16.91
VLAVG	-2.372	0.023	-33.50 μ V	-62.09 to -4.91
VMPEAK	-1.215	0.233	-52.70 μ V	-140.79 to 35.39
VMAVG	-0.063	0.95	-0.95 μ V	-31.79 to 29.89

Graph3: -Muscle Activation Between Group Comparison



DISCUSSION

This research investigated the electromyographic patterns of activation of the quadriceps muscles in volleyball players with patellar tendinopathy and healthy controls. The uniqueness of this study is its comprehensive assessment of Rectus Femoris (RF), Vastus Lateralis (VL), and Vastus Medialis (VM) activation during sport-specific tasks i.e. Countermovement jump and use of VISA-P questionnaire for identification of tendinopathy. Whereas some past work has explored general quadriceps function or quadriceps strength impairments in tendinopathy, few have examined the individual quadriceps heads' activation patterns in high-level volleyball players.

The hypothesis underpinning the research was that patellar tendinopathy athletes would exhibit altered activation of quadriceps muscles relative to healthy controls. These predictions were upheld by the findings. The tendinopathy group exhibited significantly lower activation in RF and VL for both peak and mean values. VL had the greatest peak activation of quadriceps, followed by RF and then VM, which was indicative of a VL- dominant recruitment pattern in patellar tendinopathy group. While in healthy group RF had the highest peak activation followed by VL and VM, showing AF- dominant recruitment pattern. Conversely, when averaged across measures, the three muscles were not significantly different overall, indicating impairments are most significant in considering peak values.

These findings are consistent with previous reports of altered activation of the quadriceps in patellar tendinopathy patients. For instance, Rosen et al. (2017) described that males with patellar tendinopathy display altered pre-landing VL activation when performing jumping tasks, and patellar tendon strap usage changed activation patterns to enhance performance while lessening pain ⁽²⁹⁾. Likewise, Acaröz and Candan (2023) illustrated that varying squat types affect quadriceps recruitment, especially in the VL, supporting the vulnerability of certain quadriceps heads to task-related shifts in loading ⁽²⁷⁾. This study extends previous findings by showing that the reductions in rectus femoris and vastus lateralis activation are not limited to

average levels but are especially pronounced during peak contractions. This pattern suggests the presence of a pain-related inhibition or a protective motor strategy in athletes with patellar tendinopathy.

The reductions in RF and VL activation seen can be explained by pain-induced inhibition of motor, a phenomenon well described in tendinopathy that lowers neural drive for the benefit of defending the injured tendon. Repeated jumping and landing in volleyball also lead to altered biomechanics and reduced recruitment of high-threshold motor units, particularly in those most responsible for the generation of extension torque. The VM, which is more commonly associated with patellofemoral pain syndromes, was relatively spared in this group, perhaps reflecting differences in neural control or task-specific demands placed on each muscle head during activity. The large disparity between peak and mean EMG values also suggests that peak activation, based on rapid recruitment of high-threshold units, is perhaps more sensitive to tendon disease than average activation over a movement.

These findings have important clinical implications. Rehabilitation regimens for volleyball athletes with patellar tendinopathy do not have to be focused on overall quadriceps strengthening but must address specific activation and strengthening of RF and VL. Exercise interventions to produce high-intensity contractions such as plyometric or decline squats may restore maximum activation without being disregarding of pain thresholds. Neuromuscular recovery feedback may be improved through the assessment of peak and mean EMG during rehabilitation, and early detection of altered patterns of activation could avoid further degeneration of the tendon or loss of function.

There are limitations, nonetheless. The sample size, while sufficient to detect main effects, restricted the statistical power to validate muscle-measure interactions using the most conservative corrections. Cross-sectional design does not provide insight into whether decreased activation is an effect or result of patellar tendinopathy. Surface EMG, while suitable to measure superficial muscles, does not consider deeper tissues or possible changes in motor timing. Lastly, clinical scores like pain intensity or functional ability were not correlated directly with EMG deficits within this study, and future studies will need to explore these correlations to enhance clinical relevance.

CONCLUSION

This research illustrates that patellar tendinopathy in volleyball players presents with significantly lower rectus femoris and vastus lateralis activation but not vastus medialis activation compared to healthy players. Peak EMG levels always were higher than mean levels in all quadriceps muscles, and the patterns of activation were different for muscles. These results validate the hypothesis that patellar tendinopathy modifies quadriceps recruitment, specifically in the rectus femoris and vastus lateralis. The findings emphasize the need for targeted rehabilitation interventions aiming to recover normalized quadriceps activation balance to maximize performance and minimize injury risk among elite-level volleyball players.

LIMITATION AND FUTURE SCOPE

LIMITATION OF THE STUDY

There are several limitations of this study that should be mentioned. While the sample size was sufficient to identify significant differences, a larger and more diverse cohort would have improved the external validity of the findings to different athletic populations and performance levels. Cross-sectional design limits the ability to infer causality between abnormal EMG activation and patellar tendinopathy development or worsening; longitudinal studies would be needed to determine whether these neuromuscular patterns precede injury or are a consequence of chronic tendon pain. The study was limited to male volleyball teams with few female players, restricting the degree to which there might be a sex-specific difference in quadriceps activation or tendon response. Only surface EMG was used, which, while appropriate for superficial muscles, is liable to cross-talk from neighbouring muscles and fails to define deeper layers of muscle or recruitment patterns of motor units. The EMG recordings were performed under controlled conditions and may not mirror activation patterns during more involved movement patterns like game-specific spiking or diving. The study also did not incorporate biomechanical or kinematic information such as joint angles, jump mechanics, or impact forces, which would have enriched the interpretation of muscle activation patterns. In addition, pain intensity and functional ability (e.g., jump performance or VISA-P score) were not directly associated with EMG measures, which leaves some restrictions on the clinical applicability of the results. Finally, peak and average activation were only compared without the evaluation of temporal characteristics of muscle recruitment (e.g., onset latency, inter-muscle timing) that could provide additional insight into neuromuscular control patterns.

FUTURE SCOPE

Subsequent research should address these shortcomings and extend the current findings. Longitudinal investigations of athletes over the course of a competitive season may resolve whether altered EMG activation can predict the development or the progression of recovery of injury. A larger, more representative sample, incorporating a more even mix of the sexes, ages, and levels of performance, would allow subgroup analyses to be conducted and population-specific differences to be determined. Coupling EMG data with biomechanical measurements such as motion capture, ground reaction forces, and tendon imaging (e.g., ultrasound or MRI) could provide a more transparent representation of the interaction between muscle activation and tendon loading. Examination of other quadriceps heads or synergistic

musculature, such as the vastus intermedius or gluteals, may reveal compensations not found in this study. Also, determining the effect of targeted rehabilitation protocols—e.g., eccentric decline squats, neuromuscular re-education, or tendon loading regimens—on normalizing activation patterns would have immediate practice implications. Examination of the influence of fatigue, match effort, and playing position on muscle activation patterns would be contextually relevant in terms of elite sports performance. Finally, the use of machine learning or higher-order signal processing techniques to contrast EMG waveforms could identify subtle patterns or risk predictive markers for tendinopathy, allowing precision-based injury prevention and performance optimization planning.

CONFLICT OF INTEREST

The author certifies there are no conflicts of interest in the research, authorship, and/or publication of this thesis. No personal, professional, or financial relationships affected the study design, data collection, analysis, interpretation, or reporting of the findings.

SUMMARY

This study compared electromyographic (EMG) activity of quadriceps muscles—rectus femoris (RF), vastus lateralis (VL), and vastus medialis (VM)—of elite volleyball players with patellar tendinopathy to healthy controls. Forty participants were recruited and divided into two equal groups matched for age, sex, weight, and height, thus having comparable cohorts. The primary aim was to compare peak and mean EMG activation patterns differences between cohorts and within-subject variability among the quadriceps muscles.

Descriptive analysis confirmed that demographic and anthropometric data were not significantly different between groups, indicating equal baseline characteristics. EMG results indicated that tendinopathy players had lower peak and mean rectus femoris and vastus lateralis activation but no differences in vastus medialis activity relative to healthy players. Repeated measures ANOVA also showed a significant main effect of EMG measure, with peak activations always being larger than mean activations for all muscles, as well as a significant muscle \times measure interaction, suggesting that the magnitude of this difference varied across muscles.

These findings validate the hypothesis that patellar tendinopathy disturbs quadriceps activation strategies, and in this case, targets the rectus femoris and vastus lateralis which are related to abnormal patellar loading and impaired jump mechanics. The results support previous reports of neuromuscular adaptation in athletes with tendon pathologist, and also provide new information in the form of a direct comparison between peak and mean activation values. In conclusion, the study is clarified in explaining altered quadriceps function among volleyball players with patellar tendinopathy and identifies a scientific basis for targeted rehabilitation interventions aimed at optimizing RF and VL recruitment to restore knee function and reduce tendon tension.

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ANNEXURE

ANNEXURE A (1): IEC CERTIFICATE



ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE,
BHUBANESWAR, ODISHA

CDSOReg. No.: ECR/1981/Inst/OD/24

Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2025/162

Date: 09/05/2025

APPROVAL LETTER APPENDIX- VIII

To,

PRANGYASHRI CHAUDHURY
ABSMARI
273, PAHAL, BHUBANEWAR-752101

Protocol Title: Analysis of Electromyography of quadriceps muscle of volleyball players with patellar tendinopathy - an observational study

Protocol ID.: ABS-IEC-2025-PHY-058

Subject: Approval for the conduct of the above referenced study

Dear Mr./Ms./Dr **Prangyashri Chaudhury**

With reference to your Submission letter dated 06/01/2025 the ABSMARI IEC has reviewed and discussed your application for conduct of the study on dated 24/04/2025.

The following documents were reviewed and discussed

S.N.	Documents	Document (Version/Date)
1	IEC Application Form	24/04/2025
2	Informed Consent Form	24/04/2025
3	Undertaking form PI	24/04/2025
4	CRF	24/04/2025
5	COI from the Investigators	24/04/2025

MEMBERS

Dr. Smaraki Mohanty
Clinician

Dr. Satyajit Mohanty
Scientific Member

Mr. Shib Shankar Mohanty
Legal Expert

Ms. Annie Hans
Social Scientist

Ms. Subhashree Samal
Lay Person

Mr. Deepak Ku. Pradhan
Scientific Member

IEC-SECRETARIAT

Mr. Gouranga Ku. Padhy
Mr. Susant Ku. Raychudamani

The following members were present at meeting held on 24-04-2025



ANNEXURE A (2): IEC COMMITTEE MEMBER



ABSMARI ETHICS COMMITTEE

ABHINAV BINDRA SPORTS MEDICINE AND RESEARCH INSTITUTE,
BHUBANESWAR, ODISHA

CDSCO Reg. No.: ECR/1981/Inst/OD/24

Prof. (Dr.) E. Venkata Rao
Chairperson

Mr. Chinmaya Kumar Patra
Member Secretary

Ref. No. ABSMARI/IEC/2025/162

Date: 09/05/2025

MEMBERS
Dr. Smaraki Mohanty Clinician
Dr. Satyajit Mohanty Scientific Member
Mr. Shib Shankar Mohanty Legal Expert
Ms. Annie Hans Social Scientist
Ms. Subhashree Samal Lay Person
Mr. Deepak Ku. Pradhan Scientific Member
IEC-SECRETARIAT
Mr. Gouranga Ku. Padhy Mr. Susant Ku. Raychudamani

S.N.	Name of the Member	Designation & Qualification	Representation as per NDCT 2019	Gender (M/F)	Affiliation with the Institution (Y/N)
1	Prof. Dr. E. Venkata Rao	Professor (MBBS, MD, Dept. of Community Med.) IMS & Sum Hospital, BBSR	Chair Person	M	N
2	Dr. Smaraki Mohanty	Asst. Prof-IMS & Sum Hospital/MBBS, MD (Community Med)	Clinician	F	N
3	Mr. Chinmaya Kumar Patra	Principal-ABSMARI, MPT	Member Secretary	M	Y
4	Ms. Annie Hans	Disability Inclusive Development Co-Ordinator in Humanity and Inclusion (India/Nepal/Srilanka). /MA in Social Work	Social Scientist	F	N
5	Ms. Subhashree Samal	Ref. Reader-Pol Sc.	Lay Person	F	N
6	Mr. Deepak Kumar Pradhan	Asst. Prof-ABSMARI, MPT	Scientific Member	M	Y

This is to confirm that only members who are independent of the Investigator and the Sponsor of the trial have voted/ provided opinion on the trial.

This Committee approves the documents and the conduct for the study in the presented form with necessary recommendation.

The ABSMARI IEC must be informed about the progress of the study in the prescribed format attached, any SAE occurring in the course of the study, any changes in the protocol and patient information/informed consent/assent and request to provide a copy of the final report.

The ABSMARI IEC follows procedures that are in compliance with the requirements of ICH (International Conference on Harmonization) guidance related to GCP (Good Clinical Practice) and applicable Indian regulations.

Yours sincerely


Mr. Chinmaya Kumar Patra
Member Secretary

ABSMARI ETHICS COMMITTEE
Member Secretary
Pahal, Bhubaneswar
ABSMARI ETHICS COMMITTEE



ANNEXURE B: INFORMED CONSENT

Study Title: Analysis of electromyography of quadriceps muscle of volleyball players with patellar tendinopathy- an observational study

Study Number: ABS-IEC-2025-PHY-058

Subject 's Name: _____ Subject 's Initials: _____

Date of Birth / Age: _____

Address of the Subject _____ Qualification _____

Occupation: Student/Self-Employed/ Service/Housewife/Others (Please tick as appropriate)

Annual Income of the subject _____if applicable Name and address of the nominee(s) and his relation to the subject____(For the purpose of compensation in case of trial related death).

- (i) I confirm that I have read and understood the information sheet dated _____for the above study and have had the opportunity to ask questions.
- (ii) I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected.
- (iii) I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s)
- (iv) I agree to take part in the above study
- (v) I agree and give my consent to take part in the video analysis

Signature (or Thumb impression) of the Subject/Legally Acceptable Representative:

Date: _____/_____/_____

Signatory 's Name: _____

Signature of the Investigator:

Date:

Study Investigator 's Name: Prangyashri chaudhury

Signature of the Witness: _____ Date: _____/_____/_____

Name of the Witness: _____

ANEXXURE C: CASE REPORT FORM

Name of the participant: **Date:**

Age:

Gender:

Dominance:

Height:

Weight:

ANEXXURE D: VISA-P FORM

VISA-P Questionnaire

Name: _____ Date: _____

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

0 Minutes 100 Minutes Points

0 1 2 3 4 5 6 7 8 9 10

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

Strong Severe Pain No Pain Points

0 1 2 3 4 5 6 7 8 9 10

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

Strong Severe Pain No Pain Points

0 1 2 3 4 5 6 7 8 9 10

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

Strong Severe Pain No Pain Points

0 1 2 3 4 5 6 7 8 9 10

5. Do you have problems squatting?

Unable No Problems Points

0 1 2 3 4 5 6 7 8 9 10

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

Strong Severe Pain/ Unable	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	No Pain	Points <input type="checkbox"/>
	0	1	2	3	4	5	6	7	8	9	10		

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 **question 8a** only.
- If you have pain while undertaking sport but it does not stop you from completing the activity, please complete **question 8b** only.
- If you have pain that stops you from completing sporting activities, please complete **question 8c** only.

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

NIL	1-5 min	6-10 min	7-15 min	>15 min	Points <input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
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 min	6-10 min	7-15 min	>15 min	Points
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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 min	6-10 min	7-15 min	>15 min	Points
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
0	2	5	7	10	

Total VISA Score: _____

MASTER CHART

NAME+1:31	AGE	SEX	WEIGHT	HEIGHT	GROUP	VISA-P	RF-PEA	RF-AVG	VL-PEA	VL-AVG	VM-PEA	VM-AV
SAMUEL STIPHENSON JENA	23	M	72	185	TENDINOPATH	71	189	34	468	79	334	98
RANJIT	22	M	66	189	TENDINOPATH	72	295	47	443	113	205	63
ABHIPSA JENA	27	F	66	176	TENDINOPATH	72	340	39	688	59	231	116
MAHESWAEI SINGH	21	F	70	180	TENDINOPATH	77	253	53	849	162	338	83
KRISHNA CHANDRA PRADH	20	M	79	196	TENDINOPATH	71	284	62	363	47	400	85
SUBHRANSU SEKHAR CHOL	20	M	77	192	TENDINOPATH	74	400	84	262	57	260	138
AMRIT MOHANTY	25	M	83	186	TENDINOPATH	67	314	54	320	52	362	40
PRAKSH PRAKHARI	20	M	82	190	TENDINOPATH	67	361	48	292	153	452	246
MANABENDRA SAHOO	29	M	94	203	TENDINOPATH	71	537	73	371	81	530	68
SATHVIK	25	M	89	197	TENDINOPATH	75	437	84	343	84	354	22
PRAVEEN	23	M	89	193	TENDINOPATH	72	355	73	413	100	251	46
BIMAL KUMAR ROUT	29	M	84	193	TENDINOPATH	70	399	81	404	114	261	3
KISHOR MAJHI	21	M	91	201	TENDINOPATH	72	437	48	415	86	407	103
PRAVATI GIRI	24	F	65	178	TENDINOPATH	69	424	81	235	47	137	42
ANKUSHA ANAND	27	F	71	178	TENDINOPATH	60	427	73	217	64	172	52
RAHUL NAYAK	28	M	79	188	TENDINOPATH	66	337	50	265	50	393	156
MAMATA PRADHAN	24	F	62	173	TENDINOPATH	70	387	60	381	100	117	2
PRAVAKAR BABU	23	M	90	200	TENDINOPATH	74	386	72	381	149	161	45
SANKET PATTNAIK	25	M	92	202	TENDINOPATH	71	313	79	446	45	432	46
PRASAD	23	M	88	198	TENDINOPATH	77	492	40	365	77	374	9
ANSU KUMAR RAY	28	M	85	192	HEALTHY	>90	475	90	242	81	244	63
KAMESWAR PRATAP	26	M	90	190	HEALTHY	>90	198	33	262	61	99	15
SANDESH	24	M	80	187	HEALTHY	>90	241	31	406	98	141	1
BISWAS	25	M	78	187	HEALTHY	>90	204	27	252	51	92	16
SUMIT DEV	23	M	92	203	HEALTHY	>90	570	57	561	176	194	34
SUBHENDU SAHU	24	M	78	189	HEALTHY	>90	487	92	511	99	498	65
C.S. PREM	25	M	76	188	HEALTHY	>90	541	103	595	165	272	86
BISWANATH	24	M	92	197	HEALTHY	>90	315	95	825	167	420	135
PARWEZ KHAN	26	M	89	190	HEALTHY	>90	424	129	496	130	313	107
MASUMI	25	F	61	171	HEALTHY	>90	503	86	459	106	384	66
RAKESH SAMANTA	25	M	90	190	HEALTHY	>90	806	209	926	267	583	142
PRADYASHA PATRO	25	F	67	183	HEALTHY	>90	1328	132	548	91	504	100
ARPIT SIMONS	25	M	82	189	HEALTHY	>90	540	156	521	177	528	126
SANJAY MOHANTY	25	M	83	193	HEALTHY	>90	694	86	417	102	456	125
HARIS CHANDRA MAHARAI	25	M	84	192	HEALTHY	>90	609	121	488	80	494	7
ASISH BEHERA	25	M	90	205	HEALTHY	>90	1299	140	521	78	275	76
NRUSINGHA KUMAR NAYAK	23	M	83	194	HEALTHY	>90	569	124	403	97	244	45
RIDDIHI	24	F	63	178	HEALTHY	>90	469	100	553	157	504	134
SANGRAM DAS	25	M	91	194	HEALTHY	>90	1267	132	987	99	502	87
CHIRAG PRADHAN	25	M	89	195	HEALTHY	>90	1322	127	523	107	478	85