Review Article

Patellar Tendinopathy: Comparison of Postoperative Rehabilitation Protocols and Their Impact on Functional Recovery

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Abstract

Patellar tendinopathy is a chronic overload disorder of the knee extensor mechanism that primarily affects the proximal patellar tendon and is especially common in athletes exposed to repetitive jumping, landing, running, and cutting activities. Its pathophysiology involves repetitive microtrauma, collagen disorganization, degenerative intratendinous changes, neovascularization, and extracellular matrix disruption, all of which contribute to pain, structural abnormalities, and functional limitation. When conservative treatment fails to relieve symptoms or restore function, surgery may be indicated, particularly in patients with persistent pain, marked functional impairment, or structural tendon degeneration. The main objectives of surgery are to remove degenerated tissue, stimulate tendon healing, reduce pain, and restore extensor mechanism function. Common procedures include open debridement, arthroscopic debridement, longitudinal tenotomy, and, in selected cases, inferior pole resection or adjunctive biological techniques. Postoperative rehabilitation is essential to optimize

outcomes and is generally organized into sequential phases focused on symptom control, protection of the surgical site, restoration of range of motion, progressive strengthening, tendon loading, neuromuscular recovery, advanced functional training, and return to sport. Comparative evidence suggests that early mobilization protocols may favor faster recovery and better knee flexion, whereas conservative protocols may provide greater initial tissue protection but can delay functional progress. Multimodal approaches that integrate pain management, isometric, isotonic, eccentric, and heavy slow resistance exercises, proprioceptive training, biomechanical retraining, and sport-specific progression appear to provide the most comprehensive recovery. Overall, successful outcomes are best assessed through pain scales, functional questionnaires, strength testing, performance-based measures, and return-to-sport rates, while patient age, baseline status, and metabolic factors may influence prognosis.

Key words

Patellar tendinopathy, postoperative rehabilitation, functional recovery, return to sport, eccentric exercise, tendon loading.

Introduction

Patellar tendinopathy is an overuse injury caused by repetitive stress on the patellar tendon, leading to microinjury, mucoid degeneration, and necrosis of tendon fibers [1, 2]. It is considered a non-inflammatory condition and primarily affects the proximal insertion of the patellar tendon [3]. This disorder is especially prevalent among athletes, particularly those involved in jumping sports such as basketball and volleyball, with a reported prevalence of 18.3% in athletic populations [4].

The clinical importance of patellar tendinopathy lies in its significant impact on performance and quality of life. Athletes affected by this condition frequently experience persistent anterior knee pain, which may result in prolonged recovery periods and decreased athletic performance [1]. In many cases, the disorder can persist for years, negatively affecting athletic careers and, in some individuals, even leading to early retirement from sport [5].

Initial management is typically conservative and includes interventions such as eccentric exercises, cryotherapy, platelet-rich plasma injections, and extracorporeal shockwave therapy [2, 5]. However, when these nonoperative treatments fail to provide adequate symptom relief or functional improvement, surgical intervention may be considered. The most commonly described surgical options include open or arthroscopic debridement [1, 4]. Surgical management has been associated with improved patient-reported outcomes and high rates of return to sport, while arthroscopic techniques may offer the additional advantage of faster recovery [6].

Despite the potential benefits of surgery, effective postoperative rehabilitation remains essential for successful recovery and return to sport. Nevertheless, there is currently no consensus regarding the optimal timing and progression of rehabilitation protocols, which complicates postoperative management and contributes to variability in clinical practice. At the same time, comparative studies assessing different surgical techniques and rehabilitation protocols remain limited, highlighting the need for further research in this area [1, 6].

In this context, a comparative review of postoperative rehabilitation protocols is necessary to establish evidence-based guidelines for the management of patellar tendinopathy. Such a review may contribute to the standardization of treatment approaches, improve patient outcomes, and support a more efficient return to sport in affected athletes [1, 6].

The objective of this review is to compare postoperative rehabilitation protocols used in patients with patellar tendinopathy and evaluate their impact on functional recovery, pain reduction, restoration of physical performance, and return to sport.

Methodology

This manuscript was developed as a structured narrative review aimed at providing an updated and clinically integrated analysis of patellar tendinopathy, with particular emphasis on postoperative rehabilitation protocols, their comparative characteristics, and their impact on functional recovery, pain reduction, and return to sport. The review was conducted in accordance with the SANRA (Scale for the Assessment of Narrative Review Articles) framework and followed a predefined methodological protocol established prior to literature screening. Given the clinical heterogeneity of patellar tendinopathy, the variability in surgical techniques, and the lack of uniformity among postoperative rehabilitation strategies, a narrative interpretative synthesis was selected over quantitative pooling in order to integrate surgical, rehabilitative, and functional outcome data into a coherent and clinically applicable framework. Special attention was given to differences in rehabilitation timing, progression of loading, strengthening strategies, mobility restoration, neuromuscular recovery, and return-to-sport criteria following surgical intervention. The objective was to provide a structured synthesis capable of supporting clinical decision-making in the postoperative management of patients with patellar tendinopathy.

A comprehensive literature search was conducted in PubMed, Scopus, and Web of Science, including peer-reviewed articles published in English or Spanish between January 2020 and December 2025. The final search was performed in april 2026. This timeframe was selected to capture contemporary evidence regarding surgical management, rehabilitation strategies, and postoperative functional outcomes in patellar tendinopathy, while ensuring relevance to current orthopedic, sports medicine, and rehabilitation practice. Search terms were combined using Boolean operators and included: “patellar tendinopathy,” “jumper’s knee,” “patellar tendon surgery,” “postoperative rehabilitation,” “rehabilitation protocol,” “functional recovery,” “return to sport,” “arthroscopic debridement,” and “open debridement.” Reference lists of selected articles were also manually reviewed to identify additional relevant studies not captured through the initial database search.

Eligible studies included narrative reviews, systematic reviews, cohort studies, comparative clinical studies, case series, and relevant expert-based clinical articles that addressed surgical treatment of patellar tendinopathy and/or postoperative rehabilitation approaches. Articles were included if they reported rehabilitation protocols, functional outcomes, pain evolution, return-to-sport timelines, or postoperative clinical recovery following surgery for patellar tendinopathy. Studies focused exclusively on conservative treatment without postoperative relevance, unrelated tendon disorders, animal models, purely biomechanical cadaveric investigations, conference abstracts without full text, and non-peer-reviewed sources were excluded. After screening titles and abstracts for relevance, full texts of potentially eligible articles were assessed according to the predefined thematic scope of the review.

Data extraction was performed qualitatively and focused on study design, patient population, type of surgical intervention, characteristics of the rehabilitation protocol, progression of weight-bearing and range of motion, strengthening strategies, functional recovery measures, pain outcomes, and return-to-sport data. Because of the heterogeneity in operative approaches, rehabilitation timelines, outcome definitions, and follow-up durations, no formal meta-analysis was undertaken. Instead, findings were organized into thematic domains to facilitate comparative interpretation of the available evidence. These

domains included the clinical basis of patellar tendinopathy, indications for surgery, rehabilitation phases, accelerated versus conservative postoperative protocols, exercise-based components of rehabilitation, and the effect of these strategies on functional recovery and sports reintegration. This methodological approach was intended to ensure a clinically meaningful synthesis while maintaining transparency, internal coherence, and applicability to real-world postoperative rehabilitation settings.

Anatomical, Biomechanical, and Pathophysiological Basis of Patellar Tendinopathy

The knee extensor mechanism is composed of the quadriceps muscle, the patella, the patellar tendon, and the tibial tuberosity, all of which work together to produce and transmit the forces required for knee extension. The quadriceps muscle group is essential for both extension and stabilization of the knee, generating the force necessary for movements such as jumping and running and transmitting that force through the patellar tendon to the tibia. Within this mechanism, the patella acts as a fulcrum that increases the leverage of the quadriceps muscle and optimizes force transmission across the knee joint [7]. The patellar tendon, in turn, connects the patella to the tibial tuberosity and plays a critical role in the transmission of force during knee extension. The tibial tuberosity serves as the attachment site of the patellar tendon and represents the point of force application during knee extension activities [2].

From a biomechanical perspective, the patellar tendon is fundamental for transmitting the forces generated by the quadriceps muscle to the tibia, thereby facilitating knee extension. Because of this role, it is subjected to substantial mechanical demands during activities such as jumping, landing, running, and cutting, all of which can increase tendon stress and predispose it to injury [8]. In this context, patellar tendinopathy develops as a consequence of repetitive overload and microtrauma, particularly in individuals exposed to continuous high-impact activities. These repetitive stresses are associated with collagen disorganization and degenerative intratendinous changes that contribute to pain and dysfunction. In chronic cases, these alterations may also be accompanied by neovascularization and extracellular matrix disruption, reflecting the progressive structural changes characteristic of tendinopathy [2, 9].

Several factors may predispose to or contribute to the development of patellar tendinopathy. Sports overload is one of the most important, as participation in high-impact sports significantly increases the risk of tendon injury because of repetitive stress [4]. In addition, deficits in muscle strength and flexibility may further increase susceptibility to tendon damage [10]. Altered lower-limb biomechanics, including abnormal patterns such as increased tibiofemoral rotation, can elevate tendon stress and contribute to the development of tendinopathy [8]. Likewise, training errors, including inadequate training regimens and improper technique, may exacerbate tendon loading and favor injury [11].

These structural tendon abnormalities are closely associated with pain and functional impairment. Findings such as increased tendon thickness and hypoechoic regions are often linked to symptoms and reduced athletic function in affected individuals. As a result, these changes may lead to decreased performance and a greater risk of further injury [12].

Surgical Indications and Main Operative Techniques

Surgery for patellar tendinopathy is generally indicated when prolonged conservative management fails to relieve symptoms or restore function. It is also considered in patients with persistent pain and significant functional limitation affecting daily activities or sports participation [6]. In addition, surgical intervention may be warranted when imaging

findings or clinical evaluation demonstrate structural tendon degeneration that does not respond to nonoperative measures [4].

The main goals of surgery are the removal of degenerated tissue, the stimulation of tendon healing, the reduction of pain, and the restoration of function. Surgical procedures are intended to excise damaged tendon tissue in order to promote healing. Techniques such as debridement and tenotomy are used to stimulate the body's natural healing processes. When successful, surgery can significantly decrease pain levels, as reflected by improved postoperative pain scores. Ultimately, the objective is to restore the function of the extensor mechanism and allow patients to return to their previous level of activity [6, 13].

Among the most described surgical techniques, open debridement involves direct visualization and removal of degenerated tissue and is often used in cases with more extensive degeneration. Arthroscopic debridement represents a minimally invasive approach that may allow quicker recovery and potentially better return-to-sport outcomes compared with open surgery [4, 6]. Longitudinal tenotomy consists of making longitudinal cuts in the tendon to promote healing and relieve tension. In selected cases, inferior pole resection may also be performed when specific structural abnormalities are present. In addition, adjunctive biological or reparative procedures may be used to enhance healing, including the use of growth factors or scaffolds [13].

There are also important differences between open and minimally invasive techniques. Arthroscopic procedures are less invasive, preserve more of the surrounding tissue, and may reduce recovery time. Likewise, minimally invasive approaches may permit earlier progression of loading and rehabilitation [13]. As a result, patients undergoing arthroscopic surgery often experience faster rehabilitation timelines and earlier return to sport [4, 6].

Therapeutic Goals and General Principles of Postoperative Rehabilitation

Early postoperative rehabilitation in patellar tendinopathy focuses on controlling pain, inflammation, and swelling in order to facilitate healing and prevent complications. Techniques such as cryotherapy and nonsteroidal anti-inflammatory drugs are commonly used to manage these symptoms [1]. At the same time, protection of the surgically treated tendon is essential, although excessive immobilization should be avoided because it may favor stiffness and compromise recovery. For this reason, controlled mobilization is recommended to preserve joint flexibility and prevent adhesions [14].

As rehabilitation progresses, gradual restoration of range of motion becomes a central objective. Progressive increases in knee flexion are considered essential, with passive knee flexion often exceeding 90 degrees by the fifth postoperative week. Full range of motion is typically achieved by week 16, which may allow removal of decompression wires and continuation toward more advanced stages of rehabilitation [14]. In parallel, early quadriceps activation is important to prevent muscle atrophy and neuromuscular deficits. Exercises that include both eccentric and concentric strengthening have been shown to be beneficial for maintaining muscle mass and function during recovery [15].

Rehabilitation programs also emphasize the progressive recovery of strength and endurance through gradual loading, with the aim of improving tendon load tolerance and overall muscle performance. Strengthening exercises, particularly those that combine eccentric and concentric modes, have been associated with better outcomes [15]. Ultimately, the broader goal of rehabilitation is functional reintegration into daily, occupational, and sports-related activities. In this regard, high rates of return to sport have been reported, with 89.8% of patients returning to their previous level of activity [6].

These outcomes depend on rehabilitation being gradual and individualized, taking into account the specific needs and progression of each patient. Symptom-guided load monitoring and criterion-based advancement are important principles because they allow rehabilitation to be adapted according to recovery status rather than relying exclusively on fixed timelines [16]. In addition, variables such as age, activity level, type of surgery, and severity of tendon damage influence rehabilitation planning. Bilateral involvement and comorbidities may further require modifications to the protocol in order to accommodate individual patient needs [1, 14].

Phases of Postoperative Rehabilitation

Phase I of postoperative rehabilitation is centered on protection and early symptom control. During this stage, the initial focus is placed on reducing pain and swelling through modalities such as cryotherapy and compression. At the same time, protection of the surgical site is emphasized through the use of braces or immobilization in order to prevent undue stress on the tendon. Despite the need for protection, safe early restoration of mobility is also introduced through gentle range of motion exercises designed to prevent stiffness without compromising the surgical repair. In parallel, initial quadriceps activation is promoted with isometric exercises that allow muscle engagement without placing excessive load on the tendon. Patient education is also a key component of this phase, particularly regarding load management and the importance of adherence to rehabilitation protocols [14].

Phase II focuses on the recovery of motion and baseline strength. During this period, knee flexion and extension are progressively increased in order to restore full range of motion. As tolerated, patients also transition from partial to full weight bearing, which encourages the recovery of normal gait patterns. At the same time, early strengthening is initiated, with particular attention to the quadriceps, gluteal muscles, and core musculature in order to support knee function. Low-demand closed-chain exercises, such as leg presses and mini-squats, are incorporated to build strength while avoiding high-impact stress on the recovering tendon [14].

Phase III is characterized by progressive strengthening and tendon loading. At this point, isotonic strengthening is introduced to further develop muscle strength and endurance. External resistance is gradually increased in a controlled manner to enhance both muscular and tendinous adaptation. Eccentric exercises are also progressively incorporated because of their importance for tendon health and functional recovery. In addition, this phase includes motor control retraining to improve neuromuscular coordination, as well as dynamic stability training to enhance joint stability and proprioception [15].

Phase IV is directed toward advanced functional recovery. Progressive plyometric training is introduced in order to prepare the patient for higher-impact activities. Rehabilitation at this stage also incorporates drills involving direction changes and sport-related movements so that patients can begin to reacquire the demands of athletic participation. Particular emphasis is placed on running, deceleration, and landing mechanics to reduce the risk of reinjury. In addition, restoration of interlimb functional symmetry is pursued to ensure that both lower extremities achieve comparable strength and performance [4, 6].

Phase V represents the return-to-sport stage. This phase begins with objective functional testing to determine readiness for sport-specific activity. Patients then undergo gradual reintroduction to sport-specific drills and loading in order to confirm tolerance to athletic demands. Reinjury prevention strategies are also emphasized through education and targeted exercises intended to reduce future risk. After return to full activity, continued follow-up remains important in order to monitor progress and address any emerging issues during reintegration into sport [1, 6].

Comparison of Postoperative Rehabilitation Protocols

Accelerated or early mobilization protocols are characterized by the early initiation of knee motion, often combined with early weight bearing and quadriceps strengthening. This approach has been associated with improved knee flexion and better patient-reported outcomes without an increase in complication rates, as observed in patients undergoing tibial tubercle osteotomy. In addition to promoting earlier knee motion, these protocols also encourage earlier functional loading with the aim of preventing stiffness and facilitating muscle activation, which may contribute to faster recovery. However, this strategy also carries potential risks, including tendon irritation or excessive mechanical stress, particularly if progression is not carefully controlled [17].

In contrast, conservative or protected progression protocols place greater emphasis on tissue protection during the early stages of healing by restricting movement and loading. This approach may help prevent complications and safeguard the healing tendon, but it may also be associated with disadvantages such as muscle atrophy and delayed functional recovery. Because progression is slower, patients following these protocols may experience a more prolonged return to sport and reduced muscle strength when compared with accelerated approaches [17].

Within postoperative rehabilitation, some protocols place particular emphasis on eccentric exercise because of its role in tendon remodeling. Eccentric exercises have shown positive outcomes in reducing pain and improving function, making them an important component of tendon-focused rehabilitation. Nevertheless, the timing of their introduction is critical, since eccentric loading must be incorporated at an appropriate stage of recovery in order to balance the mechanical demands placed on the tendon with the biological requirements of healing [18].

Other protocols are based on heavy slow resistance and progressive isotonic loading, both of which are intended to improve tendon load tolerance and muscle strength. Heavy slow resistance training has been shown to enhance these outcomes, with both moderate and heavy loads producing similar clinical results. These approaches are closely aligned with broader strength and functional performance goals and may therefore support a more comprehensive recovery process [19, 20].

Multimodal rehabilitation protocols combine several therapeutic elements, including strengthening, neuromuscular control, biomechanical correction, and sport-specific retraining. By integrating these different components, such protocols may offer superior outcomes compared with approaches focused exclusively on the tendon itself. Their value lies in providing a more holistic model of recovery that addresses multiple aspects of rehabilitation and may therefore contribute to improved physical and psychological outcomes [18].

Specific Components of Postoperative Rehabilitation

Pain management and supportive strategies represent an important component of rehabilitation in patellar tendinopathy. Cryotherapy is commonly used in the early stages of rehabilitation to reduce inflammation and pain, and the application of ice packs to the affected area is a frequent practice for controlling acute pain symptoms [1]. Alongside this, patients are educated on the importance of gradual loading and on the role of pain as a guide for exercise intensity, which helps prevent overloading of the tendon during recovery [15]. When necessary, physical support measures such as braces or taping may also be used to provide additional support to the knee joint, stabilize the area, and reduce strain on the tendon [21].

Therapeutic exercise modalities are central to the rehabilitation process. Isometric exercises are effective for immediate pain relief, whereas

isotonic exercises contribute to progressive strengthening of the tendon over time [22]. Eccentric loading remains a cornerstone of rehabilitation, as it has been shown to improve tendon structure and reduce pain. These exercises involve lengthening the muscle-tendon unit under load and are considered highly relevant in tendon recovery [23, 24]. Heavy slow resistance training has also demonstrated favorable effects on clinical outcomes and tendon structure, and both heavy and moderate load exercises appear to produce similar results without significant differences in mechanical properties [19].

Regional strengthening is likewise essential, since the quadriceps and hamstrings play a major role in knee stability and function [1]. In addition, strengthening of the gluteal and core muscles supports overall lower-limb function and helps maintain appropriate biomechanics during activity. Beyond muscular strengthening, recovery of neuromuscular control is also necessary. Proprioceptive training enhances joint position sense and stability, both of which are fundamental for preventing reinjury [15]. Similarly, exercises focused on single-leg stability and control of dynamic valgus are important for functional recovery [1].

Biomechanical retraining further complements rehabilitation by addressing movement patterns that influence tendon loading. Proper jumping and landing technique is emphasized in order to reduce stress on the patellar tendon during high-impact activities. In the same way, improvement of running mechanics and deceleration patterns may help reduce tendon load and prevent future injuries [1]. Additional adjunctive therapies may also be incorporated during rehabilitation. Taping and electrical stimulation can be used to provide extra pain relief and support [21], while manual therapy techniques such as massage and mobilization may be applied to improve tissue flexibility and reduce pain. Adherence to the rehabilitation program is crucial for successful outcomes. Supervision by a healthcare professional helps ensure that exercises are performed correctly, while patient education promotes self-management and motivation throughout the recovery process [15].

Outcome Assessment and Functional Impact

Clinical outcome variables are central to the evaluation of treatment efficacy in patellar tendinopathy, particularly because pain is the primary symptom of the condition. Assessment of pain both at rest and during activity provides essential information regarding recovery and therapeutic response. Surgical interventions have demonstrated significant improvements in pain scores, with a mean difference of 5 on the visual analogue scale after surgery. Similarly, ultrasound-guided percutaneous ultrasonic tenotomy has shown a marked reduction in pain, with Numerical Rating Scale scores decreasing from 6.4 to 2.8. In addition to pain, local tenderness and residual swelling are common clinical signs in patellar tendinopathy. Although specific data on these variables remain limited, improvements in pain and functional scores suggest that these symptoms also tend to decrease after treatment [6, 13].

Functional outcome variables are equally important because they reflect the patient's ability to recover meaningful physical capacity. Among these, range of motion and muscle strength are particularly relevant, as muscle strength is critical for recovery and progressive rehabilitation aimed at quadriceps strengthening has been shown to be beneficial [24]. Exercise therapy, especially strengthening-based interventions, is effective in improving muscle strength and overall functional capacity [15]. In addition, load tolerance and the ability to perform activities such as climbing stairs, running, and jumping are often compromised in patellar tendinopathy, making them important targets for outcome assessment. Performance-based evaluations, including hop tests, are commonly used to examine these abilities objectively [24]. Both surgical and non-surgical interventions have demonstrated improvements

in these functional outcomes, thereby facilitating return to sport [6, 13].

To measure these changes, several assessment tools and outcome measures are commonly employed. Questionnaires and pain scales, such as the Victorian Institute of Sport Assessment and Lysholm scores, are widely used to assess knee-specific function and pain, and significant postoperative improvements in these measures have been reported after both surgery and ultrasound-guided percutaneous ultrasonic tenotomy [6, 13]. At the same time, strength testing and performance-based assessments provide objective information about muscle function and load tolerance, complementing patient-reported measures and allowing a more comprehensive evaluation of functional recovery [24].

When outcomes are compared across protocols, recovery time and return to sport are among the most clinically meaningful endpoints. Surgical management has shown high return-to-sport rates of 89.8%, with many athletes returning to their preinjury level of activity [6]. Ultrasound-guided percutaneous ultrasonic tenotomy has also demonstrated favorable recovery, with most athletes returning to competitive sports within 3 to 4 months [13]. Nevertheless, despite generally positive results, some patients may continue to experience persistent symptoms or recurrence, indicating that recovery is not uniform across all cases. Factors such as baseline scores and age appear to influence these outcomes [25].

Several prognostic factors may therefore modify recovery after treatment for patellar tendinopathy. Younger age and lower baseline scores have been associated with better outcomes, whereas higher baseline scores may reduce the likelihood of achieving minimal clinically important differences [25]. In addition, metabolic factors may also affect rehabilitation outcomes, suggesting that recovery should be approached comprehensively and may benefit from the inclusion of metabolic assessment as part of clinical evaluation [26].

Conclusions

Postoperative recovery in patellar tendinopathy depends on a structured, progressive, and individualized rehabilitation process, since functional improvement is determined not only by the surgical procedure itself, but also by early symptom control, gradual restoration of mobility, progressive strengthening, and sport-specific reintegration.

Early mobilization protocols appear to promote faster recovery, improved knee flexion, and earlier functional return, whereas conservative protocols may provide greater initial tissue protection but can also be associated with muscle atrophy and delayed recovery. Therefore, protocol selection should be tailored to the type of surgery, clinical progression, and individual patient characteristics.

The most favorable postoperative outcomes appear to be associated with multimodal rehabilitation strategies that combine pain management, progressive strengthening, eccentric and heavy slow resistance exercises, neuromuscular control, biomechanical retraining, and objective return-to-sport criteria, as this comprehensive approach improves pain, function, load tolerance, and athletic reintegration more effectively.

References

1. Arner JW, Kaeding CC, Bradley JP. Management of patellar tendinopathy. Arthroscopy the Journal of Arthroscopic and Related Surgery [Internet]. 2023 Dec 18;40(1):13–5. Available from: https://doi.org/10.1016/j.arthro.2023.09.004
2. Marigi EM, Buckley P, Razi F, Abbas MJ, Jildeh TR, Camp CL, et al. Patellar Tendinopathy: Critical Analysis Review of Current Nonoperative Treatments.

JBJS Reviews [Internet]. 2022 Mar 1;10(3). Available from: https://doi.org/10.2106/jbjs.rvw.21.00168

3. Nutarelli S, Da Lodi CMT, Cook JL, Deabate L, Filardo G. Epidemiology of Patellar Tendinopathy in Athletes and the General Population: A Systematic review and Meta-analysis. Orthopaedic Journal of Sports Medicine [Internet]. 2023 Jun 1;11(6):23259671231173659. Available from: https://doi.org/10.1177/23259671231173659
4. Sugrañes J, Jackson GR, Mameri ES, Schundler S, Obioha OA, Pascual TA, et al. Current concepts in patellar tendinopathy. JBJS Reviews [Internet]. 2023 Aug 1;11(8). Available from: https://doi.org/10.2106/jbjs.rvw.23.00076
5. Theodorou A, Komnos G, Hantes M. Patellar tendinopathy: an overview of prevalence, risk factors, screening, diagnosis, treatment and prevention. Archives of Orthopaedic and Trauma Surgery [Internet]. 2023 Aug 4;143(11):6695–705. Available from: https://doi.org/10.1007/s00402-023-04998-5
6. Cognetti DJ, Sheean AJ, Arner JW, Wilkerson D, Bradley JP. Surgical Management of patellar tendinopathy Results in improved outcomes and high rates of return to sport: A Systematic review. The Journal of Knee Surgery [Internet]. 2022 Sep 26;36(11):1171–90. Available from: https://doi.org/10.1055/s-0042-1757701
7. Maioli V, Conconi M, Diquattro E, Traina F, Sancisi N, Cristofolini L. Quadriceps force direction affects patellofemoral kinematics without impacting tibiofemoral stability: a cadaveric study. Knee Surgery and Related Research [Internet]. 2025 Aug 28;37(1):36. Available from: https://doi.org/10.1186/s43019-025-00286-1
8. Park K, Keyak JH, Kulig K, Powers CM. Persons with Patellar Tendinopathy Exhibit Greater Patellar Tendon Stress during a Single-Leg Landing Task. Medicine & Science in Sports & Exercise [Internet]. 2022 Nov 17;55(4):642–9. Available from: https://doi.org/10.1249/mss.0000000000003084
9. Kim D, Moon HY, Lee M. Mechanotransduction as a therapeutic target in tendinopathy: molecular pathways and exercise implications. Research in Sports Medicine [Internet]. 2025 Oct 5;1–16. Available from: https://doi.org/10.1080/15438627.2025.2568936
10. Ito N, Silva RS, Silbernagel KG. Location of measurement matters: unveiling regional dynamics and sex differences in patellar tendon strain in vivo. Scandinavian Journal of Medicine and Science in Sports [Internet]. 2024 Aug 1;34(8):e14712. Available from: https://doi.org/10.1111/sms.14712
11. Llombart R, Mariscal G, Barrios C, Llombart-Ais R. The Best Current Research on patellar tendinopathy: a review of published Meta-Analyses. Sports [Internet]. 2024 Feb 1;12(2):46. Available from: https://doi.org/10.3390/sports12020046
12. Mueller J, Crockatt W, Desai N, Goldwaser E, Thomopoulos S, Wong T, et al. Poster 274: Preseason patellar tendon thickness as a predictor of symptomatic patellar tendinopathy in NCAA Division I Basketball players. Orthopaedic Journal of Sports Medicine [Internet]. 2023 Jul 1;11. Available from: https://doi.org/10.1177/2325967123s00252
13. Omodani T, Saito M, Ikuta F. Ultrasound-Guided Percutaneous ultrasonic tenotomy for refractory

patellar tendinopathy in High-Level Athletes: a case series. Clinical Journal of Sport Medicine [Internet]. 2024 Sep 10;35(3):259–63. Available from: https://doi.org/10.1097/jsm.0000000000001275

14. Qiu Z, Ma H. Rehabilitation exercise program after surgical treatment of patellar tendon rupture: A case report. Physical Therapy in Sport [Internet]. 2024 Jan 4;66:17–24. Available from: https://doi.org/10.1016/j.ptsp.2024.01.001
15. Cooper K, Alexander L, Brandie D, Brown VT, Greig L, Harrison I, et al. Exercise therapy for tendinopathy: a mixed-methods evidence synthesis exploring feasibility, acceptability and effectiveness. Health Technology Assessment [Internet]. 2023 Oct 1;27(24):1–389. Available from: https://doi.org/10.3310/tfws2748
16. Monson J, Schoenecker J, Schwery N, Palmer J, Rodriguez A, LaPrade RF. Postoperative rehabilitation and return to sport following multiligament knee reconstruction. Arthroscopy Sports Medicine and Rehabilitation [Internet]. 2022 Jan 1;4(1):e29–40. Available from: https://doi.org/10.1016/j.asmr.2021.08.020
17. Morgan C, Bell RM, Burland JP, Kriscenski D, Ilinski A, Cote MP, et al. Effectiveness of an accelerated rehabilitation protocol after tibial tubercle osteotomy. Orthopaedic Journal of Sports Medicine [Internet]. 2022 Nov 1;10(11):23259671221133105. Available from: https://doi.org/10.1177/23259671221133105
18. Niering M, Muehlbauer T. Changes After a Conventional vs. an Alternative Therapy Program on Physical, Psychological, and Injury-Related Parameters in Male Youth Soccer Players With Patellar Tendinopathy During Return to Competition. The Journal of Strength and Conditioning Research [Internet]. 2023 Feb 7;37(9):1834–43. Available from: https://doi.org/10.1519/jsc.0000000000004467
19. Agergaard AS, Svensson RB, Malmgaard-Clausen NM, Couppé C, Hjortshoej MH, Doessing S, et al. Clinical outcomes, structure, and function improve with both heavy and moderate loads in the treatment of patellar tendinopathy: a randomized clinical trial. The American Journal of Sports Medicine [Internet]. 2021 Feb 22;49(4):982–93. Available from: https://doi.org/10.1177/0363546520988741
20. Agergaard AS, Svensson RB, Malmgaard-Clausen NM, Magnusson SP. Clinical Outcomes and Tendon Structure at 3- to 4-Year Follow-up After Exercise-Based Treatment of Patellar Tendinopathy: A Prospective study. Orthopaedic Journal of Sports Medicine [Internet]. 2024 Oct 1;12(10):23259671241280192. Available from: https://doi.org/10.1177/23259671241280192
21. Souto LR, De Oliveira Silva D, Pazzinatto MF, Siqueira MS, Moreira RFC, Serrão FV. Are adjunct treatments effective in improving pain and function when added to exercise therapy in people with patellofemoral pain? A systematic review with meta-analysis and appraisal of the quality of interventions. British Journal of Sports Medicine [Internet]. 2024 Jun 18;58(14):792–804. Available from: https://doi.org/10.1136/bjsports-2024-108145
22. Challoumas D, Pedret C, Biddle M, Ng NYB, Kirwan P, Cooper B, et al. Management of patellar tendinopathy: a systematic review and network meta-analysis of randomised studies. BMJ

Open Sport & Exercise Medicine [Internet]. 2021 Nov 1;7(4):e001110. Available from: https://doi.org/10.1136/bmjsem-2021-001110

23. Yoon SY, Kim YW, Shin IS, Kang S, Moon HI, Lee SC. The Beneficial Effects of Eccentric Exercise in the Management of Lateral Elbow Tendinopathy: A Systematic Review and Meta-Analysis. Journal of Clinical Medicine [Internet]. 2021 Sep 1;10(17):3968. Available from: https://doi.org/10.3390/jcm10173968
24. Capin JJ, Bade MJ, Jennings JM, Snyder-Mackler L, Stevens-Lapsley JE. Total knee arthroplasty assessments should include Strength and Performance-Based functional tests to complement Range-of-Motion and Patient-Reported outcome measures. Physical Therapy [Internet]. 2022 Mar 29;102(6). Available from: https://doi.org/10.1093/ptj/pzac033
25. Qiao Y, Wu C, Wu X, Li Z, Chen J, Xu C, et al. The Value of Minimal Clinically Important Difference, Substantial Clinical Benefit, and Patient-Acceptable Symptomatic State for Commonly Used Patient-Reported Outcomes in Recurrent Patellar Instability Patients After Medial Patellofemoral Ligament Reconstruction and Tibial Tubercle Transfer. Arthroscopy the Journal of Arthroscopic and Related Surgery [Internet]. 2023 Jul 5;40(1):115–23. Available from: https://doi.org/10.1016/j.arthro.2023.06.042
26. Kuliś S, Kłobuchowski W, Skorulski M, Ornowski K, Gołaś A, Maszczyk A, et al. Beyond Mechanical Load: Metabolic Factors and Advanced Rehabilitation in Sports Tendinopathy: A Comprehensive Systematic review. Journal of Clinical Medicine [Internet]. 2025 Oct 22;14(21):7480. Available from: https://doi.org/10.3390/jcm14217480