IMAGING AND INTERVENTION

REVIEW IMAGING AND INTERVENTION 2021;1(2):38-43
DOI: 10.5152/iai.2021.21043

Patellar Tendinopathy: Ultrasound Diagnosis and Therapeutic Management

Julio Rosales[1], Nicolás García Álvarez[1], Sebastián Butrón, Roberto Yáñez[2], Guillermo Droppelmann[3], Marco A. Verdugo[1]

[1]*MSK Diagnostic and Interventional Radiology Department, Clinica Meds, Santiago, Chile*
[2]*Orthopedic and Trauma Department, Clinica Meds, Santiago, Chile*
[3]*Academic Unit, Clinica Meds, Santiago, Chile*

Abstract

Patellar tendinopathy is a frequent cause of pain in athletes, especially in those sports that involve jumping. It is a predominantly degenerative process (tendinosis) with little involvement of inflammatory components.

In the diagnosis approach, ultrasound offers some advantages, such as better spatial resolution, real-time evaluation, assessment of hypervascularization by color Doppler, which allow for the categorization of each patient according to the ultrasound findings. Therapeutic management includes several alternatives, such as physical therapy, tendon fenestration, platelet-rich plasma infiltration, percutaneous electrolysis, shock waves, among others, which, according to the ultrasound characteristics of the lesion, will have specific recommendations.

Keywords: Jumper's knee, tendinopathy, tendon, treatment, ultrasound

Introduction

Patellar tendinopathy is a condition clinically characterized by progressive pain related to physical activity in the lower pole of the patella or the proximal portion of the tendon.[1] It is also known as "jumper's knee," since it is a consequence of repetitive mechanical stress on the extensor apparatus through higher demand during jumping.[2] In this context, the prevalence of this condition is higher in those sports that involve jumping, such as volleyball (reported prevalence in professional athletes up to 45%) or basketball (32%).[3] In other sports like soccer, the reported prevalence is up to 2.4% in 1 season in professional players.[4]

In a systematic review of literature, the risk factors for developing patellar tendinopathy were assessed, and anthropometric factors (increased body mass index, increased abdominal girth, limb length discrepancy, flat feet), quadriceps strength deficit and reduced quadriceps, and hamstring flexibility as independent factors to develop the condition were described. Training time, the type of surface, and the type of training were not correlated with a higher incidence of the condition.[5]

The aim of this review is to describe histopathology, imaging evaluation with focus in ultrasound, and the therapeutic non-surgical alternatives. Finally, we will describe the therapeutic approach that we use in our clinical centre based on a previous ultrasound categorization.

Histopathology

A normal tendon is composed of collagen fibers, cells, and a proteoglycan-rich extracellular matrix. Collagen is arranged in parallel and gives the tendon the ability to resist tensile forces, while proteoglycans provide structural support to collagen. The cellular component is determined by the tenocytes, which are flattened cells located between collagen fibers and are responsible for synthesizing both the extracellular matrix and collagen.[6]

The term "tendinosis" refers to the process of progressive tendon degeneration with failure of the reparative response. In patellar tendinosis, a degenerative process is observed predominantly in the posterior portion of the tendon, with disorganization of collagen fibers, loss of tension and parallel arrangement, which is associated with the interposition of mucoid content. It is sometimes associated with disruptions of collagen fibrils and necrosis, caused by micro-tears.[7] This entire process of mucoid degeneration is associated with variable

Cite this article as: *Rosales J, Álvarez NG, Butrón S, Yáñez R, Droppelmann G, Verdugo MA. Patellar tendinopathy: Ultrasound diagnosis and therapeutic management. Imaging Interv. 2021;1(2):38-43.*

Corresponding author: Nicolás García Álvarez, e-mail: nicolasgarciaa@gmail.com

Received: August 19, 2021 **Accepted**: September 30, 2021

degrees of fibrosis and neovascularization, which is the manifestation of the attempt to repair.

A higher cell content is observed, with an increase in tenocytes that have lost their flattened morphology, as well as the presence of fibroblasts.[8] An important fact to be considered in histopathology is that inflammatory cells do not play a central role in the process of tendinosis, even some authors propose absence of these kind of cells,[9] even though some more recent evidence has suggested that chronic inflammatory cells are found in tendinopathy.[10]

In some cases, the degenerative process of the tendon is associated with the presence of calcifications. Endochondral ossification, with the presence of osteoblasts and osteoclasts, has been found in patients with patellar tendinosis. The origin of these types of cells is not completely clear. Different theories have been proposed, for example, some suggest that they originate from the bone marrow, while others suggest that they are derived from tenocyte precursor stem cells or directly from a tenocyte metaplasia process. It has also been proposed that osteoblasts and osteoclasts are derived from metaplasia in pericytes (blood cells that have been shown to have the ability to differentiate into chondrocytes or osteoblasts), and that the metaplasia in pericytes would be favored in tendinosis due to the hypervascularization that accompanies this process.[11] In the context of damaged tissue, intrasubstance calcifications are found in the group of "dystrophic calcifications,"[12] which must be differentiated from calcific tendinopathy caused by abnormal deposition of calcium hydroxyapatite crystals, in which no underlying degenerative process is found.

Imaging Evaluation

Both magnetic resonance imaging (MRI) and ultrasound have shown good ability to characterize abnormalities in tendons.[13] Ultrasound offers some advantages over MRI[14] including, better spatial resolution; real-time evaluation, with the possibility of performing dynamic maneuvers and directly exploring areas with greater symptomatology; assessing the presence of hyperemia/hypervascularization using color Doppler, which could have been a prognostic factor in tendon pathology,[15] and it also has a lower cost than MRI. In addition, it allows comparative evaluation of the contralateral knee. As a counterpart, MRI offers a more comprehensive evaluation of the knee. Furthermore, it is a nonoperator-dependent technique.

From an ultrasound point of view, patellar tendinosis is presented as hypoechoic areas, which are commonly first initiated in the posterior and medial portion of the tendon, which is associated with diffuse thickening. This is an imaging translation of what is happening from a histopathological perspective mainly corresponding to mucoid degeneration and disorganization of collagen fibers. The neovascularization process can be evaluated using color Doppler, which will demonstrate the increase in vascular structures at the focal point of tendinosis. Furthermore, good performance of intratendineal calcifications can also be determined, which can be part of the histopathological process as previously presented.

Classification

The most used classifications in patellar tendinopathy are the Blazina score and the Victorian Institute of Sport Assessment (VISA) score.[16,17] However, both are only based on clinical parameters and do not necessarily provide a guide for therapeutic management. Moreover, sometimes, no direct correlation between the symptoms and the degree of tissue damage in the tendon is found, especially in athletes, which may lead to an underestimation of the severity of the injury and a worsening of the prognosis.[18] In this sense, the imaging assessment in patellar tendinopathy allows a quantitative assessment of the degree, location, and type of tendon alterations, resulting in a more specific prognosis.

There are few imaging classifications that relate the severity of tendinopathy with a more specific treatment. Gemignani et al.[18] evaluated patellar tendinopathy, with the use of ultrasound, according to the percentage of tendinosis area (hypoechoic area) in axial views of the tendon, as well as the presence of tears. They classified tendinopathy into grade 1 (<20% tendinosis), grade 2 (20-50%), grade 3 (>50%), and grade 4 (presence of partial or total tears). They showed that the higher the degree of tendinosis, the longer the recovery time. However, the initial conservative management was more or less the same for all patients, so the classification does not allow for specific recommendations based on imaging findings.

Golman et al.[19] proposed a classification in MRI, also using grades 1 to 4, and an evaluation in the axial axis of the tendon, with an emphasis on partial tears. They showed that the thicker the tendon, the greater the probability of having partial tears, as well as the fact that there is a very low likelihood of success with conservative treatment if the tendon is >11.5 mm or tears are >50% of the tendon thickness.

Taking into account these previous experiences, and with the aim of guiding the therapeutic process, an ultrasound categorization is proposed that includes the evaluation of the tendon in the axial axis. The evaluation of 4 different parameters (Table 1; Figures 1-6) is laid out as follows:

1. Area of tendinosis in the transverse axis.
2. Evaluation of vascularization by power Doppler: Present/absent.
3. Presence or absence of partial tears and, if any, its percentage of compromise in relation to the thickness of the tendon in the axial axis.
4. Presence or absence of intratendineal calcifications. In this parameter, intratendineal calcifications that are completely located in the thickness of the tendon must be

Table 1. Main Features of Each Ultrasound Category

Category	Definition
1. Tendinosis	% area of tendinosis in transverse axis
Mild	<25%
Moderate	>25 to <50%
Severe	>50%
2. Hypervascularization	Present/absent with power Doppler
3. Partial tears	<50% of the thickness of the tendon in the axial axis
	>50% of thickness
4. Intrateninous calcification	<6 mm (in major axis)
	>6 mm (in major axis)

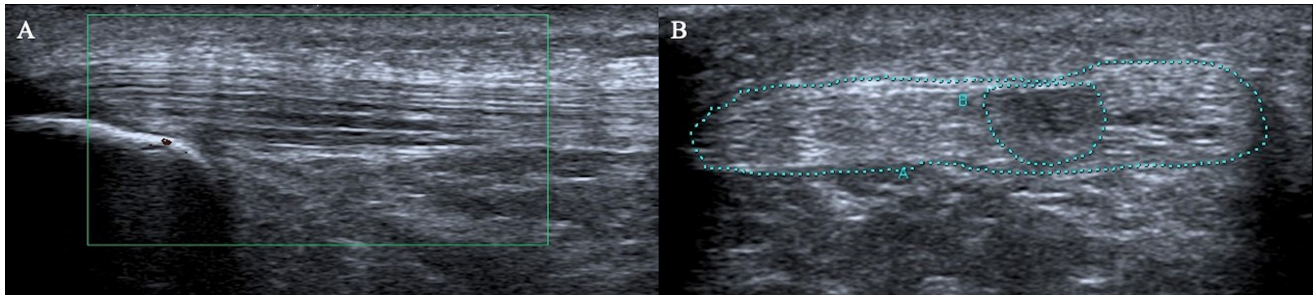

Figure 1. Longitudinal (A) and transverse (B) views of proximal patellar tendon. In (A), little enlargement is seen in the proximal segment. In (B), percentage of tendinosis area is marked, in this case being < 25%, concordant with mild tendinopathy.

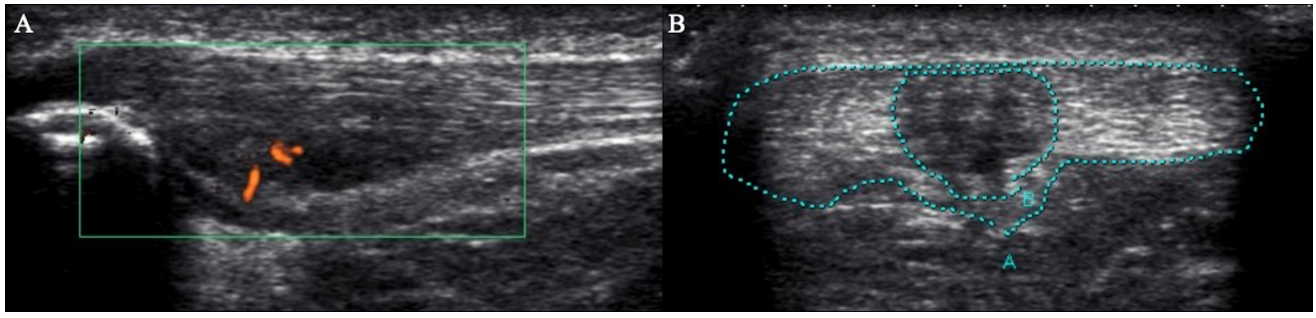

Figure 2. Longitudinal (A) and transverse (B) views of proximal patellar tendon. In this case, there is more enlargement in the tendon (A), with an area of tendinosis (B) more than 25%, but less than 50%, concordant with moderate tendinopathy. Hypervascularization is also demonstrated in (A).

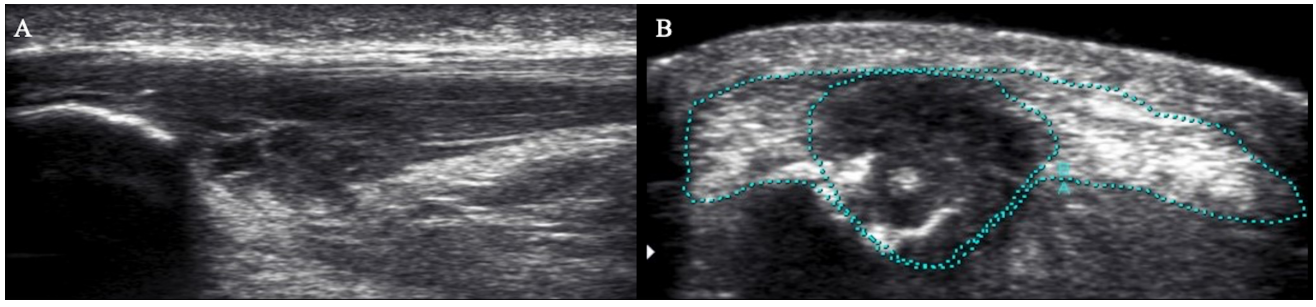

Figure 3. Longitudinal (A) and transverse (B) views of proximal patellar tendon, with marked enlargement (A) and an area of tendinosis (B) more than 50%, which corresponds to a severe tendinopathy.

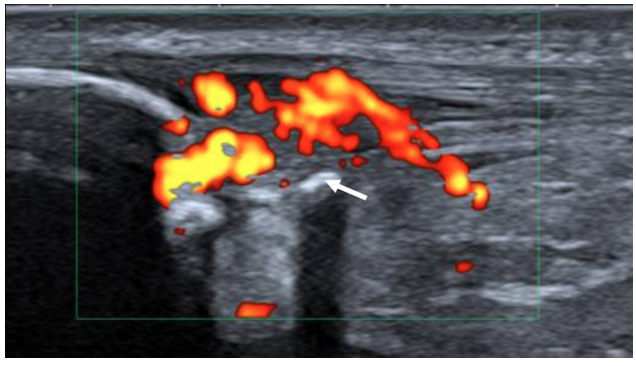

Figure 4. Longitudinal view of proximal patellar tendon, which is enlarged and heterogeneous, in context of tendinosis, with hypervascularization when power Doppler is used. Intrasubstance calcifications (white arrow) are also demonstrated.

differentiated from the enthesopathic calcifications that are immediately adjacent to the lower pole of the patella, which do not fall into this category.

Treatment

There are several treatments described in the literature. Physical treatment is one of the cornerstones for the management of patellar tendinopathy, either as initial and sole management in mild tendinosis or as supplementary management to interventional procedures. In kinesic therapy, it is important to include eccentric exercises since their effectiveness in patellar tendinopathy is widely demonstrated in the literature.[20] Alfredson[21] put forward 3 possible theories to explain their effectiveness. The first suggests that they create a change in the patient's perception of pain as the exercises are painful. The second suggests the vascularization that appears in tendinopathy

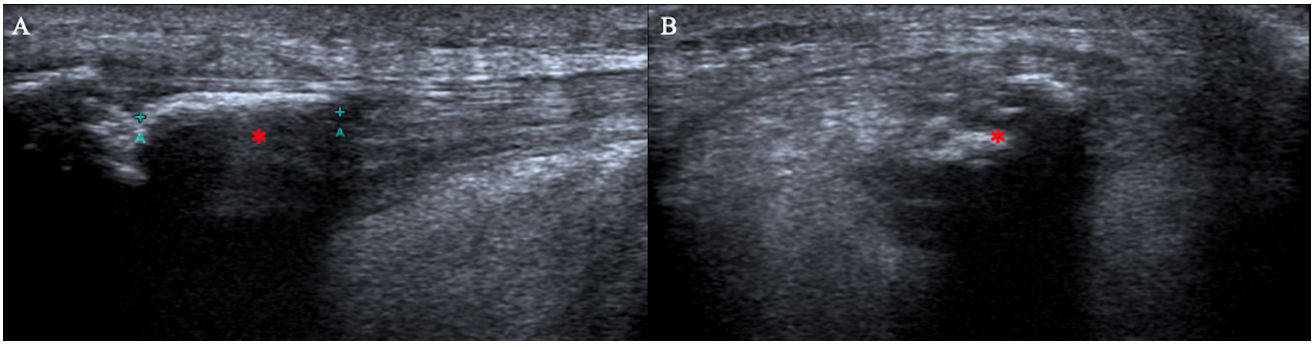

Figure 5. Longitudinal (A) and transverse (B) views of proximal patellar tendon, with a big intrasubstance calcification (*).

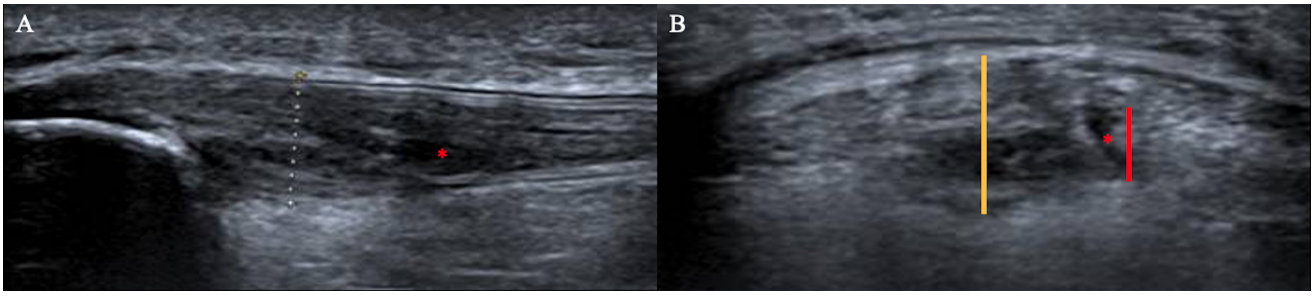

Figure 6. Longitudinal (A) and transverse (B) views of proximal patellar tendon, with heterogeneous enlargement associated to a partial tear (*). In (B), the tear thickness (red line) in relation to tendon thickness (yellow line) is shown.

is destroyed and with it the accompanying nerve endings. Finally, the third theory explains that eccentrics increase the tendon's resistance to traction, producing an elongation of the tendinous muscle unit, with the tendon bearing less tension during movement. Regardless of the underlying mechanisms, they have produced significant improvements in pain reduction and patient satisfaction in between 60% and 90% of patients.

Percutaneous needle electrolysis (PNE) is the application of galvanic current through an acupuncture needle in the area of tendinosis to produce osmotic lysis and formation of sodium hydroxide, leading to an exacerbation of the degenerative process in the tendon, thus, allowing for reparative mechanisms to be initiated.[22] Several studies have shown the effectiveness of PNE in combination with eccentric exercises.[23-25]

In ultrasound-guided tendon fenestration, several ultrasound-guided punctures are performed in the area of tendinosis, thus, a flare-up in the area that allows for the activation of inflammatory mediators is produced, and the reparative process is initiated. Although it is sometimes associated with platelet-rich plasma (PRP) injections, fenestration alone has shown good effectiveness with reports showing good or excellent improvement in pain management in up to 73% of patients with patellar tendinopathy.[26]

Another alternative is the use of PRP. Due to the high concentrations of growth factors, the PRP would have a reparative effect on the tendon. Unfortunately, there are multiple presentations, strengths and doses, also multiple rehabilitation and post-injection protocols that limit comparison between different published studies; therefore, the current evidence is still inconclusive. A systematic review[27] concluded that PRP would have a positive effect on the management of patellar tendinopathy, although the available evidence is of low quality to make a definitive recommendation. While there is a lack of larger studies, in our experience, we have had very good results in the management of patellar tendinopathies with PRP.

In relation to shock waves, there is not much literature available either, although it is proposed as a valid alternative for the management of patellar tendinopathy, specially when it is associated with calcifications. In this regard, a systematic review[28] concluded that it was a safe and promising treatment. The usefulness of shock waves is explained through 3 pathways[29]: the first postulates that pain relief is achieved by "hyperstimulation analgesia," where overstimulation of the painful area ultimately leads to less transmission of the impulse to the brainstem; the second is about the shock waves producing mechanical stress that induces the reparative process; and the third occurs through the destructive effect of shock waves on calcifications, similar to lithotripsy in kidney stones.

In patellar tendinopathies with hypervascularization, initial management should be aimed at reducing it, since patients are usually suffering from a lot of pain, which limits kinesic therapy. In this context, a more aggressive initial management with oral anti-inflammatory drugs in addition to a greater decrease in sports loads is proposed. As an interventional procedure, alternatives include ultrasound-guided percutaneous electrolysis, as previously described, or injection of sclerosing agents (e.g., polidocanol). Of the latter, there is not much literature on the matter; some studies have shown good short-term results,[30,31] but not so much in the long term.[32]

In our center, we used the ultrasound categorization previously described to guide therapeutic alternatives. Physical treatment is indicated as initial and sole management in mild tendinosis or as supplementary management to interventional procedures in the rest of the tendinopathies. In the case of moderate tendinopathies, the combined management of physical treatment

Table 2. Summary of Therapeutic Management for Each Category

Category	Definition	Therapeutic Management
1. Tendinosis	% of area	
Mild	<25%	Physical therapy (PT)
Moderate	>25 to <50%	PT + electrolysis/fenestration
Severe	>50%	PT + fenestration and PRP/shock waves
2. Hypervascularization	Present/absent	If present: anti-inflammatory drugs + PT + electrolysis/sclerotherapy
		After that, management according to the other ultrasound characteristics
3. Partial tears	<50%	PT + fenestration and PRP/shock waves
	>50%	Consider surgical management
4. Calcification	<6 mm	Shock waves
	>6 mm	Consider surgical management

PRP, platelet-rich plasma.

associated with 1 of the following 2 alternatives is proposed, upon availability: ultrasound-guided percutaneous electrolysis or ultrasound-guided tendon fenestration. In severe tendinopathies, combined kinesiology management is proposed with any of the following alternatives, upon availability: fenestration + infiltration with PRP or shockwave therapy. In patellar tendinopathies with hypervascularization, initial management should be aimed at reducing it, since patients are usually suffering from a lot of pain, which limits kinesic therapy. In this context, a more aggressive initial management with oral anti-inflammatory drugs in addition to a greater decrease in sports loads is proposed. In the case of patients with partial tears, if they involve less than 50% of the thickness of the tendon, kinesic management associated with tendon fenestration with PRP infiltration or the use of shock waves is proposed, upon availability. In the event that the tear involves more than 50% of the thickness of the tendon, surgical management is proposed, since it is more difficult to have symptomatic improvements in comparison to the rest of the alternatives.[19]

Finally, in the case of intratendineal calcifications, 2 scenarios are posed: if the size of calcifications is less than 6 mm in their long axis, the proposal includes management with shock waves; in the event that the size of calcifications is more than 6 mm, surgical management should be considered in those cases where conservative treatment fails, since we have observed cases in which the evolution is unsatisfactory. Proposed management by category is detailed in Table 2.

Conclusion

Patellar tendinopathy can have several different ultrasound characteristics. The categorization of the ultrasound findings in patellar tendinopathy provides clinicians much more detailed information, allowing for the proposal of specific therapeutic recommendations as evaluated by ultrasound, to optimize the management of each patient to achieve a better result. The challenge for the future is to carry out prospective studies with the treated patients, in order to compare the different proposed treatments and deliver a more precise prognosis according to the ultrasound finding.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – J.R., N.G., S.B., R.Y., M.V.; Design – N.G., G.D; Supervision – J.R, S.B., R.Y., M.V; Analysis and/or Interpretation – N.G, G.D.; Literature Search – N.G, S.B., G.D.; Writing – N.G.; Critical Reviews – J.R., R.Y.

Conflict of Interest: The authors have no conflict of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

References

1. Khan KM, Cook JL, Kannus P, Maffulli N, Bonar SF. Time to abandon the "tendinitis" myth. *BMJ*. 2002;324(7338):626-627. [CrossRef]
2. Kannus P. Etiology and pathophysiology of chronic tendon disorders in sports. *Scand J Med Sci Sports*. 1997;7(2):78-85. [CrossRef]
3. Lian OB, Engebretsen L, Bahr R. Prevalence of jumper's knee among elite athletes from different sports: a cross-sectional study. *Am J Sports Med*. 2005;33(4):561-567. [CrossRef]
4. Hägglund M, Zwerver J, Ekstrand J. Epidemiology of patellar tendinopathy in elite male soccer players. *Am J Sports Med*. 2011;39(9):1906-1911. [CrossRef]
5. van der Worp H, van Ark M, Roerink S, et al. Risk factors for patellar tendinopathy: a systematic review of the literature. *Br J Sports Med*. 2011;45(5):446-452. [CrossRef]
6. O'Brien M. Structure and metabolism of tendons. *Scand J Med Sci Sports*. 1997;7(2):55-61. [CrossRef]
7. Yu JS, Popp JE, Kaeding CC, Lucas J. Correlation of MR imaging and pathologic findings in athletes undergoing surgery for chronic patellar tendinitis. *AJR Am J Roentgenol*. 1995;165(1):115-118. [CrossRef]
8. Khan KM, Bonar F, Desmond PM, et al. Patellar tendinosis (jumper's knee): findings at histopathologic examination, US, and MR imaging. Victorian Institute of Sport Tendon Study Group. *Radiology*. 1996;200(3):821-827. [CrossRef]
9. Khan KM, Cook JL, Bonar F, Harcourt P, Astrom M. Histopathology of common tendinopathies. Update and implications for clinical management. *Sports Med*. 1999;27(6):393-408. [CrossRef]
10. Dean BJ, Gettings P, Dakin SG, Carr AJ. Are inflammatory cells increased in painful human tendinopathy? A systematic review. *Br J Sports Med*. 2016;50(4):216-220. [CrossRef]
11. Fenwick S, Harrall R, Hackney R, et al. Endochondral ossification in Achilles and patella tendinopathy. *Rheumatology*. 2002;41(4):474-476. [CrossRef]
12. Stewart VL, Herling P, Dalinka MK. Calcification in soft tissues. *JAMA*. 1983;250(1):78-81. [CrossRef]
13. Adler RS, Finzel KC. The complementary roles of MR imaging and ultrasound of tendons. *Radiol Clin North Am*. 2005;43(4):771-807, ix. [CrossRef]
14. Chang A, Miller TT. Imaging of tendons. *Sports Health*. 2009;1(4):293-300. [CrossRef]

15. Zanetti M, Metzdorf A, Kundert HP, et al. Achilles tendons: clinical relevance of neovascularization diagnosed with power Doppler US. *Radiology*. 2003;227(2):556-560. [CrossRef]
16. Blazina ME, Kerlan RK, Jobe FW, Carter VS, Carlson GJ. Jumper's knee. *Orthop Clin North Am*. 1973;4(3):665-678. [CrossRef]
17. Visentini PJ, Khan KM, Cook JL, et al. The VISA score: an index of severity of symptoms in patients with jumper's knee (patellar tendinosis). Victorian Institute of Sport Tendon Study Group. *J Sci Med Sport*. 1998;1(1):22-28. [CrossRef]
18. Gemignani M, Busoni F, Tonerini M, Scaglione M. The patellar tendinopathy in athletes: a sonographic grading correlated to prognosis and therapy. *Emerg Radiol*. 2008;15(6):399-404. [CrossRef]
19. Golman M, Wright ML, Wong TT, et al. Rethinking patellar tendinopathy and partial patellar tendon tears: a novel classification system. *Am J Sports Med*. 2020;48(2):359-369. [CrossRef]
20. Larsson ME, Käll I, Nilsson-Helander K. Treatment of patellar tendinopathy: a systematic review of randomized controlled trials. *Knee Surg Sports Traumatol Arthrosc*. 2012;20(8):1632-1646. [CrossRef]
21. Jonsson P, Alfredson H. Superior results with eccentric compared to concentric quadriceps training in patients with jumper's knee: a prospective randomised study. *Br J Sports Med*. 2005;39(11):847-850. [CrossRef]
22. Abat F, Alfredson H, Cucchiarini M, et al. Current trends in tendinopathy: consensus of the ESSKA basic science committee. Part II: treatment options. *J Exp Orthop*. 2018;5(1):38. [CrossRef]
23. Abat F, Gelber PE, Polidori F, Monllau JC, Sanchez-Ibañez JM. Clinical results after ultrasound-guided intratissue percutaneous electrolysis (EPI®) and eccentric exercise in the treatment of patellar tendinopathy. *Knee Surg Sports Traumatol Arthrosc*. 2015;23(4):1046-1052. [CrossRef]
24. Abat F, Sánchez-Sánchez JL, Martín-Nogueras AM, et al. Randomized controlled trial comparing the effectiveness of the ultrasound-guided galvanic electrolysis technique (USGET) versus conventional electro-physiotherapeutic treatment on patellar tendinopathy. *J Exp Orthop*. 2016;3(1):34. [CrossRef]
25. Moreno C, Mattiussi G, Núñez FJ, Messina G, Rejc E. Intratissue percutaneous electrolysis combined with active physical therapy for the treatment of adductor longus enthesopathy-related groin pain: a randomized trial. *J Sports Med Phys Fitness*. 2017;57(10):1318-1329. [CrossRef]
26. Housner JA, Jacobson JA, Morag Y, et al. Should ultrasound-guided needle fenestration be considered as a treatment option for recalcitrant patellar tendinopathy? A retrospective study of 47 cases. *Clin J Sport Med*. 2010;20(6):488-490. [CrossRef]
27. Jeong DU, Lee CR, Lee JH, et al. Clinical applications of platelet-rich plasma in patellar tendinopathy. *BioMed Res Int*. 2014;2014:249498. [CrossRef]
28. van Leeuwen MT, Zwerver J, van den Akker-Scheek I. Extracorporeal shockwave therapy for patellar tendinopathy: a review of the literature. *Br J Sports Med*. 2009;43(3):163-168. [CrossRef]
29. van der Worp H, van den Akker-Scheek I, van Schie H, Zwerver J. ESWT for tendinopathy: technology and clinical implications. *Knee Surg Sports Traumatol Arthrosc*. 2013;21(6):1451-1458. [CrossRef]
30. Alfredson H, Ohberg L. Neovascularisation in chronic painful patellar tendinosis: promising results after sclerosing neovessels outside the tendon challenge the need for surgery. *Knee Surg Sports Traumatol Arthrosc*. 2005;13(2):74-80. [CrossRef]
31. Hoksrud A, Ohberg L, Alfredson H, Bahr R. Ultrasound-guided sclerosis of neovessels in painful chronic patellar tendinopathy: a randomized controlled trial. *Am J Sports Med*. 2006;34(11):1738-1746. [CrossRef]
32. Hoksrud A, Bahr R. Ultrasound-guided sclerosing treatment in patients with patellar tendinopathy (jumper's knee): 44-month follow-up. *Am J Sports Med*. 2011;39(11):2377-2380. [CrossRef]