Partial Tear of the Patellar Tendon as a Complication of Poor Technique in the Application of Radial Pressure Waves. Case Report and Literature Review

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Abstract

Patellar tendinopathy is common, painful, and often difficult to successfully manage. Patients typically describe a dull, gradually onset pain characterized by focal pain at the distal pole of the patella. Increased load exacerbates the pain, and its prevalence ranges from 11.8% to 14.4% in recreational volleyball and basketball players reporting symptoms. The pathological process of patellar tendinopathy involves various aspects, with repetitive overload believed to play a significant role. Previously, inflammation was thought to be central to the pathological process, but histological evidence rejects this and confirms the failed nature of the healing response in these conditions. This has led to the use of the more appropriate term "tendinopathy." Extracorporeal shock wave therapy (ESWT) has been shown to improve angiogenesis and increase tenocyte proliferation, collagen synthesis, glycosaminoglycan content, protein synthesis, and activation of growth factors such as transforming growth factor, which are known to regulate tendon repair. Therefore, it is currently part of a treatment protocol for chronic patellar tendinopathy. However, there are factors associated with complications related to ESWT treatment reported in the literature. This article describes a partial tear of the patellar tendon as a complication following radial pressure wave therapy, also known as radial shock waves.

Keywords: Patellar tendon, Complication, Rupture, Extracorporeal shock waves

Introduction

Patellar tendinopathy is common, painful, and often difficult to manage successfully. Patients typically describe a dull, gradual onset pain characterized by focal pain at the distal pole of the patella. Increased load exacerbates the pain, and it is more prevalent in jumping athletes [1-3].

The diagnosis of chronic patellar tendinopathy is primarily clinical and can be classified using the Victorian Institute of Sport Assessment (VISA) scale or the modified Blazina scale [4].

The VISA-P scale can be applied to quantify symptoms, function, and the ability to perform sports activities related to patellar tendinopathy. The VISA questionnaires have sufficient clinometric evidence of reliability, measurement error, construct validity, and responsiveness. They can also be used to monitor the rehabilitation of patellar tendinopathy by quantifying progress and early detection of symptom aggravation. The VISA-P questionnaire consists of 8 items with a rating from 0 to 100, with 100 considered satisfactory [5].

The pathological process of patellar tendinopathy involves various aspects, with repetitive overload believed to play a significant role. Previously, inflammation was thought to be central to the pathological process, but histological evidence rejects this and confirms the failed nature of the healing response in these conditions. This has led to the use of the more appropriate term "tendinopathy" [6,7].

Tendon alterations include an increase in type III collagen fibers and the deposition of glycosaminoglycans (GAGs). There is a different type of regulation of matrix enzymes involved in collagen degradation, such as metalloproteinases and their inhibitors.

Macroscopically, a healthy tendon is not a neural structure,. however, during the process, innervations increase, leading to chronic pain due to cytokines, pain mediators, hypoxia, and pH changes [4].

Recently, it has been shown that the sympathetic nervous system has a direct influence on the perivascular innervation of the dorsal paratendinous tissue of the patellar tendon, which correlates with the "neovessels" found on color Doppler. It is also recognized that the location of the lesion (e.g., mid-tendon or osteotendinous junction) influences both the pathological process and subsequent treatment. Ferretti et al. evaluated 18 patellar tendon fragments from surgeries and observed that histological alterations were located at the tendon-bone junctions, while the tendon itself was healthy [8,9].

Regarding patellar tendon ruptures, they have an incidence of 0.5–6%, but they are severe injuries because the extensor mechanism is essential for normal human gait and can cause significant disability.

Men are more commonly affected than

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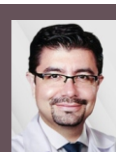
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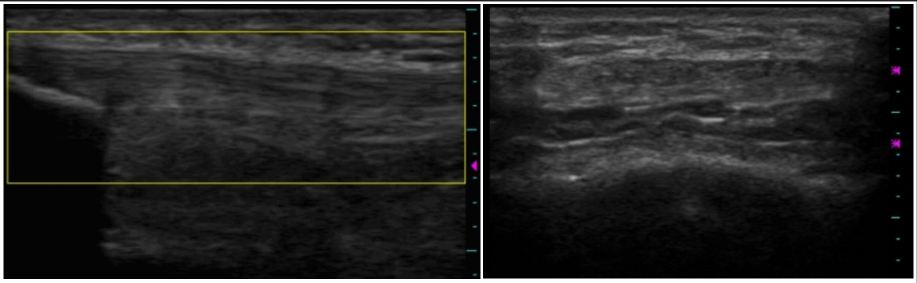

Figure 1: (a) Longitudinal section of the patellar tendon shows thickening, absence of blood vessels, mild Hoffa's fat pad edema, and intact tendon architecture. (b) Transverse section of the patellar tendon shows Hoffa's fat pad edema and intact tendon.

women. The idea behind this is that men are physically stronger and more prone to extensor mechanism rupture. In addition, women have greater ligament laxity and hormonal changes due to the menstrual cycle, which may be protective.

Some risk factors that may predispose patients to develop a rupture include tension overload in the extensor mechanism, which is usually the result of prolonged chronic tendon degeneration, obesity, being elite or recreational athletes with chronic patellar tendinopathy (resulting in repetitive microtraumas to the tendon), systemic diseases, prolonged use of corticosteroids, chronic kidney disease, use of fluoroquinolones, elderly individuals, and previous surgical procedures that alter the midsubstance or insertion sites of the patellar tendon, such as total knee arthroplasty [10-12].

In terms of the treatment of patellar tendinopathy, extracorporeal-focused shock wave therapy (ESWT-F) has been described as an effective approach. ESWT is a safe and non-invasive treatment for patellar tendinopathy when performed by a properly trained professional.

There are two types of shock waves:

1. Focused shock wave (ESWT) provides a significant amount of energy in deep planes generated by piezoelectric, electromagnetic, or electrohydraulic devices. These waves can activate reparative cellular processes even in bone tissue
2. Radial pressure wave (commonly called "radial shock wave") is generated through the kinetic transmission of energy in an applicator and has a more superficial effect on tissues [10].

Moya et al., in their article on complications and adverse effects of shock waves, explain the factors associated with complications related to ESWT treatment:

- Misdiagnosis: There is no single type of patellar tendinopathy, and the specific pathology must be correctly identified before treatment. This involves determining if it is calcific or fibrotic tendinopathy, tendon tear, or another painful syndrome
- Improperly trained operator: The operator should receive appropriate training and certification from the corresponding scientific societies
- Lack of knowledge about the pathology and the anatomy, physiology, and pathophysiology of the treated condition. It is generally recommended to perform the treatment under ultrasound guidance, and the indications and contraindications of the therapy should be followed
- Lack of knowledge about the equipment and its specific characteristics. It is essential to have a detailed understanding of the technique used for shock wave therapy
- Potential complications associated with shock waves and radial pressure waves, such as increased pain, erythema, and hematomas, among others. Medical personnel should be aware of these complications to prevent or manage them effectively [10]

There is limited literature on complications related to ESWT, and only one article published by Terán et al. discusses complications related to radial pressure waves specifically in relation to patellar tendon tears following improper application.

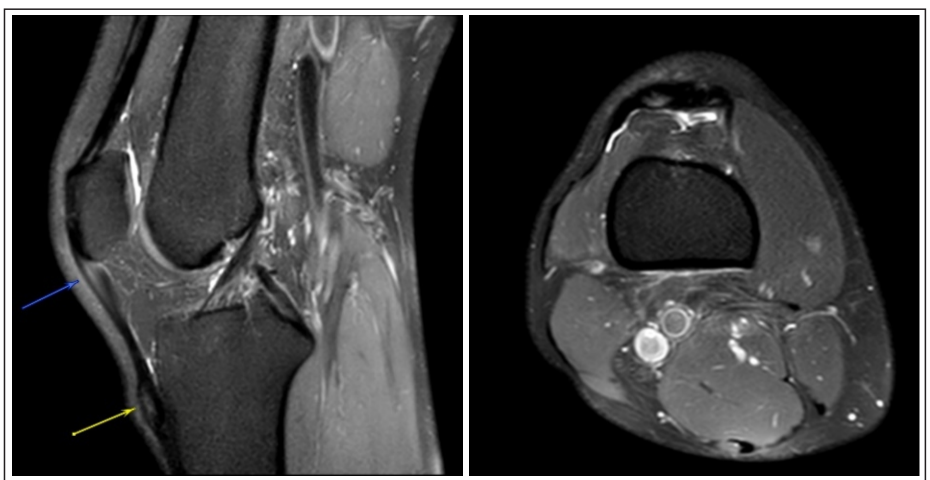

Figure 2: 3 Tesla MRI. (a) Sagittal section on the left arrow shows a partial tear of the patellar tendon at the proximal level, and on the right arrow, a small partial tear of the distal insertion of the patellar tendon. (b) Axial section shows the presence of a partial tear of the patellar tendon at the proximal end following the application of radial pressure waves.

Patients and Methods

This is a descriptive and retrospective study that analyzes the case of partial patellar tendon tear following treatment with radial pressure waves.

The patient is a 43-year-old male with no significant medical history. He engages in amateur sports activities, including boxing for 3 h per week, jogging for 20 h per week, and gym workouts for 12 h per week. He sought medical consultation due to pain in the anterior aspect of the right knee, which had been present for 9 months after engaging in endurance physical activities. Initially, the pain was localized to the inferior pole of the patella, occurring only at the end of physical activity. However, it progressed to being present during intense physical activity. The patient initially described the pain on a visual analog scale (VAS) as mild to moderate, ranging from 3 to 5 out of 10 in intensity. With this symptomatology, he received treatment at a sports medicine center in Quito, Ecuador, which included ten consecutive physiotherapy sessions, the use of orthopedic insoles, anti-inflammatory medication, and ten sessions of radial pressure wave therapy. According to the patient, the radial pressure waves were administered at the maximum energy level of the equipment and with a high frequency, which caused intense pain during each session. The patient is unaware of the number of impacts per session received. After completing the final session of radial pressure

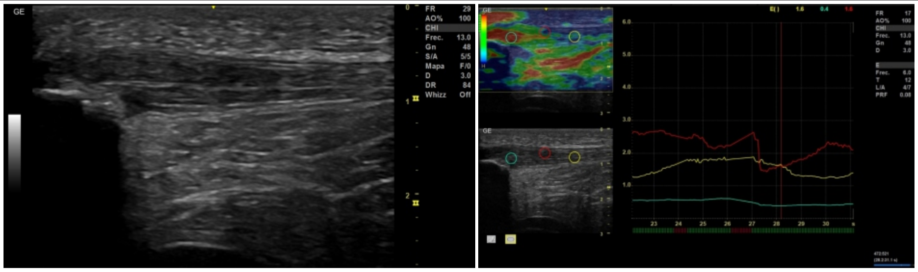

Figure 3: (a) Longitudinal ultrasound section showing tendon thickening, fiber edema, and areas of interstitial tear. (b) Elastography demonstrates altered tendon elastic quality with values below 0.5UI in the proximal zone and values close to 3UI in the rest of the patellar tendon.

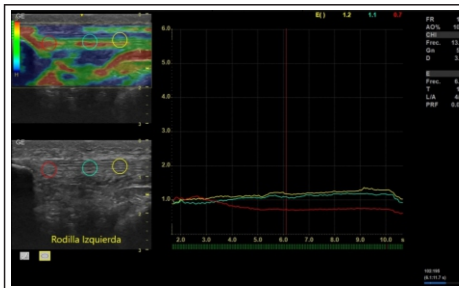

Figure 4: In the control ultrasound, the integrity of the patellar tendon is shown throughout its extent without any fiber alteration. Elastographic examination does not reveal signs of weakness or stiffness along the patellar tendon.

waves, the patient reported a significant increase in pain, reaching a VAS score of 10 out of 10 in intensity. He experienced limitations in performing daily activities such as climbing stairs or maintaining bipedal stance for more than 10 min. With these symptoms, the patient sought consultation at the Center for Orthopedic Specialties (CEOs). Upon examination at our institution, the patient exhibited tenderness upon palpation at the anterior tibial tuberosity and along the course of the patellar tendon. The Basset maneuver was positive, and pain was elicited upon extension against resistance. The VISA-P score was 17, and the VAS score for pain was 10 out of 10.

Imaging Examinations

Previous examinations

The patient had an initial ultrasound, which was performed during the management at the external sports medicine center and diagnosed patellar tendinopathy. The ultrasound reported slight thickening of the tendon with fiber edema and Hoffa's fat pad edema. Doppler findings were negative, indicating no significant vascular abnormalities. There were no reports of structural alterations such as tearing or avulsion. Elastography results are not available.

Current Imaging Examination

A 3 Tesla MRI of the right knee reveals thickening of the patellar tendon with increased signal intensity throughout its course, especially within the substance, including near the anterior tibial tuberosity. At the proximal end, it reaches a thickness of approximately 9 mm, and at the distal third, it measures 7.5 mm, showing partial tears at the patellar insertion of approximately 3 mm and at the tibial insertion of approximately 2 mm. Axial images demonstrate an area of approximately 0.12 cm2 at the proximal level, confirming structural alteration consistent with tendon tear (Fig. 1a and b).

Ultrasound and elastography demonstrate areas of tear with low resistance at the patellar insertion and along the tendon course, with elastography values reaching 3 UI.

Case Analysis

The patient clearly states that after receiving radial pressure wave treatment, the pain in the entire extent of the patellar tendon increased, and knee function deteriorated suddenly, making it impossible to perform daily activities without pain. The case is classified as Grade IV according to the Blazina scale.

Considering the need for treatment, conservative management was carried out at the CEO in Quito.

1. Ten sessions of high-intensity laser therapy (HIL) were performed consecutively. The analgesic phase utilized 12W in pulsed frequency, followed by a bio-stimulation phase using 9W of continuous power on the right patellar tendon using a BTL HIL device
2. Three sessions of focused ESWT were administered. The patient received 2000 waves at an intensity of 0.08 mJ/mm2 and a frequency of 3Hz (BTL-6000 FSWT device) with a 1-week interval between each session under ultrasound guidance
3. Percutaneous tenolysis guided by ultrasound was performed, along with a high-volume platelet-rich plasma (PRP) injection into the area between the patellar tendon and Hoffa's fat pad. Over 60 mL of PRP, poor in leukocytes, was used, with 2 mL of leukocyte-rich PRP applied to the intratendinous tear zone using atraumatic intervention needles
4. 2 weeks after the ultrasound-guided intervention, physical therapy and progressive eccentric strengthening were initiated. Fifteen physiotherapy sessions were prescribed at daily intervals. The sessions focused on lower extremity muscle stretching, transverse massage of the patellar tendon, progressive eccentric exercises, and strengthening of the hip and knee muscles.

At the 30-day follow-up after completing the treatment, complete recovery in both imaging and functionality was achieved. The patient attended consultation walking without external support, no pain, and no limitations in physical tests.

During the follow-up examination, ultrasound exploration showed the integrity of both patellar tendons, with no functional alterations observed during static and

Table 1: Recommended protocols for the management of chronic patellar tendinopathy

	Radial pressure waves	Focused shock waves
Number of impulses	>2000	1000–2000
Energy	>2 Bares	0.1–0.2 mJ/mm^2
Frequency	6–12 Hz	4–5 Hz
Sessions	2–5	1–3

Adapted from "Current concepts of shockwave therapy in chronic patellar tendinopathy" dynamic maneuvers. Doppler findings were negative, and Hoffa's fat pad was separated from the tendon during dynamic maneuvers. Palpation and the Basset maneuver were negative.

A 6-month follow-up appointment revealed a patient without pain. Ultrasound assessment showed bilateral patellar tendon integrity, negative Basset maneuvers under ultrasound guidance, negative Doppler findings bilaterally, and an elastography examination with values between 1 and 1.5 units in both patellar tendons. The VISA-P score was 100, Blazina score was 0, and the VAS score was 0/10.

Discussion

Patellar tendinopathy reduces the quality of life and interferes with participation in vigorous physical activities, often impacting both sports performance and work capacity. In active athletes with patellar tendinopathy, 55% report a negative impact on sports performance, while 16% experience work capacity limitations. Clinical manifestations in athletes are usually moderate but persistent, leading affected individuals to seek effective therapies that allow them to return to sports and professional physical activity [13].

There is a range of conservative treatment options that have shown improvement in symptoms associated with tendinopathy, including physiotherapy, image-guided high-volume injections, and eccentric loading exercises. A recent systematic review demonstrated that ESWT is also largely successful in providing an alternative conservative treatment for tendinopathy. Of the examined articles, 10 out of 11 focusing on Achilles tendinopathy and 6 out of 7 for patellar tendon reported significant symptom improvement after ESWT treatment [14].

ESWT is a safe and non-invasive treatment for patellar tendinopathy. Unlike surgical intervention, this form of therapy is not associated with major complications or side effects, and patients do not need to take time off work [10,15].

Shock waves have a direct and indirect effect on tissues, known as mechanotransduction. Absorbed shock waves produce tensile force, which explains the direct effect. Shock waves also stimulate the formation of cavitation bubbles that expand, contract, collide, and form other bubbles in the treated tissue. The resulting energy also stimulates a biological response, known as the indirect effect [16].

Due to the mechanosensitive nature of tendon cells, it is theorized that the impact of ESWT on interstitial and extracellular processes initiates tissue regeneration [17].

In vitro studies using explant models and cell culture techniques have shown that ESWT enhances angiogenesis, increases tenocyte proliferation, collagen synthesis, GAG content, protein synthesis, and growth factors such as transforming growth factor-beta 1 (TGF-β1), which are known to regulate tendon repair [18].

In a randomized controlled trial by Wang et al., which evaluated the efficacy of ESWT compared to conservative treatment for chronic patellar tendinopathy in a sample of 27 patients, positive results were found in 90% of the patients in the study group compared to only 50% in the control group. Furthermore, symptom recurrence occurred in only 13% of patients in the study group compared to 50% in the control group [19].

According to Leal et al., treatment with shock waves for chronic patellar tendinopathies that have not responded to conservative measures and physiotherapy is an effective and safe procedure. They do not recommend it for acute conditions, as over 80% of cases improve with conventional treatments, and only 20% develop dysplastic insertional tendinopathy. ESWT should be seen as part of a treatment protocol for patellar tendinopathy, rather than a standalone treatment. The best results are achieved when used in combination with eccentric exercises and standardized physiotherapy protocols [4,20].

According to protocols for the application of ESWT and radial pressure waves, the recommendation is to use at least 2000 shock waves at energies higher than 0.05 mJ/mm2 and 2 bars, respectively, in each session. Protocols may vary depending on the source, with focal devices ranging between 0.05 and 0.20 mJ/mm2 and a minimum of 1-2 sessions to achieve results. General recommendations are described in Fig. 4.

Regarding the use of HIL, there is evidence supporting its effectiveness in inhibiting pain pathways in the nervous system, as well as producing anti-inflammatory effects by locally stimulating blood and lymphatic circulation, leading to a reduction in edema and increased blood supply. Both effects occur due to the generation of heat in the diseased tissue - an increase of approximately 2–3°C - and mechanical stimulation of nociceptors and other nerve terminals, which is why it has become part of our treatment approach at our center.

The application of PRP is also not a new concept and has been used since the 1970s. Platelets have the potential to release growth factors such as TGF-β, VEGF, Platelet-Derived Growth Factor, IGF-1, and Fibroblast Growth Factor, as well as cytokines that mediate healing within tendons. Several uncontrolled studies have reported good results with the use of PRP in patellar tendinopathy. It is important to understand that PRP is not a standalone treatment but a tool within the therapeutic arsenal that modulates cellular healing or remodeling processes, and it should not be offered as a simple injection without proper ultrasound guidance and intervention. In a study of 31 patients, Filardo et al. found a statistically significant improvement in levels of sports activity at the end of a course of PRP procedures in patients with refractory chronic patellar tendinopathy compared to those treated with physiotherapy alone [21,22].

Considering all the elements described by the patient, it is evident that the indication of 10 sessions is excessive, and the method of application deviates from the protocols available in the global literature, which suggests a lack of knowledge or negligence by the personnel performing this treatment. This not only results in increased economic costs for the patient but also prolonged recovery times and an uncertain prognosis.

Conclusion

- Patellar tendinopathy is a challenging condition frequently observed in jump sports, particularly basketball and volleyball
- Adequate imaging examinations that assess and evaluate tendon quality are essential for selecting appropriate treatment options
- Functional scales should be used to assess tendinopathy to measure the impact of treatments on physical readaptation
- ESWT is an effective option in the management protocol for chronic

tendinopathy due to its low risk of secondary complications. However, it should be performed by properly trained, qualified, and certified medical personnel

• Conservative orthopedic management with physiotherapy should always be pursued, and all cellular remodeling tools should be employed to increase the likelihood of success

• It is crucial to analyze the risk factors that contribute to or exacerbate tendinopathies in order to achieve satisfactory outcomes when using orthopedic treatments

• There is limited literature describing the complications of ESWT and radial pressure wave therapy, highlighting the need for further research on this topic as standardized protocols for managing complications do not currently exist.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Conflicts of Interest: Nil. **Source of Support:** None.

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