BioMed

Review

Conservative Treatments for Patellar Tendinopathy: A Review of Recent High-Quality Evidence

Jerneja Čobec [1] and Žiga Kozinc [1,2,*]

[1] Faculty of Health Sciences, University of Primorska, Polje 42, 6310 Izola, Slovenia
[2] Andrej Marušič Institute, University of Primorska, Muzejski trg 2, 6000 Koper, Slovenia
* Correspondence: ziga.kozinc@fvz.upr.si

Abstract: Patellar tendinopathy is a common injury characterized by progressive activity-related anterior knee pain. It is highly prevalent in sports which involve jumping and changing direction. The aim of this paper is to review recent high-quality evidence regarding the effectiveness of physical therapy in the treatment of patellar tendinopathy. Randomized controlled trials (n = 22) researching the effects of exercise therapy, physical agents, and soft tissue techniques were included. The results show that exercise therapy is the most effective. While eccentric exercise is commonly used, very promising progressive tendon-loading exercise therapy programs are recently emerging. Extracorporeal shock wave therapy, dry needling, and orthoses are no more effective than eccentric exercises or placebo groups. Isometric and isotonic exercise, patellar strap, sports tape, and kinesiotaping have a short-term effect on functional improvement and pain reduction, while progressive tendon-loading exercise, dry needling, platelet-rich plasma, and extracorporeal shock wave therapy have long-term effects.

Keywords: knee pain; physical therapy; rehabilitation; tendon injury

check for updates

Citation: Čobec, J.; Kozinc, Ž. Conservative Treatments for Patellar Tendinopathy: A Review of Recent High-Quality Evidence. *BioMed* **2022**, *2*, 359–375. https://doi.org/10.3390/biomed2040028

Academic Editor: Wolfgang Graier

Received: 1 September 2022
Accepted: 28 September 2022
Published: 29 September 2022

1. Introduction

While all tendons in the human body are subjected to injury and overuse [1], patellar tendinopathy (PT), also known as jumper's knee, is one of the most common lower limb tendinopathies [2]. It is an overuse injury of the patellar tendon and reflects in anterior knee pain. Pain occurs at the proximal attachment of the patellar tendon at the patellar apex. PT is very common among active young individuals aged between 15 and 30 years, often among basketball, volleyball, and soccer players [3,4]. In one study on elite athletes, point prevalence has been reported to be as high as 14.2% (87 of 613) [3]. In adolescent athletes, PT is three times more common (5.8%) than Achilles tendinopathy (1.8%) [5]. A recent study reported the prevalence ranging from 14 to 73% in different track and field athlete subgroups; however, the sample sizes were very small [6]. In addition, PT is also prevalent in the general population, with 28.3% prevalence reported within a cohort of 50–79-year-old participants with no history of knee injury [7].

Jumping, landing, cutting, and pivoting require the patellar tendon to repeatedly store and release energy [3,8,9]. Excessive repetitions of such activities or insufficient time between loadings lead to mechanical changes in the tendon, which appear to be a key driver for developing the symptoms [10–13]. An important extrinsic factor is also a change in the type of playing surface, with symptoms occurring most often among athletes playing on hard surfaces [14,15]. Van Der Worp et al. [16] reported that weight, body mass index, waist-to-hip ratio, leg-length difference, the arch height of the foot, vertical jump performance, hamstring and quadriceps flexibility, and quadriceps strength are intrinsic risk factors for PT. Patella alta and larger infrapatellar fat pad are also risk factors in men [17,18]. The incidence of PT is two to four times higher in boys and men compared to women due to the influence of estrogen [19,20].

Cook and Purdam [21] define the three stages continuum of tendon pathology. Increasing or decreasing load is the primary stimulus that defines the stage of the continuum. Reducing load may allow the tendon to return to a previous structural and capacity level within the continuum [10]. The reactive stage is a non-inflammatory response of tenocytes and matrix due to acute overload or direct blow directly to the patellar tendon [21]. The number of tenocytes and proteoglycans that bound water increases [22]. The reactive stage is a short-term adaptation of the tendon to overload [21]. If the overload is sufficiently reduced or if there is sufficient time between loading sessions, the tendon can revert to the normal stage. Clinically, it is observed as swelling and pain localized at the patellar tendon. Tendon dysrepair is an attempt at tendon healing. There is an increase in the number of cells, reulting in the increased production of proteoglycans. This causes separation of the collagen and matrix disorganization [21]. Instead of collagen type I, disorganized collagen type III is produced [23]. With load management, this stage is still reversible [24]. In the degenerative stage, cell apoptosis occurs [25]. Matrix and vascular changes are extensive, and due to that, there is little chance for reversibility of pathological changes [21]. Individuals have recurrent bouts of pain that resolve and return with load management. Extensive degenerative tendon changes or high load can lead to tendon rupture [26]. Around 97% of ruptured tendons already had previous degenerative changes [27]. A reader interested in details of PT pathogenesis is directed to other papers [28].

PT is one of many pathologies that reflects anterior knee pain [29]. Specific clinical features are pain localized to the inferior pole of the patella and load-related pain on the knee extensors [15,30]. Tendon pain occurs immediately upon loading and stops when the load is removed, very rarely in the resting state [31]. PT also has other symptoms, such as pain with prolonged sitting, squatting, and using stairs. These symptoms can also be present in other pathologies-patellofemoral pain, Osgood–Schlatter syndrome, infrapatellar fat pad syndrome, plica, infrapatellar bursitis, or Sinding-Larsen–Johansson syndrome [17,29,32–34].

A basic check-up requires a thorough examination of the lower limb to identify any potential deficits in the hip, knee, ankle, and foot [15]. These deficits affect the coordinated movement of the lower limb kinetic chain and prevent the optimal development of muscle strength and load bearing [30]. Reduced strength in the gluteus maximus, quadriceps, and calf is often present in PT [30,35]. It is important to quantify the patient's level of dysfunction and pain. VISA-P score (the Victorian institute of sport assessment-patella) is a 100-point scale that assesses symptoms, simple tests of function, and the ability for sports activities [36]. Diagnostic imaging does not confirm PT, as pathological tendon changes may be present in asymptomatic individuals [12]. Symptoms often improve without corresponding structural changes on magnetic resonance or ultrasound imaging [37].

Although there is a wide range of techniques for the treatment of PT, a review of the literature reveals the inconsistency of physical therapy. Furthermore, the authors are not unanimous about the effectiveness of the individual method and the combination of several techniques. The aim of this review is to collect and analyze the latest evidence on the effectiveness of physical therapy for the treatment of PT. Studies about exercise therapy, physical agents, and soft tissue techniques were included.

2. Materials and Methods

A systematic search was performed in March 2022 in the PubMed database and the reference lists of relevant reviews as well as the papers already included during the process. We also performed a search in Google Scholar and ResearchGate databases. Randomized controlled trials from the last twelve years were included. The database was searched with the following combination of search keywords: (patellar tendinopathy) and (treatment OR rehabilitation). To define the research questions, the PICOS strategy was used, as shown in Table 1. Studies comparing medical and surgical treatments and studies on pathologies other than PT were excluded.

Table 1. PICOS criteria for inclusion and exclusion of studies.

Criteria	Inclusion Criteria	Exclusion Criteria
Population	Recreational and professional athletes with clinical diagnosed PT	Other pathologies that occur as anterior knee pain
Interventions	Exercise therapy, physical agents, and soft tissue techniques	Medical and surgical treatment
Comparator	The effectiveness of physical therapy methods individually (comparison with control groups) and among themselves (exercise therapy, soft tissue techniques, physical agents, platelet-rich plasma)	Effectiveness of physical therapy and surgical or medical treatment
Outcomes	Reducing pain and improving function	/
Study design	Randomized controlled trials	Studies that were published before 2010 and non-English studies

PT = patellar tendinopathy.

3. Results

After screening 415 hits in the PubMed database and the examination of the reference lists of the included articles and the available systematic reviews, 62 studies were initially included. After the abstract examination, we excluded 22 studies, and after the full-text examination, we excluded three studies. Two more studies were included after reviewing the reference lists of relevant reviews. From the final pool of included studies, 14 studies were used to compare the effectiveness of physical therapy. Seven studies investigated the efficacy of exercise therapy (isometric, isotonic, progressive exercise), five physical agents (extracorporeal shock wave therapy), two soft tissue techniques (dry needling), two orthoses, and other related interventions (kinesiotaping, patellar strap, sports tape), and two platelet-rich plasma. A summary of the characteristics of the selected studies is available in Table 2.

Table 2. Characteristics of the selected studies.

Study	Purpose	Participants	Outcome Measures	Intervention	Results	Conclusion
Pearson et al. (2020) [38]	To examine the effects of long- and short-duration isometric contraction on patellar tendon pain and tendon adaptation after 4 weeks	Sixteen basketball and volleyball players from Australian state-level leagues with PT symptoms for at least 3 months	Borg scale, 100 mm VAS for pain during SLDS and single-leg hop, US	Loading at 30° knee flexion; five times per week for 4 weeks. Short-duration contractions: 24 sets, 10 s contractions, 20 s rest, 85% MVC. Long-duration contraction: six sets, 40 s contractions, 80 s rest, 85% MVC	Significant reduction in pain after isometric loading on SLDS by 0.61 ($p < 0.01$) and hop tests by 0.25 ($p = 0.02$) There was no significant difference between long- or short-duration isometric loading for either SLDS ($p = 0.32$) or hop ($p = 0.6$). Percentage of tendon transverse strain increased after first ($p < 0.001$; 14%), second ($p < 0.001$; 17%) and third session ($p < 0.001$; 22%)	Long-(40 s) and short-(10 s) duration isometric contractions are equally effective for immediate relief of pain. Shorter duration loading was better tolerated. Tendon thickness was not significant, but there was an improvement of 22% in both cases
Holden et al. (2020) [39]	Compare the acute effects of isometric and dynamic resistance exercise on pain	Twenty active individuals aged 18–40 years diagnosed with PT	Pain with NRS during SLDS, pressure pain threshold, VISA-P, US	Isometric exercises: 60° knee flexion, five repetitions, 45 s contractions, 2 min rest, 70% MVC. Dynamic exercise: 90° ROM, 8 RM, tempo 303, 3 repetitions, 2 min rest	In both cases, the pain score was immediately lower post-exercise for an average 0.9 ($p = 0.028$). There were no significant differences in pain reduction between 45 min post-exercise and baseline ($p = 0.089$). There was also no difference between isometric and dynamic exercise interventions immediately after the exercise ($p = 0.73$) or 45 min after the exercise ($p = 0.16$)	Isometric and dynamic exercises have an immediate effect on pain reduction
van Ark et al. (2016) [40]	To examine if isometric and isotonic exercises relieved pain in competing athletes	29 basketball and volleyball players (16–32 years) with PT playing at least three times per week	Pain with NRS during SLDS, VISA-P, participation exercises diary	Four exercises per week for 4 weeks. Both groups were matched for a time under tension and rest. Weight increases by 2.5% once a week. Isometric exercises: 5 × 45 s contractions, 60° knee flexion, 80% MVC. Isotonic exercises: single leg knee extension, four sets, eight repetitions, 15 s rest, tempo 304, 80% 8 RM	There was a pain reduction after 4 weeks with isometric exercises from average 6.3 to 4.0 ($p = 0.003$) and isotonic exercises from 5.5 to 2.0 ($p = 0.012$). VISA-P score also improved with isometric exercises from average 66.5 to 75.0 ($p = 0.003$) and isotonic from 69.5 to 79.0 ($p = 0.028$). There was no significant difference in pain ($p = 0.208$) and VISA-P ($p = 0.965$) score change between groups	Both isometric and isotonic exercise programs can reduce pain and improve function during the sports season

Table 2. *Cont.*

Study	Purpose	Participants	Outcome Measures	Intervention	Results	Conclusion
Agergaard et al. (2021) [41]	Investigate if the load magnitude has long- and short-term effects on clinical outcome and tendon structure	44 participants with chronic PT	VISA-P, pain with NRS, US	MSR: 55% of 1 RM. HSR: 90% of 1 RM. Short-term effects after 12 weeks, long-term after 52 weeks	VISA-P score with MSR at the baseline 58.8 ± 4.3, after 12 weeks 70.5 ± 4.4, after 52 weeks 79.7 ± 4.6; VISA-P score with HSR at the baseline 59.9 ± 2.5, after 12 weeks 72.5 ± 2.9, after 52 weeks 82.6 ± 2.5	Both HSR and MSR showed equally good short- and long-term effects on tendon function, structure, and clinical outcome
Breda et al. (2021) [42]	Compare the effectiveness of PTLE with EE in patients with PT	76 active individuals and athletes (18–35 years) with clinically diagnosed PT for more than 2 years. Participants are active at least 3 times per week	VISA-P, return to sports rate, subjective participant satisfaction and exercise adherence, pain with VAS during SLDS	Duration of 24 weeks; progression to the next stage when VAS score was <3. Experimental group: PTLE; stage 1 (isometric exercises—single leg press or leg extension; 5 × 45 s, 60° knee flexion, 70% MVC, everyday), stage 2 (every first-day isometric exercises from stage 1, every second-day isotonic exercises- single leg press or leg extension, gradually to four sets, six repetitions, full extension and 90° flexion), stage 3 (plyometrics and running-jump squats, box jumps and cutting manoeuvres, gradually to 6 sets, 10 repetitions, single leg performance, every third-day, every first-day isometric, every second-day isotonic exercises), stage 4 (sport-specific exercises, every 2–3 days, 2× per week exercises from stage 1 and 2). Control group: EE; stage 1 (SLDS, 12 weeks, 2× per day, eccentric phase unilateral, concentric bilateral), stage 2 (sport-specific exercises, 2× week exercise from stage 1).	After 24 weeks VISA-P score increased by 28 points in PTLE and by 18 points in EE (p = 0.023). With PTLE (43%) participants returned to sport faster than with EE (27%) (p = 0.13). The subjective participant satisfaction (p = 0.54) and exercise adherence (p = 0.33) were not significantly different between groups	PTLE resulted in a significantly better clinical outcome after 24 weeks than EE

Table 2. *Cont.*

Study	Purpose	Participants	Outcome Measures	Intervention	Results	Conclusion
van Ark et al. (2018) [43]	Investigate the effects of a 4-week isometric or isotonic exercises program on tendon structure as quantified by US tissue characterization	29 volleyball and basketball players (16–31 years) with PT playing at least three times per week	US tissue characterization, pain with NRS during SLDS, VISA-P	Four exercises per week for 4 weeks. Both groups were matched for a time under tension and rest. Weight increases by 2.5% once a week. Isometric exercises: 5 × 45 s contractions, 60° knee flexion, 80% MVC, 1 min rest. Isotonic exercises: four sets, eight repetitions, 1 min rest, tempo 304, 80% 8 RM, pain-free ROM between 10–90° knee flexion	No significant change in tendon structure, disorganized structure ($p = 0.711$), and cross-sectional area of fibrillar structure ($p = 0.679$)	Isometric and isotonic exercise program improve PT symptoms, but the tendon structure did not change after the 4-week exercise program
Rio et al. (2017) [44]	Compare the immediate analgesic effect of isometric and isotonic exercises in in-season athletes with PT	20 volleyball and basketball players over 16 years with PT, playing at least three times per week	Pain with NRS during SLDS, VISA-P, a questionnaire about tendon pain and function, participation exercises diary	Four exercises per week for 4 weeks. Both groups were matched for time under tension and rest. Weight increases by 2.5% once a week. Isometric exercises: 5 × 45 s contractions, 1 min rest, 60° knee flexion, 80% MVC. Isotonic exercises: single leg knee extension, four sets, eight repetitions, 1 min rest, tempo 304, 80% 8 RM	Pain reduction with isometric exercises by 1.8 ± 0.39 and isotonic by 0.9 ± 0.25. The immediate reduction in pain was greater for the isometric group ($p < 0.002$). Both exercise protocols improved VISA-P score, but there were no significant differences between groups ($p = 0.99$). The isotonic group score change was 10.5 points, and the isometric group change was 11.5 points	Both protocols appear efficacious for in-season athletes to reduce pain. However, isometric contractions demonstrated significantly greater immediate analgesia throughout the 4-week trial. Greater analgesia may increase the ability to load or perform

Table 2. *Cont.*

Study	Purpose	Participants	Outcome Measures	Intervention	Results	Conclusion
van der Worp et al. (2014) [45]	Compare the effectiveness of focused ESWT and radial ESWT for treating PT	43 participants (18–50 years) with PT for over 3 months, VISA-P score < 80	VISA-P, pain with VAS during SLDS, sports and daily living activities, subjective rating of improvement, participation exercises diary	Three sessions with a 1-week interval for 14 weeks. Both ESWT therapies were performed in the last two weeks in combination with an eccentric SLDS (3 sets, 15 repetitions, 5× per week, pain < 4), ESWT was performed in the most painful area. Focused ESWT: frequency 4 Hz, 2000 pulses, an energy density level 0.12 mJ/mm^2 or 2.4 bar. Radial ESWT: same as focused group, frequency 8 Hz	The VISA-P score improved significantly with both therapies ($p < 0.01$), with focused ESWT by 15 points and with radial by 9.6 points. There was no difference between radial and focused ESWT treatments in improvement on the VISA-P questionnaire and pain reduction during SLDS, sports, and daily living activities	No statistically significant differences in effectiveness between focused and radial ESWT in combination with EE. However, both groups improved after 14 weeks
Thijs et al. (2017) [46]	Evaluate the effectiveness of combined treatment of focused ESWT and EE compared with placebo ESWT and EE after 24 weeks	52 physically active participants with clinically diagnosed PT	VISA-P, pain with Likert score	Focused ESWT: three sessions at 1-week intervals, frequency 4 Hz, 1000 pulses, an energy density level 0.2 mJ/mm^2, which was gradually increased during sessions. EV: 2× per day, three sets, 15 repetitions, pain < 4	VISA-P score increased from 54.5 ± 15.4 to 70.9 ± 17.8 for the ESWT group and from 58.9 ± 14.6 to 78.2 ± 15.8 for the placebo group	The combination of focused ESWT and EE has not been shown to be more effective than EE alone

Table 2. *Cont.*

Study	Purpose	Participants	Outcome Measures	Intervention	Results	Conclusion
Lee et al. (2020) [47]	Investigate the change of mechanical properties and clinical outcome after 12-week SLDS with and without ESWT	28 volleyball, basketball, and handball players in-season with PT for over 3 months	US, dynamometry, VISA-P, pain with VAS	Exercise group: 12-week SLDS performance (squatting down in 2 s, concentric phase was performed bilaterally; pain < 5; 3 sets, 15 repetitions, 2× per day). Combined group: same 12-week SLDS performance, ESWT therapy was delivered once a week for 6 weeks (30° knee flexion, frequency 4 Hz, 1500 impulses, an energy density level 0.08 mJ/mm^2)	The tendon stiffness reduction for the exercise group from 3544 ± 1820 N/mm to 3108 ± 2031 N/mm and for combined group from 3342 ± 1836 N/mm to 2363 ± 1402 N/mm. Both groups reduce pain after 7 days in the exercise group from 6.6 ± 2.0 to 3.2 ± 2.5 and combined group from 6.7 ± 1.9 to 3.9 ± 1.9. VISA-P score increased from 57.4 ± 8.3 to 77.3 ± 12.6 in the exercise group and from 55.1 ± 12.9 to 72.9 ± 14.3 in the combined group	12-week EE reduce tendon stiffness, pain, dysfunction, and increase patellar tendon strain. The combination of ESWT and EE was not shown to be more effective than EE alone
Zwerver et al. (2011) [48]	Determine the effectiveness of ESWT on pain, symptoms, and function in athletes with early symptomatic patellar tendinopathy who are still in training and competition	62 volleyball, basketball, and handball players with PT for 3 to 12 months	VISA-P, pain with VAS during sports, daily living activities, and after SLDS, subjective rating of improvement	ESWT: three sessions at 1-week intervals for 22 weeks, frequency 4 Hz, 2000 impulses, an energy density level gradually from 0.1 to 0.58 mJ/mm^2 according to individual pain tolerance Placebo: same ESWT treatment procedure, an energy density level < 0.03 mJ/mm^2, transmission gel was not applied between applicator and tissue	VISA-P score improved for the ESWT group from 59.4 ± 11.7 to 11.1 ± 18.6, for placebo group from 62.4 ± 13.4 to 10.4 ± 15.5. No significant differences were found between the ESWT and placebo groups for pain reduction during sports, daily living activities, and after SLDS	ESWT as a solitary treatment has no benefit over placebo treatment in-season for athletes with symptoms for less than 12 months

Table 2. *Cont.*

Study	Purpose	Participants	Outcome Measures	Intervention	Results	Conclusion
Tamura et al. (2020) [49]	To examine the effects of KT on pain modulation for active individuals with PT during functional activities	Seven students with PT active at least three times per week	Pain with NRS during SLDS, maximal vertical jump test, and isometric knee extension	Tests: SLDS (two sets, five repetitions), maximal vertical jump (three repetitions) and submaximal isometric knee extension (3 s). Each test was completed under three conditions: KT (Y strip at 30° knee flexion-I tail stretched to 75–100% tension over the patellar tendon, Y tail with 25–35% tension on the medial thigh), sham KT and no KT. Each season was separated from 3 to 7 days	Pain was significantly reduced during the maximum vertical jump test with KT to 3. 38 ± 1.26 compared to no KT to 4. 54 ± 2. 22 (p = 0. 05). There was no difference between the sham and no KT condition (p = 0.392). No significant difference was found between conditions for pain decrease during the single-leg squat test (p = 0.67) or the knee extensor strength test (p = 0.34). Lower jump heights were found under KT condition during the maximum vertical jump test compared to the sham KT (p = 0.000) and no KT conditions (p = 0.008)	KT with a tendon corrective strip and muscle facilitative strip was effective for decreasing pain during jump landing but led to decreased maximum jump height
de Vries et al. (2016) [50]	Investigate the short-term effect of orthosis on patellar tendon pain	97 athletes (18–50 years) with PT for over 3 months, VISA-P score < 80	Pain with VAS during SLDS, vertical jump and triple hop test, VISA-P	During the first week, participants were not using orthoses during sports. In the second week were participant divided into four groups: patellar strap, sports tape, placebo, and no orthosis	The pain was reduced by 14 mm with patellar strap and by 11.5 mm with sports tape during SLDS compared to no orthosis condition. The pain score during sports was significantly lower in both weeks. Pain with patellar strap was lower by 7 mm, placebo 66 mm, and sports tape by 5 mm. 80% of participants with patellar strap reported pain decrease, 72% with sports tape, and 56 with placebo. No significant group differences were found in the pain score the next morning	Patellar strap and sports tape reduce pain in the short-term but are no more effective than placebo

Table 2. *Cont.*

Study	Purpose	Participants	Outcome Measures	Intervention	Results	Conclusion
López-Royo et al. (2021) [51]	Determine the effect of dry needling or percutaneous needle electrolysis combined with EE and determine which is the most effective for PT	48 participants (18–45 years) with PT for at least 3 months	VISA-P, pain with VAS, US, Short form 36 to measure the quality of life	Duration 22 weeks. Three groups: dry needling and EE (20° knee flexion, four sessions every 2 weeks over 8 weeks, needle 0.25 × 0.25, 3 needle insertions for 3 s, SLDS 3 sets, 15 repetitions, 2× per day, pain < 5), percutaneous needle electrolysis and EE (same as dry needling, intensity 3 mA) and EE with sham needle	There were no significant differences in the VISA-p score among the three groups; however, a total of 66.67% of participants obtained VISA-P score of <15 points. VAS score decreased after 10 weeks with EE ($p = 0.01$) and percutaneous needle electrolysis ($p = 0.02$); after 22 weeks, there were no significant differences in mean VAS score between groups ($p < 0.05$)	Dry needling and percutaneous needle electrolysis were not shown to be more effective than EE alone after 10 and 22 weeks
Dragoo et al. (2014) [52]	To compare clinical outcomes in PT after a single ultrasound-guided, PRP injection versus DN	23 participants (age 35 ± 13 years) with persistent PT symptoms after 6 weeks of eccentric exercise physical therapy	VISA-P, pain with VAS, Tegner activity scale, Lysholm knee scoring scale, health-related quality of life (SF-36)	Duration 26 weeks. Patients were blinded and received either a single DN or PRP (6 mL) procedure, according to their assigned treatment group. They also followed an eccentric exercise program	VISA-P improved more with PRP ($p = 0.01$) at 12 weeks, but not 26 weeks, while Lysholm score only improved with dry needling. No differences in Tenger activity scores were noted. Both interventions decreased pain (VAS) after 26 weeks to a similar extent (2.4–2.6 points)	DN and PRP are both effective in accelerating the treatment of PT. While the latter appears to have a better short-term effect, after 26 weeks, there were no major differences between the treatments.

Table 2. *Cont.*

Study	Purpose	Participants	Outcome Measures	Intervention	Results	Conclusion
Vetrano et al., 2013 [53]	To compare the effectiveness and safety of PRP injections and ESWT in athletes with PT	46 participants (18 to 50 years), PT for at least six, and failure of nonoperative treatment	VISA-P, pain with VAS, Jumper's knee Blazina score	The study included 2-, 6-, and 12-month follow-ups. PRP group received 2 autologous PRP injections (6–7 mL) over 2 weeks (1 injection per week for 2 weeks) under ultrasound guidance. ESWT group received three sessions, wherein 2.400 impulses were administered with an energy flux density of 0.17 to 0.25 mJ/mm	VISA-P score was similar in both groups at baseline and after two months but showed larger improvements for PRP after 6 and 12 months ($p = 0.014$–0.026). The same pattern was observed for VAS, as PRP injection group showed better results than ESWT group at 6-month (mean 2.4 vs. 3.9; $p = 0.028$) and 12-month (mean 1.5 vs 3.2; $p = 0.009$). PRP also showed better treatment success and satisfaction at 12-month follow-up	Both PRP injections and ESWT are effective treatments for athletes with PT. While they show comparable effects in the short term, the PRP group improved more at 6 and 12 months of follow-up

Legend: MVC = maximum voluntary contraction; VAS = visual analogue scale; SLDS = single-leg decline squat; US = ultrasound; ROM = range of motion; RM = repetition maximum; ESWT = extracorporeal shock wave therapy; VISA-P = the victorian institute of sport assessment-patella; PT = patellar tendinopathy; NRS = numeric rating scale; KT = kinesio tape; EE = eccentric exercise; HSR = heavy slow resistance (90% of 1 RM); MSR = moderate slow resistance (55% of 1 RM), PTLE = progressive tendon loading exercise; DN = dry needling; PRP = platelet-rich plasma.

4. Discussion

PT is a common lower limb tendinopathy, but despite a wide range of methods, there is no consensus regarding physical therapy. The aim of this review was to investigate and compare the effectiveness of exercise therapy, physical agents, platelet-rich plasma (PRP), and soft tissue techniques for the treatment of PT. The results show that exercise therapy is the most effective, while other interventions may serve as useful and beneficial adjunct therapies.

4.1. Eccentric Exercise

Eccentric exercise involves active muscle lengthening and is characterized by a greater load compared to isometric and concentric exercises [54]. Eccentric exercise improves the mechanical properties of the tendon and consequently increases its load-bearing capacity [21]. van Ark et al. [43] found no tendon structural improvements with isometric and isotonic exercise after 4 weeks. Older studies suggest that the most effective exercise is the eccentric decline squat with the heels raised more than 15° [55,56]. Dimitrios et al. [2] found that eccentric exercise combined with static stretching of the quadriceps femoris and hamstring muscles at least 30 s before and after exercise had a greater pain reducing and function improving effect than eccentric exercise alone. Load management is one of the most important methods of treating PT. It affects matrix reorganization, collagen synthesis, reduced tenocyte activity, and reduced pain perception [57–59]. Higher knee extension load improves muscle strength and nerve activation [60]. Kongsgaard et al. [61] reported that heavy, slow resistance training from 15 to 6 repetition maximum (RM) affects the synthesis of new collagen networks and thus has a long-term impact on clinical improvement. In this systematic review, Agergaard et al. [41] found no difference between high (90% 1 RM) and moderate load magnitude (55% 1 RM) for the clinical outcome.

4.2. Other Exercise Types

Studies on isometric, isotonic, and progressive tendon-loading exercise therapy were also included. A significant progression was made in progressive tendon-loading exercise therapy, which improved the VISA-P score improved by 24 points [42]. With progressive tendon-loading exercise therapy, the tendon gradually adapts to normal functioning [62]. As described by Scott et al. [58], isometric exercise provides initial stimulation of the muscle and tendon, progressive loading adapts the tendon to the loads, and subsequent eccentric exercise is preparation for sport-specific activities [58]. Rio et al. [44] reported that isometric exercises reduce pain in the early phase of rehabilitation. Isometric exercise with short-duration loads has been shown to be more effective as it is easier to tolerate [38]. Holden et al. [39] reported that the analgesic effect is only seen 45 min after exercise. van Ark et al. [40]. Holden et al. [39] found an equivalent short-term analgesic effect of isometric and isotonic exercise.

In addition to exercise therapy, passive interventions are also used in the treatment of PT, although evidence of their effectiveness is limited [15]. Malliaras et al. [29] contend that the treatment of PT should focus on progressively developing load tolerance of the tendon with exercise and that other modalities are only beneficial as an adjunct to exercise therapy. Rutland et al. [63] agreed and stated that active rest, activity modification, and eccentric exercise are cornerstones of PT management.

4.3. Extracorporeal-Shock Wave Therapy

ESWT is based on mechanical shockwaves that travel through the affected tissue [64]. A shockwave is a special, non-linear type of pressure wave characterized by a short rise time (10 us) [65]. According to Zwerver et al. [48], ESWT is not effective as a solitary treatment during the competitive season. Although ESWT improves clinical outcomes, it is not more effective than eccentric exercise alone [45,46,66]. van der Worp et al. [45] found no difference in effectiveness between focused and radial shockwave therapy. Notable improvements in VISA-P scores were achieved in the study by Lee et al. [47] with low-intensity ESWT once a week in combination with EE. Vetrano et al. [53] showed that three sessions of ESWT were effective in facilitating long-term PT treatment; however, PRP injections were even more effective. Despite a relatively small body of evidence, ESWT is a commonly used intervention for the treatment of tendinopathies in the lower and upper extremities [66–68].

4.4. Platelet-Rich Plasma Injections

PRP is a concentrate of platelets and growth factors obtained by centrifugation from a sample of patient's blood sample [69] and is believed to enhance the tissue healing process. Indeed, increased levels of macrophages and type I and III collagen in tendons treated with PRP have been shown [70]. However, only two studies involving PRP application were included in this review [52,53]. Dragoo et al. [52] found that PRP was more effective for accelerating the treatment of PT than dry needling in the short-term (12 weeks) but not long-term follow-up (26 weeks). In addition, Vetrano et al. [53] reported that PRP injection had a similar effect to ESWT therapy in the short term; however, at one-year follow-up, PRP appeared superior. The superiority of PRP over ESWT was also noted in a recent review [71]. While further high-quality studies are needed, PRP appears as an effective approach to accelerate PT treatment.

4.5. Soft Tissue Techniques

López-Royo et al. [51] also found no significant effect of dry needling compared to EE. On the contrary, dry needling accelerated the improvement of PT symptoms in individuals that did not respond to exercise alone within 6 weeks. Other commonly used soft tissue techniques are fascial manipulation and transverse friction massage [72]. Chaves et al. [73] showed that deep friction massage induces an immediate reduction in pain intensity. Similar effects were demonstrated by Pedrelli et al. [74] using fascial manipulation of the quadriceps muscle. According to their report, manual pressure raises the temperature of the ground substance and allows it to be transformed from a pathologically dense to a physiologically fluid state. The change in density allows the restoration of gliding between the connective-tissue layers and allows the free intrafascial nerve endings to slide within the fascia more freely, which explains the sudden decrease in pain [74].

4.6. Other Treatment Modalities

Orthoses also have an effect on short-term pain reduction. Patellar straps and sports taping also tend to show some benefits. The infrapatellar strap prevents overloading of the patellar tendon at degenerative sites by increasing the angle between the patella and the patellar tendon and decreasing patellar tendon length [75]. An additional study showed the potential of kinesiotaping to reduce pain associated with PT [49].

This systematic review shows that isometric and isotonic exercise, patellar strap, sports tape, and kinesiotaping have a short-term effect on functional improvement and pain reduction, while progressive tendon-loading exercise, PRP, dry needling, and extracorporeal shock wave therapy have potential long-term effects. As a limitation, only studies comparing the effectiveness of movement therapy and one passive method were included in this systematic review. The results show that eccentric is more effective than passive methods. A retrospective chart review by Vander Doelen and Scott [76] showed that a multimodal treatment approach of a combination of dry needling, ESWT, manual, and exercise therapy have short- and long-term effects on functional improvement and pain relief. Despite the positive effects of the combination of methods reported by Vander Doelen and Scott [76], there is no research in this systematic review to support this. The heterogeneity among the included studies is a strong limitation of this systematic review. Included physiotherapeutic methods have different outcome measures, so it was difficult to compare their effectiveness with each other. The studies also differ in terms of the duration of the method, the participants, and the conditions under which they were carried out. Some of the studies were carried out during the competition season, while some participants had to stop training and only do the prescribed therapeutic exercise. Despite the number of studies, there is still no consensus on the most effective method or rehabilitation protocol. Eccentric presents the most evidence of effectiveness, while other passive techniques still need further research.

5. Conclusions

The results of this review show that recent high-quality evidence supports exercise therapy as the most effective for treating PT, and novel progressive tendon-loading exercise therapy programs are appearing as an alternative to eccentric-exercise-only approaches. ESWT, dry needling, and orthoses are no more effective than eccentric exercises or the placebo group. Isometric and isotonic exercise, patellar strap, sports tape, and kinesiotaping have a short-term effect on functional improvement and pain reduction, while progressive tendon-loading exercise, dry needling, PRP, and extracorporeal shock wave therapy have long-term effects. Despite the number of studies, there is still no consensus regarding PT rehabilitation protocol or evidence of the effectiveness of the combination of different physical methods and techniques.

Author Contributions: Conceptualization, J.Č. and Ž.K.; methodology, J.Č.; software, J.Č.; validation, J.Č. and Ž.K.; formal analysis, J.Č.; investigation, J.Č.; resources, J.Č.; data curation, J.Č.; writing—original draft preparation, J.Č.; writing—review and editing, Ž.K.; visualization, Ž.K.; supervision, Ž.K.; project administration, Ž.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Aicale, R.; Tarantino, D.; Maffulli, N. Overuse Injuries in Sport: A Comprehensive Overview. *J. Orthop. Surg. Res.* **2018**, *13*, 309. [CrossRef]
2. Dimitrios, S.; Pantelis, M.; Kalliopi, S. Comparing the Effects of Eccentric Training with Eccentric Training and Static Stretching Exercises in the Treatment of Patellar Tendinopathy. A Controlled Clinical Trial. *Clin. Rehabil.* **2012**, *26*, 423–430. [CrossRef]
3. Lian, Ø.B.; Engebretsen, L.; Bahr, R. Prevalence of Jumper's Knee among Elite Athletes from Different Sports: A Cross-Sectional Study. *Am. J. Sport. Med.* **2005**, *33*, 561–567. [CrossRef]
4. Maffulli, N.; Testa, V.; Capasso, G.; Ewen, S.W.; Sullo, A.; Benazzo, F.; King, J.B. Similar Histopathological Picture in Males with Achilles and Patellar Tendinopathy. *Med. Sci. Sport. Exerc.* **2004**, *36*, 1470–1475. [CrossRef]
5. Cassel, M.; Baur, H.; Hirschmüller, A.; Carlsohn, A.; Fröhlich, K.; Mayer, F. Prevalence of Achilles and Patellar Tendinopathy and Their Association to Intratendinous Changes in Adolescent Athletes. *Scand. J. Med. Sci. Sport.* **2015**, *25*, e310–e318. [CrossRef]
6. Janssen, I.; van der Worp, H.; Hensing, S.; Zwerver, J. Investigating Achilles and Patellar Tendinopathy Prevalence in Elite Athletics. *Res. Sport. Med.* **2018**, *26*, 1–12. [CrossRef]
7. Fairley, J.; Toppi, J.; Cicuttini, F.M.; Wluka, A.E.; Giles, G.G.; Cook, J.; O'Sullivan, R.; Wang, Y. Association between Obesity and Magnetic Resonance Imaging Defined Patellar Tendinopathy in Community-Based Adults: A Cross-Sectional Study. *BMC Musculoskelet. Disord.* **2014**, *15*, 266. [CrossRef]
8. Alexander, R.M. Energy-Saving Mechanisms in Walking and Running. *J. Exp. Biol.* **1991**, *160*, 55–69. [CrossRef]
9. Fredberg, U.; Bolvig, L. Jumper's Knee: Review of the Literature. *Scand. J. Med. Sci. Sport.* **1999**, *9*, 66–73. [CrossRef]
10. Cook, J.L.; Khan, K.M.; Kiss, Z.S.; Coleman, B.D.; Griffiths, L. Asymptomatic Hypoechoic Regions on Patellar Tendon Ultrasound: A 4-Year Clinical and Ultrasound Followup of 46 Tendons. *Scand. J. Med. Sci. Sport.* **2001**, *11*, 321–327. [CrossRef]
11. Ker, R.F. The Implications of the Adaptable Fatigue Quality of Tendons for Their Construction, Repair and Function. *Comp. Biochem. Physiol. Part A Mol. Integr. Physiol.* **2002**, *133*, 987–1000. [CrossRef]
12. Malliaras, P.; Cook, J.; Ptasznik, R.; Thomas, S. Prospective Study of Change in Patellar Tendon Abnormality on Imaging and Pain over a Volleyball Season. *Br. J. Sport. Med.* **2006**, *40*, 272–274. [CrossRef]
13. Shepherd, J.H.; Screen, H.R.C. Fatigue Loading of Tendon. *Int. J. Exp. Pathol.* **2013**, *94*, 260–270. [CrossRef]
14. Ferretti, A.; Puddu, G.; Mariani, P.P.; Neri, M. Jumper's Knee: An Epidemiological Study of Volleyball Players. *Phys. Sport. Med.* **1984**, *12*, 97–106. [CrossRef]
15. Rudavsky, A.; Cook, J. Physiotherapy Management of Patellar Tendinopathy (Jumper's Knee). *J. Physiother.* **2014**, *60*, 122–129. [CrossRef]

16. Van Der Worp, H.; Van Ark, M.; Roerink, S.; Pepping, G.J.; Van Den Akker-Scheek, I.; Zwerver, J. Risk Factors for Patellar Tendinopathy: A Systematic Review of the Literature. *Br. J. Sport. Med.* **2011**, *45*, 446–452. [CrossRef]
17. Culvenor, A.G.; Cook, J.L.; Warden, S.J.; Crossley, K.M. Infrapatellar Fat Pad Size, but Not Patellar Alignment, Is Associated with Patellar Tendinopathy. *Scand. J. Med. Sci. Sport.* **2011**, *21*, e405–e411. [CrossRef]
18. Kujala, U.M.; Österman, K.; Kvist, M.; Aalto, T.; Friberg, O. Factors Predisposing to Patellar Chondropathy and Patellar Apicitis in Athletes. *Int. Orthop.* **1986**, *10*, 195–200. [CrossRef]
19. Cook, J.L.; Khan, K.M.; Kiss, Z.S.; Purdam, C.R.; Griffiths, L. Prospective Imaging Study of Asymptomatic Patellar Tendinopathy in Elite Junior Basketball Players. *J. Ultrasound Med.* **2000**, *19*, 473–479. [CrossRef]
20. Visnes, H.; Bahr, R. Training Volume and Body Composition as Risk Factors for Developing Jumper's Knee among Young Elite Volleyball Players. *Scand. J. Med. Sci. Sport.* **2013**, *23*, 607–613. [CrossRef]
21. Cook, J.L.; Purdam, C.R. Is Tendon Pathology a Continuum? A Pathology Model to Explain the Clinical Presentation of Load-Induced Tendinopathy. *Br. J. Sport. Med.* **2009**, *43*, 409–416. [CrossRef]
22. Cook, J.; Khan, K.; Purdam, C. Achilles Tendinopathy. *Man. Ther.* **2002**, *7*, 121–130. [CrossRef]
23. Morrey, M.E.; Dean, B.J.F.; Carr, A.J.; Morrey, B.F. Tendinopathy: Same Disease Different Results-Why? *Oper. Tech. Orthop.* **2013**, *23*, 39–49. [CrossRef]
24. Öhberg, L.; Lorentzon, R.; Alfredson, H. Eccentric Training in Patients with Chronic Achilles Tendinosis: Normalised Tendon Structure and Decreased Thickness at Follow Up. *Br. J. Sport. Med.* **2004**, *38*, 8–11. [CrossRef]
25. Lian, Ø.; Scott, A.; Engebretsen, L.; Bahr, R.; Duronio, V.; Khan, K. Excessive Apoptosis in Patellar Tendinopathy in Athletes. *Am. J. Sport. Med.* **2007**, *35*, 605–611. [CrossRef]
26. Nehrer, S.; Breitenseher, M.; Brodner, W.; Kainberger, F.; Fellinger, E.J.; Engel, A.; Imhof, H. Clinical and Sonographic Evaluation of the Risk of Rupture in the Achilles Tendon. *Arch. Orthop. Trauma Surg.* **1997**, *116*, 14–18. [CrossRef]
27. Kannus, P.; Jozsa, L. Histopathological Changes Preceding Spontaneous Rupture of a Tendon: A Controlled Study of 891 Patients. *J. Bone Jt. Surg. Ser. A* **1991**, *73*, 1507–1525. [CrossRef]
28. Cook, J.L.; Rio, E.; Purdam, C.R.; Docking, S.I. Revisiting the Continuum Model of Tendon Pathology: What Is Its Merit in Clinical Practice and Research? *Br. J. Sport. Med.* **2016**, *50*, 1187–1191. [CrossRef]
29. Malliaras, P.; Cook, J.; Purdam, C.; Rio, E. Patellar Tendinopathy: Clinical Diagnosis, Load Management, and Advice for Challenging Case Presentations. *J. Orthop. Sport. Phys. Ther.* **2015**, *45*, 887–898. [CrossRef]
30. Kountouris, A.; Cook, J. Rehabilitation of Achilles and Patellar Tendinopathies. *Best Pract. Res. Clin. Rheumatol.* **2007**, *21*, 295–316. [CrossRef]
31. Rio, E.; Moseley, L.; Purdam, C.; Samiric, T.; Kidgell, D.; Pearce, A.J.; Jaberzadeh, S.; Cook, J. The Pain of Tendinopathy: Physiological or Pathophysiological? *Sport. Med.* **2014**, *44*, 9–23. [CrossRef]
32. Gholve, P.A.; Scher, D.M.; Khakharia, S.; Widmann, R.F.; Green, D.W. Osgood Schlatter Syndrome. *Curr. Opin. Pediatr.* **2007**, *19*, 44–50. [CrossRef]
33. Sarimo, J.; Sarin, J.; Orava, S.; Heikkilä, J.; Rantanen, J.; Paavola, M.; Raatikainen, T. Distal Patellar Tendinosis: An Unusual Form of Jumper's Knee. *Knee Surg. Sport. Traumatol. Arthrosc.* **2007**, *15*, 54–57. [CrossRef]
34. Schindler, O.S. "The Sneaky Plica" Revisited: Morphology, Pathophysiology and Treatment of Synovial Plicae of the Knee. *Knee Surg. Sport. Traumatol. Arthrosc.* **2014**, *22*, 247–262. [CrossRef]
35. Crossley, K.M.; Thancanamootoo, K.; Metcalf, B.R.; Cook, J.L.; Purdam, C.R.; Warden, S.J. Clinical Features of Patellar Tendinopathy and Their Implications for Rehabilitation. *J. Orthop. Res.* **2007**, *25*, 1164–1175. [CrossRef]
36. Visentini, P.J.; Khan, K.M.; Cook, J.L.; Kiss, Z.S.; Harcourt, P.R.; Wark, J.D. The VISA Score: An Index of Severity of Symptoms in Patients with Jumper's Knee (Patellar Tendinosis). *J. Sci. Med. Sport.* **1998**, *1*, 22–28. [CrossRef]
37. Malliaras, P.; Barton, C.J.; Reeves, N.D.; Langberg, H. Achilles and Patellar Tendinopathy Loading Programmes: A Systematic Review Comparing Clinical Outcomes and Identifying Potential Mechanisms for Effectiveness. *Sport. Med.* **2013**, *43*, 267–286. [CrossRef]
38. Pearson, S.J.; Stadler, S.; Menz, H.; Morrissey, D.; Scott, I.; Munteanu, S.; Malliaras, P. Immediate and Short-Term Effects of Short- And Long-Duration Isometric Contractions in Patellar Tendinopathy. *Clin. J. Sport Med.* **2020**, *30*, 335–340. [CrossRef]
39. Holden, S.; Lyng, K.; Graven-Nielsen, T.; Riel, H.; Olesen, J.L.; Larsen, L.H.; Rathleff, M.S. Isometric Exercise and Pain in Patellar Tendinopathy: A Randomized Crossover Trial. *J. Sci. Med. Sport* **2020**, *23*, 208–214. [CrossRef]
40. van Ark, M.; Cook, J.L.; Docking, S.I.; Zwerver, J.; Gaida, J.E.; van den Akker-Scheek, I.; Rio, E. Do Isometric and Isotonic Exercise Programs Reduce Pain in Athletes with Patellar Tendinopathy In-Season? A Randomised Clinical Trial. *J. Sci. Med. Sport* **2016**, *19*, 702–706. [CrossRef]
41. Agergaard, A.S.; Svensson, R.B.; Malmgaard-Clausen, N.M.; Couppé, C.; Hjortshoej, M.H.; Doessing, S.; Kjaer, M.; Magnusson, S.P. Clinical Outcomes, Structure, and Function Improve with Both Heavy and Moderate Loads in the Treatment of Patellar Tendinopathy: A Randomized Clinical Trial. *Am. J. Sport. Med.* **2021**, *49*, 982–993. [CrossRef]
42. Breda, S.J.; Oei, E.H.G.; Zwerver, J.; Visser, E.; Waarsing, E.; Krestin, G.P.; De Vos, R.J. Effectiveness of Progressive Tendon-Loading Exercise Therapy in Patients with Patellar Tendinopathy: A Randomised Clinical Trial. *Br. J. Sport. Med.* **2021**, *55*, 501–509. [CrossRef]

43. Van Ark, M.; Rio, E.; Cook, J.; Van Den Akker-Scheek, I.; Gaida, J.E.; Zwerver, J.; Docking, S. Clinical Improvements Are Not Explained by Changes in Tendon Structure on Ultrasound Tissue Characterization after an Exercise Program for Patellar Tendinopathy. *Am. J. Phys. Med. Rehabil.* **2018**, *97*, 708–714. [CrossRef]
44. Rio, E.; Van Ark, M.; Docking, S.; Moseley, G.L.; Kidgell, D.; Gaida, J.E.; Van Den Akker-Scheek, I.; Zwerver, J.; Cook, J. Isometric Contractions Are More Analgesic than Isotonic Contractions for Patellar Tendon Pain: An in-Season Randomized Clinical Trial. *Clin. J. Sport Med.* **2017**, *27*, 253–259. [CrossRef]
45. van der Worp, H.; Zwerver, J.; Hamstra, M.; van den Akker-Scheek, I.; Diercks, R.L. No Difference in Effectiveness between Focused and Radial Shockwave Therapy for Treating Patellar Tendinopathy: A Randomized Controlled Trial. *Knee Surg. Sport. Traumatol. Arthrosc.* **2014**, *22*, 2026–2032. [CrossRef]
46. Thijs, K.M.; Zwerver, J.; Backx, F.J.G.; Steeneken, V.; Rayer, S.; Groenenboom, P.; Moen, M.H. Effectiveness of Shockwave Treatment Combined with Eccentric Training for Patellar Tendinopathy: A Double-Blinded Randomized Study. *Clin. J. Sport Med.* **2017**, *27*, 89–96. [CrossRef]
47. Lee, W.C.; Ng, G.Y.F.; Zhang, Z.J.; Malliaras, P.; Masci, L.; Fu, S.N. Changes on Tendon Stiffness and Clinical Outcomes in Athletes Are Associated with Patellar Tendinopathy after Eccentric Exercise. *Clin. J. Sport Med.* **2020**, *30*, 25–32. [CrossRef]
48. Zwerver, J.; Hartgens, F.; Verhagen, E.; van der Worp, H.; van den Akker-Scheek, I.; Diercks, R.L. No Effect of Extracorporeal Shockwave Therapy on Patellar Tendinopathy in Jumping Athletes during the Competitive Season: A Randomized Clinical Trial. *Am. J. Sport. Med.* **2011**, *39*, 1191–1199. [CrossRef]
49. Tamura, K.; Resnick, P.B.; Hamelin, B.P.; Oba, Y.; Hetzler, R.K.; Stickley, C.D. The Effect of Kinesio-Tape® on Pain and Vertical Jump Performance in Active Individuals with Patellar Tendinopathy. *J. Bodyw. Mov. Ther.* **2020**, *24*, 9–14. [CrossRef]
50. de Vries, A.; Zwerver, J.; Diercks, R.; Tak, I.; van Berkel, S.; van Cingel, R.; van der Worp, H.; van den Akker-Scheek, I. Effect of Patellar Strap and Sports Tape on Pain in Patellar Tendinopathy: A Randomized Controlled Trial. *Scand. J. Med. Sci. Sport.* **2016**, *26*, 1217–1224. [CrossRef]
51. López-Royo, M.P.; Ríos-Díaz, J.; Galán-Díaz, R.M.; Herrero, P.; Gómez-Trullén, E.M. A Comparative Study of Treatment Interventions for Patellar Tendinopathy: A Randomized Controlled Trial. *Arch. Phys. Med. Rehabil.* **2021**, *102*, 967–975. [CrossRef] [PubMed]
52. Dragoo, J.L.; Wasterlain, A.S.; Braun, H.J.; Nead, K.T. Platelet-Rich Plasma as a Treatment for Patellar Tendinopathy: A Double-Blind, Randomized Controlled Trial. *Am. J. Sport. Med.* **2014**, *42*, 610–618. [CrossRef] [PubMed]
53. Vetrano, M.; Castorina, A.; Vulpiani, M.C.; Baldini, R.; Pavan, A.; Ferretti, A. Platelet-Rich Plasma versus Focused Shock Waves in the Treatment of Jumper's Knee in Athletes. *Am. J. Sport. Med.* **2013**, *41*, 795–803. [CrossRef]
54. Murtaugh, B.; Ihm, J.M. Eccentric Training for the Treatment of Tendinopathies. *Curr. Sport. Med. Rep.* **2013**, *12*, 175–182. [CrossRef] [PubMed]
55. Purdam, C.; Jonsson, P.; Alfredson, H.; Lorentzon, R.; Cook, J.; Khan, K. A Pilot Study of the Eccentric Decline Squat in the Management of Painful Chronic Patellar Tendinopathy. *Br. J. Sport. Med.* **2004**, *38*, 395–397. [CrossRef]
56. Visnes, H.; Bahr, R. The Evolution of Eccentric Training as Treatment for Patellar Tendinopathy (Jumper's Knee): A Critical Review of Exercise Programmes. *Br. J. Sport. Med.* **2007**, *41*, 217–223. [CrossRef]
57. Kjaer, M.; Langberg, H.; Heinemeier, K.; Bayer, M.L.; Hansen, M.; Holm, L.; Doessing, S.; Kongsgaard, M.; Krogsgaard, M.R.; Magnusson, S.P. From Mechanical Loading to Collagen Synthesis, Structural Changes and Function in Human Tendon. *Scand. J. Med. Sci. Sport.* **2009**, *19*, 500–510. [CrossRef]
58. Scott, A.; Docking, S.; Vicenzino, B.; Alfredson, H.; Zwerver, J.; Lundgreen, K.; Finlay, O.; Pollock, N.; Cook, J.L.; Fearon, A.; et al. Sports and Exercise-Related Tendinopathies: A Review of Selected Topical Issues by Participants of the Second International Scientific Tendinopathy Symposium (ISTS) Vancouver 2012. *Br. J. Sport. Med.* **2013**, *47*, 536–544. [CrossRef]
59. Silbernagel, K.G.; Thomeé, R.; Eriksson, B.I.; Karlsson, J. Continued Sports Activity, Using a Pain-Monitoring Model, during Rehabilitation in Patients with Achilles Tendinopathy: A Randomized Controlled Study. *Am. J. Sport. Med.* **2007**, *35*, 897–906. [CrossRef]
60. Kubo, K.; Ikebukuro, T.; Yata, H.; Tsunoda, N.; Kanehisa, H. Effects of Training on Muscle and Tendon in Knee Extensors and Plantar Flexors in Vivo. *J. Appl. Biomech.* **2010**, *26*, 316–323. [CrossRef]
61. Kongsgaard, M.; Kovanen, V.; Aagaard, P.; Doessing, S.; Hansen, P.; Laursen, A.H.; Kaldau, N.C.; Kjaer, M.; Magnusson, S.P. Corticosteroid Injections, Eccentric Decline Squat Training and Heavy Slow Resistance Training in Patellar Tendinopathy. *Scand. J. Med. Sci. Sport.* **2009**, *19*, 790–802. [CrossRef] [PubMed]
62. Mascaró, A.; Cos, M.À.; Morral, A.; Roig, A.; Purdam, C.; Cook, J. Load Management in Tendinopathy: Clinical Progression for Achilles and Patellar Tendinopathy. *Apunt. Med. l'Esport* **2018**, *53*, 19–27. [CrossRef]
63. Rutland, M.; O'Connell, D.; Brismée, J.-M.; Sizer, P.; Apte, G.; O'Connell, J. Evidence-Supported Rehabilitation of Patellar Tendinopathy. *N. Am. J. Sport. Phys. Ther.* **2010**, *5*, 166–178. [PubMed]
64. van der Worp, H.; van den Akker-Scheek, I.; van Schie, H.; Zwerver, J. ESWT for Tendinopathy: Technology and Clinical Implications. *Knee Surg. Sport. Traumatol. Arthrosc.* **2013**, *21*, 1451–1458. [CrossRef]
65. Ogden, J.A.; Tóth-Kischkat, A.; Schultheiss, R. Principles of Shock Wave Therapy. *Clin. Orthop. Relat. Res.* **2001**, *387*, 8–17. [CrossRef]
66. Gerdesmeyer, L.; Mittermayr, R.; Fuerst, M.; Al Muderis, M.; Thiele, R.; Saxena, A.; Gollwitzer, H. Current evidence of extracorporeal shock wave therapy in chronic Achilles tendinopathy. *Int. J. Surg.* **2015**, *24*, 154–159. [CrossRef]

67. Castro, B.K.C.; Corrêa, F.G.; Maia, L.B.; Oliveira, V.C. Effectiveness of Conservative Therapy in Tendinopathy-Related Shoulder Pain: A Systematic Review of Randomized Controlled Trials. *Phys. Ther. Sport* **2021**, *49*, 15–20. [CrossRef]
68. Chen, P.-C.; Wu, K.-T.; Chou, W.-Y.; Huang, Y.-C.; Wang, L.-Y.; Yang, T.-H.; Siu, K.-K.; Tu, Y.-K. Comparative Effectiveness of Different Nonsurgical Treatments for Patellar Tendinopathy: A Systematic Review and Network Meta-Analysis. *Arthrosc. J. Arthrosc. Relat. Surg.* **2019**, *35*, 3117–3131.e2. [CrossRef]
69. Taylor, D.W.; Petrera, M.; Hendry, M.; Theodoropoulos, J.S. A Systematic Review of the Use of Platelet-Rich Plasma in Sports Medicine as a New Treatment for Tendon and Ligament Injuries. *Clin. J. Sport Med.* **2011**, *21*, 344–352. [CrossRef]
70. Foster, T.E.; Puskas, B.L.; Mandelbaum, B.R.; Gerhardt, M.B.; Rodeo, S.A. Platelet-Rich Plasma: From Basic Science to Clinical Applications. *Am. J. Sport. Med.* **2009**, *37*, 2259–2272. [CrossRef]
71. Barman, A.; Sinha, M.K.; Sahoo, J.; Jena, D.; Patel, V.; Patel, S.; Bhattacharjee, S.; Baral, D. Platelet-Rich Plasma Injection in the Treatment of Patellar Tendinopathy: A Systematic Review and Meta-Analysis. *Knee Surg. Relat. Res.* **2022**, *34*, 22. [CrossRef] [PubMed]
72. Nuhmani, S.; Muaidi, Q.I. Patellar Tendinopathy: A Review of Literature. *J. Clin. Diagnostic Res.* **2018**, *12*, YE01–YE06. [CrossRef]
73. Chaves, P.; Simões, D.; Paço, M.; Silva, S.; Pinho, F.; Duarte, J.A.; Ribeiro, F. Deep Friction Massage in the Management of Patellar Tendinopathy in Athletes: Short-Term Clinical Outcomes. *J. Sport Rehabil.* **2020**, *29*, 860–865. [CrossRef] [PubMed]
74. Pedrelli, A.; Stecco, C.; Day, J.A. Treating Patellar Tendinopathy with Fascial Manipulation. *J. Bodyw. Mov. Ther.* **2009**, *13*, 73–80. [CrossRef]
75. Lavagnino, M.; Arnoczky, S.P.; Dodds, J.; Elvin, N. Infrapatellar Straps Decrease Patellar Tendon Strain at the Site of the Jumper's Knee Lesion: A Computational Analysis Based on Radiographic Measurements. *Sports Health* **2011**, *3*, 296–302. [CrossRef] [PubMed]
76. Vander Doelen, T.; Scott, A. Multimodal Management of Patellar Tendinopathy in Basketball Players: A Retrospective Chart Review Pilot Study. *J. Bodyw. Mov. Ther.* **2020**, *24*, 267–272. [CrossRef] [PubMed]