

A Narrative Review Current Physical Therapy Management for Patellar Tendinopathy

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ABSTRACT

Patellar tendinopathy, or jumper's knee, is a common chronic musculoskeletal disease in the tendon that occurs in lower-extremities injuries. It is common in athletes, particularly sports that integrate frequent jumping and landing, such as volleyball (45%), basketball (32%), and distance running (14%). Patellar tendinopathy is usually difficult for such athletes to manage during the active sports season. This review article is recommended for physical therapists for the conservative treatment in competition season and post-operative rehabilitation of patellar tendon injuries. This review article discusses a new intervention for physiotherapy treatment for Patellar tendinopathy that can support a significant improvement in performance in sport and functional daily activity. The ultimate aim is to develop a clinical practice recommendation for physical therapists for the conservative treatment and post-operative rehabilitation of patellar tendon injuries. This review article found that physical therapy is popularly used to treat Patellar tendinopathy and effective interventions consist of exercise, extracorporeal shockwave therapy, high-energy laser therapy, elastic therapeutic taping, and education for prevention of issues. The post-operative rehabilitation protocol for patella tendon injuries aims to decrease pain, improve the range of motion, and ensure early ambulation and a quick return to sport, though in a time period that is decided on a case-by-case basis depending on the person and the sport. Post-operative rehabilitation is highly important for ensuring a safe return to sport and good quality of life.

Keywords: Patellar tendinopathy; exercise; extracorporeal shockwave therapy; high laser therapy; elastic therapeutic taping and rehabilitation post-operative for patellar tendon protocol (Siriraj Med J 2024; 76: 167-173)

INTRODUCTION

The patella tendon connects the patella bone to the tibia bone. However, there is some debate about the correct nomenclature between the "patella tendon" or "patella ligament", as by definition, a tendon connects muscle to bone while a ligament connects bone to bone. However, the patella tendon acts in knee extension by integrating the quadriceps group muscle to the tibia bone. The patella bone as a sesamoid bone that is involved in knee extension. The patella tendon is involved in the knee extensor mechanism via the linkage of the quadriceps group muscles to the quadriceps tendon, which implicates

the patella bone, and therefore, links the patella tendon to the tibia bone.⁷

Patellar tendinopathy (PT), or jumper's knee, is a common chronic musculoskeletal disease in the tendon in lower-extremities injuries and is difficult to manage for athletes during the active sports season.^{3,4,7,9} PT occurs due to an overuse loading of the patellar tendon.^{1,5} The highest incidence of PT is in sports that integrate frequent jumping and landing movements, such as volleyball (45%), basketball (32%), and distance running (14%).^{5,8} The characteristics of PT include a localized anterior knee pain at the point where the patellar tendon attaches

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to the patellar bone and an impaired function.^{6,5} Apart from knee pain, PT also impact on the quality of life, so the objective of this review article was to develop a clinical practice recommendation for physical therapists to manage PT for ensuring good daily function. The full etiopathology of PT is unknown, but it is known to be related to a degenerative structural change of the tendon with cell inflammation.^{3,6,8} The risk factors for tendon issues to develop into PT include intrinsic factors (such as age, body mass index, leg length difference, hamstring group muscle flexibility, quadriceps group muscle flexibility and strength, hip extensor group muscle strength, patellar mobility, arch height of the ankle, ankle mobility) and extrinsic factors (sports training program, type of sport, physical activity). However, these risk factors have limited evidence to support them, so future research is needed on the risk factors. This would benefit designing an appropriate prevention protocol.^{5,15,17,18} Recently, concerns have been raised about the absence of a gold standard for the diagnosis of tendinitis. Current diagnosis tends to combine subjective examination and objective examination, while magnetic resonance imaging (MRI) may be used to confirm a diagnosis. MRI can differentiate between analogous diagnoses, such as patellofemoral joint pain syndrome and PT. PT is present in structural patellar tendon disruptions. In the future, a study to find a gold standard diagnosis would be useful as this would benefit ensuring patients get the most appropriate treatment.^{18,23} Current treatments of PT involve various methods, classified into conservative treatment and surgery. Conservative treatment is the first option for PT, and consists of oral medicines, injections, rest, physical therapy, and prevention.^{8,17} The following sections describe the current treatment options in more detail and their main pros and cons by the author conducted a review, collected and compiled literature to make this review article. The author has taken this knowledge for guideline clinical practice.

METHODS

Review and research from reliable sources such as PubMed, etc., a total of 23 update literature, most are in the period 2023-2018. Processing time to review research of relate physical therapy for PT about of 6 months, and compose about of 4 months.

Physical therapy

Physical therapy covers various effective interventions and consists primarily of exercise, extracorporeal shockwave therapy, high-energy laser therapy, elastic therapeutic tapping, and education for prevention. These are all described below.

Exercise

There are various types of exercises that are suited for PT, including eccentric exercise, concentric exercise, progressive tendon-loading exercise, heavy slow isotonic exercise, and isometric exercise. Studies on these have been reported their excellent results, but are somewhat controversial.¹⁸

Eccentric exercise (EE) has a strong evidence base to support its use, and it is popularly used in the management to PT in athletes and non-athletes.^{3,4,8,17} Many research studies have revealed that EE can improve function in the short term and help meet long-term goals.^{8,18} Exercise can help to increase the reconstruction of collagen fiber in the tendon.⁸ However, EE can increase pain and worsen function when practiced during the competitive season, hence its use is controversial.^{1,3,4,7} In this case, incorporating reasonable rest is advised in EE programs for rehabilitation.⁸ The success rate is estimated to be between 50% to 70% in cases undergoing EE programs.¹⁷ EE is performed on a declining board at a 25° slope, and is performed twice daily. Stage 1 in a typical EE program comprises a single-leg decline squat, in which the eccentric stage is the downward component and the concentric stage is the upward component. The patient is asked to score their pain when performing the exercise according to the visual analog scale (VAS) in the scale of 0-10, usually at this stage VAS ≥ 5. Loading can be added by the patient wearing a weighted backpack or belt to enhance the exercise intensity depending on the kind of sport they participate in, and the patient follows the stage 1 EE program twice a week. Patients in an EE program can return to sport participation generally on average after 1 month.³ Several studies have reported using a declining board at a 25° slope for single-leg squats, which presents the opportunity for a more progressive outcome than possible with a single-leg flat squat.¹⁸ One research study compared a traditional EE program with a declining board at a 25° slope program carried out over 12 months, and revealed that both groups presented progression toward the desired end outcome, with 41% of participants in the traditional EE group showing effective progression while 94% of the participants in the declining board at a 25° slope group showed improved results.¹⁷

Progressive tendon-loading exercise (PTLE) therapy is a novel exercise for PT that can be performed, providing it is within the limit of acceptable pain for the patient, during the competition season. One study compared the effectiveness of treatment between PTLE and EE and concluded that PTLE can be more beneficial than EE.^{1,3} Progressive load is managed based on a pain VAS ≤ 3 point. PTLE therapy consists of 4 stages. Stage 1 comprises daily isometric (static) exercises performed

by doing a single-leg press or single-leg extension, then holding for 45 seconds in the middle range of knee flexion at an estimated 60°, and a quadriceps group muscle isometric hold for about 70% of the maximum voluntary contraction, for 5 repetitions. Stage 2 comprises alternating exercises, starting by doing the exercise program of stage 1 on the first day and new isotonic (dynamic) exercise management on the second day with a single-leg press or single-leg extension moving in a 10° to 60° range of knee flexion, starting with 15 repetitions for 4 sets and slowly progressing to 6 repetitions for 4 sets with added load and increasing the knee angle to approximately between 90° in flexion to full extension. Stage 3 adds in plyometric (energy storage) running and loading exercises, such as jump squats, cutting maneuvers, and box jumps on every third day, beginning with 10 repetitions for 3 sets for both legs and slowly progressing to 10 repetitions for 6 sets with one leg. Isometric and isotonic exercise can be continuously done in sequence on every first and second day. Stage 4 comprises sport-specific exercise, which depends on the kind of sport played, such as volleyball or basketball. Patients can thus return to sport-specific training, managing to do so every 2–3 days to also allow time for recovery from performing high tendon-loading exercises. Progression is based on the pain level during a pain assessment test, which involves one single-leg squat. Progression in the next step is conditional upon a VAS score ≤ 3 and managing the exercise program in this stage at the lowest level for 1 week. In cases recommended for a return to competition during the active sporting season, patients should have a pain VAS score ≤ 3 . At this stage, i.e., stage 4, the aim is to maintain the exercise programs from stage 1 and stage 2 and to perform them twice a week. The approximate time to return to active sport is usually after 4 weeks. This would be an agreeable PTLE program.³

Heavy slow isotonic exercise (HSIE) is aimed at improving the signs and symptoms of PT for achieving short-term goals, long-term goals, and a return to competition during the active sporting season. The exercises comprise strengthening the single-leg seated knee extensor group muscle, hip abductor group muscle, and hip extensor group muscle with hip machines and calf raises. The exercises start with less loading and consider increasing the load with signs that there has been progress. One research study compared interventions involving HSIE, EE, and steroid injection in PT, and concluded that HSIE had better outcomes than the other interventions in meeting the short-term goals and long-term goals, and also that patient satisfaction was higher for HSIE (70%) and EE (22%).⁸

Isometric and isotonic contraction exercises can be effective at helping decrease pain during the sporting season according to recent research. Isometric contraction can decrease pain immediately and maintain this benefit 45-minute post intervention. Isotonic contraction can also decrease pain immediately, but it does not maintain this effect and the effect may be diminished or lost 45-minute post intervention. Isometric contraction is typically performed on a leg extension machine by performing knee flexion to 60 degrees, for 45 second repetitions at 70% to 80% maximum voluntary contraction, for 5 sets. Isotonic contraction is also performed on a leg extension machine, typically at 80% maximum voluntary contraction, for 8 repetitions, for 4 sets.^{4,7}

Phase of exercise

A PT exercise rehabilitation protocol should comprise three phases based on research. This protocol is beneficial to guide physical therapists in the best course of action for the treatment of PT. In the future, it is recommended to research the most appropriate exercises for PT in each phase.

Phase 1 – Pain modulation and load management

The first step in an exercise program should be focused on pain modulation and load management, particularly during the competitive season. Loading exercises and daily activities can be effective for reducing the signs and symptoms of PT. It is important though to manage the loading and activity to ensure it is appropriate, but the sudden complete discontinuation of existing activities/exercises should be avoided. Research suggests that mid-range isometric exercises are most effective to decrease pain in PT. Recent research has also shown that performing isometric squat exercises can decrease pain during the competitive season.⁸

Phase 2 – Strengthening exercises and load progression

In this second phase, eccentric exercises, isotonic exercises with the lowest pain, and heavy and slow resistance exercises can be initiated. The recommended heavy and slow resistance exercises comprise squats, hack squats, and leg press with a knee extension up to 90 degrees of knee flexion. This exercise can effectively improve hypertrophy of the patellar tendon. The exercise progression involves a gradual increase in difficulty by performing single limb exercises, while wearing a weight belt or a bag with weight. Previous research has shown the effectiveness of eccentric exercise and heavy slow resistance exercise for PT.⁸

Phase 3 – Functional strengthening and a return to sport

In this phase, the focus of functional training is

incorporating kinetic chain movement patterns and high-loading activity. Kinetic chain and movement patterns allow progress for specific sport and include plyometric exercise. The training program should comprise high-energy training, such as agility training, bounding, sprinting, skipping, and jumping. In the training program, it is important to monitor and quantitatively assess the loading. The factors that may prevent progression and a return to sports during the competitive season are dysfunction, pathology, and a severe pain level.⁸

High intensity laser therapy (HILT)

High intensity laser therapy (HILT) (Fig 1) is a novel modality that is widely applied to musculoskeletal disorders because it can significantly decrease pain and requires fewer clinical visits.^{13,20} Previously, low laser therapy was applied to treat tendinopathies. Nowadays, HILT is applied and operated at a wavelength of 1,064 nm. At this wavelength, it has minimal and slow light assimilation to penetrate deep tissue to provide effective treatment.^{2,6} HILT is now considered better than low-level laser therapy because HILT can stimulate deeper tissue and penetrate deep tissue more effectively than low-level laser therapy.² HILT is particularly effective at increasing the microcirculation, the permeability in blood vessels, the metabolic rate of cells, and oxygen saturation in the patellar tendon.^{20,2} HILT can provide photothermal and photochemical effects to promote collagen in the tendon, increase microcirculation, aid permeability in vessels, and provide an anti-inflammation effect.^{2,13} Thus, HILT can help repair the tendon and decrease pain.² HILT

protocols for treatment usually comprise two modes for the analgesic and biostimulation effects. The analgesic mode is used to promote the healing process in the acute phase, while the biostimulation mode is applied to accelerate the cell mechanisms and improve blood circulation in the chronic phase. There are two main laser movement techniques: one used in the analgesic mode, which is applied to the pain area in a circular movement from the center to outside; and a second that is used in the biostimulation mode, which involves application in a linear movement in the pain area.² Now, HILT has an evidence base to support its use with guideline protocol parameters (frequency, dose, duration time) for treatment. Research has found that one of the main risk factors for developing tendinopathy is poor blood flow, especially after sporting or daily activity. HILT is particularly useful in this regard as it can significantly increase the microcirculation and oxygen saturation in the patellar tendon. This can influence the healing process, and hence HILT is often used to treat impaired microcirculation in tendinopathy, such as from sport-related overload of the patellar tendon leading to decreased microcirculation.²⁰ Moreover, studies have found that eccentric and static stretching exercises combined with HILT can significantly improve the signs and symptoms of chronic PT.⁶

Extracorporeal shockwave therapy (ESWT)

Extracorporeal shockwave therapy (ESWT) (Fig 2) was developed from high-intensity focus shockwave therapy that is commonly applied to destroy kidney stones.



Fig 1. High intensity laser therapy.



Fig 2. Extracorporeal shockwave therapy.

However, the greatly capability of ESWT to stimulate the healing process was also revealed in research.^{14,16} Since the 1990s, ESWT has been applied as a conservative treatment for managing severe chronic tendinopathies, and is highly efficient at decreasing pain and promoting tendon healing.^{14,16,23} ESWT is a non-invasive intervention compared to surgery and is the most commonly used treatment for chronic PT that does not respond to other conservative treatment interventions. ESWT is not performed in the acute phase. ESWT involves applying a mechanical stimulus with pulse acoustic waves to enhance biological reactions by stimulating the metabolism of cells.²³ The biological aims of ESWT are to decrease pain, promote blood circulation, release fibrosis, and destroy calcified matter. ESWT can improve the functional outcomes for returning to daily activity and sporting performance.²³ ESWT comprises two types: focus shockwave therapy (FSWT) and radial shockwave therapy (RSWT).²³ FSWT involves an accurate focus on a lesion and is a deep wave form of therapy, and therefore FSWT is applied to chronic PT more than RSWT, which involves a diffuse and shallow wave form. The typical parameters for FSWT used for chronic PT are 1,000–2,500 shocks, 0.08–0.25 mJ/mm², 4 Hz, 3–6 sessions, once a week.²² There has not been enough recent research to suggest RSWT should replace FSWT in chronic PT. However, the best treatment outcome for ESWT is to amalgamate eccentric exercise and foundation physical therapy.¹⁴ In the future, research should address the effects of ESWT on PT and compare the effects between FSWT and RSWT in PT.

Elastic therapeutic taping

Elastic therapeutic taping is popularly used as a conservative treatment for athletes. Elastic therapeutic taping is a precise mechanism to relieve pain.²¹ Elastic therapeutic taping can relieve stress on the patellar tendon by modification of the patellar angle, which can relieve stress caused during activities and sport. Clinically, elastic therapeutic taping can significantly relieve pain from any sport, for up to 2 hours after sport, and improve the quality of life.¹⁹ Elastic therapeutic taping improves proprioception in the knee joint. Several research studies have encouraged the use of elastic therapeutic taping for PT in adults to decrease pain and promote functional outcomes.²¹ One study found that an infrapatellar strap is effective at decreasing knee adduction and for stimulation of the vastus lateralis muscle that has been previously used in landing movements in sport to decrease the pain on jumping. In addition, an infrapatellar strap can increase the patellar tendon–patellar angle and decrease the patellar tendon length, which can decrease

PT. Thus, athletes with PT are used to elastic therapeutic taping as a common sporting treatment. Research has also mentioned the effects of PT include decreasing the strength and flexibility in the quadriceps group muscles, leading to reduced kinetics in jumping in some sports. Here, the infrapatellar strap can reduce tension and stress in the patellar tendon and improve proprioception in the knee joint, which can promote jumping kinetics. The guideline for the immediate conservative treatment for PT is thus a strap, because it is self-applicable, low cost, and not dangerous. The infrapatellar strap is also popularly used with adolescents, because in the young it can aid musculoskeletal system development. The contraindication in some physical modalities is they may result in opening up the epiphyseal plates, such as ultrasound therapy and ESWT; however, elastic therapeutic taping is safe for relieving pain in jumping sports.²¹

Prevention

The common prevention measures for PT are education, hamstring stretching exercises, quadriceps eccentric strengthening exercises, lumbopelvic stabilization, and lower extremity stabilization. All athletes should be educated about the signs and symptoms of PT that may arise during sporting participation, although there may be minimal pain during the actual activity because of the tendon's delayed response to loading, but within a 1 day later the pain in the tendon may become moderate to maximal. Regularly after returning to sport, there is a need to control pain to within acceptable limits and to be aware of issues indicated by an increase in pain. The single-leg decline squat is an optimal exercise to detect symptoms and is thus commonly used for self-assessment in athletes to support rehabilitation programs and sport training. Hamstring stretching exercises are used by many athletes to decrease the risk factors for PT. Quadriceps eccentrics strengthening exercises can promote tendon absorption, and the literature shows they can be used for prevention too. Lumbo-pelvic and lower extremity stabilization exercises may be integrated with an ordinary prevention exercise program for promoting function in athletes. However, there is limited information in the current literature on the prevention of PT. In the future, more research needs to focus on prevention, as this would benefit decreasing the risk factors for PT in sports professionals.^{8,12,18}

Post-operative patellar tendon rehabilitation protocol

Physicians may consider operative treatment indication is a failure to respond to conservative treatment. The post-operative return to sports time period is on average about

3 to 9 months.^{8,17} The goal is to decrease pain, improve the range of motion, and enable early ambulation and a quick return to sport, but decided on a case-by-case basis. In this rehabilitation protocol, by post-operative days 1 to 4, the patient should be able to attempt early ambulation with partial weight-bearing by using crutches and attempt an active full range of motion exercises as can be tolerated, but performed under a non-weight-bearing condition. Post-operative days 5 to 7, the patient may be able undertake mild concentric exercise and eccentric exercise. Post-operative days 8 to 14, the patient may undergo progressive tendon-loading exercise as can be

tolerated. Post-operative two weeks, the patient may undergo maximal loading exercises and activities as can be tolerated.⁸

CONCLUSION

Patellar tendinopathy, or jumper's knee, is a common chronic musculoskeletal disease in the patella tendon that can occur with lower-extremities injuries and is difficult to manage for athletes during the season. The key treatments for PT are conservative treatment or surgery. Conservative treatment is the first option for PT, and consists of rest, physical therapy, and prevention.

TABLE 1. Summarizing of physical therapy management.

Physical therapy management	Physiological effect	Result	Appropriate in the case
Exercise			
Eccentric exercise	Increase the reconstruction of collagen fiber in the tendon.	Improve function	Not appropriate in the competition season and appropriate in case at rest, non-athletes
Progressive tendon-loading exercise	Same as above	Same as above	Appropriate in the competition season
Heavy slow isotonic exercise	Same as above	Same as above	Appropriate in the competition season
Isometric and isotonic contraction exercises	Same as above	Same as above	Appropriate in the competition season
Hight intensity laser therapy	Promote collagen in the tendon Increase microcirculation aid permeability in vessels Provide an anti-inflammation effect	Decrease pain Repair the tendon	Requires fewer clinical visits
Extracorporeal shockwave therapy	Promote blood circulation Stimulate the healing process Release fibrosis Destroy calcified matter	Highly efficient at decrease pain Improve function	Not respond to other conservative treatment interventions
Elastic therapeutic tapping	Improves proprioception	Decrease pain Improve function	During activities and sport
Prevention	-	Promote function Reduce repeated injuries	Appropriate in everyone
Post-operative patellar tendon rehabilitation protocol	Promote blood circulation	Decrease pain Improve range of motion Early ambulation Return to sport	Appropriate in post-operative

Physical therapy is popularly used to manage PT. Physical therapy covers various effective interventions, including exercise, extracorporeal shockwave therapy, high-energy laser therapy, elastic therapeutic taping, and education for prevention. Currently, department of orthopedic surgery, Siriraj Hospital, Mahidol University in Thailand is popular to manage PT with physical therapy by exercise combined with novel physical modality such as HILT or ESWT. Physicians may consider operative treatment in cases of a failure to respond to conservative treatment. Rehabilitation forms the key post-operative protocol, with the goal being to decrease pain, improve the range of motion, ensure early ambulation and a quick return to sport, with the approximate time period for this depending on a case-by-case basis.

A limitation and development opportunities

The author found relatively few research studies on physical therapy for patellar tendinopathy. Currently, there is a new physical modality, the peripheral magnetic stimulation, which has not been studied in patellar tendinopathy. The author is of the opinion that is interesting and hope that an excellence opportunity to treatment.

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