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Current Clinical Concepts: Clinical Management of Patellar Tendinopathy

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ABSTRACT

Patellar tendinopathy is a common, yet misunderstood pathoetiology afflicting a variety of patient populations. This lack of unified understanding affects the capability of clinicians to provide effective treatment interventions. Patients with tendinopathy often report long-term and low to moderate levels of pain, diminished flexibility, and strength, as well as decreased physical function. Load-management strategies combined with exercise regimens focused on progressive tendon loading are the most effective treatment option for patients with patellar tendinopathy. This review will provide an evidence-based approach to patellar tendinopathy, including its pathoetiology, evaluation, and treatment strategies.

Key words: Tendinitis, tendon, tendinosis, load-management, exercise, loading

INTRODUCTION

Patellar tendinopathy accounts for approximately 10% of clinical knee diagnoses making it one of the most common knee pathologies. Patellar tendinopathy occurs in physically active populations of all ages, with subsequent pain forcing many athletes to limit or discontinue sports participation.

Historically, patellar tendinitis or “jumper’s knee” has been colloquially used to characterize anterior knee symptoms experienced in the quadriceps tendon and/or patellar tendon, which suggests this condition only affects those participating in jumping sports (e.g. basketball and volleyball). However, any individuals participating in activities that cause loading of the patellar tendon through rapid acceleration/deceleration, frequent change of direction, and/or repetitive movements are at risk for symptoms originating from the patellar tendon.

Contemporary theory and histopathological examinations suggest that the term tendinitis may be inaccurate as the condition often presents with tissue degeneration rather than an acute
inflammatory response.\textsuperscript{5} However, this is disputed in the literature with some groups demonstrating active inflammation in chronic pathological tendons.\textsuperscript{6,7} Nonetheless, tendinopathy is an umbrella term which encompasses tendon degeneration with failed healing due to tissue overload without adequate recovery.\textsuperscript{5} The term tendinopathy, as opposed to tendinitis or tendinosis, is recommended when discussing overuse conditions related to the patellar tendon, unless histologically confirmed via tissue biopsy.\textsuperscript{5} The poor understanding of the underlying pathology contributing to patellar tendinopathy diminishes our capability to provide effective treatments.\textsuperscript{8} Therefore, the purpose of this current clinical concepts is to present the practicing clinician with a comprehensive, evidence-based approach to the evaluation and treatment of patellar tendinopathy. Interventions will be presented that bridge the gap from load reduction management strategies through unrestricted sports participation. When possible, Strength of Recommendation (SOR) Taxonomy are presented to grade the strength of evidence (A, B, or C, Table 1).\textsuperscript{9}

**Epidemiology**

In a general practice adult population, lower extremity tendinopathies were found to have a prevalence rate of 10.5/1000 person-years with an incidence of patellar tendinopathy at 1.6/1000 person-years.\textsuperscript{10} Injuries to the patella bone and patellar tendon account for almost 30\% of knee structures injured among high school athletes across a variety of sports, including soccer, running, volleyball, basketball, and ice hockey.\textsuperscript{11} Patellar tendinopathy reaches incidence proportions of 32\% and 45\% in elite basketball and volleyball athletes, respectively.\textsuperscript{12} Among recreational runners, patellar tendinopathy was found to be the third most common condition behind patellofemoral pain syndrome and iliotibial band friction syndrome.\textsuperscript{13} Men may experience higher rates of patellar tendinopathy than women, despite anterior knee pain such as
patellofemoral pain syndrome being more prevalent in women. Those who suffer from patellar tendinopathy are often younger (<20 years of age) and have a greater body-mass index than those without the condition. 

Pathophysiology

The pathological sequence of patellar tendinopathy and factors contributing to resulting pain and disability remain poorly understood and are often disputed. Tendons generally have poorer blood supply compared to muscle, with the blood supply of the patellar tendon emanating directly from the infrapatellar fat pad and retinaculum. Notably, the patellar tendon has areas of reduced vascularity especially at the proximal and distal attachments, and these areas are frequently linked to degeneration and failure. Stress shielding and compression may also contribute to tendon strain during movement. Histopathological findings typically suggest a paucity of acute inflammatory response and instead the presence of chronic, mucoid degeneration. Pathologic tendons demonstrate a higher concentration of type III collagen, in comparison to primarily type I collagen in healthy tendon tissue. When viewed both macro- and microscopically, the affected areas of the tendons’ collagen fibers appear thinner and disorganized with associated fibrosis. At the cellular level, changes occur including hypercellularity characterized by cell proliferation and increased fibroblast activity. Neovascularization, the presence of abnormal vascular proliferation, along with an increased concentration of proteoglycans and water content is also present. These pathological response suggest an attempt by the tendon to heal itself. These tissue responses lead to the often-observed increase in tendon thickness that often characterizes patellar tendinopathy. 

A primary contributor of patellar tendinopathy is likely mechanical overloading of the quadriceps muscle leading to tensile failure of the collagen fibers within the patellar tendon.
Repetitive tensile stresses within the patellar tendon without adequate recovery may cause microtrauma with insufficient opportunities for tissue adaptation and healing. The damage caused by excessive submaximal tensile strain weakens portions of the tendon and reduces its ability to transfer forces from the quadriceps muscle. This presents clinically as quadriceps muscle weakness.

**Risk Factors**

Repetitive activities that load the patellar tendon, often in combination with variations in training behavior, is a primary risk factor for the development of patellar tendinopathy. Patients with patellar tendinopathy demonstrate significantly higher total training volume, previous training volume, and match exposure compared to their healthy counterparts. Further, a recent meta-analysis indicated that higher body-weight is associated with patellar tendinopathy (odds-ratio=1.92). However, despite speculation to the contrary, the type of playing surface does not have a significant effect on the development of patellar tendinopathy.

The development and perpetuation of patellar tendinopathy has also been linked to alterations in muscle strength, range of motion and static lower extremity alignment. Patients with patellar tendinopathy demonstrate decreased quadriceps strength and ankle dorsiflexion range of motion. A retrospective study found 27% of those with patellar tendinopathy displayed static genu valgum alignment, a potential mechanical contributor of tendinopathy. Quadriceps and hamstring muscle strength, flexibility of the quadriceps and hamstrings, pelvic tilt, and Q-angle have all been associated with the level of self-reported disability in patients with patellar tendinopathy.

From a biomechanical perspective, decreased sagittal plane motion of the hip and knee during movement has been associated with the development and perpetuation of patellar...
tendinopathy. Individuals with patellar tendinopathy demonstrate decreased external knee
extension moments compared to controls during jump landings. However, it is unclear whether
these changes in biomechanics and movement patterns contribute to onset of patellar
tendinopathy or instead are developed secondary to the onset of the condition.

**Signs, Symptoms, and Physical Examination**

Patients with patellar tendinopathy report localized anterior knee pain at the patellar
tendon. The onset of pain is typically insidious and related to activity levels where an increase in
both frequency and intensity of patellar tendon loading activity is noted. In the early stages of
patellar tendinopathy, patients may report pain at the beginning of exercise that diminishes with
continued activity. In more advanced stages of the condition, anterior knee pain may be present
throughout the entirety of activity and result in activity reduction. Further, patients may report
pain during activities of daily living including pain during long periods of sitting and stair ascent
and descent.

Focal point tenderness is the most prevailing finding on physical examination. Although the patellar tendon may be tender throughout, the inferior pole and distal insertion at
the tibial tuberosity are most common. As part of a clinical assessment, palpation has been
shown to be statistically reliable both between and within raters; however, it demonstrates only
moderate sensitivity and poor specificity when compared to ultrasound imaging. Abnormal
ultrasound findings in the patellar tendon are frequently observed in asymptomatic individuals
and may contribute to the poor diagnostic accuracy of palpation. Similarly, providing the
patient with an image to pinpoint their pain location (pain mapping) may assist clinical
assessment. In particular, pain mapping during a single-leg squat in comparison to pain at rest
may provide useful information regarding a variety of differential knee pathologies, including
the differentiation of patellar tendinopathy if pain is mapped to the patellar tendon. Pain may exist during resisted knee extension or during other forms of high patellar tendon loading (e.g. descending stairs, declined walking, etc.). SOR: A

Other useful functional performance tests for patients with patellar tendinopathy involve jumping and jump-landing. The maximum vertical jump is the most assessed functional test in the literature related to patellar tendinopathy. However, the evidence is conflicting, with several studies reporting those with patellar tendinopathy having better vertical jump performance than healthy controls. A single-leg hop for distance and the 6-meter hop tests may also be potentially useful as part of a test battery to assess function and performance over time. Balance examinations may also provide insight relating patient symptoms to function in patellar tendinopathy, as increases in pain are associated with worse dynamic postural stability. SOR: B

Symptoms associated with patellar tendinopathy are associated with both short- and long-term outcomes. Symptom duration averages 19-months and can exceed 32-months in elite athletes. The most common outcome associated with patellar tendon injuries is loss of participation. In one long-term prospective study in male athletes, 53% of those with patellar tendinopathy reported ending their sports career due to the symptoms and their impact on physical function. Many of those athletes who continued to participate in their sports experienced mild but persistent symptoms that remained after their athletic careers concluded. The main differential diagnosis of patellar tendinopathy is patellofemoral pain syndrome, defined as a form of non-specific, non-structural knee pain around or behind the patella. Patellofemoral pain syndrome is characterized by crepitus or “grinding” underneath the patella during knee flexion and tenderness along the patellar facets. Patellar tendinopathy can be
differentiated by patellar tendon pain with palpation and tissue loading during resisted knee extension and functional activities; however, patellar tendinopathy and patello-femoral pain can coexist. Other differential diagnoses include fat pad impingement syndrome, meniscal injuries, cartilage degeneration and bony abnormalities such as Osgood Schlatter’s syndrome. 

**Imaging**

Clinical assessment is the most appropriate means and gold-standard to diagnose patellar tendinopathy. However, imaging may be used for confirmation and to assess other conditions commonly associated with patellar tendinopathy that may also be present. Plain film radiographs, diagnostic ultrasound and magnetic resonance imaging (MRI) can be used to help assess the integrity of the patellar tendon and surrounding structures. X-rays are typically utilized as the initial imaging modality to evaluate the bony structures of the knee, such as enthesiophytes that can develop off the inferior pole of the patella. Conditions such as Osgood-Schlatter and intratendinous calcifications may also be assessed using plain radiographs. 

Diagnostic ultrasound (Figure 1) is 83% accurate at correctly identifying patellar tendinopathy with moderately high sensitivity (87%) and specificity (82%) (positive likelihood ratio (LR): 4.8, negative LR: 0.2). Upon ultrasonographic examination, the patellar tendon may show thickening and have a greater cross-sectional area. On average, the thickness and width of a healthy tendon ranges from 3-6mm and 10-15mm, respectively. Hypoechoic changes within the patellar tendon are pervasive in asymptomatic athletic populations, particularly as competition levels increase. Further, patellar tendon abnormality is more prevalent in male compared to female participants. These abnormal tendon changes result in a 5 times greater risk for developing tendinopathy compared to normal tendons. SOR: A
On MRI, increased T2 signal intensity within the patellar tendon corresponds with degenerative changes (Figure 2). Tendon thickening may also be prevalent on MRI. In more severe cases, calcification within the tendon may be present, portrayed as well-defined areas of low signal within the images. Unlike diagnostic ultrasound, the accuracy of MRI in diagnosing patellar tendinopathy is only 70%, with a similar specificity (82%) to ultrasound, but worse sensitivity (57%), positive likelihood ratio (3.1) and negative likelihood ratio (0.5). 

**Patient Reported Outcome Measures**

A recent undertaking by the International Scientific Tendinopathy Symposium Consensus identified nine core domains for tendinopathy to guide clinical research trials that can also provide a comprehensive roadmap for clinicians to include in their evaluation process (Table 2). Several disease-specific, patient-reported outcomes are available to assess patellar tendinopathy that cover a significant portion of these domains, including symptom severity. The most widely used patient-reported outcome is the Victorian Institute Scale Assessment Patella (VISA-P). The VISA-P is scored out of 100 points with higher scores indicating good function and a minimally clinically important difference (MCID) of 13 points. A cutoff score of <80 is frequently utilized to determine patellar tendinopathy status and used as inclusion criteria for research groups. The VISA-P alone is able to differentiate individuals with and without patellar tendinopathy as well as to identify improvements from therapeutic interventions among patients with patellar tendinopathy. Recently, the Oslo Sports Trauma Research Center-Patellar Tendinopathy (OSTRC-P) outcome measure has been developed and assessed in a population of youth basketball players. The OSTRC-P is a 10-item questionnaire scored out of 100 used to identify patellar tendinopathy and its severity. Higher values indicate increased severity.
OSTRC-P has demonstrated good sensitivity (79%) and excellent specificity (95%) compared to the clinical assessment of patellar tendinopathy. Visual analog scales are also used frequently and have been shown to be reliable and sensitive tools in the assessment of pain in patellar tendinopathy patients. *SOR: A*

**CLINICAL MANAGEMENT**

Patellar tendinopathy rehabilitation can be a lengthy, arduous process for patients and clinicians as the condition often persists for months, if not years. Therefore, utilizing the International Classification of Function (ICF) model can provide an organized, patient-centered approach to caring for patients with patellar tendinopathy (Figure 3). Conservative treatment for symptoms of patellar tendinopathy is recommended. Surgical treatments should be considered only for those with advanced symptoms, reduced function and quality of life, and after failed conservative treatment. Consistent with Achilles tendinopathy treatment approaches, rehabilitation for patellar tendinopathy can be segmented into four phases:

- symptom management and load reduction, recovery, rebuilding, and return to unrestricted sport participation (Table 3). Specific progressions are dependent on severity, compliance, pain, and length of symptoms. Conservative management is multi-faceted and can include activity modification, exercise rehabilitation, and therapeutic modalities.

**Load Management Strategies**

Rest and passive modalities are inferior to exercise and progressive loading regiments to improve patellar tendinopathy related symptoms and function. Thus, modifications and optimization of training loads throughout the recovery process are paramount to initially reduce patellar tendon stress following by progressive increases to improve tendon health. Load-management programs that involve reduction of the volume and frequency of sporting or other
aggravating activities and have been used successfully to manage initial symptoms and
pain. Appropriate load-management can be monitored and progressed using a pain-monitoring
model. Pain monitoring models most commonly rely on visual-analogue scales. The pain
monitoring model described by Silbernagel et al. for patients with Achilles tendinopathy and
may be broadened for use with all tendinopathies. It uses 5 points out of 10 on a numeric pain
rating scale as the threshold for allowable pain. Participants may reach a 5 during and after the
exercise protocol; however, tendon pain must be reduced below a 5 the following day. If a
patient reports an increased level of pain from week to week, the athlete’s activity should be
reduced.

A collaborative approach with the sports medicine clinicians, strength and conditioning
staff, and coaching staff is necessary to successfully achieve appropriate load management. This
also requires patient education and their involvement in the decision-making processes to ensure
buy-in for the greatest opportunity for success using conservative management techniques.
Incorporating these professionals and the patient into the discussion of activity modification
allows for the athlete to continue to train or practice with limitations while minimizing loss of
sport development. For example, blocking drills in volleyball often utilize shuffle-steps with
maximum vertical jump blocking and a coordination of front-row players to “double-block”. A
drill like this could be modified in the symptom management and load reduction phase without
the vertical jump, to ensure that players are still able to get to the necessary spots on the court,
which allows the athlete and their teammates to continue to participate and maintain their court
awareness while reducing the load on their patellar tendon. This activity could be progressed in
the recovery phase by allowing submaximal jumping by only touching the top of the net. Later in
the rebuilding phase, the vertical jumping component could be progressively increased to integrate the athlete back into unrestricted sport participation.

Exercise Protocols

Exercise regimens consisting of progressive tendon loading have demonstrated the most consistent evidence to treat and provide long-term improvements in individuals with patellar tendinopathy. Tensile stresses are created within the patellar tendon during quadriceps muscle contraction. Therefore, patellar tendon loading exercise programs should be centered around quadriceps strengthening exercises. Quadriceps strengthening exercises can be effectively progressed using various methods including increases in velocity, load, or volume. This allows the clinician to provide additional personalization to eccentric programs for specific athletes or sport positions. For example, an endurance athlete may benefit from progressions with increases in exercise volume, while an athlete who relies more on power may benefit from increases in the load or velocity.

Eccentric quadriceps strengthening tendinopathy programs have been most studied and shown to be effective in improving long-term pain and patient-reported outcomes in patients with patellar tendinopathy. For any quadriceps strengthening program, the pain-monitoring model can again be used to progress training loads adequately and appropriately. For eccentric protocols, the most common and effective programs include decline squats completed at a slow speed on a 25° slant-board (Figure 4). Static stretching of the quadriceps when combined with eccentric quadriceps strengthening may provide greater benefits than strengthening alone. In a study by Dimitrios et al., static stretching of the quadriceps and hamstrings muscle was completed prior to and after strengthening exercises. They found that the group that performed
stretching combined with eccentric training demonstrated better outcomes at the end of treatment and at the six-month follow-up compared to the eccentric only group.\(^{49}\) SOR: A.

Protocols that progressively load the tendon through other methods of slow, heavy resistance exercises such as concentric and isometric quadriceps muscle contractions may be less painful than eccentric quadriceps strengthening and can also result in long-term pain reduction and tendon healing. Recently, Breda and colleagues reported that a progressive loading technique utilizing a three-staged approach of isometric, isotonic and sport-specific loading in patients with patellar tendinopathy provided better subjective functional outcomes compared to eccentric loading alone; however, there were no differences in ultrasound imaging markers of tendon healing.\(^{50}\) In a different study by Kongsgaard et al., a slow, heavy concentric and eccentric resistive exercise protocol demonstrated both better tendon morphological changes and subjective function compared to eccentric exercises alone.\(^{39}\) The slow, heavy concentric and eccentric resistive exercise protocol\(^{39}\) utilized a progressive increase in load during a squat, leg press and hack squat (Figure 5), each completed with four sets of 6 second repetitions (3 seconds concentric, 3 seconds eccentric). Their weekly progression began with 15 repetition maximum (RM) during the first week, followed by 12 R during the 2\(^{nd}\) and 3\(^{rd}\) week, to 10 RM in weeks 4 and 5, 8RM in weeks 6 through 8, and finally 6 RM in weeks 9-12.\(^{39}\) SOR: A

While progressive loading through slow, heavy quadriceps resistance exercises have demonstrated long-term effectiveness, in-season sports quadriceps isometric protocols may provide short-term pain relief to limit time loss during the season. Isometric exercises may improve adherence during the season, offering an alternative to more painful treatments such as eccentric or heavy slow resistance exercises.\(^{51}\) One study utilized a technique known as the “Spanish” or “Catalan” squat with a rigid belt or exercise band with patients completing 5
repetitions of 30s (Figure 6). 52 An alternate isometric exercise protocol uses a leg extension
machine with the knee joint at 60° of flexion while performing 5 repetitions of 45 seconds
each. 53 These isometric protocols demonstrate significant short-term pain relief for patients with
patellar tendinopathy. SOR: B

Supportive Treatments

Therapeutic interventions and injection therapies beyond exercise regimens may provide
symptomatic relief but typically only offer short-term benefits for tendon health. Several
modalities that are stalwarts in sports medicine clinics and are often employed to treat
tendinopathy have little evidence to support their use clinically. Contributing to the lack of
clarity, research studies often lack a control or placebo group and/or frequently combine these
adjunct therapies with exercise regimens muddling their efficacy as separate
entities. 39,44,46,48,54,55 Therefore, we suggest supportive treatments only be used in combination
with progressive quadriceps strengthening and patellar tendon loading programs. 39,44,46,48,54,55

Only one study 56 has assessed low-powered laser therapy to treat patellar tendinopathy that
found improvements in the VISA-P and pain when combined with eccentric training, but
multiple randomized control trials have demonstrated moderate effectiveness to reduce lateral
elbow tendinopathy pain (SOR: A). 44 Only single studies have been completed on iontophoresis
and dry needling, which both demonstrated short-term pain relief for patients with patellar
tendinopathy (SOR: C). 55 Neuromuscular stimulation in combination with quadriceps muscle
strengthening has been studied in one case series of six patients with patellar tendinopathy with
resulting improvements in pain (SOR: C). 54 In addition, some evidence exists that suggests
localized noxious pain protocols as well as low and high frequency transcutaneous electrical
nerve stimulation (TENS) may relieve short-term pain in patients with lateral elbow
tendinopathy, but again has not been studies in patellar tendinopathy populations. Non-thermal ultrasound demonstrates no differences compared to placebo treatments and offers no therapeutic benefits to patients (SOR: A).

Taping and strapping have been used to provide relief during sport-activities. Patellar tendon strapping has been found to provide an approximate 25% reduction in pain with immediate application. Only one study has evaluated kinesio-taping as a potential therapy in patellar tendinopathy patients, and demonstrated a small-moderate pain reduction compared to sham taping. Neither of these techniques have demonstrated long-term benefits or affect tendon properties. SOR: B

Another form of treatment often used in managing patellar tendinopathy are injection-based treatments such as corticosteroids and platelet rich plasma (PRP) therapy. While corticosteroid injections demonstrate good short-term (approximately one week) pain relief, they offer little long-term benefit and are potentially harmful through joint, cartilage, and tendon degeneration and thus should be avoided (SOR: A). PRP has been suggested as viable treatments to assist in patellar tendinopathy recovery; however, the quality of research in the use of it is lacking (SOR: B). Leukocyte-rich PRP shows more promise than its leukocyte-poor counterpart. Furthermore, one study found approximately 80% of their participants returned to previous sporting activities following PRP treatments with poorer results in patients who had a longer history of symptoms. As such, leukocyte-rich PRP may be a viable option in patients who have failed other forms of conservative therapy. If completed, injections should be under ultrasound guidance to localize the exact location of tendinopathy.

Surgical Interventions
In the most severe and chronic cases, surgical intervention may be warranted in those with advanced patellar tendinopathy. Surgery is typically not considered unless a patient has failed extensive conservative management for >6 months. Although arthroscopic procedures have been described, open debridement with and without repair remains a reliable means of operative intervention. Surgical techniques involve identification of the macroscopically abnormal tissue (Online supplementary document) with subsequent excision back to normal-appearing tissue borders. Depending on the volume of tissue involved and surgeon preference, subsequent repair of the tendon back to the patella can be undertaken. In one study assessing open procedures, patients on average had symptoms for 3.8 years which caused a cessation in sporting activities for approximately 7 months with a return to participation between 7-12 months post-operatively. However, mixed results for the outcomes of surgical interventions have been found with a recent systematic-review concluding that surgery was no better than sham surgery in regards to pain, function, or range of motion in patients with patellar tendinopathy. SOR: A

SUMMARY

Patellar tendinopathy is a complex condition that requires a multidisciplinary and multifaceted approach to ensure patient recovery. Understanding the pathophysiology and performing a comprehensive assessment will guide the clinician through treatment. Load management strategies combined with tendon loading exercise protocols are the most consistent, effective treatments to improve long-term outcomes in patients with patellar tendinopathy. Traditional modalities are supportive and may assist in pain-relief, while more complex, persistent cases may require surgical intervention. Regardless of treatment, patellar tendinopathy requires a lengthy course of appropriate rehabilitation and vigilance by both the patient and clinician.
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Figure 1. Ultrasound image (Terason uSmart 3300 ultrasound imaging system (Terason Division Teratech Corporation, Burlington, MA) outlining the patellar tendon.
Figure 2. a) Sagittal and b) axial views of a T2-weighted MRI of a symptomatic patient with patellar tendinopathy. Red circles highlight focal regions of tendinopathy, which present as increased [white] signal within the substance of the tendon.
Figure 3. An example of utilizing the International Classification of Function (ICF) model for patients with patellar tendinopathy, which can also be individualized based on the patient.
Figure 4. 25° decline squat
Figure 5. (top) squat, (middle) leg press, (bottom) hack squat
Figure 6. “Spanish” or “Catalan” squat with an exercise band
Table 1. Strength of Recommendation (SOR) Taxonomy grading criteria.

| Strength of Recommendation | Criteria |
|----------------------------|----------|
| A                          | The recommendation is based on 1) consistent evidence which most studies drew similar conclusions and 2) high-quality patient-oriented evidence including systematic reviews, meta-analyses, and/or high-quality randomized control trials (RCT’s) or high-quality observational studies |
| B                          | The recommendation is based on 1) inconsistent findings in which research lacked consensus or 2) there limited evidence including systematic-reviews or meta-analyses with poor quality studies included OR lower quality RCTs or observational studies |
| C                          | The recommendations are based on expert opinions, narrative reviews, case studies or series, or extremely limited evidence. |
Table 2. Core Domains for Tendinopathy Assessment (ICON 2019) and specific examples pertaining to patellar tendinopathy

| Core Domain for Tendinopathy | Patellar Tendinopathy Specific Example |
|------------------------------|---------------------------------------|
| Patient Rating of their Condition | Global rating from 0-100% of where the patient feels their patellar tendinopathy status is |
| Activity Participation | Tegner Activity Scale, Activities of Daily Living Scale |
| Pain during activity and/or loading | 100mm Visual Analogue Scale immediately following single-leg squat on the affected limb(s) |
| Patient Function | Lower Extremity Functional Scale, Lysholm Knee Scale |
| Psychological Factors | Tampa Scale of Kinesiophobia or Pain Catastrophizing Scale |
| Physical Function Capacity | Quadriceps strength, quadriceps flexibility, single-limb hop for distance, 6-meter hop test |
| Disability | Victorian Institute of Assessment – Patella (VISA-P) or the Oslo Sports Trauma Research Center - Patellar Tendinopathy (OSTRC-P) |
| Health related Quality of Life | SF-36 (Short Form survey) |
| Pain over a specific Time | 100mm Visual Analogue Scale for pain |
| Phase          | Symptom-management and load reduction | Recovery                          | Rebuilding                                                    | Return to unrestricted sport participation |
|---------------|--------------------------------------|-----------------------------------|---------------------------------------------------------------|-----------------------------------------------|
| Time          | Weeks 0-4                            | Weeks 2-6                         | Weeks 4-12                                                    | Weeks 12+                                     |
| Load Management | <5 cm VAS                             | <5 cm VAS                         | <3 cm VAS                                                    | <1 cm VAS                                   |
|               | <25% sport participation and volume  | <50% sport participation and volume | 75% of sport participation and volume                      | 100% of sport participation and volume       |
| Goal          | Understand the patient’s pathology, training loads and pain tolerance to reduce stress on the patellar tendon. | Gradually increase physical activity and introduce patient to progressive loading programs. | Continue to increase patient load capacity during physical activity and exercise program. | Patient should have minimal to no symptoms during physical activity and progressive loading phases. |
| Activity Modification | Replace jumping, squatting, etc. with cycling or aquatic therapy | Begin integrating submaximal jumping and squatting into exercise regimen. | Begin introducing maximum jumping and moderate plyometric training. | No restrictions. |
| Exercise Paradigm and Progression | Exercises completed daily Isometric quadriceps activation ("quad-sets") sitting on a table in full knee extension 5 repetitions increasing the time from 30s to 60s each as the patient progresses Isometric quadriceps contractions with leg extension machine 5 repetitions increasing the time from 30s to 60s each as the patient progresses Spanish squat 5 repetitions increasing the time from 30s to | Exercises completed daily Concentric double-leg knee extensions 3 X 10 at tolerable weight increasing to 3 X 15 guided by the pain-monitoring models as tolerated. 25° double-leg decline squats performed at ~30 s count monitor tolerance to progressing the patients to single-limb loads guided by the pain-monitoring models as tolerated. | Exercises 3-5X per week 25° single-leg decline squats performed at ~30 s count progressive increase of load Squat, 4 sets X 15 RM Leg-Press, 4 sets X 15 RM Hack Squat, 4 sets X 15 RM Progress patients to 6 RM utilizing the pain-monitoring models as tolerated. | Exercises 2-3X per week 25° single-leg decline squats performed at ~30 s count progressive increase of load Squat, 4 sets X 6 RM Leg-Press, 4 sets X 6 RM Hack Squat, 4 sets X 6 RM Progress patients to higher weight loads as their strength capacity builds |
Table 3. Patellar tendinopathy management strategies. VAS=Visual Analogue Scale; RM=Repetition Max. **Note the exercises, timing, and load management strategies are an example and may require individualization based on patient symptoms, function, and goals.

| Adjuvant therapy | Quadriceps stretching exercises 60s each as the patient progresses. | Quadriceps stretching exercises Noxious transcutaneous electrical nerve stimulation. Patellar tendon strapping during activity | Quadriceps stretching exercises Low-powered laser therapy or iontophoresis Patellar tendon strapping during activity | Quadriceps stretching exercises Patellar tendon strapping during activity |
|------------------|---------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|

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