

## Review Article

# Rehabilitation of patellar tendinopathy

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**Abstract**

Patellar tendinopathy is a common musculoskeletal disorder characterized by progressive activity-related anterior knee pain and patellar tendon dysfunction. It is highly prevalent in sports which involve running and jumping. Various treatment methods are used in the management of PT including rest, activity modification, anti-inflammatory medication, injection therapies, taping, eccentric exercises, extra corporeal shock wave therapy, percutaneous electrolysis, and surgery. Even though various treatment options are available for patellar tendinopathy, no single method has proven to result in a consistent and near complete recovery in patients. Conservative management is considered to be the first line of treatment. This study presents an overview of the current practice about the management of patellar tendinopathy with an emphasis on rehabilitation. This review can act as a guide to sports medicine and rehabilitation professionals' decision making in the management of this disorder.

**Keywords:** Anterior Knee Pain, Heavy Slow Isometric Exercise, Musculoskeletal Disorder, Load Management, Activity Modification

**Introduction**

Patellar tendinopathy (PT) which is also known as jumpers' knee is commonly seen in sports which involve running and jumping<sup>1</sup>. This musculoskeletal disorder is characterized by progressive activity-related anterior knee pain and patellar tendon dysfunction<sup>2</sup>. This disorder can lead to disability in both athletes and non-athletes, may impact on athletic performance, and may impair the athletic career of professional players. Up to 45% of elite jumping athletes and 14% of recreational jumping athletes experience the symptoms of PT at any given time<sup>3</sup>. The prevalence of PT among elite basketball and volleyball players is 45% and 32% respectively<sup>3</sup>. Cook, Khan, Harcourt, Grant, Young, Bonar<sup>4</sup> reported that more than one-third of the patients who presented with PT were not able to return to sports activities within six months following injury. A prospective follow-up

study<sup>5</sup> reported that more than 50% of athletes with PT were forced to retire from active sport. Another recent study<sup>6</sup> also found that only 46% of athletes with PT were able to return to full activity level with no pain following 12 months of supervised rehabilitation.

Hamstring and quadriceps muscle tightness, reduced ankle dorsiflexion, hyper pronation of the foot, poor joint coordination, being overweight, leg length discrepancy, increased training volume and intensity of jump training and greater activity volume are some of the common risk factors for PT<sup>7-10</sup>. Training on hard courts and synthetic turf can increase the risk of injury. The typical radiological finding includes thickening of the patellar tendon and abnormalities in the posterior border of the tendon<sup>11,12</sup>. The etiopathology of PT is not fully understood, which makes the treatment options still controversial.

Various types of treatment are used in the management of PT. These include rest, activity modification, anti-inflammatory medication, injection therapies, taping, eccentric exercises, extra corporeal shock wave therapy, percutaneous electrolysis, and surgery. Even though various treatment options are available for PT, no single methods has proven to result in consistent and near complete recovery in patients. Conservative management is considered to be the first line of treatment in PT, in the form of medical and physical therapies. Activity modification should involve reducing the volume and frequency of load on the tendon. Strength

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imbalances involving hamstring and quadriceps muscles, as well as poor flexibility, must be corrected to avoid deviation from correct biomechanics during walking, running, jumping and other sporting activities.

## Medical therapy

Non-conclusive evidence is available in the literature regarding the effectiveness of non-steroidal anti-inflammatory drugs (NSAID) in PT<sup>13</sup>. NSAID are commonly used in PT due to their analgesic effect. The beneficial effects of NSAID in acute PT has been reported in some studies<sup>14,15</sup>. However, it may negatively affect tendon healing in the long-term<sup>16</sup>. Almekinders<sup>17</sup> and Vogel<sup>18</sup> also does not support the use of NSAIDS due to their deleterious mechanism in the tendon. Peri-tendinous and intra-tendinous injections are also used in the treatment of PT. Platelet-rich plasma, corticosteroids, aprotinin and hyaluronic acid are the most commonly used injections for the promotion of tendon healing<sup>19</sup>. Various studies reported beneficial effects of PRP injection on patellar tendinopathy<sup>20,21</sup>. However due to lack of high quality researches and inconsistency in procedures makes it difficult to draw a conclusion on its effectiveness<sup>19</sup>. A systematic review by van Ark, Zwerver, van den Akker-Scheek<sup>22</sup> on the effectiveness of injection treatment in the management of PT showed promising results. However, there is a paucity of high-quality research in this area.

## Rehabilitation protocol

The key aim of rehabilitation is to develop load tolerance on the part of the tendon by addressing pain reduction initially, followed by progressive loading. Heavy slow resistance, eccentric and isometric exercises are used in the rehabilitation of PT. Studies reveal that eccentric exercise is one of the most effective and commonly-used intervention strategies in the management of PT. Long-term and short-term improvement in symptoms were reported by several researchers into the effectiveness of eccentric exercises in PT. Such exercises can augment the remodeling of collagen fibers within the tendon<sup>1</sup>. This leads to the musculotendinous unit adapting itself from stress resulting from physical activity. Excellent results have been reported in both athletic and non-athletic populations. Strong evidence for the use of eccentric training in the management of PT was reported in a systematic review of RCTs conducted by Larsson, Käll, Nilsson-Helander<sup>23</sup>. Several types of eccentric loading methods are used in PT. In a 12 week prospective study, Frohm, Saartok, Halvorsen, Renström<sup>24</sup> reported that both bilateral and unilateral decline squats were equally effective in the management of PT. Purdam, Jonsson, Alfredson, Lorentzon, Cook, Khan<sup>25-27</sup> also asserted the supremacy of eccentric decline squats compared with other management methods in reducing the symptoms of PT. In a critical review, Visnes, Bahr<sup>28</sup> confirmed the effectiveness of eccentric decline squats. The authors suggested that the squat should be performed at certain

levels of difficulty<sup>28</sup>. Purdam, Cook, Hopper, Khan, Group<sup>29</sup> compared the effectiveness of standard squat training and eccentric squat training in patients with PT. Six out of eight athletes who had undergone eccentric training were able to return to sports participation, whereas only one athlete from the standardized squat sample were able to return to their sport. Cannell, Taunton, Clement, Smith, Khan<sup>30</sup> compared the efficacy of drop squats with leg curls in a 12-week follow-up study, and reported that both treatment methods were equally effective in reducing symptoms of PT. An excellent outcome was reported in 70% of patients with PT who underwent a well-designed rehabilitation program. The major component of this rehabilitation program involved open kinetic chain eccentric training of the knee<sup>31</sup>. In a retrospective study of 66 PT patients treated with eccentric training, the researchers reported a complete relief of pain and other symptoms in 20 patients, and a marked improvement in symptoms in 42 patients<sup>32</sup>. At the same time, there was a worsening of the symptoms in volleyball players who had received eccentric decline squat training during the competitive season<sup>28</sup>. Fredberg, Bolvig, Andersen<sup>33</sup> also reported a detrimental effect and increased risk of injury following the use of in-season eccentric exercises among Danish super league players. These reports suggest that addition of eccentric loading while the players is in a high loading environment can have a negative impact on the tendon. Adequate rest is advised for athletes who are undergoing eccentric exercising as part of a rehabilitation program.

Heavy slow isotonic exercises have also been reported as leading to long-term and short-term improvement in pain and other symptoms<sup>30,34,35</sup>, improvement in pathology<sup>34</sup>, augmentation in the remodeling of fibers<sup>34</sup> and normalization of the morphology of tendon fibrils<sup>36</sup>. Even though there are structural and observable changes associated with heavy slow resistance exercises, most of the evidence supporting managing PT is obtained from patient reported outcomes and clinical examinations rather than observed structural changes<sup>37</sup>. A four-week in-season heavy slow isotonic training program resulted an improvement in pain in athletes with PT<sup>38</sup>. Such training can restore muscle bulk and the strength of the lower extremity, and can be performed with minimal pain<sup>39</sup>. These exercises include single leg seated knee extensions, hip extensions and abduction with hip machines, calf raises, etc. The exercise can be started with a minimal load and progress by increasing load as the symptoms progress. Kongsgaard, Kovanen, Aagaard, Doessing, Hansen, Laursen, Kaldau, Kjaer, Magnusson<sup>34</sup> compared steroid injections, eccentric exercise, and heavy slow resistance exercise in patients with PT. Even though there was improvement in symptoms in all the three treatment methods after 12-weeks of follow-up, only eccentric and slow resistance exercise showed improvement in the VISA P score and the VAS scale after six months. The heavy slow resistance exercise showed an improvement in tissue normalization and reported a better clinical presentation than the other methods in both long-term and short-term follow ups. Patient satisfaction was found to be significantly higher (70%) in the heavy slow

resistance exercise program when compared to the eccentric training program (22%). In a systematic review which compared various loading programs, Malliaras, Barton, Reeves, Langberg<sup>40</sup> recommended a combined approach involving both concentric and eccentric training programs in the management of PT. Silbernagel, Thomeé, Eriksson, Karlsson<sup>41</sup> also recommended a combined approach including eccentric, concentric, and plyometric training programs in the management of PT.

## Stages of rehabilitation

The proposed three-stage rehabilitation protocol is based on latest researches and opinion of the author. This protocol can guide the clinician in the exercise progression of PT patients. The exercise dosage is not mentioned as it may vary, based on individual factors.

**Stage 1: Pain modulation and load management:** The initial stages of rehabilitation should focus on load management and pain modulation, especially in the case of in-season athletes. Biomechanical impairment of the lower extremities such as strength imbalance and poor flexibility must be addressed at this stage. Load management and activity modification are some of the most effective methods to reduce pain and other symptoms of PT<sup>2</sup>. However, it is also important to avoid the complete cessation of activities as this may further reduce the loading capacity of the tendon. Reducing the volume and frequency of training, removing high load energy storage activities such as running, jumping etc. from the training are some of the most effective methods for the load management of the tendon. Studies shows that sustained mid-range isometric exercise is an effective method of pain reduction in PT. Substantial acute effect of isometric exercise on patellar tendon pain was reported in a cross-over study<sup>42</sup> and in a randomized control trial<sup>38</sup>. A recent pragmatic clinical trial conducted by Rio, Purdam, Girdwood, Cook<sup>43</sup> demonstrated that an isometric squat exercise offered to in-season athletes reduces pain across different sports and schedules. According to Rio, Kidgell, Purdam, Gaida, Moseley, Pearce, Cook<sup>42</sup> five repetitions of 45-second isometric quadriceps exercises on a leg extension machine induces analgesia for several hours in patients with PT. A Spanish squat with 70-90 degree knee flexion angle with the support of a rigid strap fixating at the lower leg can be an alternative way when there is a limited access to gym equipment<sup>44</sup>.

**Stage 2: Strengthening exercises and load progression:** Once the patient can perform isotonic exercise with minimal pain, heavy slow resistance exercises and eccentric exercises can be initiated<sup>7</sup>. An heavy slow resistance exercises protocol for PT has previously been suggested by Kongsgaard, Kovanen, Aagaard, Doessing, Hansen, Laursen, Kaldau, Kjaer, Magnusson<sup>34</sup> which consists of squat, hack squat and leg press from knee extension to 90° of knee flexion. The beneficial effects of heavy slow resistance training and eccentric exercises are reported in previous studies<sup>28,29,34,45</sup>. Heavy slow resistance exercise

can augment tendon mechanical properties and can cause hypertrophy of the tendon<sup>45</sup>. A gradual progression of the exercises are recommended. Exercises involving a single limb can be performed as the condition progresses. Additional resistance can be provided by means of weighted belts, vest or bags with weight.

**Stage 3: Functional strengthening and return to sports:** The major focus of functional strengthening is on movement pattern and kinetic chain deficits, as well as on the high load tendon capacity. Once the movement pattern and kinetic chain is improved the training can progress to plyometric and sport-specific activities. High energy training such as skipping, jumping and sprinting, and bounding movements and agility training should also be included in the training program. All the training and loading must be monitored and quantified, and a high -low medium load day approach is recommended with regard to the re-introduction of high-load activities. The determinants of prognosis and return to sport are pain severity, pathology, and dysfunction.

## Other interventions

Other commonly-used interventions for PT are cryotherapy, myofascial release, transverse friction massage, taping and bracing, etc.<sup>13</sup>. Cryotherapy can be used for pain relief but cannot be recommended prior to competition or training as it may mask the pain and ultimately lead to a new injury<sup>46</sup>. Even though the literature doesn't provide much evidence, pulsed ultra sound has also been used as a therapeutic modality for the management of PT<sup>47</sup>. A systematic review by van Leeuwen, Zwerver, van den Akker-Scheek<sup>48</sup> concluded that extra-corporeal shock wave therapy (ECSWT) can provide promising results in the management of PT. At the same time, Zwerver, Hartgens, Verhagen, van der Worp, van den Akker-Scheek, Diercks<sup>49</sup> did not find any beneficial effect of ECSWT in athletes with PT. According to van der Worp, van den Akker-Scheek, van Schie, Zwerver<sup>50</sup>, ECSWT can diminish the transmission of pain signals to the brain by hyper-stimulation of the painful area, can support tissue regeneration of the tendon, and can destroy tissue calcification. Counter-taping and bracing can reduce patellar strain by correcting the angle between the patella and the patellar tendon<sup>51</sup>.

## Surgical management

A vast majority of patients positively respond to conservative treatment. However, a few progresses to surgical management if conservative management fails. Both arthroscopy and open surgery are commonly used. The average time period for return to sports activities may vary from 3 to 9 months following a supervised rehabilitation<sup>13</sup>. According to Brockmeyer, Diehl, Schmitt, Kohn, Lorbach<sup>52</sup>, the success rate of open and arthroscopic surgeries are 87% and 91% respectively. At the same time, return to sports activities takes longer (8.3 months on average) in the case of open surgery compared to in

the case of arthroscopy (3.9 months on average)<sup>52</sup>. The average rate of return to sports are similar in both surgical methods. The post-operative rehabilitation procedures for both surgical techniques are almost similar, and includes pain modulation, eccentric exercises and strengthening programs. There are no clear guidelines available in the literature about the use of one technique over another. The arthroscopic technique is most-commonly preferred due to its leading to a faster return to sport.

Post-operative rehabilitation can be initiated with partial weight bearing in crutches (day 1- post surgery)<sup>53</sup>. Non weight bearing full range of motion exercises can be started at earlier stages. Light concentric and eccentric exercises (5-7 days post-surgery) and tendon loading can be progressed (7-14days post-surgery) as the patient improves his condition<sup>53,54</sup>. Maximal loading activity can be started two weeks post-surgery.

## Injury prevention

There is a limited literature available regarding the prevention of PT. The most common preventive methods used in PT are static stretching, core stability exercises, foot orthosis, shock absorption insoles and hormone replacement therapy in females<sup>55</sup>. Soccer-specific balance training can reduce tendinopathy with a dose effect relationship between the duration of training and the incidence of injury<sup>56</sup>. Fredberg, Bolvig, Andersen<sup>33</sup> reported that prophylactic eccentric exercises and stretching of the lower limb muscles can prevent the development of tendon abnormalities. However, there was no positive impact on risk of injury. Further research is recommended regarding the prevention of patellar tendinopathy.

## Conclusion

Patellar tendinopathy is a musculoskeletal condition predominantly seen in sports which involve activities made up of running and jumping. Even though several treatment options are available, the management of PT is still controversial. Conservative management is the most preferred method of treatment and includes pain modulation, load management, load progression and functional strengthening. The aim of such rehabilitation is to develop load tolerance on the part of the tendon by addressing pain reduction initially, followed by progressive loading.

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