



# Quadriceps tendinopathy: a review, part 2—classification, prognosis, and treatment

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**Abstract:** Overuse injuries of the extensor mechanism of the knee are common in both athletes and non-athletes and usually occur during activities associated with repetitive loading, stress, and knee extension. Numerous reports have been published describing extensor mechanism injuries in athletes, but there is a paucity of studies that focus on quadriceps tendinopathy in the non-athlete population. In addition, there is no universally accepted classification system for tendon pathology. Therefore, we performed a comprehensive literature review of these studies. This review consists of 2 parts. In the previous part we reviewed: (I) epidemiology and (II) diagnosis of quadriceps tendinopathy in the athlete as well as the general population. In this part we discuss: (I) classification; (II) prognosis; and (III) treatment results.

**Keywords:** Quadriceps tendinopathy; classification; prognosis; treatment

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## Current classification systems

The main symptom of quadriceps tendinopathy is anterior knee pain, with varying intensity levels located within various areas of the extensor mechanism apparatus. Patients often complain of gradual worsening of pain which is related to activity, and often do not recall or describe an inciting event (1). The most common location is the origin of the patellar tendon (65% to 70% of the cases), followed by the insertion of the quadriceps tendon at the superior pole of the patella (20% to 25%), and the patellar tendon insertion on the tibial tuberosity (5% to 10%). The classification proposed by Blazina *et al.* (2) and Roels *et al.* (3) is based on the effects of pain and sports performance, however, a more recent classification by Ferretti *et al.* (4) is based on the intensity of pain.

The Blazina classification consists of:

- (I) Pain after activity only without functional impairment;
- (II) Pain during and after activity with satisfactory performance levels;
- (III) Pain during and after activity more prolonged with progressively increasing difficulty performing at a satisfactory level.

The classification by Roels *et al.* modified the Blazina classification scheme to include tendon rupture:

- (I) Pain at the infrapatellar or suprapatellar region after practice or event;
- (II) Pain at beginning of activity, disappearing after warming up and reappearing after completion of activity;
- (III) Pain remains during and after activity and the patient is unable to participate in sports;
- (IV) Represents a complete rupture of the tendon.

Ferretti *et al.* modified Blazina's classification based on the intensity of pain:

- (I) Stage 0: no pain;
- (II) Stage 1: pain only after intense sports activity with no functional impairment;
- (III) Stage 2: moderate pain during sports activity with no restriction on sports performance;
- (IV) Stage 3: pain with slight restriction on performance;
- (V) Stage 4: pain with severe restriction of sports performance;
- (VI) Stage 5: pain during daily activity and unable to participate in sport at any level.

To date, there is no tendinopathy classification scheme to diagnose and guide treatment protocols based on the wide pathologic tendon features rather than symptoms based alone. This highlights the importance of further studies that are needed to assist in the management of tendinopathy in clinical practice.

### Prognosis and treatment

Historically, the management of quadriceps tendinopathy is based on the classifications by Blazina, Roels *et al.*, and Ferretti *et al.*, which correlated the treatment based on the stage of patient symptoms. It is most commonly treated non-operatively with rest, activity modification, ultrasound, and physical therapy with eccentric training programs (5-13) (*Table 1*). However, among patients with severe tendinosis who fail non-operative treatments, the options of injections are also available. Patients with severe quadriceps tendinopathy are at increased risk for tendon rupture without treatment (26). A prospective study of 20 athletes with quadriceps tendinopathy were followed for 15 years by Kettunen *et al.* (23), found that compared to healthy controls, athletes with quadriceps tendinopathy had higher mean visual analog scale scores for knee pain with squatting (12.8 *vs.* 1.4;  $P < 0.01$ ), increased functional limitations measured by Kujala score (27) with means of 85.1 *vs.* 97 points ( $P < 0.01$ ), and increased early retirement of their sports careers because of their knee problems 9 (53%) *vs.* 1 (7%).

In the early stages of quadriceps tendinopathy described by Blazina *et al.* (2) and modified by Roels *et al.* (3) non-operative treatment is often successful at providing symptomatic relief (11,20,25). A retrospective study of 172 athletes with patellar tendinopathy (110 who remained in sport) by Ferretti *et al.* (4) evaluated the outcomes of non-operative and surgical treatment in the various Blazina

stages. The prevalence of different stages in the study included 24 (21.8%) stage 1, 42 (38.1%) stage 2, 43 (29.1%) stage 3, and 1 (1%) stage 4. Among the athletes being treated, localized pain was found at lower pole of the patella in 71 (64.5%), at the insertion of quadriceps tendon in 27 (25%), and at the tibial tuberosity in 11 (10%). The overall results obtained from the study was classified into the following groups.

- (I) Very good: no pain, tenderness, muscle wasting or limitation of activities.
- (II) Good: mild pain during vigorous sport but no restriction, slight tenderness, and moderate muscle wasting.
- (III) Poor: moderate to severe pain after a long period of sitting and during sport, limitation of activity, moderate to severe tenderness and severe quadriceps muscle wasting.

According to the groups that were classified, they found non-operative treatment used on all patients had good outcomes in those with early stages of the disease. Non-operative treatment without rest or reduction of sports activity was used in 81 athletes, the outcomes of those in the first and second stage included very good in 16 (38%), good in 10 (24%), and poor in 16 (38%) compared to the outcomes of those in the third stage included 4 (10%) very good, 8 (20%) good, and 27 (69%) poor of which 15 of the 27 were operated on later. In 36 cases, the addition of a long period of rest and reduction of sporting activity was added to the treatment, and was found to be beneficial in all stages, especially for those in the later stages. A total of 16 patients (19 knees) with stage 3 or 4 underwent surgical treatment which resulted in 7 (38%) very good, 5 (26%) good, and 7 (38%) poor outcomes.

Multiple studies have evaluated the use of injections such as platelet rich plasma (PRP), and sclerosing agents such as polidocanol. Both of these may be viable treatment options and provide symptomatic relief in certain cases of tendinopathy (17,28). A randomized controlled trial of 23 patients with patellar tendinopathy by Dragoo *et al.* (14) compared patients who were undergoing eccentric training, and compared outcomes of the addition of leukocyte-rich PRP injection with dry needling. They found that the addition of a leukocyte rich PRP injection with dry needling provided earlier symptomatic relief compared to eccentric exercise and dry needling alone. After 12 weeks of treatment, only the PRP group demonstrated statistically significant improvements in pain and function compared to dry needling. At 26 weeks, both groups had clinical

improvements, however, the differences between the groups was not statistically significant.

A retrospective review of 408 patients who had tendinopathy of the upper or lower limbs treated by a single US-guided PRP injection by Dallaudière *et al.* (15) demonstrated increased rapid tendon healing, satisfactory patient tolerance, as well as improvements in patellar tendinopathy tear lesion size (9.2 mm at day 0 to 3.3 mm at week 6,  $P < 0.001$ ). Filardo *et al.* (18) evaluated the efficacy of multiple PRP injections in 31 patients with chronic grade III Blazina (29) patellar tendinopathy who failed conservative treatment for a minimum of 2 months compared with physiotherapy alone (15 PRP, 16 control physiotherapy). At 6-month follow-up the PRP treatment group had greater improvements in post-treatment sport activity levels compared to the control group (39% *vs.* 20%,  $P = 0.048$ ), with mean Tegner (30) scores of 6.6 from 3.7 for PRP ( $P = 0.001$ ) *vs.* 6.8 from 5.3 for controls ( $P = 0.0005$ ). These results demonstrate that PRP injections can improve clinical outcomes in refractory cases of patellar tendinopathy.

A randomized controlled trial of 33 patients (42 tendons), who had chronic patellar tendinopathy by Hoksrud *et al.* (22) compared outcomes with treatment of sclerosing injections of polidocanol compared with controls using lidocaine/epinephrine [17 patients (22 knees) were included in the treatment group *vs.* 16 patients (20 knees) in the control group]. They found significant improvements in knee function and reduction in pain in the polidocanol group compared to control with improvement in mean VISA (31) scores from 51 to 62 after 4 months in the polidocanol group *vs.* no change in control group ( $P = 0.052$ ). At 8 months, patients in the lidocaine/epinephrine control group received polidocanol treatment and demonstrated greater improvement in mean VISA scores compared to the primary polidocanol treatment group at 58 to 79 *vs.* 54 to 70 points ( $P = 0.022$ ). At 12 months follow up, no differences in patient satisfaction between the lidocaine/epinephrine control and polidocanol treatment groups were seen.

## Surgical treatment

Several studies have evaluated the surgical treatment of athletes who had tendinopathy and have shown superior outcomes in patients who have failed non-operative treatments for a minimum of 3 months (4,16,25). Various surgical techniques for treatment of patellar tendinopathy have been described in the literature, however, a consensus

for the best surgical treatment option still does not exist (32-38). A retrospective study by Cucurulo *et al.* (19) examined outcomes of 64 athletes who had patellar tendinopathy treated by arthroscopic or conventional open surgery after failing non-operative treatment that averaged 28 months. Both arthroscopic and conventional surgical treatments provided symptomatic relief of activity related knee pain classified by Blazina *et al.* (2) when compared to the preoperative levels, however, differences between the two surgical techniques were not statistically significant. A randomized controlled trial by Willberg *et al.* (39) compared the clinical outcomes of 45 patients (52 knees) with patellar tendinopathy treated by either sclerosing polidocanol injections or arthroscopic shaving, both treatments utilized ultrasound plus color Doppler. Compared to the polidocanol injection group, the arthroscopic treatment group had significant improvements in mean VAS scores for pain at rest (5 *vs.* 19,  $P = 0.004$ ), pain with activity (12 *vs.* 41,  $P = 0.001$ ) as well as increased patient satisfaction. A similar study by Alfredson *et al.* (40) evaluated treatment consisting of ultrasound and Doppler guided arthroscopic shaving with open scraping followed by immediate weight bearing on 9 professional rugby players with patellar tendinopathy. They achieved good clinical results with increased mean VISA scores at 78 from 49 at baseline ( $P < 0.05$ ), and 7 out of the 9 players returned to play full professional rugby within 4 to 6 months. The two players who could not return to sport due to poor clinical outcomes had previous tendon revision surgeries.

A prospective study of 32 athletes, who had patellar tendinopathy by Ferretti *et al.* (4) evaluated long-term surgical outcomes according to symptoms and return to sport with a minimum of five years follow-up. Using a modified Blazina classification (2), as previously described, they grouped the results at the final follow-up into stages.

- (I) Excellent: when patient was at stage 0 at the final follow-up.
- (II) Good: when patient was at stage 1 with postoperative improvement of at least two stages.
- (III) Fair: when improvement occurred but the final result was stage 2 or higher.
- (IV) Poor: no improvement occurred.

According to the grouped stages, satisfactory results were obtained for their technique of longitudinal splitting of the tendon, excision of abnormal tissue, and resection and drilling of the inferior pole of the patella. At final follow up, good or excellent results were seen in 28 (85%) knees, excellent in 23 (71%), good in 5 (16%), fair in 1 (3%), and

**Table 1** Treatment of quadriceps tendinopathy

Reference	Level of evidence	Number of patients	Application	Results/Findings
Dragoo et al. (14), 2014	I	23 patients with patellar tendinopathy	Double blinded RCT of 23 patients to compare outcomes after single US guided leukocyte rich PRP injection compared with dry needling, both groups had standard eccentric exercise regimen	Leukocyte rich PRP injection with DN accelerates recovery and provides earlier symptomatic relief compared to eccentric exercise and DN alone. Improvements of VISA mean scores after 12 weeks of treatment were 5.2±12.5 in DN group (P=0.20) vs. 25.4± 23.2 in PRP group (P=0.01), and at greater than 26 weeks scores improved to 33.2±14.0 in the DN group (P=0.001) vs. 28.9±25.2 points in the PRP group (P=0.01)
Dallauidière et al. (15), 2014	III	408 patients	Retrospective review 408 patients with single PRP injection under US guidance of tendinopathy (medial/lateral epicondyles, patella, achilles, hamstrings and adductor longus	Single intratendinous PRP injection improved (WOMAC) scores for patellar tendons at 38.1±16.6 at day zero, 16.1±13.5 at week 6, and 6.0±6.9 at long term follow up averaging 20.2 months (P<0.001). Improvements in patellar tendinopathy or tear lesion size were seen from 9.2±3.7 mm at day 0 to a decrease of 3.3±4.8 mm at week 6 (P<0.0001)
Santander et al. (16), 2012	III	23 patients	Retrospective 23 patients with symptoms for at least 6 months who had arthroscopic debrided patellar tendon at inferior pole and peritendon: outcomes	Arthroscopic treatment of chronic patellar tendinopathy relieves pain in those who failed conservative treatment, comparable outcomes reported from open techniques
Gosens et al. (17), 2012	I	36 patients with patellar tendinopathy	Evaluated outcomes of patients treated by PRP injections and identified if previous treatments affected the results. Fourteen of 36 patients previously treated cortisone, ethoxysclerol and or surgery	PRP treatment provided significant improvements in both groups. Patients with no prior treatment had the largest improvement. Improvements in pain reduction in the total group after PRP injection were seen with VISA-P mean scores improving from 40.1 to 57.7 (P<0.0001), VAS ADL decreased from 5.9 to 2.7 (P<0.0001), VAS work decreased from 6.3 to 3.2 (P<0.0001), and VAS sport decreased from 8.50 to 4.61 (P<0.0001)
Filardo et al. (18), 2010	II	31 patients with chronic patellar tendinopathy	Evaluated the efficacy of multiple PRP injections in chronic patellar tendinopathy. 15 patients with chronic patellar tendinopathy who failed non-surgical and surgical treatments were treated with 3 PRP injections spaced 2 weeks apart, as well as physiotherapy vs. 16 patients primarily treated with physiotherapy only	PRP treatment group had superior outcomes in sport activity levels compared to control group with EQ VAS 39%±22% vs. 20%±27% (P=0.048). There were no significant differences in pain relief, time to recover, and patient satisfaction between the PRP and control group
Cucurulo et al. (19), 2009	II	64 patients	Evaluate the outcomes of 64 patients who failed conservative treatment and underwent surgery: 10 of 64 had arthroscopic surgery. Average follow-up 22 months	Arthroscopic and conventional surgical treatment had comparable effectiveness with improved function and reductions in pain, although there was no significant differences between the two groups
Vulpiani et al. (20), 2007	II	73 patients (83 knees)	Evaluated long term outcomes of treating sports patients with jumper's knee with extracorporeal shock wave therapy	Effects of Shock wave therapy are time dependent: improvements in mean VAS pain scores were seen from 7.1 before treatment, 4.23 at 1 month, and 3.32 at less than 12 months, 3.28 between 12-24 months, and 1.35 after 12 month follow up (P<0.01). Improvements in clinical evaluation were seen from before treatment at 1.95 to 1.21 at 1 month treatment, 0.96 at less than 12 months, 0.83 between 12-24 months, and 0.31 at greater than 24 months follow up (P<0.01)

**Table 1** (continued)

Table 1 (continued)

Reference	Level of evidence	Number of patients	Application	Results/Findings
Bahr et al. (21), 2006	I	35 patients	35 patients, 40 knees with grade 3b patellar tendinopathy randomized to surgical treatment vs. eccentric strength training (20 vs. 20) patients evaluated at 12 weeks 3, 6, 12 months. Outcomes for VISA	Both the surgical and eccentric treatment groups demonstrated improvements in mean pain scores in all functional tests when compared to baseline to 12 months, including standing jump 4.3 (3.3–5.3) to 1.3 (1.0–1.7) surgery group vs. 3.9 (2.7–5.1) to 1.7 (0.9–2.5) eccentric training group (P=0.002), counter-movement jump 4.8 (3.8–5.8) to 1.7 (0.7–2.7) surgical group vs. 3.9 (2.7–5.1) to 1.8 (1.0–2.6) eccentric training group (P=0.001), and leg press strength test 4.1 (2.9–6.2) surgical group vs. 4.0 (2.6–5.4) to 1.3 (0.5–2.1) eccentric training group (P=0.019). Amongst the surgical and eccentric training groups, no difference in overall treatment satisfaction and complications were found
Hoksrud et al. (22), 2006	I	33 patients (42 tendons)	RCT 33 elite athletes (basketball, handball, volleyball). Seventeen patients (23 knees) treatment, 16pts control. Investigate sclerosing injections with polidocanol to decrease vascular ingrowth on elite athletes with patellar tendinopathy	Significant improvement in knee function and reduction in pain in the treatment group compared to control with improvement in VISA score from 51 to 62 after 4 months in treatment group vs. no change in control group (P=0.052). At 8 months patients in control group were crossed over to polidocanol treatment group and demonstrated greater improvement of VISA scores of 58 to 79 vs. primary treatment group with 54 to 70 (P=0.022). At 12 months follow up no differences in patient satisfaction between control and treatment groups were seen.
Ferretti et al. (4), 2002	II	32 patients (38 knees) with patellar tendinopathy	Long term follow-up of surgical outcomes of patellar tendinosis in regard to symptoms and return to sports. 22 of the 32 knees were athletes who still competed at time of last follow up. Single surgeon used same technique of longitudinal splitting of tendon, excision of abnormal tissue and resection and drilling of inferior pole of patella	The surgical technique used produced reliable satisfactory outcomes overall: 28 (85%) of the 33 knees had good or excellent results at final follow up. Excellent result in 23 knees, good in five, fair in one and poor in four. Four of the five unsatisfactory results were in volleyball players. 5 patients who had given up sports for other reasons had complete healing of tendon and were asymptomatic. Eighteen patients (82%) were able to return to sports at an average of 5.5 months postoperatively, 63% of those knees were asymptomatic
Kettunen et al. (23), 2002	II	47 patients	Total 47 patients: 27 jumpers knee, 20 control. 15-year follow up prognosis for symptoms related to jumpers knee	Athletes with jumper's knee had higher mean VAS scores for knee pain with squatting 12.8 vs. 1.4 mm (P<0.01), increased functional limitations Kujala scores with means of 85.1±15.8 vs. 96.9±6.5 (P<0.01), and increased early retirement of sports careers because of their knee problems 9 of 17 (53%) vs. 1 of 14 (7%). Increased patellar height (patellar tendon length to patella length ratio) was correlated with increased symptoms with higher VAS score (r=0.51, P=0.04), and Kujala scores (r=-0.46, P=0.05) compared to healthy controls
Ferretti et al. (24), 1985	III	172 patients treated for jumpers knee	Clinical findings and results of conservative and surgical treatment of 125 patients followed at least two years since onset of symptoms	Conservative treatment used as primary approach for all pts: adequate warm-up, ice, stretching, quadriceps strengthening, physical therapy and injection of hydrocortisone in 11 patients. Operation in 15 patients with ruptured tendons

Table 1 (continued)

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Reference	Level of evidence	Number of patients	Application	Results/Findings
Martens et al. (25), 1982	II	90 patients with jumpers knee	90 patients with jumpers knee, 12 bilateral, 102 total knees: clinical, radiological and pathologic data as well as results of conservative and operative treatments with two year minimum follow-up	Conservative treatment 68 knees, surgical 34 knees. Average duration preoperative symptoms 17 months, motivation for surgery was to regain function for sports or persistent pain. Surgical procedure directed at tendon insertion which was different from Blazina. Conservative treatments in stages 1 and 2 showed good outcomes, surgical treatment with stage 3 which is usually initially treated conservatively showed good outcomes
Roels et al. (3), 1977	II	36 patients	Clinical, radiographic findings and results of treatment in 36 patients. 23 conservative trt , 10 surgical, 3 surgical repair of complete patellar tendon rupture	Only one patient had radiographic changes with lower patella pole lengthening. All patients initially treated conservatively. Patients with higher phase/level of symptoms (III) did better with surgical treatment. Anatomic pathology excised tendon local mucoid degeneration, fibrinoid necrosis

poor in 4 (13%), while 80% of the unsatisfactory results were in volleyball players. Eighteen patients (82%) were able to return to sports at a mean of approximately 6 months postoperatively, of those, 11 (63%) were asymptomatic.

In summary, there are multiple treatment modalities for quadriceps tendinopathy. Non-operative measures have shown good outcomes in the early stages of tendinopathy. Injections of PRP and sclerosing agents such as polidocanol may provide symptomatic relief in those who have failed first line non-operative measures and are alternative treatment options. Surgical treatment for quadriceps tendinopathy should be reserved for those who are in the later stages of tendinopathy, and those who have exhausted non-operative treatments. Arthroscopic and open surgical treatments have shown superior outcomes in advanced stage tendinopathy compared to non-operative treatments. The outcomes of surgical treatment of quadriceps tendinopathy have been studied extensively in athletes, however, there is a need for additional studies in the non-athlete population.

### Discussion/conclusions

Quadriceps tendinopathy is an important cause of anterior knee pain. It is a clinical diagnosis characterized by activity-related anterior knee pain and is most commonly seen with overuse activities in athletes. Structural histologic tendon changes found in quadriceps tendinopathy have consistently demonstrated more degenerative rather than inflammatory changes. The use of conventional diagnostic imaging for quadriceps tendinopathy diagnosis reveals morphologic changes of localized tendon thickening, hypoechoic areas, and increased vascularity. Quadriceps tendinopathy is initially managed non-operatively with rest, ice, proper warm-up, and physical therapy. Injections of PRP and sclerosing agents such as polidocanol have shown good outcomes in patients with patellar tendinopathy who have failed non-operative treatment. Arthroscopic and open surgical procedures have shown good outcomes in patients with severe symptoms who have failed non-operative treatment. More recently, an association has been found between non-athletic patients who have a high BMI and patellar tendinopathy. These findings highlight the importance in surveillance of quadriceps tendinopathy as a cause of anterior knee pain in non-athletes. In addition, the development of an ultrasound classification scheme for the management of tendinopathy based on pathologic tendon changes rather than just symptomology alone would prove invaluable for clinical practice, however, there is a

need for additional validation studies.

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## Footnote

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