Taping, Bracing, and Injection Treatment for Patellofemoral Pain and Patellar Tendinopathy

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Abstract

Purpose of Review This article will focus on additional treatment options for the two most common causes of anterior knee pain, patellofemoral pain syndrome, and patellar tendinopathy. Conservative management is the first-line treatment for these conditions. For clinicians to maximize the efficacy of conservative treatment options for their patients, they must understand the most up-to-date literature evaluating the potential benefit of taping, bracing, and injections as adjunctive treatments for maximizing treatment success.

Recent Findings Recent studies of bracing and taping have found them to be helpful for patients in the short-term management of pain and improving function. However, less is known about their exact mechanism but studies are encouraging that they have a subtle role in changing patellofemoral biomechanics. Injections remain a commonly used treatment for musculoskeletal conditions; however, the evidence for their use in patellofemoral pain and patellar tendinopathy is limited. The use of platelet-rich plasma (PRP), sclerosing, high volume, or stem cell injections is an exciting new area in the treatment of patellar tendinopathy. However, evidence at this time to recommend these treatments is lacking, and more well-designed studies are needed.

Summary The treatment of patellofemoral pain and patellar tendinopathy consists of a multi-faceted approach of physiotherapy and physical modalities. There is evidence for short-term use of taping and bracing for these conditions. The evidence for injections at this time is limited and remains under investigation. Future well-designed randomized controlled studies will provide insight into the efficacy of several different types of injections in the treatment of patellar tendinopathy. Physicians should feel comfortable integrating taping and bracing into their anterior knee pain treatment paradigm while making cautious use of invasive injections as adjunctive therapy.

Keywords Anterior knee pain · Patellofemoral pain syndrome · Patellar tendinopathy · Knee bracing · McConnell taping · Knee injections

Introduction

Anterior knee pain is a broad category encompassing several different but related musculoskeletal diagnoses. Diagnosis of

anterior knee pain can be challenging as it requires careful integration of clinical history, biomechanics, and imaging to identify the underlying cause of the patient's complaints. Careful examination of chronicity, pain location, and aggravating activities can help narrow the diagnosis. Two of the most common causes of anterior knee pain are patellar tendinopathy and patellofemoral pain (PFP). Non-operative management targeting the underlying cause is the first-line treatment for the most common causes of anterior knee pain [1]. The use of exercise therapy and physical modalities, such as taping and bracing, are valuable assets in the conservative management of anterior knee pain, especially patellofemoral pain and patellar tendinopathy [2•, 3]. When these treatments fail or are slow to help the patient recover, more invasive interventions such as injections should be considered.

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Physicians with a clear understanding of the non-operative treatments at their disposal, such as taping and bracing for biomechanical issues and injections for anterior knee pain, can help improve patients' pain and quality of life.

Anatomical Considerations

In order to understand how taping can be helpful for patellofemoral pain, one must first understand normal biomechanics of the anterior knee. The patella acts a fulcrum for the quadriceps increasing the lever arm to help the knee into extension. The patella is a unique fulcrum as it is mobile within the trochlea. Part of the force that would be transferred through the fulcrum leads to displacement of the patella vertically. The contact zone of the patella is changing constantly during knee flexion. As the patella moves distal to proximal, the contact zone increases with increasing flexion [4, 5]. As the contact zone changes so does the compressive forces transmitted through the patella. There is a constant increase in patellofemoral pressure with increasing knee flexion until 80–90° of knee flexion at which time it decreases with further knee flexion. Naturally, the body is well adapted to this phenomenon. As the knee enters increasing flexion, there is increased contact area of the patella with the underlying trochlea. With increased contact area, this helps to distribute out the force over a larger area decreasing stress on the joint. Following the same pattern, there is increasing cartilage thickness in the patellofemoral joint peaking around 80–90° of flexion that cushions the load [4, 6].

This is a delicate relationship between contact area and cartilage thickness that if disturbed can lead to dysfunction. Vertical displacement of the patella in either direction (patella alta or patella baja) can alter the zone of maximal contact pressure to an area with decreased cartilage thickness [7]. The patella during flexion is also at risk to mediolateral maltracking leading to laterally displaced compressive force which means increased contact stress on the lateral trochlear facet. Soft tissue structures surrounding the knee play a role in patellar tracking especially the lateral retinaculum. This is a fibrous tissue composed of fibers from the quadriceps and iliotibial band that extend to the lateral aspect of the patella. This tissue acts a lateral restraint preventing medial deviation of the patella during flexion or varus forces. Unfortunately, the lateral retinaculum can often exceed medial forces leading to lateral deviation of the patella and thus maltracking. Studies have shown an association with of IT band and lateral retinaculum thickness and tightness to be increased in patient with patellofemoral pain than those without, ultimately leading to patellar maltracking [8–12].

Taping

Patellofemoral Pain

There are several taping options widely available for patients. One is the McConnell taping technique which is designed to be structurally supportive rigid tape that adheres to the skin for most of the day theoretically reducing pain by limiting mediolateral displacement, lateral patellar tilt, patellar rotation, and aiding the activation of vastus medialis oblique (VMO) [13–15]. Kinesio taping on the other hand is an adhesive tape that is designed to stretch giving gentle functional stretch to muscles, increasing proprioception, increasing blood flow, and helping correct joint malalignments [16, 17].

If taping is shown to be able to change patellar contact area, patellofemoral joint pressure or patellar displacement this could give evidence to the efficacy of taping for patellofemoral pain. Ho et al. attempted to answer these questions by using MRI in weight-bearing patients with and without taping. Using MRI, they examined the patellar alignment (patellar tilt, lateral displacement, patellar height) and contact area in 14 women with patellofemoral pain. They scanned them at three different angles of knee flexions at three different time points. First, they imaged prior to taping and then with the first taping method (Kinesio or McConnell taping) and then with the other type of taping. Even though there was subjective improvement in pain for many of the participants following taping, this study did not find a change in patellar contact area or with patellar alignment with either taping method [18]. Derasari et al. performed a similar study using MRI to look at the effect of taping on patellar displacement. When they looked at symptomatic knees before and after taping, they found joint mechanics did in fact change. They noted significant inferior displacement of the patella which would lead to increased contact area and decreased contact stress [19]. Despite the uncertainty, there is evidence that taping can alter patellar position, but this is an area of study that would benefit from further exploration.

How taping dynamically affects biomechanics and patients during functional activities to lessen pain has also been evaluated. Patellar taping has been shown to increase symptomatic patients' ability to load the knee in flexion activities improving shock absorption and tolerance of higher joint reaction forces [20]. This has been borne out in studies focusing on functional tasks. They showed patients using taping had improved squat depth, vertical jump, and knee flexion during stair ambulation [21–23]. Given the important role VMO plays in patellar tracking [24–26], studies have looked at patellar taping's effect on quad activation. Several studies have shown that taping may improve VMO activity and alter the onset timing of VMO and vastus lateralis (VL) [27, 28]. Nociceptive feedback from the tape-stretching cutaneous receptors around the knee is the theorized mechanism.

However, this finding has not been consistently shown in the literature [23, 29, 30]. One group recently looked how patellar taping may change lower extremity kinematics. Pelletier et al. took 32 individuals, some with patellofemoral pain and others pain free and analyzed their running gait pre- and post-taping. They found that taping altered knee and hip flexion angles and flight time as compared to no taping [31]. This shows there may be proprioceptive benefits from the taping that is missed when solely looking at joint mechanics, but further study is needed to better understand the effects on joint and gait mechanics.

In addition to alterations in biomechanics, several studies have focused on how taping can improve pain and function of patients with patellofemoral pain. A recent study by Kakar et al. found short-term benefits of taping [32]. They observed individuals with and without taping in various functional activities that classically reproduce patellofemoral pain (e.g. squats and step downs). In short term, several kinds of taping improved pain with functional activities. They postulated that there may be sensory effects associated with short-term taping that may block nociceptive pain effects and improve the patient's function. Logan et al. conducted a systematic review of five randomized controlled trials consisting of 235 patients [33]. There were multiple intervention arms comparing taping alone vs. sham taping with exercise vs. taping with exercise. Taping of any kind did better for improving patient pain levels than no taping. Taping and exercise together did better than taping alone. This study could not support taping in isolation but did find benefit of taping in the short term especially when used in conjunction with exercise, but improvements were not borne out long term. These ultimately show that taping can be helpful for pain in short-term management especially when combined with other modalities [32, 33]. However, there is not consensus in the literature as several studies have found no benefit of taping as compared with sham-taping strategies [34, 35]. Guideline recommendations at this time consider taping an adjunctive treatment for short-term pain and function for patients but should be combined with exercise therapy which is the gold standard treatment of patellofemoral pain [2•].

Patellar Tendinopathy

Patellar tendinopathy is a common cause of anterior knee pain in patients. It is activity related pain typically at the proximal pole of the patellar tendon classically associated with jumping sports. It is thought to be a result of overuse repetitive stress of the extensor mechanism of the knee [3]. Several risk factors have been associated with the development of patellar tendinopathy including quadriceps strength, hamstring flexibility, quadriceps flexibility, leg length different, foot arch height, and body habitus [36]. Unlike patellofemoral pain, the goal of taping is not to change patellar joint mechanics but potentially lessen stress on the proximal of the tendon.

Theoretically, this could be achieved by altering the patellar angle lessening stress during jumping activities. Unfortunately, the studies examining the use of taping are limited. De Vries et al. conducted a randomized-controlled trial (RCT) looking at the use of “sports taping” across the patellar tendon to help with pain and activity duration [37]. Patients were trialed with taping, sham taping, and no taping during sports and patellar tendon-loading exercises. There was a clinically significant decrease in pain with sports taping during sports and 2 hours after sports as well as exercises compared to no taping. However, there was also a decrease in pain for sham taping which may suggest there was a nociceptive benefit of something tactile over the patellar tendon. It is difficult to draw definitive conclusions from a small number of studies but to this point there is limited to no evidence taping is an effective treatment for patellar tendinopathy so more well-designed randomized trials are needed.

Bracing

Patellofemoral Pain

Another strategy to potentially improve joint mechanics and improve pain and function of patient with anterior knee pain is with orthotic bracing. There are several different types of bracing on the market, but there are a couple types that are commonly seen. The type of brace one chooses will affect the knee in different ways. Remember, in patients with patellofemoral pain their patella often exhibits signs of maltracking such as patellar tilt and lateral displacement of the patella. The goal of a knee brace for patellofemoral pain is to correct these biomechanical abnormalities and support proper mechanics. Two commonly used braces on the market for patellofemoral pain is the patellar sleeve and patellar-stabilizing brace. In a study by Draper et al., they set out to see if these braces altered the mechanics of the patellofemoral joint (PFJ). They imaged the knees of 36 females with and without PFJ pain with MRI. It was noted that there were two distinct groups of patellofemoral pain: those that exhibited increased lateral translation and patellar tilt (maltrackers) and those with pain and normal tracking. Using MRI, they showed both the brace and the sleeve were able to reduce lateral displacement of the patella but the brace did so to a larger degree. Only the brace influenced patellar tilt [38]. This suggests the choice of brace matters in correcting patellar mechanics as part of a comprehensive treatment plan for patellofemoral pain.

The goal of a knee orthosis in patellofemoral pain should improve biomechanics but more importantly make clinically relevant improvements in pain and function. Patellofemoral bracing has been shown to provide short term benefits in pain and functional activities such as walking and squatting. [39–41]. Postulated mechanisms of pain relief in addition to

improved patellar tracking include unloading of the extensor mechanism, increased temperature and proprioception, or improved confidence. Peterson et al. conducted a study to show if bracing has an additive effect with exercise therapy which continues to be the gold standard for patellofemoral pain treatment [2•]. In a prospective RCT, they divided patellofemoral patients into knee bracing with exercise therapy and exercise therapy alone. Patients were followed out to 52 weeks. There were statically significant differences in pain scores at 6 weeks and 12 weeks in the combined treatment group in activities including ADLs, stairs, and playing sports. Unfortunately, the effects diminished at long-term (52 weeks) follow-up [42]. Bracing has been shown to be a good short-term treatment for pain [39–42], but much like taping has not shown significant long-term effects. Despite this, one should consider bracing as adjunctive therapy as they are low cost, safe, and able to provide patients short-term benefit to pain and functional activities.

Patellar Tendinopathy

In patellar tendinopathy, strap bracing has been used to minimize pain and help patients continue to activity. It acts as a counter brace across the patellar tendon decreasing tensile stress. Recent studies have looked at how this brace may be improving other areas of a patient's biomechanics. Rosen et al. used EMG to look at quad activation during jumping activities in 20 men without and without patellar tendinopathy. They found that quad activation in all participants was reduced when wearing the strap brace especially vastus lateralis. Theoretically, this would decrease tensile stress on the tendon which may be clinically important in modulating patient pain [43]. One other group noted that the patellar strap may have proprioceptive benefits for a subset of patients who have had mild symptoms for a short period of time [44]. Several studies back up these findings when looking at pain. Several recent studies have shown short-term improvements in pain in patients with patellar tendinopathy when using a strap brace across the patellar tendon without finding any adverse effects [37, 45, 46]. Further well-designed RCTs are needed to better understand the effect of strap braces on patients with tendinopathy. However, studies have shown patellar strap bracing to be a cheap, non-invasive adjunctive therapy with no adverse effects making it a reasonable treatment to trial in conjunction with exercise therapy and activity modification.

Injections

Patellofemoral Pain

Treatment of patellofemoral pain is best using a multi-faceted approach consisting of exercise therapy as well as adjunct

modalities such as foot orthoses, patellar taping, or manual therapy [2•]. Ideal treatment is individualized to meet each patient's unique patellofemoral risk factors. PFP may be related to tissue inflammation and loss of homeostasis with repetitive trauma [47]. A trial corticosteroid injection to reduce inflammation and pain in an effort to restore homeostasis of the joint tissues may be warranted. Unfortunately, there are no clear well-designed studies showing benefit of steroid injections in this population; however, it may be reasonable to consider in patients who have been otherwise refractory to non-interventional treatments. There have been a few small studies looking at the use of botulinum toxin to help with patellofemoral pain. The target of the injection was vastus lateralis; the patient saw improvement in pain and functional activities requiring increased knee flexion in short-term follow-up [48, 49]. Theoretically by paralyzing the vastus lateralis, there is improvement of the imbalance of lateral vs. medial forces on the patella improving patellar maltracking. These are encouraging results but given the lack of well-designed randomized controlled trials, it is not recommended as part of the treatment plan for patellofemoral pain at this time as more study is needed to determine its efficacy.

Patellar Tendinopathy

Steroid Injections

Steroid injections are not recommended treatment for patellar tendinopathy. Several randomized controlled trials have looked at steroid injections for patellar tendinopathy compared to non-interventional treatment and found no long-term benefit [50–52]. Kongsgaard et al. looked at steroid injection versus eccentric training versus heavy slow resistance training. The eccentric and resistance were the only groups that were able to maintain benefit long term out to 6 months [51]. The use of steroid injection carries the risk of tendon rupture; studies have shown exposure of tendons to steroids leads to tendon structural remodeling to weaker tendon fiber types [53, 54]. Given the lack of long-term effects coupled with the risk of weakening tendon structure, the use of steroid injections for patellar tendinopathy are not recommended as standard treatments.

Platelet-Rich Plasma

Platelet-rich plasma (PRP) is autologous plasma with a platelet concentration above normal blood which is deposited at the site of injury. Theoretically, it promotes the healing of tissue with poor healing potential through the introduction of growth factors and inflammatory mediators. Use of PRP injections for patellar tendinopathy is a growing area of interest. There have been several studies that have shown promising results. Dragoo et al. conducted a randomized controlled trial

involving 23 patients compared dry needling and PRP injections [55•]. There was greater improvement in pain and function scores at 12 weeks in the PRP treatment group compared to dry needling but no difference at 26-week follow-up. Vertrano et al. showed short-term improvement and found more promising results at 12-month follow-up for patients treated with PRP but their comparison group was treated with extracorporeal shock wave therapy [56].

Improvement of patients with patellar tendinopathy has not necessarily been consistent in the literature; one study found PRP to be no better than injection of saline [57]. This may suggest the true benefit is related to the injection of fluid and freeing of adhesions. Mautner et al. looked at PRP use for tendinopathy across several anatomical locations and although PRP was helpful in short- to medium-term follow-up for patients; the patellar tendinopathy patients in the study had the lowest rate of complete resolution of their symptoms. Other studies suggest that PRP outcomes may continue to improve as we optimize our techniques. They showed multiple injections provide better relief than one injection alone with high rates of symptom improvement and functional scores even out to 6 months [58, 59, 60•]. There has not been consistency with the design of PRP protocols which has made it more difficult to draw large conclusions from the studies. However, several studies have shown PRP may have promise in treating patellar tendinopathy, but at this time remains investigational as more uniformly well-designed studies are needed to draw strong conclusions on PRP effectiveness.

High-Volume Image-Guided Injections

Another option that has emerged over the last few years is the use of a high-volume image-guided injections (HVIGI) delivered around the diseased tendon. The studies looking at HVIGI have used several different formulas of medications, but the results have been similarly positive [61–64]. In these protocols, ultrasound is used to deliver a high volume of solution to the deep interface of the patellar tendon to mechanically disrupt neovascularization of the tendon. All of these studies used around 40–50 ml of fluid. The bulk of this solution was saline, but in three of the studies they included some combination of bupivacaine, hydrocortisone, or aprotinin [62–64]. These studies were case series which showed good short-term improvements in pain and function for patients, but conclusions are limited without a randomized control group. One study looked at the use of high volume of only saline compared with use of PRP and showed equally positive improvements in pain and function for patients [61]. This reinforces the mechanism of action for this injection is the mechanical separation of the tendon from the underlying tissue and less importance of the specific medication used. Well-designed prospective studies are needed to determine the

efficacy of the procedure as well as the most effective and safest solution mixture.

Other Injections

There are limited studies on stem cell-based therapies for patellar tendinopathy. A systematic review of studies using adipose and bone marrow-derived stem cells use for tendinopathy found no benefit to tendon healing and did not recommend its use [65]. There have been studies specifically evaluating its use in the patellar tendon. Pascual-Garrido et al. used bone marrow-derived cells in eight patients who had failed 6 months of conservative treatments [66]. At a 5-year follow-up, there was a statically significant improvement and seven of eight patients said they would repeat procedure if needed. Although an interesting result, the lack of a control group makes interpreting these results difficult. A significant increase in studies in patellar tendinopathy is needed. Until large randomized controlled trials are conducted to show efficacy and safety, the treatment of patellar tendinopathy with stem cells remains experimental.

Mechanical debridement of the diseased tendon is one intervention for patellar tendinopathy that has been gaining popularity. Debridement can be performed using percutaneous ultrasonic tenotomy or as a scraping procedure. By debriding away dead necrotic tendon tissue, this should promote healing of the tendon and ultimately provide pain relief and functional improvement. There is some literature supporting their use in Achilles tendinopathy [67–69]. Unfortunately, studies looking at its use in patellar tendinopathy is lacking beyond a few case series [70, 71]. Early returns are intriguing, but this is an area that could benefit from well-designed studies for it to be recommended as an evidence-based treatment of patellar tendinopathy.

Other injections such as hyaluronic acid, sclerosing agents, and aprotinin are also being evaluated in the treatment of patellar tendinopathy. Short-term returns have been encouraging for improvement of pain in this patient group, but studies remain limited [72–74]. At this time, these treatments would be considered experimental, and based on current limited evidence, cannot be recommended as a standard treatment.

Conclusion

Anterior knee pain consists of several clinically similar but anatomically different musculoskeletal diagnoses. Conservative management consisting of exercise therapy with adjunctive treatment is the preferred management of patellofemoral pain and patellar tendinopathy. Recent evidence suggests an adjunctive short-term benefit for the use of bracing and taping for patellofemoral pain. Patellar tendinopathy can benefit from bracing as part of a

comprehensive treatment plan, but taping's benefit is less clear. Injection treatment for patellar tendinopathy shows promise if non-interventional treatment fails but further studies are needed to evaluate the efficacy of PRP, stem cells, and other experimental injections. Clinicians should have a clear understanding of the evidence for non-operative treatments at their disposal to best develop well-rounded treatment plans for conditions causing anterior knee pain.

Compliance with Ethical Standards

Conflict of Interest Daniel Sisk declares that he has no conflict of interest. Michael Fredericson declares he has no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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