**Medial Patellar Plica Syndrome (MPPS)**

Introduction

Synovial plicae are intra-articular synovial folds within the knee that arise from embryologic development.2,4 They are located at the superior, inferior, and medial aspects of the knee.4 The medial plica is present in 18.5-80% of individuals and is encountered the most in clinical practice.3,4 Damage or irritation to this structure results in plica syndrome. However, medial patellar plica syndrome is an uncommon pathologic condition with an incidence of only 3.8%-5.5%.1,5 Despite this low incidence, over diagnosis and misdiagnosis is common which contributes to unsuccessful treatments and prolonged painful symptoms. An improved understanding of medial patellar plica syndrome is necessary to improve clinical decision making skills that can guide the correct identification and treatment of this syndrome.

Embryology, Anatomy, and Function

The knee begins to form during the first few weeks of embryologic development. There are two recognized theories that attempt to explain plicae development during this time.4,6 The first theory involves three primitive synovial cavities that are separated by mesenchymal tissue.1,2 By the 9th to 12th weeks, these membranes are absorbed to form one single joint cavity.2,4 The second theory involves mesenchymal tissue filling the space between the distal femur and proximal tibia epiphyses.4 The tissue undergoes two changes—1) it condenses in the areas that will become menisci and cruciate ligaments, and 2) is reabsorbed in the remaining areas to form cavitations and eventually a single cavity.4,6 Incomplete absorption can occur in either theory; therefore, the presence of plicae is a sign that the resorption of mesenchymal tissue failed or cavitation was incomplete.1,2,4 Since the medial patellar plica is a vestigial structure, it has no main function after fetal development.

The medial patellar plica originates from the medial wall of the suprapatellar pouch, under the medial retinaculum of the vastis medialis oblique (VMO) muscle, or near the superior plica.4,6 It descends parallel to the medial aspect of the patella, over the medial femoral condyle, and then inserts on the infrapatellar fat pad.2-4,6 Plicae can vary in appearance but are normally thin, elastic, and transparent.1,2 These characteristics allow the plicae to move, change shape and length during lower extremity movements.1,2 Due to the various sizes and orientations of the medial plica, Sakakibara classified it into four types:1-4

 Type A: thin, cord-like elevation of the synovial wall located under the retinaculum

 Type B: shelf of synovium that does not cover the anterior medial femoral condyle

 Type C: large shelf of synovium that partially covers the medial femoral condyle

 Type D: large shelf of synovium that is separated, creating a bucket handle tag

Depending on its size, a plica may come into contact with the medial patellar facet, medial femoral condyle, or the medial meniscus during knee flexion.2 Types A and B usually remain asymptomatic while Types C and D may become compressed or impinged.4 Damage or irritation to the plica can produce painful symptoms that limit lower extremity function, and contribute to further injury of other knee joint structures.

Mechanisms of Injury and Pathophysiology

Injury to the medial plica stems from primary and secondary sources. Direct trauma to the plica, twisting movements, strenuous exercise, repetitive knee flexion-extension patterns (i.e. running, swimming, rowing), and increased activity levels are common primary sources of injury.1,2,4,6 Secondary sources of injury involve mechanisms that cause intra-articular bleeding or synovitis, triggered by loose bodies, osteochondritis dissecans, a torn meniscus, patella subluxation, or surgical procedures (i.e.arthoscopy).4,6

Upon injury, the acute inflammatory process increases the vascularity, hyalinization, and number of inflammatory cells to the injured plica.2 If prolonged, chronic inflammation will initiate histologic changes where the plica becomes inelastic, thick, fibrotic, calcified, and white in appearance.2,4 The plica becomes symptomatic when these structural changes occur.3

These changes may cause the plica to either bowstring across the trochlea and medial femoral condyle or become impinged between the medial patellar facet and the medial femoral condyle. This leads to softening and degeneration of the articular cartilage due to increased friction and shear forces from altered joint mechanics.1,2,4 Similar degenerative changes can occur without direct contact as well. The high tensile forces of the medial plica may alter quadriceps muscle activation. This, in turn, creates areas of high contact pressures that further contribute to articular cartilage softening.3,4

Examination

Variations of the standard patient exist within the literature. Some studies find the highest prevalence of MPPS to occur during the second and third decade of life in both genders.2,4 While other studies indicate that children and adolescents are frequently affected as well, especially males who are involved in athletic activities.2,3,6,9,11

The most common symptom associated with medial plica syndrome is non-specific, anteriomedial knee pain.3,6 The pain is often described as an intermittent or constant dull ache over the medial femoral condyle, which presents at rest and during activities.2,6  Other common symptoms include: popping or snapping during knee flexion, giving way, clicking, catching, pseudo-locking, stiffness, and tightness around the anteriomedial aspect of the knee.1-4 Symptoms are often elicited or aggravated during repetitive knee flexion-extension activities (i.e. stairs, walking, squatting) and prolonged knee flexion during sitting that is relieved with knee extension.2,6 Symptoms may also suddenly subside upon activity completion.3

The patient’s history is an important element in determining the correct diagnosis. About half of the patients will report a history of trauma or twisting with succeeding hemarthrosis.2 Patients may experience immediate or delayed pain responses to this trauma.2 The remaining patients may report a recent increase in vigorous physical activity in the work or athletic arenas.2 Additionally, non-traumatic related events such as changes in shoe wear, running surface, and orthotic use can be contributing factors as well.2

Physical examination should involve active and passive range of motion, and strength testing of bilateral hip flexors, quadriceps, hamstrings, and triceps surae.2 Standing balance tests and functional movements should be evaluated for technique and the detection of abnormal movement patterns. For example, single leg stance and squatting can demonstrate lower extremity strength, neuromuscular control, presence of malalignments, compensatory patterns, and associated symptoms.10

Clinical findings during the examination may be limited and similar to other pathologies of the knee.2 Findings indicative of MPPS include restricted range of motion especially in the hamstrings and gastrocnemius.4 A painful arc between 30-60o,“shuttering” of the patella, crepitus, and popping may be detected with active knee flexion.2,4,6 Additionally, quadriceps weakness and atrophy may be present secondary to chronic symtpoms.2,3 Mild to moderate quadriceps atrophy of about 0.5 to 1.0 inch around the VMO area has been seen in more than 50% subjects in previous studies.2,3

Palpation along the medial femoral condyle may reveal a cord-like structure that pops or rolls as it is pressed.4,6 Mobilizing the patella in the medial direction can reproduce painful symptoms.3 These symptoms are either above or below the joint line of the knee.2 Tenderness is frequently noted over the medial femoral condyle and at the medial aspect of the fat pat where the medial plica inserts.2,3,6 Effusion is not normally present, and is more indicative of superior patellar plica syndrome or internal derangement of the knee.4

A number of medial plica special tests are available for therapists to utilize in the clinic. Seven provocation tests have been identified that aim to bias the medial plica either through compression and impingement within the joint or tensile stress from muscle activation. The compressive tests include: the Mital Hayden Test, Plica “Shutter” Test, Hughston’s Plica Test, Patellar Bowstring Test, and the Medial Patellar Plica (MPP) test.5,8,9 The remaining two tests consist of the Flexion and Active Extension Test.4 The testing procedures are explained in further detail in Table 1 of the Appendix.

Which clinical tests are the most valuable to use in the clinic for the diagnosis of MPPS? The Medial Patellar Plica (MPP) Test was recently created under arthroscopic investigation where impingement was confirmed to occur during knee flexion.5 The authors reported the sensitivity and specificity of this test to be 0.90 and 0.89, respectively.13 Another study by Irha and Vrdoljak11 investigated the active extension test, flexion test, and the Mital-Hayden Test in adolescents who complained of anterior knee pain. These authors discovered that the performance of special tests should differ depending on the etiology. Painful symptoms from overuse injuries are replicated by traction of the plica, not compression. Therefore, dynamic testing is necessary. Compression testing may reproduce symptoms that are related to traumatic or chronic injuries, and/or increased age where internal derangement injuries are more likely.11 Overall, these three tests were capable of detecting a symptomatic medial plica, but the accuracy increases when used with the correct etiology. Further research is needed to determine the diagnostic statistics for the remaining special tests.

Differential Diagnosis

As noted earlier, a pathologic medial plica can present a plethora of symptoms that are also common to internal derangement of the knee.9 Due to its low incidence, MPPS can be misdiagnosed, with the correct diagnosis given about 50% of the time.1 In order to determine if MPPS is present, therapists need to rule out other common causes of knee pain that have similar clinical findings. The differential diagnosis of anteriomedial knee pain involves patellofemoral syndrome, medial meniscus tear, arthritis, osteochondritis dissecans, and pes anserine bursitis.1,4,6

Tindel and Nisonson1 voice that the most challenging aspect of diagnosing plica syndrome is to differentiate it from patellofemoral syndrome or maltracking of the patella.1 The suspecting presence of plica syndrome is often just sustained patellofemoral syndrome.1 This diagnosis can create snapping or clicking in the anterior compartment of the knee. Pain at the medial femoral condyle is likely referred from the medial facet of the patella and is reproduced with patellar compression during knee flexion or extension.1,10 The patient will complain of pain after prolonged knee flexion and while descending stairs.10 A complete examination should take into account the patient’s patellar alignment, Q-angle, genu valgum, femoral anteversion, and midfoot pronation.1

Joint line tenderness is a classic sign of medial meniscus damage. The patient may complain of pain, swelling, and locking of the knee after a specific event that involved flexion, rotation, and valgus stresses. Painful symptoms may limit active and passive range of motion of the knee while resisted isometric strength testing remains normal. Special tests such as McMurrary and Apley’s tests may be positive; however, these tests can also produce false positives.6,9

Arthritic symptoms of the knee are common in middle and older aged patients. Patients will report an insidious onset where painful symptoms are first manifested at the end of the day or after prolonged activities, such as walking. The symptoms will then progress to pain and stiffness in the morning that subsides with movement throughout the day. Upon examination, joint swelling, tenderness, and crepitus may be noted throughout the range of motion.10

The classic site for osteochondritis dessecans is on the medial femoral condyle near the intercondylar notch.9 The typical patient is a young male who presents with knee pain during flexion-extension activities, swelling, tenderness, and decreased range of motion.14 The patient may complain of locking, weakness or giving way.14 These symptoms commonly arise after sustaining trauma to the joint.14 The Wilson Test can be utilized to localize the damaged area and differentiate these symptoms from other pathology.9

Pes anserine bursitis is characterized by spontaneous inferomedial knee pain, localized swelling over the site of the bursa, pain and tenderness during knee flexion.15 This site may be tender upon palpation and pain may also be referred to the distal medial hamstrings.9,10 These symptoms can occur when the bursa becomes damaged, irritated, or infected from direct trauma, tight hamstrings that place additional pressure on the bursa, degenerative joint disease, obesity, valgus deformity, pes planus, overuse athletic activities and diabetes.15

It is important to note that MPPS can occur in combination with these and other intra-articular pathologies.4 Therefore, it is pertinent that therapists include other special tests as well.8 Further investigation may be required via imaging modalities to obtain a definitive diagnosis.

Imaging

The diagnosis of MPPS should be based on the patient’s history, symptoms, and clinical examination.5,7 But, due to many similarities, imaging may be necessary to confirm its diagnosis and rule out other competing pathologies. The available imaging modalities that can assist in the diagnosis of MPPS involve radiographs, magnetic resonance imaging (MRI), sonography, and arthroscopy.

Radiographs of the knee are unable to identify pathological plica, but are useful to rule out other pathologies such as fracture, arthritis, osteochondritis desiccans, chondromalacia, patellar malalignment, or the presence of osteophytes.2,4 Patients with a pathologic medial plica will have normal radiographic findings unless secondary pathology is present.4

MRI is another diagnostic tool.4 Multiple studies have determined its sensitivity to be between 93-95% in the diagnosis of MPPS.7 However, the specificity is reported to be about 72%.13 The literature has mixed recommendations regarding its use. Some studies encourage MRI use for initial screening due to its non-invasive, reliable method.7 Whereas, other studies do not recommend its routine use for diagnosis; instead, it should be utilized to rule out other common pathologies of the knee.3

Another option is dynamic sonography. This diagnostic tool is commonly used in the sports medicine setting to diagnose meniscal and ligamentous injuries.8 This tool is unique because it allows the assessment of active tissue, which helps determine if the medial plica is interfering within the joint. In a recent study, dynamic sonography had 88% accuracy, 90% sensitivity, and 83% specificity.8 This tool may be useful to determine the correct diagnosis while avoiding expensive and invasive testing.8

Despite these options, arthroscopy is the gold standard.1 However, exploratory arthroscopy is somewhat controversial as it can heighten plica irritation and reduce the chances of recovery through conservative measures.4 During arthroscopy, the appearance of the plica in terms of its thickness, color, consistency, shape, and vascularity is evaluated.1,6 Next, possible impingement of the plica between the femoral condyle or patella and the integrity of the articular cartilage in these areas of impingement are assessed.1 The mere presence of the medial plica does not indicate pathology, the source of pain, or warrant intervention.1,4 Regardless of the plica’s condition, exploration for other causal pathologic conditions should occur.1,6

Treatment

Once MPPS has been diagnosed, a conservative treatment approach is the recommended first step.1-4,6 Rest and activity reduction and modifications should be encouraged. Movements that are painful, involve repetitive flexion-extension of the knee, and prolonged knee flexion should be avoided.1,3 In addition, a short course of non-steroidal anti-inflammatories can reduce inflammation of the synovium.1,3 Therapeutic modalities such as cross friction massage, ice massage, ultrasound, and phonophoresis have also been seen to reduce acute inflammation.1 When symptoms begin to subside, physical therapy will identify and focus on impairments that contribute to the patient’s painful symptoms. This involves decreasing compressive forces at the knee by stretching the quadriceps, hamstrings, and triceps surae and strengthening the quadriceps.3,4 Strengthening should occur via isometrics and movements through a pain-free range of motion. Exercise progression should be gradual as symptoms may be aggravated.2 In particular, progressive resistive strengthening exercises for the quadriceps should be avoided because the repetitive flexion-extension pattern can cause continued irritation of the plica.3 This exercise program is recommended for 2 times a week for 6-8 weeks.4 If the symptoms do not improve or are too severe to complete therapy, a corticosteroid injection may be appropriate.4

Treatment is successful when there is a significant decrease in synovitis and painful symptoms that allows the plica to regain its normal resiliency.3 However, conservative treatment has a low success rate.2 A 60% success rate has been seen, but the majority of studies report a success rate below 20%.4,6 Success with conservative treatments may be higher for young patients with acute symptoms that are less than three months in duration, and that are associated with a history of trauma.1,2,4 Patients with chronic symptoms are less likely to respond to these measures and may require surgical interventions.1

If conservative treatment fails then surgical intervention is warranted via arthroscopy where the entire plica is excised.4 Only true pathological plica should be excised; therefore, a thorough inspection of the knee should confirm and rule out other diagnoses prior to its excision.1,3 There are four possible outcomes after the excision. First, the patient may have immediate relief of preoperative symptoms which confirms plica involvement.6 Secondly, the symptoms may improve but continue to persist, signifying that other pathologic conditions may still be present.6 Next, if the symptoms do not change then this indicates that MPPS was an incorrect diagnosis. Lastly, the symptoms may dissipate, but reappear due to the formation of scar tissue in the area.6

Surgical failure can occur where symptoms continue to persist due to misdiagnosis or incomplete excision of the pathologic plica.1,4 Good to excellent surgical outcomes are reported to be between 65-100%.4,12 However, the percentage declines to 40% when a cartilage lesion is present.12 In order to prevent failures, surgical criteria has been suggested which includes: 1) persistent symptoms that do not improve with conservative treatment, 2) a clinically painful and palpable cord, and 3) a large, thickened plica or associated cartilage changes on the patella or femur with or without other pathology.3,6 Researchers are continuing to refine this criteria as it may help to better identify surgical candidates.

In order to improve surgical outcomes and prevent recurrent symptoms, Yilmaz et al. investigated the effects of excising the retinacular bands in addition to the medial plica.12 Doing so resulted in a significant difference in outcomes where the success rate increased to 100%.12 Patellar instability was not found to be an issue with this surgical method. Therefore, the retinacular bands may play a larger role in developing and sustaining MPPS than initially thought.12

Post-operative management allows full weight bearing 24 hours after the arthroscopy procedure.12 Although, depending on the physician and the patient, an assistive device may be provided for the first week. Swelling needs to be eliminated and prevented through cryotherapy, compression, and elevation of the limb.16 Bandages should remain in place and stay dry for 3 days after the procedure.16 Physical therapy begins on post-operative day one where active and passive range of motion is initiated, as well as quadriceps and hamstrings stretching and strengthening.12 An initial home exercise program includes: calf stretches, ankle pumps, quad sets, straight leg raises in flexion, abduction, adduction, and extension.16 These exercises should be completed 4-6 times a day with 15-30 repetitions for the strength exercises and a 30 second hold for the stretches.16 Full knee extension should also be promoted through the use of a heel prop for 15-20 minutes multiple times a day.16 Post-operative management can be complicated and prolonged by significant bleeding in the joint, prolonged swelling, quadriceps weakness, and premature resumption of physical activities.4,6 However, most patients are able to return to physical activities within 3 to 6 weeks after surgery.2

Conclusion

Medial patellar plica syndrome has been characterized as an uncommon pathologic condition that is often misdiagnosed. Physical therapists should be wary of the multiple similarities MPPS shares with other common pathologies of the knee, such as patellofemoral syndrome and medial meniscus injuries. Further diagnostic testing may be required to rule out other pathologic conditions, and conservative treatment should precede surgical interventions. Successful treatment outcomes are dependent upon making the correct diagnosis, the presence of secondary pathology, proper surgical excisions, scar tissue formation, and post-operative treatment.

Appendix

**Table 1: Special Tests for Medial Patellar Plica Syndrome (MPPS)**

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| **Technique** | **Objective** | **Patient Position** | **Set-up** | **Positive Test** |
| Mital-Hayden Test8 | Detect MPPS via impingement | Supine | The therapist supports the affected knee at 30o of flexion then uses their thumb to push the patella medially | If the patient complains of pain or clicking |
| Plica “Shutter” Test8 | Detect MPPS via compression | Sitting with both knees flexed to 90o | The therapist palpates the patella as the patient actively extends their knee | If the patella “shutters” or jumps;This commonly occurs around 60-45o flexion |
| Hughston’s Plica Test9 | Detect MPPS via compression and impingement  | Supine | The therapist flexes the knee and internally rotates the tibia while pushing the patella medially and palpating the medial femoral condyle. The therapist repeatedly flexes and extends the knee | If the therapist feels popping under fingers that are positioned over the medial femoral condyle |
| Patellar Bowstring Test9 | Detect MPPS via compression and impingement | Side lying with affected side up | The therapist pushes the patella medially with their hand while flexing the knee and internally rotating the tibia. Then extends the knee. | If sounds are present during knee extension |
| Medial Patellar Plica (MPP) Test5 | Detect MPPS via compression | Supine with affected knee extended | The therapist pushes the inferomedial aspect of the patella. While maintaining this force, the therapist flexes the knee to 90o. | If painful symptoms are replicated with knee extension, but dissipate or decrease with knee flexion |
| Flexion Test4 | Tensile stress via eccentric muscle contraction | Supine with affected knee extended | The patient actively flexes their knee. The therapist blocks continued knee flexion to between 30-60o | If painful symptoms are reproduced |
| Active Extension Test4 | Plica abruptly pulled with concentric muscle contraction | Supine with the affected knee flexed to 90o | The patient quickly extends their leg, as if kicking a ball | If painful symptoms are reproduced |

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