



KNEE

Synovial plicae of the knee

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KEYWORDS

Plica;
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Arthroscopy

Summary Synovial plicae represent inward folds of the synovial lining of the knee joint capsule, which are considered vestiges of a membranous knee joint partition present during foetal development. Three such folds are found with regularity in the human knee, but most are asymptomatic and of little clinical consequence. Plicae are more commonly seen in young adults, and can be an important cause of anterior knee pain, presenting with a plethora of symptoms. Most patients give a history of blunt trauma or an increase in repetitive sporting activities, but any form of chronic or transient synovitis can cause the plica to lose its elasticity by becoming inflamed and thickened. Such changes can affect suprapatellar and medial para-patellar plicae, which may bowstring and impinge in the patello-femoral joint during flexion, subsequently leading to localised chondromalacia. As the clinical picture is not well defined, a high degree of suspicion is required. MRI might be of value in the diagnostic assessment. The clinical diagnosis, however, is one of exclusion, and other more common pathologies relating to antero-medial knee pain should be considered first. Arthroscopy remains the gold standard for treatment of pathological plicae, although intraplica injection and physiotherapy might be beneficial in patients with a short history of symptoms. Complete excision is recommended and provides satisfactory results especially if the plica represents the only intra-articular pathology.

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Introduction

Synovial plicae are found with regularity during arthroscopic knee assessments, and mostly represent incidental findings with no clinical consequence. Very occasionally, plicae may become symptomatic, often clinically indistinguishable from other intra-articular conditions such as meniscal tears or osteochondritic lesions. In the past this clinical ambiguity together with a lack of awareness by clinicians, has led to misdiagnosis and insufficient treatment.

Early reports on synovial plicae date back as far as the 16th century, when André Vesalius a Belgian physician and anatomist was the first to describe the infra-patellar plica.¹ Mayeda from Japan and Hohlbaum from Germany complemented Vesalius' description by highlighting the existence of synovial plicae within the medial and lateral para-patellar region and the suprapatellar pouch.^{2,3} It was not however, until the advent of arthroscopy, that intra-articular anatomy of the knee joint started to be appreciated with increasing clarity.⁴ As a result of direct visualisation, the understanding of disorders such as patello-femoral maltracking and plica syndrome improved considerably. Mayeda in 1918 was the first to suggest the possibility that plicae might be responsible for intra-articular derangements, a proposition which remained

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unconfirmed until Pipkin's seminal work about plicae in 1950.⁵

Consequently, symptomatic synovial plicae have since been removed of their Cinderella status and nowadays represent a well-documented pathological condition which has found broad acceptance within the orthopaedic community.⁶⁻¹² However, the frequency of occurrence of symptomatic plicae is still subject to controversy, with some surgeons suggesting the condition might be over-diagnosed.¹³

Phylogeny and embryology

Embryologically the knee evolves from mesodermal elements and progresses through different development stages. In the first few weeks of foetal development a membrane of mesenchymal tissue divides the knee joint into three compartments, the medial and lateral tibio-femoral compartments and the suprapatellar bursa.^{14,15} This membrane usually fuses together by 9½ to 12 weeks of intrauterine life, creating a single joint cavity.¹⁴ If however, the membrane fails to be reabsorbed completely, the formation of plicae in various parts of the knee cavity is possible.¹⁵⁻¹⁷

In a detailed study, Ogata and Uthoff looked at 116 embryos and fetuses confirming earlier findings by Gray and Gardner that the early intrauterine development of the knee joint was by far not as simplistic as generally proposed.^{14,18} Their studies indicate that the cartilaginous anlagen of the femur, tibia and patella are recognisable by the sixth week of intrauterine life. By 8 weeks, mesenchymal condensations representing cruciate ligaments and menisci are created, and a proper joint cavity separating the three cartilaginous anlagen can be identified for the first time. Thereafter small peripheral cavitations develop in the mesenchyme of the patello-femoral, femoro-meniscal and menisco-tibial regions, which through amalgamation create larger cavitations. This process progresses in a centripetal fashion over a period of 2 weeks and culminates in the creation of a single knee cavity. At this stage, the main adult knee structures, with patello- and tibio-femoral compartments, menisci and cruciate ligaments, are present.

In areas where the mesenchymal cavitations fail to coalesce completely, persistent mesenchymal tissue may differentiate into folds of synovium, and if large enough are considered as plicae.

The origin of the infrapatellar plica in particular has attracted scientific attention, and is thought to represent a phylogenetic remnant, present in certain reptiles and amphibians.¹ In these species the lower end of the femur forms separate and

equal articulations with the tibia and fibula, which are usually similar in size. In mammals, the fibula is considerably smaller and does not articulate with the femur. The tibio-femoral articulation however, now has a medial and lateral joint space, and the infrapatellar plica is considered a remnant of the archetype septum between the femoro-tibial and femoro-fibular joints.

Morphology

Plicae are essentially inward folds of the synovial membrane. They are thin and pliable in their normal state, and in principle can be found anywhere in the knee joint. Depending on their position three types of plicae are commonly known to exist; suprapatellar plica, medial para-patellar plica and the infrapatellar plica, whilst a fourth type, the lateral para-patellar plica, is considered rare (Fig. 1).^{12,19-21} On the basis that infra-, supra-, and medio-patellar plicae might exist concomitantly by blending into each other, some authors argue as to whether these plicae should be regarded as separate entities or considered as one unit.^{20,22}

The *plica synovialis suprapatellaris* is also known as the suprapatellar plica or septum.²⁰ It commonly takes the form of a simple crescent-shaped fold arising from the under-surface of the quadriceps

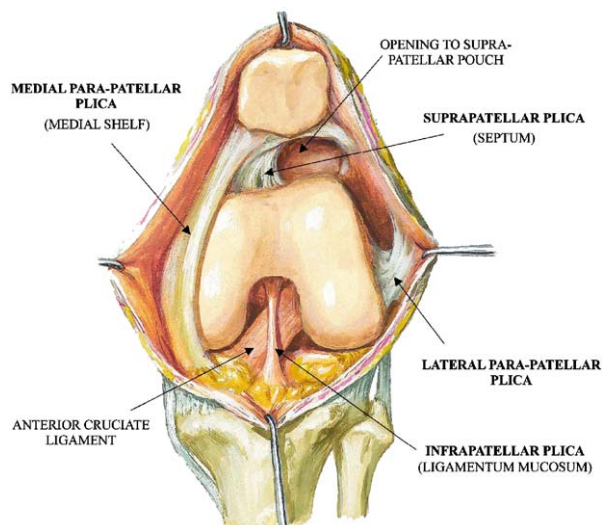


Figure 1 Knee model (opened up) demonstrating the origin and insertion of common synovial plicae. For better visualisation patellar tendon detached from the tibial tuberosity and patella reflected superiorly. 'Reproduced by kind permission of Icon Learning Systems LLC, Yardley/Pennsylvania, a division of MediMedia USA Inc. (copyright holder), from the Netter Collection of Medical Illustrations, Volume 8: Musculoskeletal System, Part 11'.

tendon and extending onto the medial wall of the suprapatellar pouch. Its free border may appear sharp, thin, wavy or crenated in the normal state. The fold may extend further to involve the roof, the lateral wall, and sometimes the floor of the suprapatellar pouch. It forms an arched or circumferential membrane surrounding an opening or fenestration, which provides communication between the suprapatellar pouch and the cavity of the knee joint. A suprapatellar plica with no opening or fenestration is called a complete septum, hence creating two separate cavities. The plica lies entirely suprapatellar, and according to Gandolfi et al. blends into the medial patellar plica in 50% of cases.²³ Anteriorly, suprapatellar plicae are attached to the quadriceps tendon, leading to a change in orientation and dimension during knee movements. Most suprapatellar plicae are transverse to the femur in knee extension and adopt a position that parallels the axis of the femur during flexion, a phenomenon, which has been demonstrated both arthrographically and arthroscopically (Fig. 2).²⁴⁻²⁶ Depending on their size and elasticity, suprapatellar plicae may impinge between the quadriceps tendon and femoral trochlea at 70° to 100° of knee flexion.^{27,28} Although uncommon variations such as pillared types have been described, most suprapatellar plicae are classified according to Deutsch et al. into type A: complete septum, type B: incomplete septum or arch with a central portal, and type C: plica confined to the superomedial side only.^{17,29}

The *plica synovialis mediopatellaris* or medial para-patellar plica was first described by Mayeda in 1918, who carried out a detailed anatomic study attempting to classify such plicae into different varieties.² He was followed by Iino, who in 1931 was the first to describe the medial plica and its

relation to the patello-femoral mechanism by means of arthroscopic assessment of cadaveric human knee joints.⁴ Through the centuries the medial para-patellar plica has been variously known as 'plica synovialis mediopatellaris', 'medial shelf', 'Iino's band', 'Aoki's ledge', 'plica alaris elongata' and 'meniscus of the patella'.^{12,30,31} The inferior extremity of the medial plica is continuous with the plicae alaris, which represents the synovium covering the infrapatellar fat pad. Only occasionally, it might originate directly from an existing infrapatellar plica. Superiorly, it fades into the synovium at the level of the vastus medialis obliquus muscle insertion. In some instances, it may however continue its crescent across the suprapatellar pouch, blending imperceptibly into an existing suprapatellar plica.²⁰ Like the suprapatellar plica, the medial patellar plica changes dimension and orientation with knee movements by virtue of its attachment to the synovium covering the fat pad and ligamentum patellae. Similarly, its free border may exhibit a variety of appearances. During knee flexion, a plica of more than 1 cm in width, might come into contact with the medial patellar facet, the medial femoral condyle, or even the outer edge of the medial meniscus (Fig. 3).²³ Several uncommon anatomic variations such as pillared, duplicated, and perforated types have been described.^{23,29} Sakakibara has classified the medial patella plica into type A: chord-like elevation of the synovium, type B: a shelf of synovium, not wide enough to cover the medial femoral condyle, type C: a wide shelf, covering the medial femoral condyle to a variable extent, and type D: a shelf with two to three pedunculated tags impinging upon the patello-femoral joints.³¹



Figure 2 A suprapatellar plica (incomplete septum) viewed from the antero-lateral portal of a left knee.

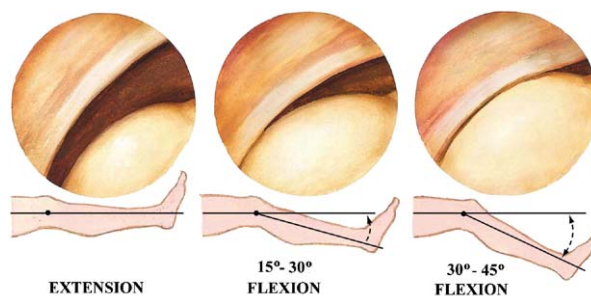


Figure 3 Mechanism of impingement of the medial para-patellar plica across the medial femoral condyle, viewed arthroscopically through a supero-lateral portal. Impingement usually occurs between 30° and 45° of knee flexion. 'Reproduced by kind permission of Icon Learning Systems LLC, Yardley/Pennsylvania, a division of Medi-Media USA Inc. (copyright holder), from the Netter Collection of Medical Illustrations, Volume 8: Musculo-skeletal System, Part II'.

The *plica synovialis patellaris* is considered to be the commonest plica, also known as the infrapatellar plica or ligamentum mucosum.³² It exists as a fold of synovium arising from a narrow base in the intercondylar notch, traversing downwards and forwards in a sagittal plane, roughly parallel to the anterior cruciate ligament, blending into the synovium covering the infrapatellar fat pad. At this point, it may be continuous with the inferior extremity of a medial para-patellar plica. In its terminal course, it may exhibit two fringe-like alar folds. Wachtler classified this plica into four types based on its size, with its largest variation presenting as a complete septum separating the medial and lateral tibio-femoral joint spaces.¹ This type may be seen as an incidental finding, but has also been associated with nail-patella syndrome and congenital discoid meniscus.^{28,33,34} If large it may cause mechanical interference during arthroscopy or be mistaken for the anterior cruciate ligament by the inexperienced arthroscopist.³⁵

Very little has been published about the *plica synovialis lateropatellaris* or lateral para-patellar plica (Fig. 1). It is considered to be the counterpart to the medial patellar plica, traversing from the fat pad toward the superior aspect of the lateral para-patellar recess.³⁶

Histology

Microscopically, normal plicae consist of a lining of single or reduplicated synovial cells resting on a stroma of connective tissue containing abundant small blood vessels and collagen fibres, but no elastic fibres.³¹ Pipkin reported on two cases with a pathological suprapatellar plica, one of which showed calcification of the plica and the other showed fibrosis, increased vascularity, hyalinisation and inflammatory cells.⁵ Sakakibara noted cartilaginous metaplasia in one of his specimens.³¹ Richmond and McGinty found mild inflammation, fibrosis and fibrocartilaginous metaplasia changes in 25 of 45 medial patellar plicae excised arthroscopically in symptomatic knees.³⁷ Other studies have also confirmed the presence of chronic inflammation and fibrosis in surgically excised symptomatic plicae but calcification, hyalinisation or cartilage metaplasia appear to be uncommon.^{11,38}

Incidence

There is wide variation in the reported incidence of synovial plicae, largely depending on the inter-

pretation of the individual investigator, differences in nomenclature, assessment method and racial groups studied.^{7,29,31,39}

Medial patellar plicae are reported to be present in 18.5–80% of knees.^{4,7,20,31} The reported incidence of suprapatellar plicae ranging from 9.1% to 55%, with a complete suprapatellar septum being present in 4–20% of knees.^{4,15,20,29,39} The infrapatellar plica is generally said to be the commonest and according to Wachtler found in 85% of knees, whilst a lateral para-patellar plica is extremely rare with an incidence well below 1%.^{1,11,21,32} In an arthroscopic study of 500 knees, Dandy described the variations in the dimensions of the suprapatellar and medial para-patellar plica.²⁹ A suprapatellar plica extending up to one third of the suprapatellar pouch was seen in 64.2%, between one third and two thirds in 4%, and two thirds and more in 31.6%. A medial para-patellar plica was absent or present as a low ridge in 36%, up to 1 cm wide in 44.8%, and more than 1 cm in 12%. The remaining 6.6% of plicae were perforated, high or duplicated. Dandy also noted a significant similarity in the appearance of plicae when both knees were arthroscoped. In another arthroscopy study Sakakibara described the presence of a medial para-patellar plica in 45 out of 100 knees.³¹ Of these, 9% presented as a chord-like elevation, 36% as a small shelf, 51% as a wide shelf, covering the medial femoral condyle to a variable extent, and 4% as a shelf with two to three pedunculated tags impinging upon the patello-femoral joint. According to the aforementioned results it would appear that a plica of some dimension is found in most knee joints.

Whilst the existence of synovial plicae is not controversial, the frequency of truly pathological plicae is.^{13,35} Reliable figures are difficult to obtain as most study groups are small. The literature has reported a prevalence of the plica syndrome ranging from 3.8% to 5.5%, as assessed by arthroscopy.^{11,40} In keeping with our own experience, the incidence of the medial para-patellar plica syndrome has been reported to be as high as one in 10 hypertrophic medial plicae, and is estimated to be present in 3–7% of arthroscopies.^{37,41,42}

Pathophysiology

Most synovial plicae present as thin and pliable areolar tissue lying within a para-patellar recess. Their elastic nature allows for constant change in shape and length during knee movements. If large enough, suprapatellar and para-patellar plicae may, during knee flexion and extension, slide gently over the femoral condyles.

There is no published report of a pathological infrapatellar plica, and from all accounts it is clear that the medial para-patellar plica is most commonly implicated in causing symptoms.^{6-12,20,28,31,45,46} However, reports of symptomatic suprapatellar plicae and very occasionally lateral para-patellar plicae also indicate the pathological potential of these structures.^{5,12,15,17,19,21-23,25,32,43,44}

For a plica to be considered pathologic, it has to change its inherent qualities. The well-established theory of the pathophysiology of the plica syndrome is based on an inflammatory process that alters the extensible qualities of synovial tissue. Any primary disorder of the knee capable of producing transient or chronic synovitis may therefore be instrumental for the development of pathological synovial plicae.⁴⁵ Synovial haematoma after blunt trauma, and mechanical irritation due to repetitive flexion extension activities, are common, but intra-articular haemorrhage or synovitis secondary to a torn meniscus, loose body, osteochondritis dissecans, patella subluxation or post-arthroscopic procedures may also be found responsible.^{22,32,37,45}

Inflammatory synovitis can lead to oedema and thickening of plical folds and if ongoing may precipitate the replacement of elastic tissue with fibrous elements.⁴⁷ Consequently, some plicae may become relatively inelastic and tight, adopting a thickened, white and fibrotic appearance. A medial para-patellar plica affected by such changes may henceforth bowstring across the trochlea and the medial femoral condyles, or impinge between the medial patella facet and the medial condyle in knee flexion (Figs. 3 and 4a,b).^{28,32,44,48,49} Such a process may provoke a secondary mechanical synovitis, and possible alteration of patello-femoral mechanics.^{5,10,32,41,45,49} The articular cartilage of the medial patellar facet and trochlea may undergo softening and degeneration (chondromalacia) or even erosion (Figs. 4a,b and 5).^{20,24,43} It is therefore not surprising, that high incidences of chondromalacia have been noted in patients with pathological medial plicae, and to a lesser extent with suprapatellar plicae (Fig. 5).^{20,38,49,50} It should however be noted, that direct contact between plica and patello-femoral mechanism is not necessary to cause symptoms. The tethering effect of a thickened plica might interfere with normal quadriceps function, placing excessive traction on its synovial insertion, which is known to have rich nerve endings.^{41,42,51}

A pathological medial para-patellar plica usually intrudes upon patello-femoral joint between 30° and 50° of flexion, subsequently subluxing over the medial

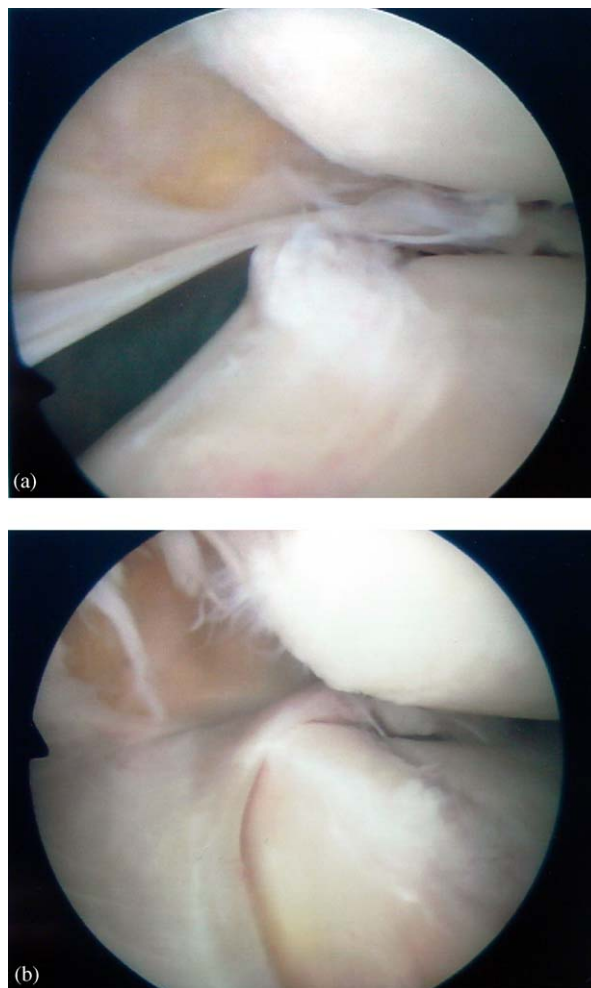


Figure 4 A right medial para-patellar plica viewed from the supero-lateral portal at different degrees of knee flexion. At 20° (a) the plica bowstrings across the medial femoral condyle, and displaces into the medial gutter at flexion angles beyond 45° (b). Note the already present degenerative changes affecting the underlying condylar cartilage.

femoral condyle (Figs. 3 and 4a, b).^{7,9,11,12,20,28,31,45,52} The uncommon pathological lateral para-patellar plica, in principle presents with the same pathomechanism, though affecting the lateral femoral condyle instead.^{12,19} Pathological suprapatellar plicae are known to impinge between the quadriceps tendon and the femoral trochlea and may abut the medial femoral condyle beyond 70° of flexion.^{27,28} A complete suprapatellar septum or a septum with a small porta may be associated with recurrent effusions in the suprapatellar pouch, but very rarely with structural damage such as chondromalacia (Fig. 6).^{13,19,50} Pipkin believed that increased hydraulic pressure caused changes in the suprapatellar plica, and attributed this phenomenon to a valve-like function of the porta.¹⁵

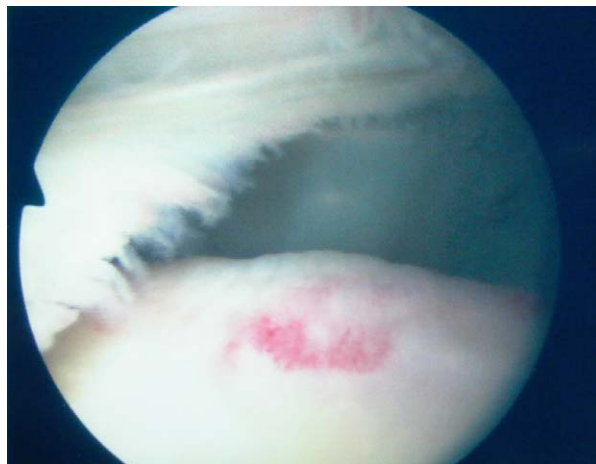


Figure 5 Arthroscopic view from the supero-lateral portal in a left knee at full extension. Localised inflammatory changes of articular cartilage on the medial femoral condyle caused by plica impingement can be seen.



Figure 6 Sagittal gradient echo MRI sequence through a right knee, demonstrating signs of an infrapatellar (*) and suprapatellar (**) plica. The suprapatellar plica proved to be a complete septum when assessed arthroscopically. An intra-articular effusion is present.

Clinical presentation & diagnosis

Anterior knee pain as a descriptive term comprises a variety of symptoms, and although not a condition in its own right, frequently receives unjustified status of a diagnosis. It is linked to a number of different knee disorders, and commonly presents in patients with pathological synovial plicae.^{53,54}

Prevalence of supra- and medial para-patellar plica related symptoms is highest in young people of both sexes in the second and third decade, but

children might also be affected.^{6,9,11,32,37,50} Approximately 50% of patients will present with a history of a blunt trauma or a twisting injury and the subsequent development of a haemarthrosis.^{32,41} Once the initial injury has healed a latent period free of symptoms might follow, only to be superseded by a delayed onset of anterior knee pain weeks or months later.⁵⁵ Most of the remaining patients give a history of pain following strenuous physical or repetitive activity or changes in activity level.^{32,45,52} Those patients are commonly engaged in exercises, involving repetitive knee flexion and extension like jogging, field sports, swimming, cycling, gymnastics or athletics. Patients often report that symptoms are absent in the early phases of sporting activities, then suddenly occur and progressively become worse. Hardaker et al. reported a series of 69 patients with plica syndrome, of which 63 were involved in active sports or heavy labour when symptoms began. Thirty-three patients gave a history of blunt trauma or twisting injury, 26 developed symptoms after a sudden increase or change in exercise pattern and 10 patients presented after previous arthroscopic knee surgery.³²

Pathological plicae can express a plethora of symptoms, which has led to the creation of the term *synovial plica syndrome*.^{9,11,12,25,32} The clinical history usually is one of non-specific anterior or antero-medial knee pain, which might be accompanied by a popping or snapping sensation during knee flexion. Patients commonly describe a pain of intermittent, dull and aching character, which is frequently aggravated by patello-femoral loading activities such as stair climbing or descending, squatting, kneeling, and after prolonged periods of rest with the knee being held in a flexed position.^{11,32,37,41} Other symptoms include a sense of tightness around the anterior or antero-medial aspect of the knee particularly on squatting, the feeling of instability or giving way, a clicking or popping sensation, swelling, stiffness, catching and locking.^{5,7,10,11,22,35,37,41} A subset of patients might also complain of pain referred to the superior border of the patella, which can be suggestive of a pathological suprapatellar plica.³² Due to the intermittent nature of the discomfort experienced by most patients, Nottage et al. coined the term 'shelf claudication'.¹¹

Physical examination findings are limited. Tenderness on direct palpation over the antero-medial capsule proximal to the joint line, or around the suprapatellar pouch is frequently present.^{20,35,37,42,56} Retro-patellar tenderness although less common can affect up to 25% of patients.³⁷ A variety of provocation tests have been

described, with most of them based on the principle of simulating conditions, leading to the flare up in symptoms.^{9,15,35,42,57,58} The examiner applies medial or lateral patella translation whilst pressurising the plica against the medial or lateral femoral condyle. The knee is then passively flexed and extended, with the tibia moved from internal to external rotation. The test is considered positive if the discomfort elicited is in keeping with the patient's usual symptoms. Mild to moderate quadriceps muscle atrophy of at least 1–2 cm has been reported to affect more than 50% of patients in some series.^{32,37}

A symptomatic medial para-patellar plica may be palpable as a thickened cord-like band, which can produce a noticeable snap or pop at knee flexion angles between 30° and 60° (Fig. 4a,b).^{7,9,10,12,15,23,32,37,57} Hardaker noted a palpable snap in 53% of 73 patients, however, a palpable band was only present in 15%.³² Richmond and McGinty discovered a palpable medial plica in only 9% of their 64 cases.³⁷ In addition, examination of the patellofemoral joint may reveal retro-patellar pain, crepitus or clicks which may be associated with chondromalacia or patello-femoral arthritis.^{37,56} Knee effusion is uncommon and should always raise the suspicion of an associated intra-articular lesion.^{32,41,42}

As it is evident that the signs and symptoms displayed by pathological plicae are by no means very specific, a high level of suspicion is required in the diagnostic process. Broom and Fulkerson found that more than 50% of their patients were misdiagnosed as having a medial meniscal tear, whilst Hardaker et al. considered chondromalacia patellae in 38% and meniscal tears in 15% as their most common preoperative diagnosis.^{32,41} However, one has to bear in mind that the incidence of truly pathological plicae is low, hence care should be taken to rule out other much more common causes of anterior knee pain and to distinguish any signs or symptoms from ligamentous instability, patello-femoral maltracking, chondromalacia, and in particular from meniscal tears.^{6,22,32,41} Some authors have therefore urged to consider the diagnosis of a plica syndrome as one of exclusion.^{8,35,48,55} This should, however, not rule out that a pathological plica might be present in conjunction with another intra-articular knee derangement causing associated synovitis.^{6,23,32,45}

Although mainly a clinical diagnosis, the desire to verify a plica syndrome has attracted the use of different imaging modalities. Plain radiographs might be useful in ruling out associated conditions such as patellar maltracking, loose bodies and osteochondritis dissecans, but are of no diagnostic

value for plica syndrome.^{32,37,41} Some authors have attempted lateral pneumoarthrography and double contrast arthrography with varying success in demonstrating pathological plicae.^{17,25,26,32} The use of CT following double contrast arthrography allows not only the visualisation of medial plicae but also distinguishes whether or not impingement is present.⁵⁹ However, arthrography and CT arthrography have gone out of fashion, mainly because of difficulties in producing reproducible and reliable results, their invasiveness, and exposure to radiation. More recently, the use of ultrasound and magnetic resonance imaging have attracted attention (Figs. 6–8).^{60,61} MRI in particular has been found useful in the evaluation of thickness and extension of medial para-patellar plicae, and can, as reported by Nakanishi et al., provide 93% sensitivity and 81% specificity levels.⁵⁸ The signal intensity of medial plicae is low on both T1- and T2-weighted images, indicative of reduced water content due to fibrotic changes. Plicae are more reliably demonstrated on sagittal and axial MRI sequences, if a concomitant intra-articular effusion is present (Figs. 6–8).

Treatment

Once the diagnosis of a plica syndrome is established, a course of non-surgical treatment might be appropriate, although success rates are usually below 20%.³² Conservative treatment should include a period of rest from all strenuous physical activities, with an emphasis on avoiding patello-femoral loading, followed by a course of non-steroidal anti-inflammatory medication, moist heat



Figure 7 Axial proton density MRI sequence through the patello-femoral joint of a right knee, demonstrating a medial para-patellar plica abutting the medial femoral condyle (*).



Figure 8 Sagittal proton density MRI sequence through the centre of the medial compartment of a right knee, demonstrating a medial para-patellar plica overriding the medial femoral condyle. An intra-articular effusion is present.

application and hamstring stretching.^{32,55} Quadriceps strengthening exercises known to be beneficial in patello-femoral disorders, may sometimes aggravate symptoms and should be avoided.^{9,11,23,53} Intraplival injection with corticosteroids has also been advocated, with a reported success rate of 73% in one series.⁵² However, most authors believe that a conservative treatment approach is more likely to be successful in younger patients with a short duration of symptoms associated with a history of trauma.^{23,32}

If non-operative measures fail despite compliant therapy, consideration should be given to arthroscopic assessment and excision of the symptomatic plica, which was first advocated by Patel in 1978.^{20,23,37,45} Arthroscopy offers the advantage of a more thorough inspection of the joint, and any associated lesion or coexisting pathologies such as cartilage defects and meniscal tears may be dealt with simultaneously.

Standard antero-lateral and antero-medial portals often do not allow appropriate visualisation of plical impingement, as the patello-femoral joint invariably obstructs the view. The addition of a supero-lateral portal in combination with a 70° scope will not only provide a panoramic view across the patello-femoral joint, but will also allow assessment for plica impingement through a dynamic investigation of the plica during joint movement (Figs. 4a,b and 5).^{27,37,57,62}

Symptomatic plicae should always be completely excised to their base.^{13,37} Simple transection or incision to remove their bowstring effect should be

avoided as it may produce fibrosis and reformation of the band and recurrence of symptoms.^{7,11,32} Overzealous resection might render the medial retinaculum incompetent, which can lead to patella subluxation.^{56,63} Due to the extensive blood supply around the synovial attachment of plicae, care should be taken not to carry the resection into the capsule, as otherwise excessive intra-articular bleeding may be encountered.^{42,55} Meticulous haemostasis using electro-cautery is paramount thus avoiding postoperative haemarthrosis, the main complication of plica surgery.⁵⁵ Recently introduced bipolar radiofrequency devices have been advocated to counteract this problem by allowing simultaneous plica resection and haemostasis.⁴² However, in order to avoid potential problems with visualisation, it is recommended to address any concomitant intra-articular pathology prior to the plica resection.⁴² If chondromalacia of the medial femoral condyle and medial patella facet is extensive, resection of chondral flaps (chondroplasty) may be helpful in relieving symptoms and to prevent the development of loose bodies.^{32,64}

The removal of plicae is usually performed as an arthroscopic day case procedure, with minimum morbidity and quick postoperative rehabilitation, allowing most patients to return to sporting activities within 3–6 weeks.⁴² However, even after arthrotomy athletes have experienced no significant disability.²² Early range of motion exercises 3–4 days post-surgery should be encouraged to prevent intra-articular scarring and subsequent stiffness.³² A short course of non-steroidal anti-inflammatories may reduce the risk of exuberant intra-articular fibrosis and counteract possible plica recurrence.^{32,37} Indomethacin, which is known to influence the development of heterotopic ossification, might be an effective agent in reducing intra-articular scar tissue formation, but clinical evidence is still awaited.⁶⁵

Reported postoperative results after pathological plica excision have generally been good.^{7,9,11,20,37,38,40,41} Hardaker et al. reported on 61 knees, after open or arthroscopic medial plica excision. After an average follow-up of 19 months, excellent results were noted in 53, good in six and poor in two patients.³² Harrewyn et al. reported the results of 32 patients who underwent arthroscopic excision of suprapatellar and medial patellar plicae.⁵⁰ Satisfactory results were seen in 65% of patients who showed no associated chondromalacia, compared to 40% in those who did. Richmond and McGinty reported on the results of arthroscopic segmental resection of medial para-patellar plicae in 64 knees.³⁷ At an average interval of 21 months

after surgery, those knees having pathological plicae with or without localised chondromalacia showed good to excellent results in 86% cases, against 69% in those with other associated intra-articular lesions. Mital and Hayden assessed a group of 14 children, who presented symptomatic medial patellar plicae.⁹ Satisfactory results after arthroscopic plica resection were achieved in 13 children. Other investigators have reported a similar percentage of satisfactory results and noted that the presence of associated lesions such as chondromalacia or meniscal tears decreases the likelihood of a satisfactory outcome.^{7,12,23,38} However, some authors have stated that, despite good results in the majority of their patients, some continued to have mild symptoms, which in their opinion might indicate an underlying subtle abnormality in the knee such as an extensor mechanism malalignment, an articular lesion, or an associated patellar imbalance.^{41,64}

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