Alternative surgeries for patello-femoral disorders

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Summary
The treatment of patello-femoral disorders despite over 80\% of cases being successfully treated by non-operative methods is one of the most challenging problems for the orthopaedic surgeon.

The understanding of the underlying pathology in each patient before embarking on a treatment plan is paramount.

This review intends to clarify the patello-femoral pathophysiology, discusses management plan and describes different surgeries for patello-femoral disorders.

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Introduction
While more than 80\% of cases of patello-femoral disorders are successfully treated by non-operative methods, they remain one of the most challenging problems for the orthopaedic surgeon. However, most published studies are flawed; cited clinical tests and radiological assessments and the outcome measures are inconsistent, and most studies are retrospective including patients with mixed symptoms and pathology, and of insufficient statistical power.

Patello-femoral disorders cover a wide range of pathology (Table 1). The aetiologies of these disorders include soft tissue imbalance, injury, dysplasia and degeneration. These may be linked, with one leading to another. They can present with a variety of symptoms including pain, locking, instability and dislocation.

Recent advances in the understanding and identification of the causative factors have allowed development of aetiological based treatments.

This article aims to set out guidelines for the surgical management of each of the underlying conditions, described above, that patients may present with.

Pathology
Dejour showed that in patients with a dislocating patella, independent of a traumatic event, there are four factors contributing to pathology of patellar instability and pain. Eighty-five per cent have trochlear dysplasia, 83\% have patellar tilt, 56\% have a tibial tuberosity lateralised by at least 20 mm with respect to the centre of the trochlea and 24\% have patella alta.\textsuperscript{2} There are other factors such as dysfunction of passive or active soft tissue restraints and extrinsic abnormalities, e.g. femoral neck anteversion, medial tibial torsion and valgus hindfoot with hyperpronated forefoot, all of which influence patellar tracking and stability.\textsuperscript{3}
Unfavourable tracking or mal-alignment results in increased shear and compressive stress in the joint leading to cartilage damage and subsequent degenerative change, but before this point is reached, pain may arise from overstrain of soft tissues. Acutely, chondral injury may follow patellar subluxation or dislocation, usually affecting the lateral facet of the trochlea on dislocation and medial facet of the patella on relocation.

Recently, damage to the medial patello-femoral ligament (MPFL) has been shown to be an important aetiological factor in recurrent patellar instability (Fig. 1). The MPFL is a medial passive primary restraint of the patella ruptured during lateral dislocation.\(^3\) It is a band of retinacular tissue overlaid by the vastus medialis obliquus (VMO) which connects the medial femoral epicondyle and adductor tubercle to the medial edge of the patella. It is approximately 55 mm long and 3–30 mm wide contributing to an average of 50–60% of the passive restraining force against lateral patellar displacement while the knee is extended or in early flexion. While clinical reports have shown rupture in 75–87% of cases after dislocation, biomechanical studies have found that the ligamentous collagen structure fails at about 20–30% elongation, equivalent to only 12–18 mm lateral patellar subluxation. Undoubtedly, during patellar dislocation this distance is exceeded.\(^4\)

Patello-femoral arthritis is found in 79% of cadavers, either in isolation or in association with femoro-tibial arthritis. Clearly not all patients are symptomatic. Loss of articular cartilage is most commonly found on the lateral articular facet of the patella, implying excessive comparative loading of this facet. This may or may not be the result of pre-existing malalignment.

**Assessment**

Pain and instability are the two most common complaints in patello-femoral disorders. The pain may be associated with instability or arthritis and is usually felt in the anterior aspect of the knee joint and is characteristically exacerbated by extended periods of inactivity (including sitting or driving), kneeling, ascending or descending stairs, and walking/running especially downhill. Patients may also complain that their knee has a tendency to “give way”. Instability may present as frank dislocation or only subluxation;\(^5\) true instability may be used to describe a feeling of the patello-femoral joint subluxing and can relate to deficiency of bony contours and/or ligament/tendon imbalance. However patients may also use it to describe a feeling of instability of the patello-femoral or knee joint secondary to pain with or without secondary muscle weakness.

**Examination**

Examination of the knee includes an assessment of the back, hips, lower limb alignment and evaluation of the gait. There are a variety of specific patello-femoral joint signs, which can assist the surgeon to assess the underlying pathology:

- The J sign is a sign of pathological tracking during initiation of flexion and refers to the inverted J course of the patella that begins lateral to the trochlea and moves medially to enter the trochlea.\(^6\)

- The Q angle is widely reported in the current literature but it has questionable reproducibility and relevance to underlying malalignment.\(^1,5\) Nonetheless, the suspicion is that, if the Q angle is wide, the larger the lateral moment arm, and consequently the greater the lateral instability (normal angle <20°).

**Table 1** Insall classification of patello-femoral disorders (Data from Insall, Scott. Surgery of the Knee. Third edition, chapter 46, p. 955).

<table>
<thead>
<tr>
<th>Presence of cartilage damage</th>
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<tr>
<td>○ Chondromalacia</td>
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<th>Variable cartilage damage</th>
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<td>○ Malalignment syndromes</td>
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<td>○ Synovial plica</td>
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<th>Usually normal cartilage</th>
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<tr>
<td>○ Peripatellar causes: bursitis, tendonitis</td>
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<td>○ Overuse syndromes</td>
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<tr>
<td>○ Reflex sympathetic dystrophy</td>
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<tr>
<td>○ Patellar abnormalities</td>
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**Figure 1** Anatomical description of the medial patello-femoral ligament: Horizontal structure from medial aspect of the patella to medial epicondyle.
Examination for lateral retinacular tightness is carried out keeping the knee relaxed in full extension and pushing the patella medially. Normal mobility allows the patella to be parallel to the examination couch or beyond (patella gliding test); if otherwise, consider tight lateral retinaculum or iliobial band.

Patellar stability is assessed by gently pushing the patella laterally while flexing the knee. If the patient is apprehensive this is a sign of poor engagement and possible instability. Finally, the position of the tibial tuberosity with respect to the mid patella position will give some indication of an excessive force pulling the patella laterally.

Imaging

Radiological assessment of the patello-femoral joint should aim to demonstrate the patellar configuration, trochlear depth, lateral patellar displacement, lateral tilt (lateral patello-femoral angle), patella height and the presence of arthritis. To achieve this, the minimum recommended radiographic views are the antero-posterior weight bearing, lateral and axial (skyline) views. The AP weight bearing semiflexed view provides information about the tibio-femoral joint. The lateral view allows assessment of patellar height, patellar tilt and trochlear groove depth. The lateral radiograph is taken with the knee in at least 30° of flexion to place the patellar tendon under tension. A true lateral with the posterior borders of the femoral condyle overlapping is needed to assess the trochlear groove depth; normally 7–8 mm measured lcm from its upper limit. Less than 5 mm is considered dysplastic.

Several methods have been described to assess the vertical position of the patella. The most widely used is the Insall–Salvati method, where the ratio of the patella tendon length to the patella height is recorded. A ratio of <0.8 is considered to show patella baja, whilst a ratio of >1.2 is indicative of patella alta. This index has some pitfalls as the tibial tendon insertion may vary, especially after tibial tuberosity transposition. Caton described a ratio that compares the length of the patella articular surface with the distance between its lower end and the nearest point on the tibia, which is usually close to one. Different shapes of the trochlea have been described by Dejour (Fig. 2). In the axial view, tracking and alignment of the patella varies with the amount of knee flexion. The patella engages on the trochlea at 15–30° of flexion. This view is useful, but is only routinely requested at present by 23.1% of UK surgeons. In this position various measurements of patello-femoral congruency and dysplasia can be made (Fig. 3). These measurements may not be a true reflection of the actual angles, as bony outlines do not always correlate with that of the articular cartilage seen on MR. On all types of image the degree of osteoarthritis present may be underestimated.

Cross-sectional imaging may give a better understanding of the dynamics of the patello-femoral joint, and help to plan surgery. We use the method described by Aglietti and Insall where a CT is taken at three different ranges of flexion with relaxed extensor mechanism: 0°, 15°, 30°. In addition to the measurements made using the axial radiograph, the tibial tuberosity-sulcus femoralis distance (TT-SF) described by Insall where a CT is taken at three different ranges of flexion and congruence angle (curved line) = c (the sulcus angle is bisected to produce a reference line) – d (line joining the apex of the sulcus and the lower point in the patella). Normal range no more than 16° lateral to the bisected sulcus angle. (A) Lateral patellar displacement = e f line – g (dropping a perpendicular to this at the level of the summit of the medial femoral condyle). The distance of the medial margin of the patella from this perpendicular is measured. In the normal knee the medial patellar margin should lie no more than 1 mm lateral to the perpendicular. The lateral patello-femoral angle (curved arrow) = e f–h. The angle is taken to be normal when it opens laterally, and abnormal when it opens medially.
by Goutallier can be measured. On the same sequences lower limb rotational alignment can be assessed, including femoral anteversion. Finally a CT scanogram scout film can measure any angular deformities in the coronal or sagittal plane, although interpretation needs to be guarded as these films will be non-weight bearing.

MR scanning may be of some use in assessing the soft tissue structures around the patella and excludes other internal pathology. Assessment of the depth of the joint surfaces can be difficult depending on the resolution of the scanner. There may be a role in the future for dynamic MR scanning of patello-femoral joint motion.

Arthroscopy

Arthroscopy ought only to be used when combined with treatment and not for purely diagnostic purposes. It is helpful in assessing the status of the articular cartilage, but the dynamics of patello-femoral engagement even when using the supero-lateral portal is not particularly easy to assess.

Surgical treatment

The majority of patello-femoral problems can be treated with conservative measures. Before embarking on surgery the degree of soft tissue imbalance, injury, dysplasia and degeneration must be evaluated and correlated with the symptoms as surgery undertaken without a well-defined underlying pathology gives poor results. It is must not be forgotten that (Dejour), several anatomical defects may be present in the same knee. Thus while discussed separately here, more than one procedure may be necessary in a given knee.

Soft tissue imbalance and injury

Tight lateral structures with otherwise normal anatomy, as demonstrated by lateral subluxation/tiit of the patella, usually respond to lateral retinacular release with satisfactory results. However, this procedure has an overall complication rate of 10.2%. The most common is haemarthrosis and in the long term excessive loading of the medial facet can give as severe symptoms as the lateral side did pre-operatively. Early complications can be reduced by performing the procedure by arthroscopic means without tourniquet, using diathermy and avoiding the use of a post-operative suction drain.

Distal re-alignment procedures

Many distal soft tissue realignment techniques such as the Goldthwait-Roux have been described in the past. They give moderately satisfactory results and are advocated for skeletally immature patients with recurrent dislocation. However, there is a risk of patella tendon rupture following this procedure.

In the adult with associated patella alta or a laterally sited tibial tuberosity, medial tibial tuberosity transfer has been used successfully. This procedure was described originally by Roux in 1888 and modified later on by Elmslie and Trillat in 1964. Medial transposition alone is inadequate in most cases. It is usually supplemented with a lateral release and possibly medial reinforcement, although the latter’s efficacy is less well proven. A recent study has shown that medialisation alone prevents recurring dislocation in 87% of cases, but may not affect the development of long term patello-femoral degeneration. However, if the procedure is performed before significant cartilage damage has occurred the long-term results appear to be better.

First time dislocator

The management of first time dislocation has to be considered separately. Treatment of an initial dislocation is still controversial. Conservative treatment, with a period of immobilisation has a redislocation rate of up to 63% with restriction in activity level at 6 months of 58%. Rupture of the MPFL is the essential lesion in traumatic dislocation, but the only randomised trial for acute repair of the MPFL showed no improvement in the risk of recurrent dislocation after surgery, compared to patients treated non-operatively treatment. However, not all the operative patients underwent the same procedure.

Nonetheless MPFL reconstruction is emerging as a treatment for recurrent patella dislocation and subluxation, often in association with correction of other predisposing factors (Fig. 4). Semitendinosus tendon, quadriceps tendon or medial retinacular autograft have been used as a biomechanical study that has shown that simple sutured repairs are weaker than the normal MPFL; 18% of the natural strength. However, the repair with suture anchors or tunnel reconstruction shows strengths of 68% and 94% respectively. Autograft reconstruction is a more extensive procedure with possible donor site morbidity. A recent study of 15 patients at 5 years after MPFL reconstruction had no redislocations, 94% were pain free and 88% showed normal tracking, but only 50% had returned to normal activity.

On balance non-operative treatment is still the mainstay for the first time dislocator. While MPFL is an important structure to maintain stability of the patella, further research is needed to define the best reconstruction technique.

Correction of trochlear dysplasia

Lateral condylar elevation (Albee osteotomy) was described as a salvage operation to treat recurrent patellar dislocations. A biomechanical study of patello-femoral joint pressures showed a significant increase of mean and peak contact pressures which may lead to chondral damage and arthrosis.

More recently there has been interest in trocheoplasty or deepening the trochlea. Initially described by Dejour and published by Reynaud, nearly all studies are published in French (Fig. 5), and there is little in the English literature. To our knowledge, there is only one study written in English. Thirteen knees with trochlear dysplasia underwent Dejour trochleoplasty for recurrent patella dislocation and or persistent retropatellar pain. Good to very good
Subjective results were achieved in 77%. However, there were five cases of arthrofibrosis. Two patients complained of persistent retropatellar pain and three patients developed impingement of the fixation material.

Surgery for patello-femoral arthritis

Surgery may be appropriate for patello-femoral arthritis if non-operative measures fail to control pain. In the past, many surgical procedures were advocated including those now considered of historical interest, e.g. patellectomy. While soft tissue procedures have a limited role in the treatment of established arthritis, lateral release may be of benefit if there is patellar tilt in absence of patellar instability. While some have suggested incision of the retinaculum may provide analgesia through denervation, we would not recommend this as a procedure in isolation.

Osteotomy of the tibial tubercle can be used to correct malalignment of the extensor mechanism. Performed correctly it off-loads diseased articular cartilage and transfers loading onto healthier cartilage. Thus a Trillat (straight medial) tibial tubercle transfer is indicated when lateral tracking results in a lateral articular facet lesion.

Anteriorisation of the tibial tubercle (Maquet procedure) is indicated for the treatment of an articular lesion confined to the distal aspect of the patella, with normal alignment. Schmid found that 28 out of 35 patients were rated as very good or good following this procedure for patello-femoral arthritis. The outcome of the remaining seven cases was attributed to wrong indications to perform this procedure or technical error. Schepsis achieved similar results with an excellent or good outcome in 48 out of 56 knees following anterior tibial tubercle transposition for patello-femoral osteoarthritis.

The most common presentation is a lesion affecting the lateral and distal portion of the articular surface of the patella, consequent on lateral patellar tracking. An oblique osteotomy to transpose the tibial tubercle anteriorly and medially may be considered, to off-load the damaged articular cartilage and improve patellar tracking. Originally described in 1983, this technique avoids the necessity for bone graft required for the Maquet procedure, but offers the same off-loading of the patello-femoral joint. Fulkerson demonstrated good or excellent results in 90% of 30 patients at 35 months follow-up.

An antero-lateral tibial tubercle transfer can be utilised in patients presenting with articular lesions of the medial articular facet of the patella.

Autologous chondrocyte implantation

Autologous chondrocyte implantation is indicated for large contained full thickness cartilage injuries in the presence of a maintained radiographic joint space in young patients with isolated patello-femoral non-inflammatory arthritis. It is essential to simultaneously correct alignment and tracking of the patella to optimise the outcome. It may be also be used to improve the outcome of antero-medial tibial

Figure 4 Medial patello-femoral reconstruction. There are different alternatives to reconstruct MPFL. The new ligament is passed through the patellar tunnel and is fixed looping into the semimembranosus. Another alternatives is to fix to the medial epicondyle by screw.

Figure 5 Trochleoplasty as described by Dejour. Lateral parapatellar arthrotomy. The subchondral bone is shaved from proximal to distal. Longitudinal cartilage incision along the new trochlear groove. The cartilage is impacted and fixed with screws.
tubercle osteotomy in patients with medial facet or proximal pole articular lesions as such patients are known to have a poorer outcome compared to those with inferior pole or lateral facet lesions.

An arthroscopy is performed to assess suitability for the procedure and to obtain the cartilage sample (from which the chondrocytes are to cultured). It is harvested from the non-weight bearing portion of the superior intercondylar notch. Approximately 4 weeks later the graft is inserted as an open procedure, either cells in suspension under a sutured patch (ACI) or as a matrix implanted with the cells (MACI).

Peterson studied 101 patients receiving 110 autologous chondrocyte transplants. Fifteen patients had multiple focal femoral/patellar defects with a mean size 4.6 cm², nine patients had an excellent or good result at a mean follow up of 2.7 years. The outcome of treatment of isolated patellar lesions in previous studies was less favourable. The more radical debridement of chondromalacic tissue around the lesions in previous studies was less favourable. The more radical debridement of chondromalacic tissue around the defect and attention to correcting patello-femoral mal-tracking resulted in good or excellent outcomes in eleven of nineteen patients.

Summary and conclusion

A better understanding of patello-femoral pathophysiology, should lead to an improvement in the management of patello-femoral disorders. Thus it is important to understand the underlying pathology in each patient before embarking on treatment.

Arthroplasty

Patello-femoral or total knee replacement is now becoming increasingly popular for established patello-femoral osteoarthritis. Patello-femoral arthroplasty is indicated in patients with isolated patello-femoral arthritis with an intact fibro-femoral joint, and normal ligaments and menisci. It may be considered for the younger patient with severe trochlear dysplasia resulting in marked instability. Clearly for whichever indication it is used, the need for future revision needs to be weighed against the benefits especially in the younger patient.

Lubinus reported the first total patello-femoral arthroplasty in 1979, but this procedure was found by Tauro et al. to have an 8 year failure rate of 50%. Causes of failure included wear, impingement, disease progression and persistent malalignment. Better results have been obtained with the Avon patello-femoral prosthesis (Stryker Orthopaedics, Limerick, Ireland), which was introduced in 1996. The design of this prosthesis is such that the biomechanics replicate better the normal patello-femoral joint, with less constraint than its predecessors. Whichever system is used it must be anatomically placed and any other anatomical deformity be addressed, such as lateral placement of the tibial tuberosity causing instability after insertion of the prosthesis.

References