

Operative Treatment Options for Patellofemoral Arthritis

An Expert Recommendation of the AGA Patellofemoral Committee

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Background: The operative therapy of patellofemoral arthritis requires an individual approach depending on the underlying injury. However, the literature lacks recommendations for its course of action.

Purpose: To generate an expert recommendation of therapy for different patellofemoral abnormalities in patients suffering from isolated patellofemoral arthritis.

Study Design: Consensus statement.

Methods: To generate recommendations, the AGA Patellofemoral Committee performed a consensus process using the Delphi method based on the available literature on isolated patellofemoral arthritis.

Results: In most statements and recommendations, a high percentage of consensus could be found. However, also in the expert group of the AGA Patellofemoral Committee, some controversies on the treatment of patellofemoral arthritis exist.

Conclusion: The operative therapy of isolated patellofemoral arthritis is a challenging topic that leads to controversial discussions, even in an expert group. With this consensus statement of the AGA Patellofemoral Committee, recommendations on different operative treatment options were able to be generated, which should be considered in clinical practice.

Keywords: patellofemoral arthritis; patellofemoral instability; knee surgery

Patellofemoral arthritis is a complex and multifactorial disease. In the majority of cases, its development is based on deviations from physiological patellofemoral biomechanics that are responsible for acute or chronic instability and subsequent maltracking of the patella. Underlying anatomic factors such as trochlear dysplasia or lower leg malalignment may lead to degeneration of the patellofemoral articulation due to abnormally distributed and increased pressure. Other secondary factors are based on a traumatic

origin with subsequent cartilage defects. Primary degeneration occurs in cases in which no underlying pathological kinematics of the patellofemoral joint (PFJ) can be found. In each case, an individual approach is necessary to address the pathogenesis: for example, fixing possible instability on one hand and correcting anatomic variations and pressure distribution on the other hand.

A prerequisite for operative treatment is a thorough clinical and radiographic analysis of the abnormality, including standard radiographic examinations and cross-sectional imaging. In the present expert consensus statement, the AGA Patellofemoral Committee summarizes its recommended surgical procedures for isolated patellofemoral arthritis based on the available literature with regard to the underlying injury and pathomechanics as well as stage of degeneration.

METHODS

To generate the present expert opinion, a consensus process resulting in statements and recommendations was performed. On the basis of the evidence presented, the AGA Patellofemoral Committee performed this consensus

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process according to the Delphi method and agreed on the generated statements and recommendations. First, statements and recommendations were generated, allowing all 13 AGA Patellofemoral Committee members to contribute. Thereafter, an online survey was administered using SurveyMonkey.

The percentage of approval by all 13 AGA Patellofemoral Committee members involved is provided to indicate the degree of their agreement on the statements and recommendations. The grade of agreement was classified as “disagree,” “rather disagree,” “divided,” “rather agree,” and “totally agree.” The results of the consensus are given after each procedure section below.

RESULTS

Soft Tissue Interventions

Lateral Retinaculum Lengthening/Release

The aim of lateral retinaculum lengthening (LRL) and lateral retinaculum release (LRR) is to unload the lateral patellofemoral contact surface. In patients suffering from lateral hypercompression syndrome with incipient isolated patellofemoral arthritis, these are widely accepted operative treatment options if nonoperative treatment fails.

An increased lateral patellar tilt with reduction of the lateral joint gap and appropriate clinical symptoms is an indication according to the literature. The indication is based on a clinical examination and imaging and optional on an unloading taping or bracing test.¹² Clinically, lateral hypercompression syndrome can be confirmed by minimized lateral patellar gliding at 10° of flexion (<1 quadrant) and a pathological patellar tilt test result.¹³ When performing the patellar tilt test, the examiner lifts the lateral edge of the patella from the lateral condyle. A pathological, excessively tight lateral patella is present if a neutral or negative angle relative to the horizontal plane can be found. However, it should be noted that an increased lateral patellar tilt does not always appear because of an excessively tight lateral retinaculum. In many cases, anatomic variations (eg, trochlear dysplasia or patella alta) are the reason. However, lateral lengthening is contraindicated in cases of isolated patellofemoral instability.⁷

Looking at the anatomy of the lateral retinaculum, a superficial layer and a deep layer can be found. The deep layer is made out of epicondylopatellar and patellotibial fibers. Between both layers, the proximal and distal branches of the arterial and lateral genicular veins can be found. The distance between the proximal and distal vessels is about 5 to 6 cm. To achieve a sufficient mechanical effect, an intervention at the deep layer with a longitudinal incision of 2 to 3 cm should be performed. The intervention site should not exceed the distal patellar pole and the patellar base to avoid bleeding. An expansion of the release site or the lengthening plastic device proximally or distally is biomechanically not necessary.⁴

Finally, the still prevalent and performed LRR is viewed critically and is not recommended by the AGA

Patellofemoral Committee. The concept of a tilted knee cap corrected by LRR is not valid and rather induces medial and lateral instability of the PFJ.⁷ Furthermore, especially using the arthroscopic technique, the integrity of the joint capsule is disturbed; an opening of the joint capsule occurs, which cannot be closed again.

Therefore, LRL has replaced LRR and must be seen as the new standard for interventions on the lateral soft tissue complex of the patella. In contrast to classic LRR, the integrity of the joint capsule is not disturbed, and an exact amount of tension is possible. It has been shown that the clinical and functional results in comparison to classic LRR are significantly better and accompanied by fewer complications.¹⁶ Additionally, using the same approach, exophytes can be removed or additional lateral facetectomy performed.

Consensus: LRL and LRR

Statements:

- The lateral retinaculum provides restraint against lateralization and medialization of the patella (0%, 0%, 0%, 7.69%, and 92.31%, respectively).
- The indication for an operative procedure at the lateral retinaculum is based on a clinical examination and imaging and optional on an unloading taping or bracing test (0%, 0%, 0%, 38.46%, and 61.54%, respectively).
- The goals of a lateral lengthening procedure are to decrease the lateral patellar tilt, lateral patellar shift, and lateral patellofemoral pressure (0%, 0%, 15.38%, 30.77%, and 53.85%, respectively).
- Isolated lateral release is contraindicated in cases of patellofemoral instability (0%, 0%, 0%, 0%, and 100%, respectively).

Recommendations:

- Lengthening of the lateral retinaculum should be preferred over a release procedure with complete transection of the lateral retinaculum (7.69%, 0%, 0%, 7.69%, and 84.62%, respectively).
- The intervention's site of lateral release or lengthening should not exceed the distal and proximal patellar poles (0%, 15.38%, 0%, 46.15%, and 38.46%, respectively).
- If a lateral patellar tilt (>5°) with a narrow lateral PFJ gap in the Merchant view on the radiographic examination is present with appropriate clinical symptoms, a lateral lengthening procedure should be considered (0%, 0%, 15.38%, 38.46%, and 46.15%, respectively).

Bony Interventions

Lateral Partial Facetectomy

Isolated retropatellar arthritis often occurs as a result of years of patellofemoral instability and appears frequently because of chronic lateralization of the patella. Typically, pullout of the lateral patellar facet can be observed, which looks like a raven's beak on the lateral trochlea and lateral femoral condyle. Lateral partial facetectomy is achieved by reduction of the overhanging lateral patellar facet. This

relaxes the lateral retinaculum and thus pressure in the lateral aspect of the PFJ. It is performed by a skin incision along the lateral patellar facet. The retinaculum is incised (Z-shaped if additional lateral lengthening is needed) and partially mobilized at the lateral facet.

Resection then should be performed on a width of about 1 cm and can be done with a small oscillating saw. Osteophytes at the lateral trochlea and the lateral femoral condyle should additionally be removed. With this relatively small and technically simple procedure, good long-term results can be achieved. In a study published by López-Franco et al¹⁴ with a follow-up of 10 years, only 33% of patients had to undergo knee replacement after lateral partial facetectomy. Similar positive results were found in the study by Wetzels and Bellemans.²⁴ For partial lateral facetectomy with or without additional soft tissue interventions, we see the indication for middle-aged patients with isolated lateral arthritis of stage 3 to 4 according to the Iwano classification¹² in whom nonoperative treatment options fail and PFJ replacement is too early or not possible to perform.

Consensus: Lateral Partial Facetectomy
Statements:

- Lateral partial facetectomy is achieved by reduction of the overhanging lateral patellar facet (0%, 0%, 0%, 7.69%, and 92.31%, respectively).
- Lateral partial facetectomy relaxes the lateral retinaculum and thus decreases pressure in the lateral PFJ and lateral soft tissue structures (0%, 7.69%, 0%, 15.38%, and 76.92%, respectively).

Recommendations:

- After lateral partial facetectomy, the lateral border of the patella should be in line with the lateral border of the lateral femoral condyle (0%, 0%, 0%, 30.77%, and 69.23%, respectively).

Realignment With Osteotomy at the Tibial Tuberosity

Tibial tubercle osteotomy is probably one of the best known and most performed procedures for the surgical treatment of patellofemoral abnormalities. Repair of the distal extensor mechanism can be performed via multiplanar tibial tubercle osteotomy in the frontal plane through medialization, the sagittal plane through anteriorization/anteromedialization, or the axial plane through distalization (correction of patella alta).

Dejour et al⁸ introduced the concept of the tibial tuberosity–trochlear groove (TT-TG) distance. The TT-TG distance is able to quantify distal malalignment. Once the TT-TG distance exceeds 20 mm, a pathological increase is present. Accordingly, the indication for tibial tuberosity transfer in patients with patellofemoral instability is a TT-TG distance >20 mm.⁶ The TT-TG distance can be determined via a computer or magnetic resonance imaging, which measures the distance of the trochlear groove to the bony attachment of the patellar tendon at the tibial tuberosity.³ Because the cartilaginous joint's geometry is

dependent on the given bony geometry, in particular in patients with trochlear dysplasia,²² the interpretation of the measured values has to be performed with great care.

The tibial tuberosity–posterior cruciate ligament (TT-PCL) distance is an alternative measurement tool. The TT-PCL distance describes the distance between the tibial tuberosity and the medial border of the posterior cruciate ligament parallel to the dorsal condylar line of the proximal tibia in millimeters. The norm value is specified as <24 mm.¹⁹

To describe patella alta, the measurement protocol according to Caton-Deschamps is our favorite method. The distance of the distal end of the retropatellar articular surface to the anterior edge of the tibia divided by the length of the retropatellar articular surface is measured.³ If the quotient is >1.2, patella alta is present. Distalization is recommended if a quotient of >1.3 is measured.³ The aim of this transfer procedure is to correct the Caton-Deschamps index to a standard value of 1.1. However, it should be noted that lateralization of the patella can also be present because of relatively increased internal rotation of the femur or external rotation of the tibia as well as through present trochlear dysplasia.

Anteromedialization of the tibial tuberosity was described by Fulkerson¹⁰ in 1983. The procedure involves obliquely performed osteotomy in the frontal plane. By performing this oblique osteotomy, the positive effects of medialization (correction of lateral patellar maltracking) and anteriorization (relief of pressure on patellofemoral cartilage) can be combined. Through this procedure, pressure on the lateral patellar facet and the distal patella can be decreased.¹⁷ Therefore, preoperative clinical and radiological examinations, in particular of the localization of cartilage damage and the TT-TG and TT-PCL distances, should also be conducted. Even if the effect of pressure relief is higher in the lateral PFJ, an increase of pressure in the medial PFJ caused by overcorrection should be avoided²⁰ and physiological TT-TG and TT-PCL distances achieved. A biomechanical work by Rue et al¹⁸ showed relevant pressure relief even with low anteriorization. The mean retropatellar pressure could be reduced between 20% and 32%. This technique can therefore also be used for patients without distolateral malalignment (normal TT-TG/TT-PCL distance). For tibial tuberosity transfer with or without additional soft tissue interventions, we see the indication for middle-aged patients with stage 1 to 2 arthritis (stage 3) according to the Iwano classification¹¹ in whom PFJ replacement is too early or not possible to perform.

Consensus: Tibial Tuberosity
Statements:

- Pressure in the lateral and distal PFJ can be decreased with anteriorization and medialization of the tibial tuberosity (0%, 7.69%, 7.69%, 38.46%, and 46.15%, respectively).
- Tibial tuberosity transfer is indicated for middle-aged patients with stage 1 to 2 arthritis (Iwano stage 3) or if PFJ replacement seems too early or not possible to perform (0%, 7.69%, 23.08%, 46.15%, and 23.08%, respectively).

- In isolated arthritis of the lateral patellar facet with a patellar tilt angle $>5^\circ$ and a narrow lateral PFJ gap in the Merchant view on the radiographic examination, lateral partial facetectomy with additional tibial tuberosity anteromedialization (Fulkerson) should be considered, even if there are no signs of patellofemoral instability (7.69%, 0%, 7.69%, 46.15%, and 38.46%, respectively).
- The Fulkerson procedure involves obliquely performed osteotomy in the frontal plane, which leads to medialization and anteriorization of the tibial tuberosity (0%, 7.69%, 0%, 0%, and 92.31%, respectively).
- The osteotomy site at the tibial tuberosity should be 5 to 7 cm in length, and osteosynthesis should be performed with at least two 3.5-mm bicortical screws (0%, 7.69%, 0%, 15.38%, and 76.92%, respectively).
- Singular anteriorization of the tibial tuberosity (Maquet procedure) is not recommended (0%, 0%, 0%, 23.08%, and 76.92%, respectively).

Recommendations:

- In isolated patellofemoral arthritis with patella alta, tibial tuberosity distalization should be considered with regard to the cartilage defect location (0%, 15.38%, 0%, 15.38%, and 69.23%, respectively).
- When performing osteotomy at the tibial tuberosity, overcorrection should be avoided and a physiological TT-TG distance (<20 mm) achieved (0%, 0%, 0%, 23.08%, and 76.92%, respectively).

Arthroplasty in Isolated Patellofemoral Arthritis

A variety of authors have reported their results of PFJ prostheses through case series (evidence level 4). Publications with the longest available follow-up can be found on the Richards prosthesis (Smith & Nephew). The 3 available publications on that prosthesis reported, by consensus, good postoperative knee scores and a 10-year survival rate between 84% and 90%.^{5,13,23} Publications with the second longest follow-up period can be found on the Avon prosthesis (Stryker) and the Journey prosthesis (Smith & Nephew). Regarding the Avon prosthesis, a 5-year survival rate of 96% and good knee scores were observed.¹ The Journey prosthesis demonstrated good functional outcomes and a survival rate of 88% after 7 years.²

Looking at prosthesis registers in terms of outcomes after isolated PFJ replacement, the results vary. For example, the 2010 annual report by the Australian prosthesis registry of 1519 patients reported a 5-year survival rate of 85%. These poor results are ascribed to the additional use of obsolete implants that are no longer available on the market. However, the annual report by the English registry of pooled prostheses found a survival rate of 90% after 5 years, comparable with the rates of unicompartmental tibiofemoral arthroplasty.

From a synopsis of the literature and the experiences of the AGA Patellofemoral Committee members, patellofemoral arthroplasty (PFA) should be performed in case of the following:

- advanced degenerative changes of the PFJ (eg, Iwano stage >2 on radiographs¹²),
- little degenerative changes in the tibiofemoral joint compartments (eg, International Knee Documentation Committee [IKDC] grade $<C^{12}$ on Rosenberg view radiography or chondromalacia grade 0-2 on magnetic resonance imaging), or
- failed nonoperative therapy over a minimum of 3 to 6 months.

Widely accepted contraindications are the following:

- chronic inflammatory abnormalities,
- extension deficiency of more than 5° to 10° , and
- flexion $<90^\circ$.

In addition, the patellar height, the TT-TG distance, malrotation of the femur or the tibia, and genu valgum/varum should be identified preoperatively. In some cases, additional surgical procedures such as tibial tuberosity transfer or derotational osteotomy should be considered if there is no centrally placed patella or a severe lateral patellar tilt after implantation is present.

In principle, PFJ replacement can be performed with or without the use of a retropatellar button. However, the number of revision surgical procedures might be higher in patients without retropatellar resurfacing because of anatomic deformities of the patella and/or the trochlea.¹¹ Factors such as patient age, stability, and congruency between the trochlear implant and the native patella should be always considered. If patellar replacement is not used, additional partial lateral facetectomy can be performed to achieve better patellar tracking and avoid lateral hypercompression syndrome.

Alternatively to the standard medial parapatellar approach, a lateral parapatellar approach can be used (especially in genu valgum). With this approach, an overly tight lateral retinaculum can be released without an extra incision while performing LRL.

Patellofemoral Inlay Prosthesis

With an inlay prosthesis, just a very limited part of the bone, namely, only the injured cartilage area, has to be removed. The advantage of an inlay system is the small bone loss and the possibility of keeping the anteroposterior trochlear width. Therefore, by using an inlay prosthesis, an iatrogenic increase in the patellofemoral pressure distribution and ventral "overstuffing" are very low risks. Because of the minimal bone loss through appropriate reaming technology, a later change to an implant with a larger "cutout" is feasible. An inlay system provides not only different sizes but also different curvatures to restore the individual shape of the trochlea.

Using an inlay prosthesis, the central area of the trochlea is reamed and the prosthesis is implanted to the same surface level as healthy cartilage, avoiding iatrogenic femoral "notching" and thus preventing overstuffing. The best indication for an inlay prosthesis is symptomatic, isolated arthritis of the PFJ with completely intact tibiofemoral

cartilage.¹¹ There are studies available on the HemiCAP Wave prosthesis (Arthrosurface).^{9,11} The authors reported good outcomes in terms of knee scores and physical activity with a follow-up of 2 years.

Surgeons should be aware of lower limb malalignment and persisting patellofemoral instability. An inlay prosthesis might not be appropriate in patients suffering from severe trochlear dysplasia and/or rotational malalignment, which might be better repaired by using an intramedullary device. Additional procedures such as soft tissue stabilization with reconstruction of the medial patellofemoral ligament or osteotomy should be considered and performed if pathological parameters occur and persistent acentric patellofemoral tracking is present.

Patellofemoral Onlay Prosthesis

In contrast to an inlay system, with an onlay prosthesis, the trochlea is completely replaced. The advantage of using an onlay prosthesis is that surgery can be performed regardless of the trochlear shape. Even high-grade trochlear dysplasia is not a contraindication for using an onlay prosthesis. Therefore, also in strongly dysplastic trochlear types, an anatomic shape can be achieved after surgery. Furthermore, the entire trochlea is replaced, avoiding leaving a nonreplaced area with the risk of secondary degeneration. Especially, rotation and coronal alignment of the lower limb are very important to achieve physiological patellar tracking. Through positioning of an onlay prosthesis, realignment of the PFJ can be achieved in most cases, and the necessity of additional surgical interventions to center the patella is reduced by this effect.

As a disadvantage, a larger bone loss and a higher risk of ventral overstuffing and parapatellar soft tissue tensioning of the PFJ are reported among surgeons. However, these do not appear to be clinically relevant.^{9,15} Feucht et al⁹ were unable to show a significant difference between inlay and onlay prostheses with regard to clinical outcomes in a matched-pair analysis. However, the group of onlay prostheses showed a significantly higher progression of tibiofemoral osteoarthritis.⁹

Since 1995, there have been 12 studies of evidence level 2 and 48 studies of evidence levels 3 and 4 published on the topic of patellofemoral onlay prostheses. In a recent review, the results were summarized²¹: The 10-year revision rate averaged 18.7%. Regarding functional outcomes, 87% of the patients reported a very good to good result. It remains to be seen if these results can be improved through the inlay technique.

Consensus: Arthroplasty in Isolated Patellofemoral Arthritis

Statements:

- Isolated PFA can be considered in cases of advanced patellofemoral arthritis (Iwano stage >3) and the presence of minor degenerative changes in the tibiofemoral joint compartments (eg, Kellgren-Lawrence grade 1-2, IKDC grade <C in the Rosenberg view, or chondromalacia

[International Cartilage Repair Society grade 0-2]) (0%, 0%, 38.46%, and 61.54%, respectively).

- Nonoperative therapy should be performed over a minimum of 3 to 6 months before considering isolated PFA (0%, 0%, 0%, 15.38%, and 84.62%, respectively).
- Isolated PFA should not be performed with an extension deficit >10° or flexion <90° (0%, 7.69%, 7.69%, 7.69%, and 76.92%, respectively).
- Patellar replacement should be considered in all cases of isolated PFA (0%, 30.77%, 7.69%, 7.69%, and 53.85%, respectively).
- In cases of patellofemoral or tibiofemoral malalignment, additional procedures such as medial patellofemoral ligament reconstruction, tibial tubercle osteotomy, or osteotomy for correction of the frontal-plane axis should be considered (0%, 0%, 0%, 7.69%, and 92.31%, respectively).

Recommendations:

- In patients with severe trochlear dysplasia, it is recommended to use an onlay prosthesis (0%, 15.38%, 15.38%, 15.38%, and 53.85%, respectively).
- To address mild rotational femoral malalignment up to 20.4° ± 9° of femoral antetorsion (according to Waidelich), an onlay prosthesis is preferable to use (0%, 15.38%, 7.69%, 38.46%, and 38.46%, respectively).
- It is recommended to achieve external rotation >3° between the posterior condylar line and the ventral prosthesis plane to reduce tensioning of the lateral retinaculum (0%, 15.38%, 23.08%, 38.46%, and 23.08%, respectively).
- It is recommended to place the femoral component on the lateral aspect while avoiding lateral overhang of the implant to achieve better patellofemoral tracking (0%, 0%, 15.38%, 15.38%, and 69.23%, respectively).
- A symmetric patellar button should be placed on the medial aspect of the patella to reduce lateral retinaculum tensioning (7.69%, 7.69%, 0%, 30.77%, and 53.85%, respectively).
- Partial lateral facetectomy should be performed if the patellar button does not cover the whole patella to avoid secondary lateral patellofemoral hypercompression (0%, 0%, 23.08%, 23.08%, and 53.85%, respectively).

DISCUSSION

Isolated patellofemoral arthritis is a complex abnormality when it comes to operative treatment options. For each patient and each underlying injury, a surgical treatment plan has to be established. However, the literature lacks detailed recommendations on surgical treatment options and dos and don'ts in terms of individual patellofemoral arthritis cases. Therefore, the AGA Patellofemoral Committee generated this expert report to offer surgeons a recommendation for actions. However, even in some of the above consensus statements and recommendations, a high consensus was not possible to generate. This result emphasizes the complexity of this topic. The generated consensus statements and recommendations should help surgeons to

find the right treatment option for the individual patient with patellofemoral arthritis.

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