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Journal of ISAKOS

journal homepage: www.elsevier.com/locate/jisakos

Current Concepts Review

Patello-femoral arthroplasty- indications and contraindications

Cécile Batailler^{a,*}, Thibaut Libert^a, Sam Oussedik^b, Stefano Zaffagnini^c, Sébastien Lustig^a^a Orthopaedic Department, Lyon North University Hospital, Hôpital de La Croix Rousse, Hospices Civils de Lyon, 103 Grande Rue de la Croix Rousse, 69004, Lyon, France^b University College London Hospitals NHS Foundation Trust, NW1 2PG, London, UK^c Ila Clinica Ortopedicae Traumatologica, IRCCS Istituto Ortopedico Rizzoli, 40136, Bologna, Italy

ARTICLE INFO

Keywords:

Patellofemoral arthroplasty
Osteoarthritis
Trochlea dysplasia
Patella-femoral arthroplasty

ABSTRACT

Patellofemoral arthroplasty (PFA) is emerging as an attractive alternative to total knee arthroplasty (TKA) for isolated patellofemoral-osteoarthritis (PF-OA) for selected patients. The success of PFA is highly dependent on patient selection. This intervention is still burdened with a higher rate of revisions and a lower survival rate than TKA when the indications or the surgical technique are not optimal. We highlight the indications and contraindications of PFA to obtain satisfying functional outcomes and survivorship. Preoperative clinical and radiological assessment is critical to determine the presence of PFA indications, the absence of contraindications and the necessity of any associated procedures, particularly for the tibial tubercle.

The typical indications are patients with isolated symptomatic PF-OA, with trochlear dysplasia, when bone-on-bone Iwano 4 osteoarthritis is observed, without significant malalignment and with the absence of risk factors for developing progressive tibiofemoral-OA. The three main causes of isolated PF-OA are primary OA, trochlear dysplasia and posttraumatic OA following patellar fracture. Trochlear dysplasia is the preferred indication for PFA. Lack of experience with arthroplasty or realignment of the extensor mechanism is a relative contraindication to performing PFA.

Current concepts

- PFA emerges as an alternative to TKA for isolated PF-OA.
- Success relies on meticulous patient selection.
- Isolated PF-OA secondary to trochlear dysplasia is a key indication for PFA.
- Preoperative assessments crucial for optimal outcomes.

Future perspectives

- Evaluate advanced implanting guides like robotics, PSI, and computer-assisted surgery for PFA. Require large-scale and long-term clinical studies for accuracy in surgical precision, implant positioning, and patient satisfaction.
- Develop and validate AI algorithms for precise patient selection in PFA. Incorporate diverse patient factors to guide personalized treatment strategies.
- Continue research with larger populations to refine patient selection criteria, surgical techniques, and implant designs in PFA. Prospective studies are needed for long-term outcome validation.

* Corresponding author. Tel.: +33686248043

E-mail address: cecile.batailler@chu-lyon.fr (C. Batailler).

<https://doi.org/10.1016/j.jisako.2024.01.003>

Received 2 July 2023; Received in revised form 22 October 2023; Accepted 2 January 2024

Available online xxxx

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INTRODUCTION

Isolated patellofemoral arthritis is found in 9% of people over 40 [1]. Given its prevalence and the development of patient-specific medicine, isolated patellofemoral disease merits more personalised surgical or non-surgical treatments. Patellofemoral arthroplasty (PFA) is emerging as an attractive alternative to total knee arthroplasty (TKA) for isolated patellofemoral-osteoarthritis (PF-OA) for selected patients. Indeed, the literature reports encouraging results after PFA with sparing of the tibiofemoral compartments and cruciate ligaments, resulting in superior functional outcomes compared to TKA [2] but the questions remains about who is the ideal patient.

The success of PFA is highly dependent on patient selection [3]. This intervention is still burdened with a higher rate of revisions and a lower survival rate than TKA when the indications or the surgical technique are not optimal [4]. Short-term complications are generally related to implant malpositioning and patellar maltracking, while the main cause of long-term failure is the progression of tibiofemoral osteoarthritis (TF-OA) [5,6].

We highlight the indications and contraindications of PFA to obtain satisfying functional outcomes and survivorship, which mirrors that seen with TKA. We also discuss factors that could adversely affect the outcomes of this type of arthroplasty.

CLINICAL INVESTIGATIONS AND IMAGING

Clinical assessment

Clinical investigation involves the patient's demographic data and medical and surgical history, especially prior patellar instability and surgery. Confirming that the pain described exclusively arises from the patellofemoral joint is essential. This will be typically at the front of the knee and aggravated by activities such as squatting, negotiating stairs (often worse descending), getting up from a chair, or doing open chain extension against resistance. Clinically, the surgeon can palpate patellar crepitus and reproduce pain during retro-patellar palpation. The Zohlen sign can be helpful.

Within the clinical examination, it is crucial also to assess the following [7]:

- range of motion (especially the presence of stiffness),
- knee alignment (especially the genu valgus),
- knee laxity in the coronal and sagittal planes (especially the presence of ligament insufficiency),

- patellar tracking and signs of patellar instability,
- femorotibial joint line tenderness or symptoms of meniscal pathology
- femoral or tibial rotational disorders,
- other causes of anterior knee pain, such as prepatellar bursitis or patellar tendonitis.

Patellar tracking must be evaluated for the whole range of motion, especially while actively extending over the side of the examination couch to assess for the J-sign, which confirms a patellofemoral mal-tracking and should be considered for surgical planning [8] (video 1). Apprehension is not an important parameter to assess for PFA (Apprehension or RedPAT [9]).

Supplementary video related to this article can be found at <https://doi.org/10.1016/j.jisako.2024.01.003>

Imaging assessment

The initial radiographic evaluation includes standing anteroposterior and lateral knee radiographs, Rosenberg (or schuss) view, patellar skyline (axial or merchant) view and standing full-leg radiographs (Fig. 1).

Several parameters should be assessed and measured by preoperative radiographs to establish the proper indication:

- a degenerative process involving the femorotibial compartments,
- femorotibial malalignment [7],
- stage of PF-OA (classified with the Iwano classification [10])
- trochlear dysplasia (often modified by osteoarthritis) [11,12]. Trochlear dysplasia constitutes a relevant indication of PFA, with a high satisfaction rate.

It is essential to identify the biomechanical parameters of the patellofemoral joint to plan the surgery and potentially associated procedures:

- patellar height (Caton-Deschamps index [13])
- patellar subluxation.

Arthro CT Scan or MRI may be necessary when there's doubt about another pain aetiology. They are performed in some cases to evaluate meniscal pathology and to exclude any features of osteoarthritis in the tibiofemoral compartment. MRI is also helpful to exclude prior ligament injuries, an excessive tibial tuberosity-trochlear groove (TT-GT) distance [14] and other causes of anterior knee pain, including tendinopathy and bursitis. If a femoral or tibial rotational disorder is suspected clinically, a CT scan must be performed to search for rotational malalignments.

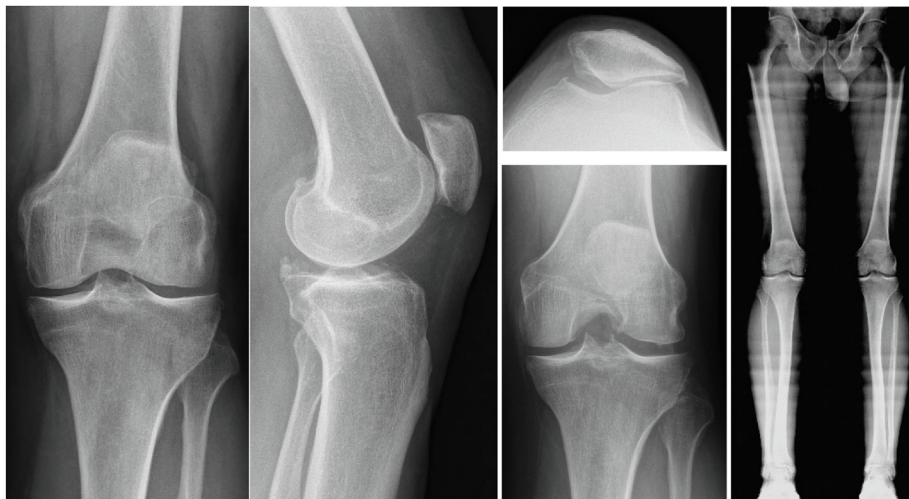


Fig. 1. Preoperative radiological assessment includes standing anteroposterior and lateral knee radiographs, Rosenberg view, patellar skyline view and standing full-leg radiographs.

INDICATIONS

The key to success with PFA is to perform the surgery when indicated and to avoid it when contraindications exist. Conservative strategies should be exhausted before a PFA is considered. The typical indications are patients with isolated symptomatic PF-OA, with trochlear dysplasia, when bone-on-bone Iwano 4 osteoarthritis is observed, without significant malalignment and with the absence of risk factors for developing progressive TF-OA [15] (Fig. 2).

The indications and contraindications of PFA described in the literature are shown in Table 1 [6,16,17]. In addition to the strict contraindications, several factors can negatively impact the outcomes of PFA. Without formally contraindicating this type of arthroplasty, their presence imposes increased rigour and requirements before finalising the indication of PFA (Table 1).

Age

In the 2021 annual report of the Australian registry, the mean age of patients undergoing PFA is 58.5 ± 12.2 years. Importantly, patients under 65 years had a significantly higher rate of revision [18] compared to those above 65 years. Higher life expectancy and higher activity levels at younger ages increase the risk of developing TF-OA in patients receiving PFA at a young age. Given that the symptoms of the PF-OA are well relieved by the PFA, utilising PFA as a staging operation in the 40–65 age group is considered a reasonable option. A conservative medical or surgical treatment should be preferred for young patients. PFA must only be proposed in carefully selected cases, with failure of every conservative surgery [19].

Body mass index

Body mass index (BMI) has been shown to have little impact on the functional outcome after PFA. Marulo et al. showed a similar improvement of functional outcome among 120 PFA at a mean follow-up of 6.9 years in both obese ($BMI > 30 \text{ kg/m}^2$, $n = 25$) and non-obese ($BMI < 30 \text{ kg/m}^2$, $n = 95$) patients [20]. Tishelman et al. reported the same improvement in function after PFA in 35 obese ($BMI > 30 \text{ kg/m}^2$) patients as non-obese ($n = 41$, $BMI: 18.5\text{--}25$) patients [21].

However, it is not surprising that BMI does affect revision rates, given progressive wear in the tibiofemoral compartments remains the most typical cause for revision of isolated PFA. Several studies report a higher risk of revision for patients with a BMI higher than 30 kg/m^2 due to TF-OA progression. In a series of 185 consecutive PFAs, with a mean follow-up of 13.3 years, a BMI over 30 kg/m^2 is a risk factor for the rapid progression of TF-OA and revisions after PFA [22]. Despite similar functional outcomes, Marulo et al. reported a failure rate of 20% in the obese group compared to 4.2% in the non-obese group [20]. A retrospective study including 51 PFA for isolated PFOA with a mean follow-up of 4.1 years concluded that patients with obesity ($BMI \geq 30 \text{ kg/m}^2$) were at higher risk of revision surgery by TKA [23].

Given that most of the literature reports that obese patients have a higher failure rate, mainly due to TF-OA progression, caution should be exercised when considering PFA in patients with a BMI over 30 kg/m^2 .

Range of motion

Most authors agree with restricting PFA to patients with a flexion contracture that doesn't exceed 10° [2,6,16,17]. While there's no specific



Fig. 2. a. Isolated symptomatic right PF-OA, with trochlear dysplasia and bone-on-bone Iwano 4 osteoarthritis. b. Postoperative radiographs of right patellofemoral arthroplasty.

Table 1
Indications and contraindications for patellofemoral arthroplasty.

Preoperative characteristics	Indications of PFA	Potential risk factors of failure - To discuss	Contraindications of PFA
Demographic data	<ul style="list-style-type: none"> • Age > 40 years old • BMI < 30 kg/m² 	<ul style="list-style-type: none"> • Age < 40 years old • Obesity (BMI > 30 kg/m²) • Male gender • High patient activity or bent-knee use • Unrealistic patient expectations 	
Previous surgery		<ul style="list-style-type: none"> • Prior meniscectomy • Multiple previous procedures or extensive soft-tissue trauma associated with residual quadriceps atrophy • Prior arthrofibrosis in the same joint or another operative site 	
Symptoms	<ul style="list-style-type: none"> • Severe symptoms affecting daily activity 		<ul style="list-style-type: none"> • Fixed stiffness • Psychogenic pain • Ligamentous tibiofemoral instability
Patellar tracking	<ul style="list-style-type: none"> • Good patellar tracking 	<ul style="list-style-type: none"> • Patellar maltracking (to need correction) 	<ul style="list-style-type: none"> • Uncorrected patellofemoral instability or maltracking
Prior treatment	<ul style="list-style-type: none"> • Unresponsive to lengthy nonoperative treatment (>3–6 months) • Failed prior conservative procedure 	<ul style="list-style-type: none"> • Failure of a previous extensor unloading procedure 	<ul style="list-style-type: none"> • No attempts at nonoperative care or to rule out other sources of pain
Aetiologies	<ul style="list-style-type: none"> • Trochlear dysplasia with or without instability 	<ul style="list-style-type: none"> • Post traumatic • Chondrocalcinosis • Primary osteoarthritis 	<ul style="list-style-type: none"> • Systemic inflammatory arthropathy • Active infection
Radiological parameters	<ul style="list-style-type: none"> • PF-OA Iwano stage 3–4 	<ul style="list-style-type: none"> • Patella alta 	<ul style="list-style-type: none"> • Evidence of chronic regional pain syndrome • Subtotal patellofemoral cartilage damage without exposed bone (< grade 3) • Patella baja • Severe uncorrected tibiofemoral malalignment (>3–5°) • Tibiofemoral OA • TF-OA greater than Kellgren–Lawrence grade 1
Other compartments	<ul style="list-style-type: none"> • Isolated degenerative PF-OA 		

PFA: patellofemoral arthroplasty; BMI: Body mass index; PF-OA: Patellofemoral osteoarthritis, TF-OA: Tibiofemoral osteoarthritis.

cause given, it's commonly accepted that more marked flexion contractures are associated with tibiofemoral disease. There's less agreement in the literature with the restriction of indications related to flexion. Some authors recommend resurfacing should not be performed if it does not exceed 110° [6,16,17], while others suggest 90° [2]. Isolated PFA will not improve extension, and flexion is unlikely to be improved apart from the case of large trochlear or patellar osteophytes, which restrict flexion. Accordingly, patients should be advised that PFA is unlikely to result in an improvement in range of motion except in the circumstance of large osteophytes that restrict flexion.

Patellar height

Patellar height is an essential consideration in patients with isolated PF-OA. There is little in the literature with objective data confirming that

patella baja (Caton-Deschamps ratio of less than 0.8) is a valid contraindication to PFA. Patella baja can theoretically be an issue as a lower patellar height means the patellar implant articulates with the native femur beyond the trochlear implant at a lower angle of flexion is the case with a standard patellar height. This means a larger area of the intercondylar region of the distal femoral articular cartilage articulates with the prosthetic patella. While this occurs with the current prosthetic design irrespective of patellar height, a larger femoral intercondylar area is involved with patella baja. It should be pointed out that this is the only area in current joint replacement where polyethylene articulates with articular cartilage. It remains an unresolved issue that may contribute to the incidence of reported persistent effusion after PFA [16] (Fig. 3).

The patella alta is commonly found in patients with patellofemoral osteoarthritis. Compared with patients who did not present with patella alta, patients with patella alta reported similar outcomes after PFA [24].

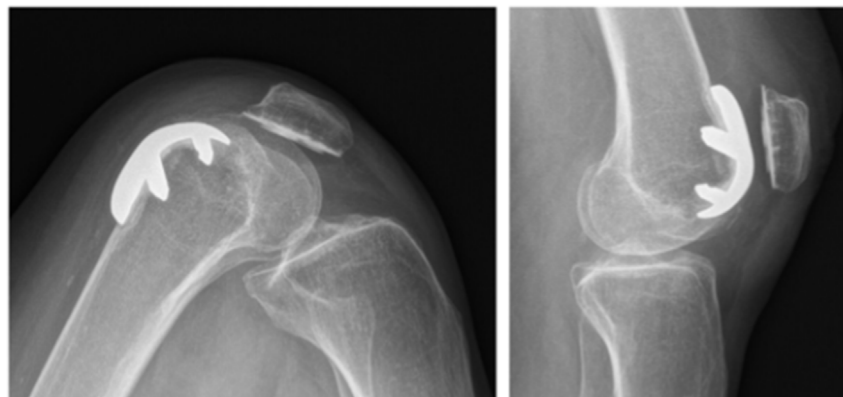


Fig. 3. At over 90° of flexion, the patellar implant articulates with the native femoral condyle articular cartilage, which a patella alta or baja can impact.

Aetiology of isolated patellofemoral osteoarthritis

Chondromalacia patella with subtotal patellofemoral cartilage damage without exposed bone is not an appropriate indication for PFA. More appropriate management includes non-surgical care with weight loss, activity modification, injections, bracing and an exercise program supervised by a physiotherapist. If these measures fail, surgical options such as arthroscopic debridement, microfracture, mosaicplasty and autologous chondrocyte transplantation can be utilised [16].

The three main causes of isolated PF-OA are primary OA, trochlear dysplasia and posttraumatic OA following patellar fracture. In erosive full-thickness damage cases, conservative surgeries are frequently ineffective. Patellectomy has been utilised and is sometimes efficient in relieving anterior pain, particularly with severe lateral patellofemoral osteoarthritis. However, PFA remains a more appropriate option for isolated and severe PF-OA.

In a large multi-centre review of 578 patients, trochlear dysplasia was found to be a strong risk factor for isolated PF-OA, with 78% of patients with PF-OA having a positive crossing sign on the true lateral radiograph [25]. Better clinical outcomes after PFA have been reported in patients with osteoarthritis secondary to trochlear dysplasia rather than other causes of PF-OA [5]. A prospective series of 103 consecutive PFAs, with a mean follow-up of 7.1 years, showed that 17% of the knees with preoperative trochlear dysplasia had been revised for progression of TF-OA, compared to none preoperative trochlear dysplasia. While more than 50% of PFA revisions are due to tibiofemoral disease progression in the Australian registry [18], detecting patients presenting with TF-OA or risk factors for rapid degenerative progression is paramount. Accordingly, isolated PF-OA without trochlear dysplasia is an uncommon indication of PFA due to the risk of TF-OA progression. These studies concluded that trochlear dysplasia was the best PFA indication (Fig. 2).

Posttraumatic PF-OA can be a good indication of PFA in the setting of a patellar fracture with relative sparing of the tibiofemoral joint. Usually, these patients have no malalignment or risk factors for progression in the tibial femoral joint. Nevertheless, several situations after patellar fracture are not indicated for PFA. Patients with posttraumatic patella magna without severe chondral damage shouldn't undergo PFA. Still, they will respond to the conservative surgery of patelloplasty, which has a quicker recovery and gives reliable pain relief. It also helps avoid arthroplasty in younger patients for several years. Some patients with a previous patellar fracture have had several surgeries, with bone defect, tendon scarring, patella Baja and sometimes prior infection. These situations are associated with a greater risk of a poor outcome with complications such as sepsis, implant loosening and failure. Thus, posttraumatic PF-OA is a good indication of PFA in the setting where the patient hasn't had complications from prior fracture management (Fig. 4).

Patellofemoral instability

The clinical and radiological parameters of patellar instability should be assessed when considering PFA. While progressive tibiofemoral wear is the commonest late cause of revision, the most frequent early cause of PFA failure is uncorrected patellar maltracking or instability. Accordingly, special attention must be paid to preoperative analysis, and intraoperative maltracking must be corrected [17]. Trochlear, dysplasia, excessive TT-GT distance and patella alta are the main anatomical factors leading to patellofemoral instability [14]. Preoperatively, the patella height must be measured on the lateral view radiograph at 30° with the Caton-Deschamps index. A CT scan or MRI must be performed to measure the TT-GT distance if there is clinical patellar maltracking.

A combined PFA and tibial tubercle osteotomy is needed in approximately 10% of PFA. The tibial tubercle is commonly transferred distally and medially to address patellofemoral maltracking. An ascension for a patella baja during a PFA is not recommended. Preoperative grade-3 J-sign (defined as lateral dislocation of the patella in the terminal

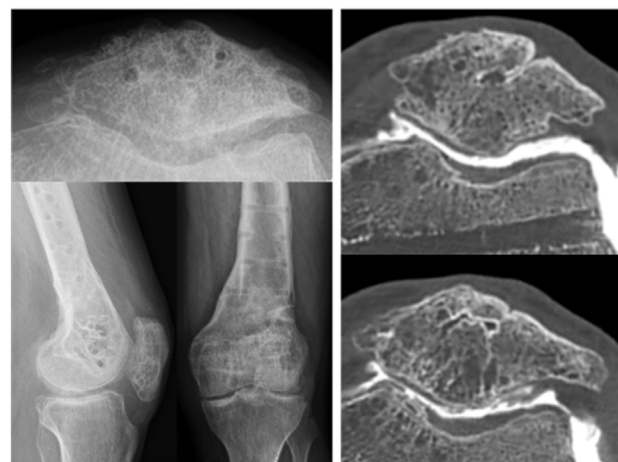


Fig. 4. Posttraumatic patellofemoral osteoarthritis with multiple previous surgeries and a patella baja. The risk of PFA failure is high, even without tibiofemoral chondral lesions on the arthro CT scan.

extension [8]) is an indication of a tibial tubercle medialisation because isolated PFA cannot stabilise only by itself a severe maltracking [26] (Fig. 5). Significant patellar subluxation or tilt during the surgery should also be addressed by medialisation of the tibial tubercle (TT) with or without lateral release associated with facetectomy.

A distalisation procedure can be considered in case of severe patella alta if the patella does not engage with the trochlea at maximum knee flexion [26]. Anteriorisation of the tibial tubercle to reduce the patellofemoral contact is irrelevant to PFA and may not significantly reduce compression forces [27].

Tibiofemoral ligament insufficiency

In the literature, there is insufficient information to determine whether chronic anterior laxity harms the function and longevity of PFA. Nevertheless, few studies pointed out altered patellar tracking, patellofemoral cartilage contact and pressure resulting from anterior cruciate ligament deficiency in cadaveric [28] and native knees [29]. In addition, both ACL injuries carry a high risk of FT-OA development [30].

Coronal malalignment

Coronal malalignment can lead to rapid TF-OA progression, so most authors recommend avoiding PFA with uncorrected severe tibiofemoral malalignment. Nevertheless, there is no unanimous consensus on the threshold values of malalignment. Some authors recommend the following threshold values: valgus superior to 8° varus superior to 5° [6, 16,17]. Other authors consider that mechanical femorotibial alignment exceeding 3° corresponds to a relative contraindication. Therefore, in case of excessive coronal malalignment, combining a tibial and or femoral osteotomy with PFA can be discussed [16].

In selected cases, PFA could also be associated with tibiofemoral unicompartamental knee arthroplasty (UKA) [16,31]. This extends PFA indications to young and active patients with bicompartamental osteoarthritis or raises the possibility of adding UKA in case of TF-OA progression [5]. Bicompartamental arthroplasty shows better function and biomechanics than TKA [32] but higher failure and revision rates than TKA [33].

Surgeon experience

Lack of experience with arthroplasty or realignment of the extensor mechanism is a relative contraindication to performing PFA [16,17]. This is corroborated by the more promising results of higher activity-level centres [2].

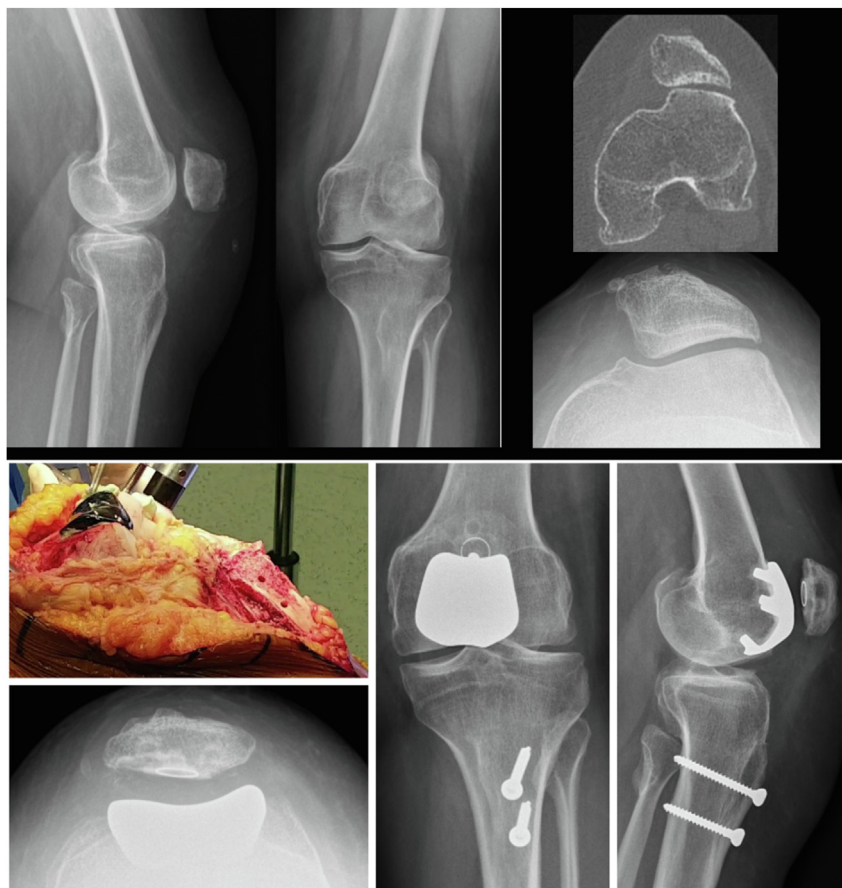


Fig. 5. Preoperative radiographs and CT scan show PF-OA with severe trochlear dysplasia. The patient had severe patellar maltracking preoperatively. PFA was performed with medialisation of the tibial tubercle osteotomy.

CONCLUSION

Patient selection remains crucial for the success of PFA. This is the most essential ingredient in a successful outcome. Preoperative clinical and radiological assessment is critical to determine the presence of PFA indications, the absence of contraindications and the necessity of any associated procedures, particularly for the tibial tubercle. The best results are seen in patients with isolated symptomatic PFOA, with trochlear dysplasia, when bone-on-bone Iwano 4 osteoarthritis is observed, without significant tibiofemoral malalignment and without risk factors for developing TF-OA.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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