Original Research

Associated patellofemoral osteoarthritis is not a contraindication for unicompartmental knee replacement. Report of one hundred ten prostheses with an average 6-year follow-up

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ABSTRACT

Introduction: Associated patellofemoral joint osteoarthritis (APFJ-OA) has typically been considered a contraindication for unicompartmental knee arthroplasty (UKA) in the treatment of femorotibial joint osteoarthritis. However, this contraindication is being challenged. The aim of this study was to assess clinical and functional outcomes, complications, and implant survival in medial or lateral UKA, regardless of clinical symptoms or radiographic signs of APFJ-OA.

Methods: This retrospective, comparative study included patients treated with medial or lateral UKA regardless of preoperative symptoms or signs of APFJ-OA, with a minimum 2-year follow-up. Intraoperatively, knees were subdivided based on APFJ-OA grade, according to the Outerbridge classification. Clinical and functional outcomes were analyzed using the 2011 Knee Society Score (KSS) at the last follow-up control. APFJ-OA was treated systematically, in a tailored, stepwise fashion according to its severity. Complications and implant survival rates were evaluated. Two-sided paired T-test, ANOVA, and Kruskal-Wallis tests were used with a significance level of 5%.

Results: Finally, 110 UKAs were assessed 81 (73.6%) medial and 29 (26.4%) laterals. The average follow-up was 6 years (2–19.5). According to Outerbridge, 22 knees (20%) were in grade 2, 59 (53.6%) were in grade 3, and 29 (26.4%) were in grade 4. All three groups showed a statistically significant increase in KSS scores and range of motion. There were no significant differences in clinical KSS improvement and flexion contracture between Outerbridge groups (average 35.7 and 4.9, respectively). Group 3 showed statistically significant improvement in functional KSS when compared to group 2 (68.8 vs 61.2). In maximum flexion, groups 3 and 4 did significantly better than group 2 (20° vs 15°). Three prostheses (2.7%) needed revision after 7, 8.6, and 12 years due to aseptic tibial loosening. Implant survival was 100% at 5 (64 of 64), 97% at 7 (30 of 31), 93% at 9 (14 of 15), and 89% at 12 years, respectively (8 of 9).

Conclusion: Clinical and functional results, complications, and survival of medial or lateral UKA were not negatively affected by APFJ-OA. We consider that APFJ-OA is not a contraindication for UKA when treated systematically according to its severity.

Level of evidence: IV.

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What are the new findings

- The grade of associated patellofemoral osteoarthritis did not have a negative impact on patients' clinical and functional outcomes after femorotibial unicompartmental knee arthroplasty.
- The grade of associated patellofemoral osteoarthritis did not have a negative impact on complication rates or survival after femorotibial unicompartmental knee arthroplasty.
- Associated patellofemoral osteoarthritis must be systematically treated in a tailored, stepwise fashion using different techniques based on its severity, to extend indications for unicompartmental knee arthroplasty.
- There was a statistically significant association between the magnitude of the preoperative femorotibial malalignment and the severity of associated patellofemoral osteoarthritis.

INTRODUCTION

Unicompartmental knee arthroplasty (UKA) is a widely used procedure to treat unicompartmental knee osteoarthritis (OA) [1–4]. As compared to total knee arthroplasty (TKA), UKA is less invasive and presents multiple advantages, such as less blood loss, shorter operative time and hospital stay, faster recovery, better functional results, knee kinematics and proprioception, and lower rates of infection [5–8]. UKA has become an increasingly popular procedure for its excellent functional results and mid-term implant survival rates comparable to TKA [9]. In the hands of high-volume and experienced surgeons, implant survival rates in the UKA can reach 97% at 10 years, 85.9% at 20 years and 80% at 25 years [5,10–14].

According to international studies, only 8–15% of patients with knee OA are treated with UKA, though it could be performed in almost 50% of cases [15–19]. In 1989, Kozinn and Scott suggested that exposed bones in the patellofemoral joint (PFJ) should be regarded as a contraindication for UKA [20]. These historical indications are currently considered too restrictive, as they limit UKA to only 6% of the total number of patients with knee OA [17]. Many recent studies claim that associated patellofemoral osteoarthritis (APFJ-OA) does not have a negative impact on UKA functional outcomes. However, most of them exclude the most advanced cases of APFJ-OA and do not describe the treatment performed on the PFJ according to the APFJ-OA grade [3,4,21–32].

The aim of this study was to assess and compare clinical and functional outcomes, complications, and implant survival of medial or lateral UKA in the treatment of femorotibial joint osteoarthritis (FTJ-OA), regardless of clinical symptoms and radiographic signs of APFJ-OA. A subanalysis was done in order to evaluate the association between the degree of femorotibial malalignment and the severity of PFJ chondropathy. The secondary objective was to describe the different surgical procedures performed on the PFJ according to APFJ-OA severity. Our hypothesis was that clinical and functional outcomes, complications, and survival of UKA are not negatively affected by the presence of APFJ-OA, and, therefore, APFJ-OA is not a contraindication for UKA.

METHODS

Level of evidence: IV, relevant. retrospective cohort study

This was a comparative, observational study to assess clinical and functional outcomes, complications, and implant survival of medial or lateral UKA for treatment of unicompartmental knee OA, and their relationship with APFJ-OA grade. We included all cases of lateral and bilateral simultaneous UKA (the latter mostly medial) with APFJ-OA, performed between January 1999 and January 2019, with a minimum 2-year follow-up. We excluded patients aged <18 years old, lost to follow-up, or treated with a different procedure. All cases were treated by the same surgeon and technique. This study was approved by the ethics committee, and all patients provided informed consent for participation.
Indications

According to our experience, there are two different conditions: primary or isolated and secondary or APFJ-OA. The first represents the underlying pathology that shows degenerative changes in the PFJ, neutral morphotype, or incipient genu valgus with preservation of femorotibial compartments. This condition is very disabling and includes patellofemoral symptoms, no femorotibial symptoms, and adequate correlation between clinical examination and PFJ imaging findings. Secondary, or APFJ-OA, occurs in patients with primary medial or lateral FTJ-OA; it is part of the evolution of medial or lateral FTJ-OA as coronal malalignment leads to medial or lateral patellar hyper-pressure, and finally to APFJ-OA. This condition usually causes slightly disabling patellofemoral symptoms; it is associated with coronal malalignment in all cases, patients suffer from medial or lateral femorotibial pain, and there is a mismatch between clinical and imaging findings in the PFJ. In secondary or APFJ-OA (unlike the primary condition), treating the FTJ-OA with UKA significantly improves patients’ clinical outcomes by correcting patellofemoral alignment [28]. Thus, secondary, or APFJ-OA, is not a contraindication for medial or lateral UKA. Conversely, primary PFJ-OA must receive specific treatment, and medial or lateral UKA is contraindicated because there is no femorotibial involvement [16,17,28,35].

The procedure was indicated in symptomatic medial or lateral unicompartmental knee OA, regardless of clinical symptoms or radiographic signs of APFJ-OA. No degree of associated patellofemoral osteoarthritis was considered a contraindication to performing the procedure. In order to perform UKA, the following conditions were required: a correctable deformity in varus or valgus stress radiographs with contralateral femorotibial compartment preservation, a varus or valgus malalignment up to 20°, preoperative flexion >90°, preoperative extension deficit ≤15°, coronal and sagittal clinical ligament sufficiency, and BMI ≤40.

Surgical protocol

A midline reduced skin incision was made (10–12 cm), followed by a mid-vastus approach for medial UKA and a lateral transretinacular approach for lateral UKA. The PFJ was assessed intraoperatively by patellar eversion and direct visualization of patellar and trochlear surfaces. In all cases, they were treated systematically, in a tailored, stepwise fashion according to its severity. Outerbridge 2 cases were treated with cartilage shaving with a scalpel and osteophyte excision, which allowed the size and shape restoration of bone structures. Outerbridge 3 and 4 also included trochlear and patellar microdrilling with 1.5 mm Kirschner wire pins. The pins used were specific for microdrilling, presenting a mark at 4 and 6 mm depth to guarantee adequate subchondral bone penetration. The exit of blood and bone marrow through the microperforation holes must be evident. Outerbridge 4 cases were treated with all the previous surgical procedures, adding lateral patellar facetectomy with saw, when necessary, usually in valgus knees (Figs. 1 and 2). Finally, lateral retinaculum was totally or partially released in all Outerbridge 3 and 4 cases to reduce lateral patellofemoral hyper pressure and achieve adequate patellar tracking. All patients received unicompartmental fixed-bearing prostheses. Image intensifiers were not used.

Statistical analysis

Python statistical software was used. Qualitative variables were expressed using frequency tables, and for quantitative variables, central tendency and dispersion measures were calculated. Mean and standard deviation were used for variables with a normal distribution (mean (SD)) and median and interquartile range for variables that did not follow a normal distribution (median [Q1-Q3]). Q1 and Q3 are the percentiles that accumulate 25% and 75% of the variable distribution respectively.

To evaluate the variable's normality, normal Q–Q plots and the Shapiro–Wilk test were used. To make comparisons between groups, an ANOVA test was used for cases where the variable's normality was verified, and
Kruskal–Wallis test was used in cases where the variable did not follow a normal distribution. Since this is a nonparametric test, it does not assume normality in the data, as opposed to the traditional ANOVA. Variances homogeneity was studied using Levene’s test. To perform post hoc comparisons, the Tukey’s test was used in cases where homogeneity of variances was observed between groups and Games–Howell test otherwise. All hypothesis tests were carried out considering a significance level of 5% and were bilateral. Finally, Kendall’s correlation coefficient is used to study the correlation between Outerbridge and preoperative malalignment degree. Implant survival was calculated at 5, 7, 9, and 12 years.

RESULTS

Between January 1999 and January 2019, a total of 33 lateral UKA and 94 bilateral medial or lateral simultaneous UKA were performed. Five lateral UKA were bilateral and simultaneous procedures; 2 patients were bilateral lateral UKA, and 1 was bilateral lateral and medial UKA. Four lateral UKA were excluded due to death not related to surgery, and eight bilateral UKA (4 patients) were lost to follow up. Finally, our sample was made up of 110 UKAs; 80 UKAs were performed in women (72.7%) with a mean age of 65.8 ± 8.4 years, a BMI of 29.2 ± 4.1, and an average follow-up of 6 years (2–19.5). Eighty-one UKAs (73.6%) were medial and 29 (26.4%) laterals; 17 knees (15.5%) had undergone previous arthroscopy.

Implants used were: 92 ZUK (Zimmer®, Warsaw, IN, USA), 11 Allegretto (Sulzer, Winterthur, Switzerland), and 7 MG (Zimmer®, Warsaw, IN, USA) prostheses. All of them were fixed bearing implants, without differences in the surgical technique.

Patellofemoral chondropathy was intraoperatively classified according to Outerbridge as grade 2 in 22 (20%) knees, grade 3 in 29 (26.4%), and grade 4 in 29 (26.4%). Four cases with grade 4 patellofemoral chondropathy (13.8%), in the lateral UKA group required lateral patellar facetectomy (Fig. 3). Radiographically, out of 81 knees with medial knee OA, 8 (9.9%) were grade 3, according to Ahlbäck classification, 35 (43.2%) were grade 4, and 38 (46.9%) were grade 5. Out of these Ahlbäck 5, 22 (57.9%) presented correctable subluxation in the coronal plane under valgus stress radiography. All lateral knee OA cases were grade 4 under the Kellgren–Lawrence classification.

All 3 groups showed a statistically significant increase in KSS scores and range of motion as compared to preoperative values. Clinical KSS increased from 50 ± 7.7 to 85.7 ± 5.2; and functional KSS from 26 ± 12.9 to 92.4 ± 8.9 (p < 0.001). Maximum flexion increased from 106.4° ± 5.6–124.9° ± 3.8, and flexion contracture went from 7° ± 2.7 to 2° ± 1.7 (p < 0.001) (Table 1). According to femorotibial alignment, the preoperative varus axis for medial UKA was corrected from 9.2° ± 2.3° to 3.6° ± 1.4° of the varus, while for lateral UKA, the valgus axis went from 12.3° ± 4.1° to 5.2° ± 3.1° of valgus (p < 0.05).

There were no differences between groups in terms of improvements in clinical KSS, flexion contracture, pain when using stairs, KSS Standard Activities and KSS Advanced Activities (p = 0.07, p = 0.37, p = 0.79, p = 0.19, and p = 0.09, respectively) (Table 2). At least one Outerbridge group differed from the others in functional KSS improvement (p = 0.04) and maximum flexion (p = 0.04) (Table 2). At functional KSS, Grade 3 was statistically superior to Grade 2 (p = 0.03), with 7.4 points difference between the mean values of both groups. The median values of the differences in postoperative and preoperative maximum flexion range from Outerbridge 2 was 5 points lower from that of Outerbridge 3 and 4 (p = 0.04 and p = 0.01 respectively) (Table 3).

The complication rate was 5.5% (n = 6 knees). All complications were minor, evolved favorably, and included: 2 mobilizations under anesthesia and 4 superficial wound problems that did not need antibiotics or...
surgery. One lateral UKA needed an arthroscopic reintervention for medial femorotibial chondropathy after 3.5 years, though prosthesis removal was not necessary. Three medial UKAs (2.7%) presented tibial aseptic loosening (one was trauma-related). Two cases required revisions to TKA and the other to a new UKA tibial component after 7, 12, and 8.6 years, respectively. One case was Outerbridge 2 (4.5%), and 2 were Outerbridge 3 (3.4%). No revision procedures were performed to treat patellofemoral symptoms. The Outerbridge 4 knees did not undergo revision procedures.

As per follow-up periods, 42% (n = 46) of prostheses had a <5-year follow-up, and none of them had undergone a revision procedure at the time of this analysis. For the rest of the cases, implant survival was 100% at 5 years (64 of 64 prostheses), 97% at 7 years (30 of 31 prostheses), 93% at 9 years (14 of 15 prostheses), and 99% at 12 years (8 of 9 prostheses). Eight prostheses had a minimum follow-up of 15 years (15–19.5 years) with no revisions in this group, and persistently good clinical and functional results over time (clinical KSS 87.6 and functional KSS 92.1). Fifty percent of the patients under study have at least 6 years of follow-up. No significant differences were observed in follow-up periods, according to Outerbridge (p = 0.89).

A statistically significant association was observed between the preoperative femorotibial malalignment degree and APFJ-OA severity. Average preoperative varus degree for the Outerbridge 4 group, 10.4° ± 2.1°, significantly differed from grade 3, 8.6° ± 2.4° (p = 0.01). However, there was no statistically significant difference between grade 3 and 4 groups and grade 2 groups with an average of 8.7° ± 1.9° (p > 0.05).

On the other hand, the average preoperative valgus for the Outerbridge 4 group, 15.2° ± 4.5°, significantly differed from grade 2 group, 9.7° ± 3.2° (p = 0.01), and grade 3 group, 11.2° ± 2.7° (p = 0.03) (Table 3).

**DISCUSSION**

The most important findings of this study were that medial or lateral UKA's clinical and functional results were not negatively affected by the APFJ-OA degree. We observed a low rate of complications, all of them minor in the acute period, unrelated to APFJ-OA severity. After an average follow-up of 6 years, the revision rate was 2.7% due to tibial component loosening in all cases. None of them occurred in Outerbridge 4 group or due to patellofemoral symptoms. Thus, medial or lateral UKA's clinical and functional parameters, complications and implant survival were not negatively affected by the APFJ-OA grade.

Multiple articles report similar outcomes with improved functional parameters after UKA regardless of APFJ-OA grade and, therefore, challenge this contraindication [3,4,24–26,28–32]. In their 10-year follow-up study, Hamilton et al. observed that preoperative anterior knee pain, radiographic APFJ-OA, and intraoperative patellar or trochlear bone exposure do not affect 10-year-old outcomes or 15-year-old implant survival, and, therefore, APFJ-OA should not be considered a UKA contraindication [27]. Although it was not evaluated in this study, there seems to be a biomechanical explanation for this phenomenon. Thein et al. concluded that patellofemoral congruence significantly improves after medial UKA [28]. This patellofemoral realignment is a
mechanical factor that seems to contribute to the low clinical impact of APFJ-OA after UKA [26,28].

Some articles describe APFJ-OA as the cause of revision procedures following fixed-bearing UKA [36]. We are not aware of any publications that mention the treatment used in the PFJ [21,22,24–28,31,32]. In our series, good and comparable results between groups without an increase in the revision rate may result from the different systematic, tailored, stepwise surgical procedures used in the PFJ based on the APFJ-OA grade. To improve patellofemoral tracking, lateral retinaculum was released routinely in all Outerbridge 3 and 4 cases, partially in genu varus and completely in genu valgus. In the most severe cases, usually genu valgus, lateral patellar facetectomy was performed. In most published studies, advanced cases of APFJ-OA were excluded and do not mention whether they perform any type of treatment or surgical procedure at the patellofemoral level. Likewise, many of them highlight that they use mini approaches and do not evert the patella, so that PFJ access and treatment become difficult [21,22,24–29,31,32,37]. In our series, we used UKA regardless of APFJ-OA severity. The most severe cases were treated with a more aggressive patellofemoral approach, and functional outcomes were obtained were comparable to knees with lower APFJ-OA grades. Even though our study did not focus on combined approaches, femorotibial UKA may be associated with other procedures such as PFJ arthroplasty, anterior tibial tunnel transfer, or patellofemoral ligament reconstruction to realign the joint [38,39].

Our series revision rate was 2.7%, consistent with reported rates from international studies [28]. No revision procedures were performed to treat patellofemoral symptoms. According to Foran et al., 2 revision surgeries out of 51 UKA were performed to treat patellofemoral symptoms [11]. However, most cases with PFJ radiographic progression were not associated with clinical symptoms [11]. After analyzing 638 medial UKAs and their relationship with the APFJ-OA degree after 1-to-7-year follow-up, Berend et al. observed a 97.9% and 93.8% implant survival in the group with and without APFJ-OA, respectively. They did not observe revisions in the more advanced APFJ-OA group, or revisions due to patellofemoral causes [40]. Similar results were published by Hamilton et al. and Lu et al. after evaluating the prosthetic survival of 805 and 3014 UKAs, respectively [24,27].

Patellofemoral chondropathy can be asymptomatic in a significant number of patients. After MRI evaluation of 230 asymptomatic adult knees, Horga et al. observed alterations in 97% of them, and the PFJ was affected in 57% of cases [41]. A prevalence greater than 40% of patellofemoral chondral lesions were observed in asymptomatic amateur and professional athletes [42,43]. In addition, there is a poor correlation between preoperative symptom location and intraoperative findings [21,22,32,37,44,45]. This was also observed in the context of TKA to decide when to perform patellar replacement [45]. Song et al., in their comparative study between patients with and without APFJ-OA with a 5.4-year follow-up, observed that preoperative anterior pain and PFJ degeneration were not related to poor outcomes after medial UKA [37], Beard et al. analyzed 100 knees, of which 54% presented anterior pain and radiographic patellofemoral degenerative changes preoperatively. After performing medial UKA, only 1 had anterior pain at 2 years [22]. Additionally, a recent comparative study assessed the usefulness of associating trochlear resurfacing with UKA in cases of trochlear full-thickness chondral lesions without observing significant differences between groups after a minimum follow-up of 7 years, concluding that these lesions can be ignored [46]. Thus, according to our experience and some publications, APFJ-OA symptoms would be caused mainly by primary femorotibial osteoarthritis, so treatment using medial or lateral UKA would lead to symptomatic improvement [21,22,32].

In this series, we used medial or lateral UKA in very advanced cases; 90.1% of varus knees were Ahlbäck 4 or 5, and 100% valgus knees were Kellgren–Lawrence 4 and 57.9% of Ahlbäck 5 knees presented correctable subluxation under valgus stress radiographs. Most patients presented patellofemoral chondropathy grades 3 and 4 (80%), associated with advanced femorotibial malalignment. We observed a statistically significant association between femorotibial malalignment degree and patellofemoral chondropathy severity, which indicates these were extreme cases of extended indication. We are not aware of any publication that includes patients with APFJ-OA as advanced as in this series. In our case, APFJ-OA was not considered a contraindication in any of its presentations, clinical or imaging. We consider the surgical technique description used for the different associated patellofemoral chondropathy degrees to be very useful, which allows extending UKA indications without compromising clinical and functional results.

This study has the limitations inherent to retrospective studies. Preoperative and postoperative patellofemoral congruence was not assessed. APFJ-OA was only evaluated intraoperatively under direct vision with no

Table 3
Average differences in functional KSS, maximum flexion, preoperative varus and valgus malalignment per Outerbridge group.

Multiple Comparison of Mean values - Differences in fKSS - Tukey

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Multiple Comparison of Mean values - Differences in flexion - Kruskal–Wallis

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Multiple Comparison of Mean values - Varus* Pre-Tukey

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KSS = 2011 Knee Society Scoring System; fKSS = functional KSS; * = degrees; Pre = preoperative; * = significant.
radiographic classification. Due to the long reference period of our analysis (1999–2019), 3 different implant brands were used. However, only fixed-bearing UKAs were implanted using the same surgical technique. Another limitation is the variable follow-up, from 2 to 19.5 years. Despite that, the protheses number included is representative for the purposes of conducting a comparative study.

CONCLUSION

Clinical and functional results, complications, and implant survival of medial or lateral UKA were not negatively affected by APFJ-OA assessed intraoperatively using the Outerbridge classification. A significant statistical association was found between the degree of preoperative femoral joint degeneration and the clinical result in medial unicompartmental knee arthroplasty. Another limitation is the variable follow-up, from 2 to 19.5 years.

Declaration of competing interest

Gabriel Gaggiotti: None.
Stefano Gaggiotti: None.
Santino Gaggiotti: None.
Julio César Ringa: None.

References

[11] Hamilton TW, Pandit HG, Lombardi AV, et al. Anterior knee pain and evidence of patellofemoral malalignment and APFJ-OA severity. We consider that APFJ-OA is not a contraindication for UKA, and the technique success depends on a systematic, tailored, stepwise approach over the PFJ.


