

Patellofemoral osteoarthritis does not influence clinical outcomes of fixed-bearing unicompartmental knee arthroplasty

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Abstract

Unicompartmental knee arthroplasty (UKA) is an ideal surgical approach in treatment of end-stage knee osteoarthritis (KOA), however, indications of UKA have been controversial, and the radiographic and symptomatic patellofemoral osteoarthritis (PFOA) are often considered as a contraindication of medial UKA. 337 fixed bearing UKAs were retrospectively recruited in our joint center between January 1, 2011 and June 30, 2020. There were 105 patients accompanied by PFOA and 232 patients have normal PF joint. International Cartilage Repair Society (ICRS) system was introduced to quantify the degeneration degree of PF joint. Oxford Knee Score (OKS), Forgotten Joint Score (FJS), Kellgren-Lawrence (K-L) classifying system and visual analogue scale (VAS) were adopted to evaluate outcomes between with and without PFOA. There was no significant difference of age, BMI, gender, OKS, FJS and other variables between PFOA and Non-PFOA group. After more than 5 years follow-up, UKA patients with or without PFOA could all achieve a satisfactory improvement of OKS, VAS and FJS score. ROM of the replaced knee increased from preoperative 110° to 130°. 74.3% (78/105) and 75.0% (174/232) patients have no change of K-L grade in PFOA and Non-PFOA group, OKS, FJS, VAS score and ROM were also comparable in all patients and no significant outcomes difference were found between two group. The presence of patellofemoral joint osteoarthritis and anterior knee pain should not be considered to be contraindications to medial fixed-bearing UKA.

Abbreviations: BMI = body mass index, FJS = Forgotten Joint Score, ICRS = International Cartilage Repair Society, K-L = Kellgren & Lawrence, KOA = knee osteoarthritis, OKS = Oxford Knee Score, PFOA = patellofemoral osteoarthritis, ROM = range of motion, TKA = total knee arthroplasty, UKA = unicompartmental knee arthroplasty, VAS = visual analogue scale.

Keywords: fixed-bearing, FJS, K-L classification, OKS, patellofemoral joint, UKA

1. Introduction

With the aggravation of aging population, incidence of knee osteoarthritis (KOA) shows an increasing trend and this degenerative disease has been recognized as a global public health problem. In China, prevalence of KOA in people aged 65 years or older is 8.1%, of whom more than 30% of patients have only isolated medial compartmental degeneration and destruction.^[1]

Unicompartmental knee arthroplasty (UKA) and total knee arthroplasty (TKA) are ideal surgical approaches in treatment of end-stage KOA, and UKA is a less invasive alternative to TKA for the treatment of anterior medial osteoarthritis, as it preserves bone stock and cruciate ligaments while providing better functional score and range of motion. UKA also possess the preponderance of shorten rehabilitation time, lower incidence

of complication and satisfactory clinical outcomes, therefore, UKA has gained its popularity recent years.^[2,3] However, indications of UKA have been controversial, and the radiographic and symptomatic patellofemoral osteoarthritis (PFOA) are often considered as a contraindication of medial UKA. Previous studies reported that one of main reason for UKA failure was the progressive PFOA, and most of these patients revised to TKA.^[4-6] However, recently some authors advocated that anterior knee pain (AKP) and patellofemoral degeneration have no relationship with a compromised postoperative outcome of UKA, and PFOA is even recommended to be ignored in patient selection.^[7,8]

Scholars reported that half of patients who accompanied by a painful knee have patellofemoral involvement, cadaverous studies also confirmed that PFOA was founded in 79% individuals in

This study was supported by the Health Commission of Hebei Province (no. 20210429).

The authors have no conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

This material has not been published and is not under consideration elsewhere.

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How to cite this article: Ji X, Li H, Yang S, Zhao M, Liu N, Cheng Y, Huang X. Patellofemoral osteoarthritis does not influence clinical outcomes of fixed-bearing unicompartmental knee arthroplasty. *Medicine* 2022;101:45(e31409).

Received: 19 July 2022 / Received in final form: 28 September 2022 / Accepted: 29 September 2022

<http://dx.doi.org/10.1097/MD.00000000000031409>

people aged 65 years, and more than 50% of patients undergoing meniscectomy have evidence of chondromalacia, thus, PFOA is quite common in elderly person. Considering UKA is the main treatment option for isolated medial/lateral compartment KOA, it is of great significance to explore whether patellofemoral joint degeneration a contraindication to UKA and the influence of PFOA on the efficacy of UKA in the treatment of geriatric KOA.

However, currently, most studies evaluated the relationship between PFOA and outcome scores and survivorship of mobile-bearing UKA, few researches concentrated on PFOA in fixed-bearing UKA designs. Therefore, we conducted this study with the objective to compare clinical outcomes of fixed-bearing UKA in patients with and without PFOA; and evaluate the correlation of chondral lesion grade and anterior pain in the PFOA group patients.

2. Materials and Methods

2.1. Study design

After approved by institutional review board of our hospital, 337 fixed bearing UKAs were retrospectively recruited in our joint center between January 1, 2011 and June 30, 2020. Intraoperative assessment of the patellofemoral joint cartilage status for each knee was completed by two senior surgeons, and the International Cartilage Repair Society (ICRS) classification system (ICRS 0, no cartilage lesion; I, a normal contour with superficial lesions, fissures, cracks, and indentations; II, involvement of < 50 % of the entire cartilage thickness; III, involvement of > 50 % of the entire cartilage thickness; IV, full-thickness cartilage loss) and indentations was introduced to quantify the degeneration degree of PF joint. There were 105 (31.2%) patients accompanied by PFOA at least moderate severity (ICRS grade III–IV) and 232 (68.8%) patients diagnosed with mild patellofemoral OA (ICRS grade 0–II) and without clinical symptoms or sign.

The inclusion criteria were: patients diagnosed with medial compartmental osteoarthritis and Kellgren & Lawrence (K-L) classification^[9] grading II–IV (K-L II, anteroposterior (AP) weight-bearing radiograph shows definite osteophytes and possible joint space narrowing; III, multiple osteophytes, definite joint space narrowing, sclerosis, possible bony deformity; IV, large osteophytes, marked joint space narrowing, severe sclerosis, and definite bony deformity); range of motion (ROM) of the knee joint $\geq 90^\circ$; varus deformity of lower limb $\leq 15^\circ$ on the AP weight-bearing radiograph; flexion contracture of knee joint $\leq 15^\circ$; the anterior and posterior cruciate ligaments and the medial and lateral collateral ligaments are structurally intact; and patients with complete perioperative radiographic data and medical records. The exclusion criteria were: patients with inflammatory arthritis (villonodular synovitis, rheumatoid arthritis, etc.); and severe chondromalacia patellae; pre- and intraoperative ICRS classification data missing; patients underwent revised UKA in our center; patients with postoperative surgical site infection, periprosthetic fracture, aseptic loosening of the prosthesis and other complications affecting rehabilitation exercise and functional evaluation; and patients who lost follow-up for Change of residential address, telephone number and other contact information.

2.2. Surgical technique

All the surgical procedures were performed by two senior surgeons with standard and homogenized perioperative management protocols. Patients were in a supine position, and a tourniquet was applied for all UKAs. The approach was a minimally invasive surgical incision from the superior pole of medial edge of patella and then extending downward to knee joint space. Access was established with limited anteromedial release

and partial resection of the fat pad. The status of tibiofemoral joint and PFOA was assessed intraoperatively according to ICRS classification. Bony resections were performed with standard instrumentation as provided by the manufacturer. After the bone surfaces were prepared, femoral and tibial prosthesis test molds were placed to test whether the flexion and extension space was balanced. Once an ideal ROM and stability of the knee were obtained the femoral and then tibial components were cemented. Patients were encouraged to carry out full weight-bearing rehabilitation exercise the day after operation.

2.3. Outcome measures

The postoperative clinical outcomes evaluation was conducted by a well-trained investigator. We assessed clinical and functional outcomes of the two groups using the following subjective and objective measurement: Oxford Knee Score (OKS), which constitutes a 12-item questionnaire and scores of each item run from 1 to 5 and minimum is the best score, specifically designed and developed to assess function and pain before and after UKA; Forgotten Joint Score (FJS), this questionnaire including 12 items with scores ranging from 0 to 100, was introduced to evaluate patient's awareness of an artificial joint during various daily life activities and a higher score indicating a better clinical outcome. K-L classifying system was adopted to assess PFOA progression in the Merchant's view and anterior knee pain visual analogue scale (VAS) were recorded respectively at final follow up time.

2.4. Statistical analysis

The continuous data were expressed as mean \pm SD, Mann-Whitney *U* test was used for non-normally distributed continuous variables, *t* test for normally distributed variables and the Chi square (χ^2) test for categorical data. Values of $P < .05$ were considered to indicate a significant difference. Statistical procedures were performed by SPSS 23.0 software package (SPSS Inc., Chicago, IL).

3. Results

There were 103 male and 234 female in this study, the 337 patients had a mean age of 67.1 years. Obviously, body mass index (BMI) of all the UKAs participant was larger than 24 kg/m², and according to the Chinese reference criteria they were all belong to overweight or obesity group (24–27.9, overweight; 28–31.9, obesity; ≥ 32 , morbid obesity). 298 (88.4%) patients underwent unilateral UKA, 194 cases of right side and 104 for left knee, the other 39 (11.6%) patients received bilateral arthroplasty. ASA scoring system was introduced by anesthesiologists in clinical practice to evaluate the general physiological status and anesthesia or operation tolerance of patients undergoing surgery. In the present study, majority of patients had ASA scores ranging from 2 to 3.

Demographic information and other baseline characteristics were summarized in Table 1, and there was no significant difference of age, BMI, gender and other variables between PFOA and Non-PFOA group. Table 2 showed preoperative KOA related indicators for the two groups. AP weight-bearing radiograph showed 18.1% versus 19.8%, 51.4% versus 58.6% and 30.5% versus 21.6% of KOA graded K-L II, III and IV for PFOA and Non-PFOA group respectively. Preoperative OKS and FJS score between patients with and without patellofemoral joint arthritis were not significantly different (44.6 ± 5.7 vs 43.9 ± 5.1 ; 16.2 ± 10.2 vs 15.7 ± 11.8), moreover, ROM of the knee for patients in the two groups can reach almost 110° . In general, the statistical results demonstrated that preoperative knee functional status, degeneration degree of PF joint and ability of daily activity between patients with and without PFOA were homogeneously ($P > .05$).

Table 1
Comparison of baseline characteristics between PFOA and non-PFOA group.

| Variables | PFOA group (n = 105) | Non-PFOA group (n = 232) | P value |
|--------------------------|----------------------|--------------------------|---------|
| Age | 66.9 ± 5.3 | 67.2 ± 5.5 | n.s. |
| Gender | | | |
| Male | 34 | 69 | n.s. |
| Female | 71 | 163 | |
| BMI (kg/m ²) | 27.3 ± 2.9 | 27.6 ± 3.1 | n.s. |
| Side (%) | | | |
| Right | 59 (56.2) | 135 (58.2) | n.s. |
| Left | 35 (33.3) | 69 (29.7) | |
| Bilateral | 11 (10.5) | 28 (12.1) | |
| ASA Score (mean) | 2.4 ± 0.5 | 2.5 ± 0.6 | n.s. |
| Follow-up time (yr) | 5.8 ± 3.5 | 5.6 ± 3.2 | n.s. |

ASA = American Society of Anesthesiologists, BMI = body mass index, PFOA = patellofemoral osteoarthritis.
 n.s. *P* > .05.

Table 2
Preoperative characteristics of KOA for patients between PFOA and Non-PFOA group.

| Variables | PFOA group (n = 105) | Non-PFOA group (n = 232) | P value |
|---------------|----------------------|--------------------------|---------|
| OKS | 44.6 ± 5.7 | 43.9 ± 5.1 | n.s. |
| FJS | 16.2 ± 10.2 | 15.7 ± 11.8 | n.s. |
| K-L grade (%) | | | |
| II | 19 (18.1) | 46 (19.8) | n.s. |
| III | 54 (51.4) | 136 (58.6) | |
| IV | 32 (30.5) | 50 (21.6) | |
| ROM (°) | 112.6 ± 10.7 | 115.0 ± 11.4 | n.s. |

FJS = Forgotten Joint Score; K-L, Kellgren & Lawrence classification, KOA = knee osteoarthritis, OKS = Oxford Knee Score, PFOA = patellofemoral osteoarthritis, ROM = range of motion.

Table 3
Comparison of clinical outcomes and radiographic evaluation of PFOA progressions for the two groups at final follow-up.

| Variables | PFOA group (n = 105) | Non-PFOA group (n = 232) | P value |
|-------------------------|----------------------|--------------------------|---------|
| OKS | 21.5 ± 4.2 | 19.6 ± 4.0 | n.s. |
| FJS | 75.0 ± 25.8 | 75.7 ± 24.9 | n.s. |
| VAS | 1.8 ± 0.39 | 1.6 ± 0.43 | |
| Change of K-L grade (%) | | | |
| 0 | 78 (74.3) | 174 (75.0) | n.s. |
| 1 | 15 (14.3) | 30 (12.9) | |
| 2 | 12 (11.4) | 28 (12.1) | |
| ROM (°) | 137.0 ± 0.37 | 137.5 ± 4.1 | n.s. |

FJS = forgotten joint score, K-L, Kellgren & Lawrence classification, OKS = oxford knee score, PFOA = patellofemoral osteoarthritis, ROM = range of motion, VAS = visual analogue scale.

After more than 5 years follow-up period, UKA patients with or without PFOA can achieve a satisfactory improvement of OKS and FJS score and mean anterior knee pain VAS score for PFOA and Non-PFOA group were 1.8 and 1.6 respectively. ROM of the replaced knee joint increased from preoperative 110° to almost 130° which indicating a better knee activity that guaranteed more daily life. As for progression of patellofemoral arthritis, there were 74.3% (78/105) and 75.0% (174/232) patients have no change of K-L grade in the patellofemoral joint postoperatively in PFOA and Non-PFOA group, and 11.4% (12/105) and 12.1% (28/232) cases changed two grades for the two group respectively (Table 3). OKS score, FJS score, VAS score and ROM were also analyzed with respect to cartilage lesion grade in all patients and no significant difference for these variables were found in different ICRS grades patients (Table 4).

4. Discussion

Patellofemoral joint osteoarthritis is one of the most common disabling diseases, typical clinical manifestations of PFOA are

anterior knee pain, joint swelling, stiffness, etc., and PFOA often accompanied by limited motion of squatting, running, stair climbing, lateral subluxation of patella, quadriceps disuse atrophy, which will inevitably comprise the quality of life for patients. Under the condition of reasonable indication selection, UKA is an ideal surgical method for the treatment of degenerative knee osteoarthritis. In China, an estimated 580,000 total hip and knee arthroplasty were carried out in 2017, however, epidemiologic study showed 54.7% end-stage KOAs were suitable for medial or lateral UKA. Hence, it is of great clinical significance to explore the effect of patellofemoral joint degeneration on the outcomes of UKA for geriatric patients. In the present study, we have demonstrated that status of PF joint could be neglected and no different clinical outcomes between patients with or without PFOA who underwent fixed-bearing UKA was observed.

Interrelation of UKA and PFOA was identified by many previous researches, and many scholars advocated that PFOA should be a contraindication when surgeons offered treatment algorithm. Tyler et al demonstrated that 63.5% of fixed-bearing UKA knees

Table 4
Comparison of clinical outcomes among UKA patients classified by ICRS grades.

| Grade | Cases (n = 337, %) | OKS | FJS | ROM (°) | VAS |
|--------|--------------------|------------|-------------|-------------|------------|
| 0 | 26 (7.7) | 19.7 ± 3.8 | 77.4 ± 25.1 | 139.9 ± 4.3 | 1.4 ± 0.29 |
| I | 59 (17.5) | 20.2 ± 4.1 | 76.9 ± 26.0 | 136.4 ± 3.9 | 1.5 ± 0.31 |
| II | 147 (43.6) | 19.3 ± 4.0 | 74.8 ± 24.6 | 137.2 ± 4.1 | 1.7 ± 0.50 |
| III | 90 (26.7) | 21.4 ± 3.9 | 75.3 ± 26.3 | 136.7 ± 3.7 | 1.8 ± 0.36 |
| IV | 15 (4.5) | 21.7 ± 4.4 | 73.5 ± 24.7 | 138.0 ± 4.1 | 1.8 ± 0.42 |
| Pvalue | – | n.s. | n.s. | n.s. | n.s. |

FJS = forgotten joint score, ICRS = International Cartilage Repair Society, OKS = oxford knee score, ROM = range of motion, UKA = unicompartmental knee arthroplasty, VAS = visual analogue scale. n.s. $P > .05$.

had postoperative progression of patellofemoral compartment arthritis: 10 to grade 1, 14 to grade 2, 7 to grade 3, and 2 to grade 4, at a minimum 4-year radiographic follow-up.^[10] However, some studies found that main reason for the revision of UKA to TKA was progression of osteoarthritis in the patellofemoral joint.^[11,12] Berger et al^[5] conducted a study in 2004, 59 patients had isolated unicompartmental osteoarthritis without symptoms or radiographic evidence of PFOA were recruited. Patellofemoral symptoms were present in 1.6% of patients at 10 years, and this proportion increased markedly to 10% at 15 years and 10% patients had moderate or severe patellofemoral symptoms, moreover, two patients underwent revised TKA at 7 and 11 years for progressive patellofemoral degeneration. Even impingement of the femoral component on the patella was reported in patients who received unicompartmental knee arthroplasty.^[13] However, most of these investigations were published earlier and sample size of those studies was relatively small.

Conversely, some recent studies have concluded that the status of patellofemoral joint does not comprise outcomes of UKA. Abdulkarim et al^[14] have prospectively gathered 147 consecutive Repicci II UKAs, and they found IKS (International knee society) scores, alignment and flexion between PFOA and normal PF compartment were comparable, meanwhile, measured extension was significantly increased postoperatively in those patients with minimal or no PF joint degenerative disease. Long term follow-up results on the relationship between PFOA and UKA have also been established by Asian scholar, Lim et al^[15] and his colleagues have assessed 10-years functional outcome and survivorship in patients with radiographic evidence of PFOA and underwent fixed-bearing UKA. Normal and patellofemoral group patients had similar OKS and KSS scores at final follow-up, and there were 2.4% and 5.4% revision were observed in patients with and without PFOA respectively, moreover, all the revision was due to progression of contralateral compartment rather than patellofemoral osteoarthritis. Similar result was also reported in the lateral unicompartmental knee arthroplasty, Burger et al^[16] et al have conducted an investigation on the impact of patellofemoral joint degeneration and malalignment on patient-reported outcomes after lateral UKA. They retrospectively reviewed a consecutive series of 130 (140 knees) patients who received robotic arm-assisted fixed-bearing lateral UKA, after mean 4.1 years follow-up, good Kujala scores were collected and the presence of mild to moderate preoperative PFOA had no impact on the effectiveness of UKA, moreover, lateral UKA could result in improvements to patellofemoral alignment. Meanwhile, biomechanical study also provided evidence that degenerative changes in the PF joint should not be considered an absolute contraindication of UKA.^[17]

The preoperative anterior knee pain followed by medial patellofemoral osteoarthritis is usually caused by degeneration of the medial compartment of the knee joint and the impact of osteophytes. For a congruent patellofemoral articulation, the patella track centrally in the trochlear groove. UKA can correct the preoperative varus deformity, movement trajectory of the patella typically returned to normal with the restoration of the

alignment of lower limb, subsequently, medial and lateral compressive stress of the PF joint tends to balance, and the pressure transmitted from the quadriceps to the patella decreased during flexion and extension of knee. This may be the biomechanical mechanism of the absence of significant degeneration of PFOA after UKA and even the relief of anterior knee pain. Moreover, it is reported that incidence of PFOA was 79% in 100 randomly selected cadavers who aged more than 65 years older, therefore, PFOA should be asymptomatic in most aged patients and would not compromise the clinical outcome of UKA, and anterior knee pain is likely to be resolved after UKA.^[17]

There are some limitations for the present study. Firstly, the single center and retrospective analysis design leads to some selection bias of the data; secondly, all UKA procedures were performed by two senior surgeons, and possible impact of surgical techniques on clinical outcome could not be eliminated; what's more, due to the long-time span of patients' inclusion, surgical techniques were improved in the late stages, which may have an impact on data analysis. Nevertheless, we believe that our study provides a reasonable assessment of the effect of patellofemoral degeneration on clinical outcomes for patients underwent fixed-bearing UKA.

In conclusion, based on the postoperative functional outcomes score, we have demonstrated that the presence of patellofemoral joint osteoarthritis and anterior knee pain should not be considered to be a contraindication to medial fixed-bearing UKA.

Author contributions

XH designed the study. HL and SY searched relevant studies. MZ, NL, and YC analyzed and interpreted the data. XJ and XH wrote the manuscript.

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