CLINICAL ARTICLE

# Joint Awareness after Patellofemoral Arthroplasty Evaluated with the Forgotten Joint Score: A Comparison Study

Wei Lin, MD, Yike Dai, MD, Conglei Dong, MD, Kang Piao, MD, Kuo Hao, MD, Fei Wang, MD

*Third Hospital of Hebei Medical University, Shijiazhuang, China*

**Objective:** The aim of the present study was to compare the forgotten joint score (FJS) in patients with isolated patellofemoral osteoarthritis who underwent patellofemoral arthroplasty (PFA) *versus* those who underwent total knee arthroplasty (TKA) and to analyze the predictors of the FJS after PFA.

**Methods:** From January 2014 to December 2017, a retrospective cohort study of 56 consecutive patients with isolated patellofemoral osteoarthritis underwent PFA and were included in the PFA group. The patients in the PFA group were matched in a 1:1 ratio based on age, sex, body mass index (BMI), and follow-up duration; 56 patients with isolated patellofemoral osteoarthritis underwent cruciate-retaining TKA (TKA group). The FJS, range of motion of the knee, and Knee Society Score were assessed at 1 and 3 years postoperatively. In addition, the associations between the potential influencing factors (age, sex, BMI, and preoperative Iwano score of the patellofemoral joint) and the FJS were analyzed using multiple linear regression in the PFA group.

**Results:** There were no significant differences between the PFA and TKA groups regarding age ($P = 0.316$), sex ($P = 0.832$), BMI ($P = 0.447$), and follow-up duration ($P = 0.625$). Postoperatively, the range of motion of the knee and Knee Society Score was significantly higher in the PFA group than the TKA group at both follow-up points ($P < 0.05$). The PFA group had a significantly higher mean FJS than the TKA group at 1 year postoperatively ($62.9 \pm 12.3$ *vs* $54.1 \pm 14.2$, $P = 0.034$) and 3 years postoperatively ($63.3 \pm 14.1$ *vs* $55.6 \pm 16.4$, $P = 0.042$). In the PFA group, multiple linear regression analysis showed that older age was positively correlated with the FJS, while a higher BMI was negatively correlated with the FJS.

**Conclusion:** The patients with isolated patellofemoral osteoarthritis who underwent PFA were more likely to forget the artificial joint and, consequently, may experience a higher degree of satisfaction. In addition, we identified two preoperative patient-related factors (age and BMI) that may predict the FJS after PFA, which might help in chosing the most appropriate operation.

**Key words:** Forgotten joint score; Patellofemoral arthroplasty; Patellofemoral osteoarthritis; Total knee arthroplasty

## Introduction

Osteoarthritis (OA) is a common joint disease in older adults that often leads to disability; for patients with symptomatic knee arthritis, the risk of lifetime disability is 50%[1]. Isolated patellofemoral OA (PFOA) is characterized by anterior knee pain, stiffness, and impaired function[2]. Epidemiological studies have shown that PFOA affects approximately 10% of people older than 40 years[3]. In people older than 55 years with symptoms of knee arthritis, the incidence of isolated degeneration of the patellofemoral joint is reportedly 11% and 24% in men and women, respectively[4]. These patients with isolated degeneration of the patellofemoral joint are usually relatively young, active, and have high knee function requirements[5]. The wear of end-

Address for correspondence Fei Wang, Department of Orthopaedic Surgery, Third Hospital of Hebei Medical University, No. 139 Ziqiang Road, Shijiazhuang, Hebei, China 050051 Tel: +86-311-88602013; Fax: 0311-88602013; Email: doctorlinw@163.com

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stage PFOA often involved the femoral trochlea, patellar facet, or both. The pathological factors of patellofemoral articular degeneration are various. Besides the joint diseases related to aging and trauma, trochlear dysplasia is also an inducing factor[6]. Femoral anteversion and patellar instability also aggravate the progress of PFOA[7]. Autogenous chondrocyte implantation, bone and/or soft tissue reconstruction, and other operations may alleviate the early symptoms and delay the progress of PFOA, but the long-term outcomes are poor[8]. Therefore, the main surgical intervention for isolated PFOA is arthroplasty, especially in the end stage[9]. However, it remains controversial whether patellofemoral arthroplasty (PFA) or total knee arthroplasty (TKA) should be selected to treat isolated PFOA.

More than 85% of patients with TKA obtain good postoperative results, but the result is not always as expected[10]. In contrast, PFA retains the intact tibiofemoral bone, and, thus, revision after failed PFA entails a simpler and faster recovery compared with that for failed TKA[11]. The development of anatomical PFA prosthesis designs has resulted in improved clinical results, patient satisfaction, and prosthesis survival rate[12]. Although PFA has existed for 30 years, it is still controversial because of the high failure rate in the early design of the trochlear prosthesis[13]. The improved second generation of PFA, such as Zimmer PFA[14], has achieved better clinical results and higher prosthesis survival. We found that the new implant jigs developed for this prosthesis were easy to use, accurate, and reproducible. No complications related to the design of the prosthesis occurred on the trochlear or patellar side. In general, early failure of all PFA implants is related to patellar instability or patellar maltracking, while long-term failure is related to the progression of tibiofemoral OA[15]. Errors in surgical techniques are also one of the causes of early failure of PFA [16]. Similar results can be found in our study. However, in all of the PFA revisions, the conversion was very simple and was performed using non-stemmed TKA implant. For the second generation of PFA implants, other authors have noted the ease of conversion to TKA[17, 18].

Because of the reported advantages of PFA, there is interest in comparing the results of PFA and TKA, especially regarding patients' perceptions of functional outcomes. Historically, the outcome of arthroplasty has been assessed based on the implant survival rate, clinical outcome indicators evaluated by doctors, incidence of complications, and radiologic parameters. Although these outcomes are important, there was no information on patients' perception of the results. Consequently, patient-reported outcome measures (PROM) were established and clinically validated. However, due to the heterogeneity of the PROM scores, the reliability of current results compared with previously published data is questionable[5]; in addition, these PROM are susceptible to the ceiling effect[19], especially in young patients. The goal of arthroplasty is for patients to forget that they have an artificial joint while performing activities of daily living, which not only reflects patient satisfaction but also reflects the surgical skill of the surgeon[20, 21]. The forgotten joint score (FJS) is a recently introduced PROM that is not limited by the ceiling effect[22].

It is well known that final outcome scores after arthroplasty are related to pre-intervention data. Therefore, it is important to determine the predictors of the outcome after PFA, as this information helps patients to obtain accurate expectations before surgery and also allows surgeons to risk-stratify patients regarding the outcomes while identifying modifiable factors or interventions that may improve the results. Few studies have evaluated the outcome predictors for PFA, and it is unclear whether there are predictors of forgotten joints after PFA.

The purpose of the present study was to: (i) compare the FJS of patients with isolated PFOA who underwent PFA *versus* those who underwent TKA to assess the joint awareness in the two groups at 1 and 3 years postoperatively; and (ii) identify the associations between the underlying influencing factors (age, sex, body mass index [BMI], and preoperative Iwano score[23]of the patellofemoral joint) and the FJS after PFA.

## Methods

With the approval of the Institutional Review Committee, we performed a retrospective case-matched study of 56 consecutive patients with isolated PFOA who underwent PFA from January 2014 to December 2017 (PFA group). The patients in the PFA group were matched in a 1:1 ratio based on age, sex, BMI, and follow-up duration, with 56 patients with isolated PFOA who underwent cruciate-retaining TKA (TKA group). All operations were performed in our center by the same senior orthopaedic surgeon using the same surgical techniques.

The inclusion criteria were: (i) patients with isolated PFOA; (ii) bone-on-bone contact at the patellofemoral joint on the skyline view and preserved joint lines of the tibiofemoral joint on the positive weight-bearing view of the knee; and (iii) the control group, for patients diagnosed with isolated PFOA who underwent cruciate-retaining TKA with follow-up time of at least 2 years.

The exclusion criteria were: (i) patients with major tibiofemoral OA[24]; (ii) simultaneous or staged bilateral PFA; and (iii) a history of surgery on the surgical knee.

### *Surgical Technique*

In both groups, the arthroplasty was performed through a standard medial parapatellar approach, as described by Odgaard *et al.*[25] However, in all cases, the patellar prosthesis was not replaced and the patellar surface was only reshaped to fit the prosthesis. All PFA used the Zimmer Gender Solutions PFA prosthesis (onlay, Zimmer, Warsaw, IN, USA), while all TKA used the cruciate-retaining mobile bearing implant (LINK, Germany, Gemini MK II or Smith & Nephew, USA). All patients received the same postoperative analgesia and participated in the same rehabilitation programs.

### *Outcome Evaluation*

*Range of Motion*

Assessments were performed by a senior orthopaedic surgeon who did not attend the treatments. The range of motion (ROM) of the knee was assessed preoperatively at a minimum of 1 year and 3 years postoperatively. The ROM refers to the maximum radian that can be achieved during joint movement, which is one of the indexes to evaluate the range and degree of joint motion function damage. The ROM was measured with the protractor.

*Knee Society Score*

The Knee Society Score (KSS; including clinical and functional scores of the knee)[26] was assessed preoperatively and at a minimum of 1 year and 3 years postoperatively. All patients in our study were contacted by phone to complete the KSS questionnaire. The dual assessment system eliminates the problem of decreased knee score associated with the patient's infirmity.

*Forgotten Joint Score*

The FJS was assessed at a minimum of 1 year and 3 years postoperatively. The FJS includes 12 different questions that reflect the ability of the patient to forget the artificial joint. The responses are graded from 0 to 100, with the score increasing in accordance with how natural or "forgotten" the patient perceives the artificial joint to be.

*Radiographs*

During follow up, X-rays, including anteroposterior, lateral, and skyline views of the patellofemoral arthroplasty, were taken to assess the tibiofemoral OA progression and implant loosening.

### *Statistical Analysis*

All data are presented as numbers, percentages, means, and standard deviations. The normality of continuous variables was checked with the Shapiro–Wilks test. If the data were normally distributed, the two groups were compared using the Student *t*-test; otherwise a non-parametric test was selected. Categorical variables were checked with the $\chi^2$-test or Fisher's exact test. Age, sex, BMI, and Iwano grade (III, IV) were analyzed with Pearson correlation and multiple linear regression to identify the potential risk factors for a low FJS. Data were analyzed with SPSS 19.0 (SPSS, Chicago, Illinois, USA). Differences were considered statistically significant at $P < 0.05$.

## Results

### *Basic Patient Data*

There were no significant differences between the PFA and TKA groups regarding age ($P = 0.316$), sex ($P = 0.832$), BMI ($P = 0.447$), and follow-up duration ($P = 0.625$) (Table 1). No reoperation or revision surgeries were performed during follow-up. There was no knee extension delay or persistent pain in all patients.

### *Range of Motion*

Preoperatively, there were no significant differences between the two groups regarding the ROM ($P > 0.05$). However, there were significant differences between the two groups in the ROM at 1 year postoperatively ($106.6 \pm 12.7$ *vs* $100.2 \pm 11.5$, $P = 0.037$) and 3 years postoperatively ($118.2 \pm 11.2$ *vs* $107.7 \pm 12.5$, $P = 0.022$) (Table 2).

### *Knee Society Score*

Preoperatively, there were no significant differences between the two groups regarding the KSS ($P > 0.05$). However, at the follow-up, there were significant differences between the two groups in the knee clinical score at 1 year postoperatively ($79.8 \pm 13.2$ *vs* $75.7 \pm 12.6$, $P = 0.043$) and 3 years postoperatively ($84.1 \pm 10.6$ *vs* $84.1 \pm 10.6$, $P = 0.036$) and the knee functional score at 1 year postoperatively ($80.1 \pm 10.6$ *vs* $73.2 \pm 12.4$, $P = 0.024$) and 3 years postoperatively ($86.4 \pm 8.3$ *vs* $79.9 \pm 10.6$, $P = 0.041$) (Table 2).

### *Forgotten Joint Score*

The PFA group had a significantly higher mean FJS than the TKA group at 1 year postoperatively ($62.9 \pm 12.3$ *vs* $54.1 \pm 14.2$, $P = 0.034$) and 3 years postoperatively ($63.3 \pm 14.1$ *vs* $55.6 \pm 16.4$, $P = 0.042$). There was no significant difference between the FJS at 1 year postoperatively *versus* 3 years postoperatively within either group ($P > 0.05$) (Table 3). The multiple linear regression analysis results are summarized in Table 4. The FJS was positively correlated with older age but negatively correlated with higher BMI.

### *Radiographic Outcome*

During the follow-up period, there were no clinical or radiological signs of prosthetic loosening in either group (Figs 1 and 2).

## Discussion

The most important finding of the present study was that patients with isolated PFOA who underwent PFA had lower awareness of the artificial joint and better functional recovery than patients with isolated PFOA who underwent TKA. In addition, we identified two preoperative patient-related factors (age and BMI) that may predict patients' ability to forget the joint after PFA. Few studies have investigated the joint awareness after PFA compared with that after TKA.

### *Patellofemoral Arthroplasty Has Positive Effects on Forgotten Joint Score*

The FJS is a newly developed scoring system that is often used to measure patients' ability to forget the joint replacement or joint awareness in daily life. During daily activities, people are often not aware of their healthy joints, and so the lack of awareness of normal healthy joints (forgotten joints)

**TABLE 1 Patient demographics in the two groups**

| | PFA group ($n$ = 56) | TKA group ($n$ = 56) | $P$-value |
|---|---|---|---|
| Age (years) | 59.2 ± 6.4 | 58.6 ± 6.5 | 0.316 |
| Sex, $n$ (%) | | | 0.832 |
| Female | 40 (71.4%) | 41 (73.3%) | - |
| Male | 16 (28.6%) | 15 (26.7%) | - |
| BMI (kg/m$^2$) | 26.8 ± 3.2 | 27 ± 3.6 | 0.447 |
| Iwano grade, $n$ (%) | | | 0.838 |
| Iwano grade (III) | 15 (26.8%) | 14 (25%) | - |
| Iwano grade (IV) | 41 (73.2%) | 42 (75%) | - |
| Follow-up (years) | 3.4 ± 0.3 | 3.5 ± 0.4 | 0.625 |

Data are presented as the mean ± standard deviation or number (%); BMI, body mass index; PFA, patellofemoral arthroplasty; TKA, total knee arthroplasty.

is used as the standard to assess the outcomes after arthroplasty. This "forgotten joint" state integrates variables such as activity levels, patient expectations, and psychosocial factors, and eliminates any substantial subjective barriers such as instability, stiffness, or pain. The FJS has been proven to be a simple, tangible, and valuable parameter with which to evaluate the subjective joint function after knee replacement[21, 22, 27, 28].

Few studies have used the FJS to evaluate the postoperative results and patient satisfaction after PFA and TKA. Thienpont *et al.*[21] found that patients who underwent PFA had a significantly lower FJS than those who underwent TKA. However, in the present study, patients with isolated PFOA who underwent PFA achieved a significantly higher FJS than patients who underwent TKA. This discrepancy between studies may be due to our study having a longer follow-up duration and following strict indications so that PFA was only performed in patients with isolated PFOA.

While the FJS has rarely been used in the literature, many PROM have been used to evaluate patients' postoperative status. A previous study comparing the Tegner activity scale and the KSS of 23 patients with PFA and 22 patients with TKA found that PFA achieved similar analgesic results to TKA but achieved significantly better function and recovery[5]. This corresponds to the present findings that patients who underwent PFA achieved a significantly higher KSS and had a better functional recovery than those who underwent TKA.

A retrospective case-matched cohort study compared the Tegner activity scale, Knee injury and OA scores, and the University of California Los Angeles scores for 23 patients who underwent PFA and 23 who underwent TKA, and showed that although TKA performed better in 1-year functional outcomes, TKA and PFA performed equally well at the 2-year follow-up[6]. This suggests that these PROM scores do not assess top-end differences after arthroplasty, as the ceiling effect is achieved; however, this ceiling effect does not limit the FJS. Behrend *et al.*[22] found that the average FJS was 82.5 rather than 100, even in healthy people, indicating that the FJS accurately distinguishes the outcomes in the high-functioning population after joint replacement. Thus, the FJS was used as a PROM after PFA in the present study.

### *Underlying Influencing Factors of Forgotten Joint Score*

Another significant finding of the present study was the predictive value of preoperative age for the final FJS. Older age was a positive predictor of an excellent outcome. This interesting finding corresponds to a previous study that reported

**TABLE 2 The ROM and Knee Society Score in the two groups**

| | PFA | TKA | $P$-value |
|---|---|---|---|
| Range of motion | | | |
| Preoperation | 94.2 ± 8.1 | 92.1 ± 9.7 | 0.631 |
| 1 year | 101.6 ± 12.7 | 100.2 ± 11.5 | 0.037 |
| 3 year | 118.2 ± 11.2 | 107.7 ± 12.5 | 0.022 |
| Knee clinical score | | | |
| Preoperation | 36.1 ± 12.1 | 36.9 ± 11.4 | 0.424 |
| 1 year | 79.8 ± 13.2 | 75.7 ± 12.6 | 0.043 |
| 3 year | 84.1 ± 10.6 | 79.3 ± 11.5 | 0.036 |
| Knee functional score | | | |
| Preoperation | 32.3 ± 16.2 | 33.7 ± 12.5 | 0.397 |
| 1 year | 80.1 ± 10.6 | 73.2 ± 12.4 | 0.024 |
| 3 year | 86.4 ± 8.3 | 79.9 ± 10.6 | 0.041 |

Data are presented as the mean ± standard deviation. PFA, patellofemoral arthroplasty; TKA, total knee arthroplasty.

**TABLE 3 Forgotten joint score (FJCS) in the two groups**

| FJS | 1 year | 3 year | $P$-value |
|---|---|---|---|
| PFA group | 62.9 ± 12.3 | 63.3 ± 14.1 | 0.413 |
| TKA group | 54.1 ± 14.2 | 55.6 ± 16.4 | 0.362 |
| $P$-value | 0.034 | 0.042 | - |

Data are presented as the mean ± standard deviation.; FJS, forgotten joint score; PFA, patellofemoral arthroplasty; ROM, range of motion; TKA, total knee arthroplasty.; PFA, patellofemoral arthroplasty; TKA, total knee arthroplasty.

**TABLE 4 Multiple linear regression analysis results**

| | 1 year | | | 3 year | | |
|---|---|---|---|---|---|---|
| | Coefficient | 95% CI | *P*-value | Coefficient | 95% CI | *P*-value |
| Age | 0.303 | 0.157 to 0.448 | <0.001 | 0.535 | 0.389 to 0.681 | <0.001 |
| BMI | −0.906 | −1.213 to −0.599 | <0.001 | −0.4728 | −0.791 to −0.155 | 0.004 |
| Sex | 0.854 | −1.834 to 3.543 | 0.526 | 2.280 | −0.855 to 5.415 | 0.152 |
| Iwano grade | −0.890 | −3.617 to 1.837 | 0.517 | −1.324 | −4.570 to 1.921 | 0.413 |

BMI, body mass index; CI, confidence interval; PFA, patellofemoral arthroplasty; TKA, total knee arthroplasty.

that older age was a predictor of a higher degree of patient satisfaction after TKA, and suggested that this may be because older adults with various diseases have lower expectations than younger patients[29]. Another possible explanation for the positive correlation between older age and patient satisfaction after arthroplasty may be that the level of activity decreases with age, and the awareness of joints becomes lower during activity compared with younger patients.

The present study also found a negative correlation between BMI and the FJS, indicating that it was more difficult for the heavier patients to forget their PFA. Many studies have evaluated the potential effects of BMI on prosthesis survival, functional result, and complications after joint replacement. Obesity tends to lead to a higher infection rate[30] and lower implant survival[31]. A recent study reported that non-obese patients (defined as those with a BMI $\leq$30 kg/m$^2$) had better functional improvement after TKA than obese patients (defined as those with a BMI > 30 kg/m$^2$)[30]. However, the relationship between obesity and the FJS after PFA has not been reported.

Several studies have reported that men have better arthroplasty outcomes than women[32, 33] This may be because women in the age bracket that generally requires arthroplasty are more likely to live by themselves, and people who live alone may delay joint replacement until they are older and the joint pain and dysfunction become more severe compared with people who live with another person, which leads to poor outcomes[34]. However, in our study, although some of the women had no life partner, the FJS did not significantly differ between men and women. Furthermore, we did not find a significant correlation between the Iwano grade and the FJS after PFA. This finding may be related to the small sample size in our study.

### *Limitations*

The present study had some limitations. First, the study was retrospective and the sample size was relatively small. A prospective study is required to confirm the present findings. Second, the patients were not matched using the preoperative FJS. Third, the follow-up was only short-term, and further follow-up is needed to prove the long-term advantages

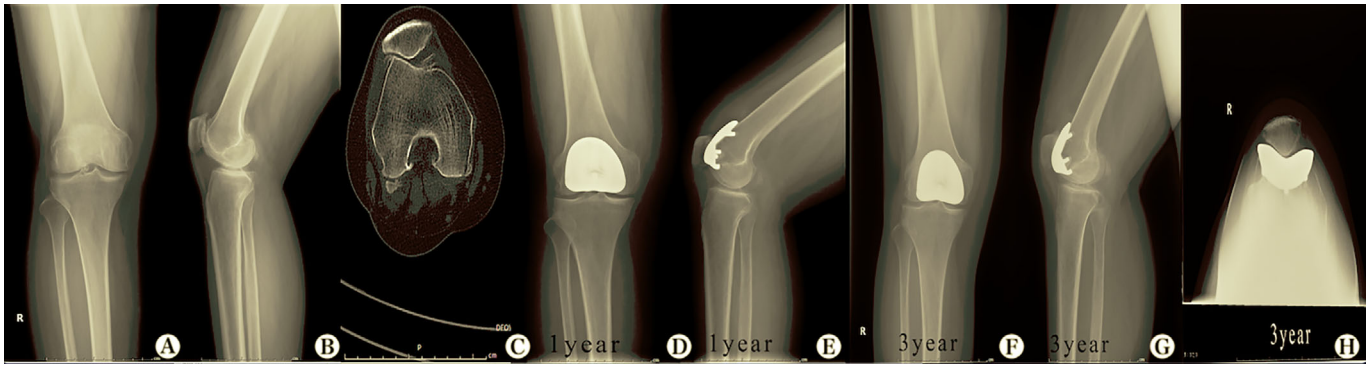


**Fig. 1** X-rays of the patellofemoral arthroplasty. (A) Preoperative anteroposterior X-ray of the patellofemoral arthroplasty. (B) Preoperative lateral X-ray of the patellofemoral arthroplasty. (C) Preoperative skyline view of the patellofemoral arthroplasty. (D) Postoperative anteroposterior X-ray of the patellofemoral arthroplasty taken at 1 year. (E) Postoperative lateral X-ray of the patellofemoral arthroplasty taken at 1 year. (F) Postoperative anteroposterior X-ray of the patellofemoral arthroplasty taken at 3 years. (G) Postoperative lateral X-ray of the patellofemoral arthroplasty taken at 3 years. (H) Postoperative skyline view of the patellofemoral arthroplasty taken at 3 years. The X-rays showed a good position of the prosthesis with no loosening at 1 and 3 years postoperatively.

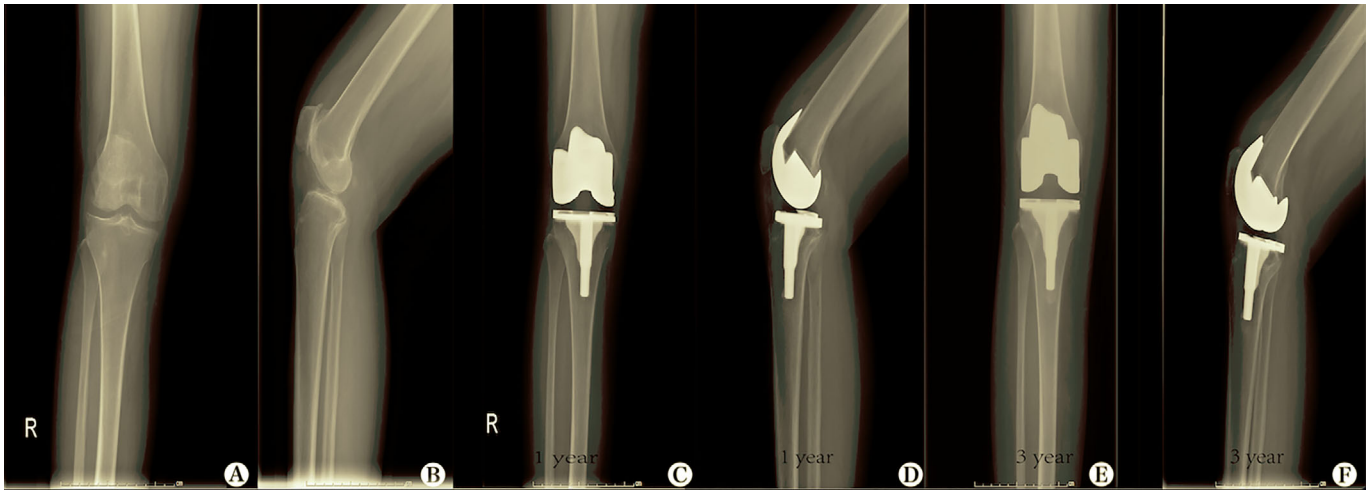


**Fig. 2** X-rays of the total knee arthroplasty. (A) Preoperative anteroposterior X-ray of the total knee arthroplasty. (B) Preoperative lateral X-ray of the total knee arthroplasty. (C) Postoperative anteroposterior X-ray of the total knee arthroplasty taken at 1 year. (D) Postoperative lateral X-ray of the total knee arthroplasty taken at 1 year. (E) Postoperative anteroposterior X-ray of the total knee arthroplasty taken at 3 years. (F) Postoperative lateral X-ray of the total knee arthroplasty taken at 3 years. The X-rays showed a good position of the prosthesis with no loosening at 1 and 3 years postoperatively.

of PFA. Over time, the progression of arthritis in the rest of the joint may result in impaired outcomes.

### *Conclusion*

The patients with isolated PFOA who underwent PFA were more likely to forget the artificial joint and, consequently, achieved a higher degree of satisfaction compared with those who underwent TKA. In addition, we identified two preoperative patient-related factors (age and BMI) that may predict the FJS after PFA. These factors may be used to guide the important preoperative discussion of patients' expectations before PFA so that the most appropriate operation is selected.

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