

Posterior-stabilized Arthroplasty Versus Cruciate-retaining Arthroplasty in Treatment of Osteoarthritis: a 5-year Follow-up Study

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Abstract

Background: A prospective cohort study was performed to compare clinical outcomes between cruciate-retaining (CR) and posterior-stabilized (PS) arthroplasty.

Methods: In total, 210 patients (210 knees) underwent CR arthroplasty (n=102) and PS arthroplasty (n=108) from January 2014 to January 2015. The Knee Society Score (KSS), range of motion, patellar stability, and complications were compared between the CR and PS groups 5 years postoperatively.

Results: The CR group comprised 99 knees and the PS group comprised 105 knees at the 5-year follow-up. In the CR and PS groups, the mean postoperative KSS improved to 90 ± 5 and 91 ± 4 , and the function score improved to 87 ± 4 and 84 ± 6 , respectively ($p>0.05$). The mean postoperative range of motion was $-2^\circ\pm 3^\circ$ extension to $114^\circ\pm 8^\circ$ flexion in the CR group and $-2^\circ\pm 4^\circ$ extension to $126^\circ\pm 7^\circ$ flexion in the PS group, with no significant difference ($p>0.05$). In terms of patellofemoral complications, eight patients had patellar clunk syndrome, one had patellar subluxation, and one had patellar lateral facet fracture in the PS group. Three patients had patellar clunk syndrome, and one had symptomatic subluxation in the CR group. These patellofemoral complications were significantly different between the groups ($p<0.05$).

Conclusions: CR and PS TKA can achieve good clinical outcomes with respect to the KSS. Better knee flexion but more patella complications in the PS arthroplasty than CR group 5 years postoperatively.

Trail registration: This study was approved by our hospital institutional ethics committee.

Background

Total knee arthroplasty (TKA) is effective for advanced osteoarthritis, rheumatoid arthritis, and other knee disorders¹. Increasingly more patients are obtaining good knee function and improvements in daily life, and some research has demonstrated 87% Kaplan–Meier survivorship after primary TKA². The demand for primary total knee replacement, especially among patients of advanced age, is expected to increase in future.

Both posterior cruciate-retaining (CR) and posterior-stabilized (PS) TKA are widely used for primary TKA. Many researchers have shown that both CR and PS have good clinical outcomes^{3,4}. However, the optimal procedure for primary TKA remains controversial⁵. The posterior cruciate ligament (PCL) has different kinematic functions, and CR TKA provides inherent stability, increased rollback, improved proprioception, improved knee kinematics^{3,6}. PS TKA with a post-cam design and PCL removal provides a conforming articulation, better knee flexion and stair-climbing ability, more predictable kinematics, reduced peak and mean patellofemoral pressure, and lower ranges of axial rotation and condylar translation³. The main procedural difference between CR and PS TKA is that PS TKA involves removal of the PCL and osteotomy of the femoral intercondylar fossa³. The choice of CR or PS TKA depends on the degenerative

status of the PCL and the surgeon's experience. Because of these inconsistencies, a clear standard with which to select the CR or PS technique for primary TKA has not been established⁷.

Many studies have shown no difference in clinical outcomes between CR and PS TKA, and many researchers have focused on tibiofemoral functions^{5, 8-11}. Patellofemoral function is very important after TKA, but patellar instability occurs in some patients¹². Patellar instability after TKA is a severe complication that impairs the functions of the knee and may lead to the need for revision¹³. Patella clunk syndrome is another potential complication with complex causes. To explore the differences in patellofemoral complications between CR and PS TKA, we performed a prospective cohort study to compare the clinical outcomes between CR and PS TKA, and we assessed patellofemoral function and patellar stability 5 years after surgery. The hypothesis was that PS TKA is associated with more complications involving the patellofemoral joint than is CR TK 5 years postoperatively.

Methods

From January 2014 to January 2015, a total of 241 patients (252 knees) with advanced osteoarthritis were treated with CR and PS TKA in our hospital. All patients provided informed consent to participate. This study was approved by our hospital institutional ethics committee. (Study No. 2014-K-076).

The inclusion criteria were as follows:

- (1) Severe osteoarthritis (Kellgren–Lawrence grade > III)
- (2) Substantial pain and loss of function in the knee
- (3) Primary total knee replacement

The exclusion criteria were as follows:

- (1) History of high tibial osteotomy in the knee or contralateral total knee replacement
- (2) Hemophilia or juvenile rheumatoid arthritis
- (3) Severe bony defect, valgus deformity, revision TKA, or active knee joint infection
- (4) Concomitant performance of another surgery with the TKA, such as ligament repair

Based on these criteria, 210 patients were included in this study; among them, 102 patients underwent CR TKA and 108 underwent PS TKA. The demographic data were compared between the two groups (Table 1). All patients underwent clinical follow-up for at least 5 years after surgery.

The follow-up parameters were the Knee Society Score (KSS), range of motion (ROM), patient satisfaction, patellar stability, and complications.

Table 1
Demographics of the patients

	CR	PS	P value
No. of patients	102	108	n.s.
Sex (male/female)	42/60	43/65	n.s.
Side involved (right/left)	54/48	53/55	n.s.
Age (years)	67 ± 5	65 ± 4	n.s.
BMI (kg/m ²)	31 ± 4	32 ± 5	n.s.
Kellgren & Lawrence III	20	31	
Kellgren & Lawrence IV	82	77	n.s.
Passive flexion	87 ± 7	90 ± 5	
Passive extension	14 ± 5	15 ± 7	n.s.
Follow-up time (months)	60 ± 4	60 ± 3	n.s.

Surgical technique

All surgical procedures were performed by a senior surgeon. A pneumatic tourniquet was used for all cases. A standard medial parapatellar approach was performed in all surgeries. All tibial and femoral components were cemented, incorporating a posterior referencing guide for sizing the femoral component. Sequential soft tissue release was performed if the flexion and extension gaps were not balanced.

All patients underwent patelloplasty in which an oscillating saw was used to trim the patella. No patients underwent patellar replacement. No drainage tube was used in any cases. The Gemini MK II CR TKA prosthesis (Link, Hamburg, Germany) and Gemini Legacy PS TKA prosthesis (Zimmer Biomet, Warsaw, IN, USA) were used in our experiment.

Postoperative rehabilitation training

All patients were given rehabilitation instructions and training by a rehabilitation team. After the operation, walking was encouraged on the day of surgery under the supervision of a physiotherapist. Walking and active ROM exercises were conducted by the rehabilitations every day after the operative procedure.

A follow-up evaluation was scheduled 5 years postoperatively. This postoperative follow-up was completed by the same follow-up team and involved assessment of the KSS, ROM, patellar stability, and

complications.

Passive postoperative flexion and extension were measured using a standard goniometer with the patient in the supine position. Patellar grinding, catching, and clunking were tested and recorded. Postoperative radiographs were reviewed, and the position of the implant, Insall-Salvati ratio, and joint line position were evaluated.

Patellar stability was evaluated with the apprehension test, and the patients were divided into three groups according to the test result: those with patellar stability, subluxation, and dislocation. According to the lateral translation grade, grades I and II with a hard end point were consistent with patellar stability, grade III with a hard end point was consistent with patellar subluxation, and a soft end point was consistent with patellar dislocation. Grade > III was also consistent with patellar dislocation. Radiographic evaluation included the patellar tilt and the patellar lateral shift.

Statistical analysis

SPSS statistical software, version 20.0 (IBM Corp., Armonk, NY, USA) was used for the statistical analysis. A t-test or nonparametric test was used to compare the measurement data among the groups, and the chi-square test or a nonparametric test was used to compare the count data. A p value of < 0.05 indicated a statistically significant difference.

Results

In total, 99 knees in the CR group and 104 knees in the PS group were available for the 5-year follow-up examination. Three patients in the CR group and four patients in the PS group were lost to follow-up because their addresses had changed. No prosthesis infections, deep vein thrombosis of the lower extremities, or blood vessel or nerve injury were observed, and no obvious immune rejection, hepatitis B, or acquired immunodeficiency syndrome were reported during the follow-up period.

In the CR group, the mean postoperative KSS improved to 90 ± 5 and the function score improved to 87 ± 4 . In the PS group, the mean postoperative KSS improved to 91 ± 4 and the function score improved to 84 ± 6 . There was no significant difference between the two groups.

The mean postoperative ROM was $-2^\circ \pm 3^\circ$ extension to $114^\circ \pm 8^\circ$ flexion in the CR group and $-2^\circ \pm 4^\circ$ extension to $126^\circ \pm 7^\circ$ flexion in the PS group, with no significant difference ($p > 0.05$).

With respect to patellofemoral complications (Table 2), eight developed patellar clunk syndrome, one developed patellar subluxation, and one developed patellar lateral facet fracture in the PS group. Three patients developed patellar clunk syndrome, and one developed symptomatic subluxation in the CR group. There were significant differences in patellofemoral complications between the CR and PS groups ($p < 0.05$). No patients underwent revision.

Table 2
Patellofemoral Complication

	CR	PS	P value
Patella clunk	3	8	
Patellar subluxations	1	1	
Patellar fracture	0	1	
Totals	4	10	n < 0.05

Discussion

The most important finding in this study was the lack of a difference in the KSS 5 years after surgery between CR and PS TKA. There is a better flexion of knee in PS group but more patellofemoral complications (i.e., more patellar clunk, subluxations).

In terms of clinical scores, both CR and PS TKA can achieve a high KSS. In the CR group, the mean postoperative KSS improved to 90 ± 5 and the function score improved to 87 ± 4 . In the PS group, the mean postoperative KSS improved to 91 ± 4 and the function score improved to 84 ± 6 . Other studies have also shown that patients recover very well after CR and PS TKA and achieve a good KSS and Hospital for Special Surgery knee score^{5,7,11}. Our study also showed that CR and PS TKA allowed patients to return to their normal life. Both CR and PS TKA are effective for treatment of advanced osteoarthritis^{10,14,15}.

Our study showed that the mean postoperative ROM was $-2^\circ \pm 3^\circ$ extension to $114^\circ \pm 8^\circ$ flexion in the CR group and $-2^\circ \pm 4^\circ$ extension to $126^\circ \pm 7^\circ$ flexion in the PS group 5 years after surgery, there was a difference between the two groups ($P < 0.05$). As other researchers have reported that ROM was better after PS TKA, and they considered that the PS design results in better ROM and a better reproduction angle and that PS TKA with a post-cam design and PCL removal provides a conforming articulation, better knee flexion and stair-climbing ability, and more predictable kinematics¹². However other researchers have shown that the ROM was not significantly different after PS and CR TKA^{9,11,16,17}. Although most of studies have shown that patients can perform knee flexion and straightening well enough after surgery to return to live. The PS prosthesis is still a good choice for patients who needed a good ROM in their activities of daily living.

These patellofemoral complications were more in PS than CR groups. In the PS group of the present study, eight developed patellar clunk syndrome, one developed patellar subluxation, and one developed patellar lateral facet fracture. In the CR group, three patients developed patellar clunk syndrome, and one developed symptomatic subluxation. All procedures were performed by one senior surgeon, and no other complications were reported. The main difference between the CR and PS groups was the femoral component. So PS femoral component may lead patellofemoral complications. For PS TKA, more bony

cuts and shorter trochlear were accepted in the femoral component, and the changed track of the femoral trochlea may lead to patella impact and anterior knee pain, patellar clunk syndrome, patellar subluxation, and patellar fracture. In the CR group, the Lachman test was performed for the four patients with complications, and the Lachman test was positive in three of the patients. Loss of the PCL may be the main cause of patellofemoral complications with changes in pressure on the patella. A recent study showed that PCL rupture results in higher pressure on the medial patella. Some researchers have found that more complications occur after PS than CR TKA. A study involving 108 PS TKAs and 136 improved PS TKAs showed that femoral components with a deep trochlear groove and smooth transition of the intercondylar box were associated with fewer cases of crepitance and patellar clunk syndrome¹⁸.

The patellofemoral complications in this study included patellar grinding, catching or clunking, patellar instability, and patellar fracture. Alleviation of anterior knee pain is integral to the overall success of TKA^{19,20}. Such pain continues to be associated with problematic complications that often lead to revision surgery¹². Anterior knee pain is a common patellofemoral complication, and patellofemoral complications are associated with anterior knee pain^{13,20}. Causes of anterior knee pain include the patellofemoral implant design, surgical technique, patient characteristics, and degree of chondromalacia. Patellofemoral crepitance and patellar clunk syndrome develop in the early postoperative period. Patellar clunk is mainly associated with the surgical technique and component positioning. Hamlin reported that more cases of patellar clunk occurred after PS TKA¹⁹. Instability after TKA is a severe complication, but few studies have compared patellofemoral complications between CR and PS TKA. Few patellar dislocations occurred in both groups of the present study. Patellar instability after TKA has many causes, including the surgical technique, component position, and extensor mechanism imbalance^{13,21}.

This study had several limitations. First, this was not a randomized controlled study. A good control group will lead to improved studies in the future. Second, an inadequate number of samples was obtained, and the 5-year follow-up was short. More samples and a longer follow-up study are needed in the future. Finally, a mechanics study is needed to further confirm our hypothesis.

Conclusions

In conclusion, we found that CR and PS TKA can attain good clinical outcomes in terms of the KSS. However, PS TKA is associated with more complications involving the patellofemoral joint than is CR TKA after 5 years of follow-up.

List Of Abbreviations

Cruciate-retaining (CR)

Posterior-stabilized (PS)

The Knee Society Score (KSS)

Total knee arthroplasty (TKA)

Range of motion (ROM)

Declarations

Ethics approval and consent to participate

This study was approved by our hospital institutional ethics committee.

Consent for publication

Written informed consent for publication was obtained from all participants.

Availability of data and materials

The datasets used or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing financial interests.

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None

Authors' contributions

Fei Wang and Yingzhen Niu conceived and designed the study. Fei Wang performed the procedures. Weixia Bai, Gang Ji and Kang Piao gather data. Zhenyue Dong and Conglei Dong wrote the paper.

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