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Original article

# Effect of posterior condylar offset on clinical results after posterior-stabilized total knee arthroplasty

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ABSTRACT

*Purpose:* To determine the effect of the posterior condylar offset (PCO) on clinical results after total knee arthroplasty (TKA) using a high-flex posterior-stabilized (PS) fixed-bearing prosthesis.

*Methods:* We prospectively studied the clinical and radiographic materials of 89 consecutive female patients (89 knees), who had undergone primary TKAs for end-stage osteoarthritis. All operations were performed by a single senior surgeon or under his supervision using the same operative technique. Based on the corrected PCO change, we divided all cases into two groups: group A (corrected PCO change $\geq$0 mm, 58 knees) and group B (corrected PCO change <0 mm, 31 knees). One-year postoperatively, clinical and radiographic variables from the two groups were compared by independent *t*-test. The associations between the corrected PCO changes and the improvements of clinical variables in all patients were analyzed by Pearson linear correlation.

*Results:* One-year postoperatively, the Knee Society Scores, the Western Ontario and McMaster Universities Osteoarthritis Index, non-weight-bearing active and passive range of knee flexion, flexion contracture, extensor lag, and their improvements had no statistical differences between the two groups (all $p > 0.05$). The corrected PCO change was not significantly correlated with the improvement of any clinical variable (all $p > 0.05$). Group A demonstrated greater flexion than group B during active weight bearing ($p < 0.05$).

*Conclusions:* Restoration of PCO plays an important role in the optimization of active knee flexion during weight-bearing conditions after posterior-stabilized TKA, while it has no benefit to non-weight-bearing knee flexion or any other clinical result.



## 1. Introduction

During the past decade, some studies in regard to total knee arthroplasty (TKA) have focused on the femoral posterior condylar offset (PCO).[1–31] In 2002, Bellemans et al[1] was the first to propose the concept of PCO. The authors defined it as the vertical distance from the most prominent point of the posterior femoral condyle to the tangent of the posterior cortex of the femoral shaft as seen on true lateral radiographs. They found that 93% (27/29) of patients experienced abnormal forward sliding of the femur during deep flexion in the weight-bearing position after cruciate-retaining (CR) TKA. In addition, impingement of the posterior aspect of the tibial insert against the shaft of the femur in the deep squat position was noted in 72.4% of the patients. On the contrary, when a sufficient PCO is reconstructed, a larger posterior clearance may be obtained that helps delay impingement on the posterior aspect and maximizes the range of flexion (ROF). However, the potential correlation between PCO and ROF, especially after posteriorly stabilized (PS) TKA, remains controversial.

Previous studies that addressed this subject had some limitations. First, all of the factors that are present before (e.g. physical

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condition of the patients), during (e.g. surgical techniques, implant design), and after (e.g. complications, rehabilitation procedures) TKA can affect final ROF.[32–35] Most studies, however, did not consider the impact of these factors when analyzing the correlation between PCO and ROF. Second, conventional measurement methods neglect to address the actual thickness of the articular cartilage, the variation of which can be large,[26] leading to a markedly smaller preoperative PCO value compared with the actual value. Finally, the difference in the weight-bearing status can markedly affect the flexion angle.[34–36] Even under the same weight-bearing status, active and passive ROF may also differ significantly.[36,37] Except for Bellemans et al[1] the other authors explored the impact of PCO only on non-weight-bearing ROF after TKA, even though weight-bearing ROF is a better indicator of knee function.[34] During ROF measurement, the inconsistencies in weight-bearing position and/or knee flexion status (active or passive) definitely affect interpretation of the results.

Although improved quadriceps performance and pain alleviation are key items in almost all TKA outcome evaluation systems,[38,39] none of the studies reported in the literature deeply analyzed the impact of PCO on these two indicators following TKA. Mitsuyasu et al[20] analyzed the impact of changes in the thickness of the posterior femoral condyle on the extension gap in regard to PS-type TKA, and Onodera et al[25] compared the posterior morphology of the knee in six healthy Japanese adults with universal TKA prostheses. In both studies,[20,25] the authors speculated that the increased PCO might tighten the posterior articular capsule and thus increase the risk of flexion contracture after TKA. To our best knowledge, however, this hypothesis has not yet been validated clinically.

In the present study, after minimizing the impact of various confounding factors, we prospectively explored the possible influence of PCO reconstruction on ROF in nonfunctional (non-weight-bearing) and functional (weight-bearing) positions, the pain level and performance of the quadriceps, and flexion contracture after PS TKA.

## 2. Materials and methods

### 2.1. Subjects

The medical ethics committee of our hospital approved this study. The study was registered in the Chinese Clinical Trial Register (ChiCTR) in 2012 (registration number: ChiCTR-ONC-12002787). All data were collected prospectively, and all patients gave informed consent. Operations were performed by the same senior surgeon or under his supervision using the same surgical techniques with the PS-type, open box Vanguard Complete Knee System (Biomet Orthopedics, Warsaw, IN, USA).

The inclusion criteria were as follows: (1) presence of end-stage knee osteoarthritis requiring unilateral TKA; (2) female subjects aged 50–70 years; (3) without genu recurvatum; (4) flexion contracture $\leq 15^\circ$; (5) varus knee with tibiofemoral angle of $\leq 15^\circ$; (6) active ROF of $\geq 90^\circ$ in bilateral knee joints in a non-weight-bearing position; (7) body mass index (BMI) of 20–35 kg/m$^2$; (8) thigh circumference of 40–55 cm at 10 cm above the patella; (9) bilateral quadriceps with muscle strength between 4+ and 5; (10) absence of any disease that may affect the movement of the knee or hip joint, cause pain in the lower extremities, or affect lower limb function; (11) the contralateral knee joint has no obvious pain or it has undergone successful TKA.

The exclusion criteria were as follows: (1) the affected knee has undergone open surgery or has a history of fracture; (2) severe osteoporosis; (3) bone deformity or ligament insufficiency around the affected knee and/or an obvious bone defect at the distal end of the femur or proximal end of the tibia; (4) obvious residual osteophytes in the posterior knee area after surgery; (5) deep infection, heterotopic ossification, unexplained stiffness, instability, lower extremity deep vein thrombosis, or other complications that might affect rehabilitation during hospitalization or follow-up; (6) lost to follow-up or incomplete/missing intraoperative data.

A total of 89 female patients (89 knees: left 41, right 48) were enrolled in this study.

### 2.2. Perioperative management and intraoperative measurements

The same surgical technique was used in all cases under routine spinal or general anesthesia. The target limb was compressed with a tourniquet at a pressure of 250–300 mmHg. All procedures were performed through a medial parapatellar approach with use of an anterior median incision. After the soft tissue was initially released, the medial osteophytes were removed. Then, the distal femur and the proximal tibia were cut perpendicular to the mechanical axis in the coronal plane. An intramedullary femoral guide and an extramedullary tibial guide were used to achieve a 0° mechanical axis. We performed resection at the anterior and posterior condyles with an anterior referencing technique based on the posterior condylar angle or twist angle, which had been measured on computed tomography (CT) scans before surgery. For this purpose, an anteroposterior (AP) femoral shift block was used to adjust the cut block holes to avoid anterior notching. The femoral components were selected according to the AP dimension of the distal femur. A larger one was usually selected when a choice had to be made between two adjacent sizes. In the case where there was a lateromedial overhang greater than 2–3 mm, a smaller component was chosen with more resection of the posterior condyles. Lower limb alignment was then examined, and the flexion-extension gap was carefully adjusted by further soft tissue release. The knee was then maintained in an extension position, and an appropriate position for the rotational alignment of the tibial component was marked. After this step, the tibial cutting surface was further prepared and osteophytes on the posterior aspect of the knee were also removed. The prosthesis was placed after thoroughly flushing the intramedullary canals and the cutting surfaces with a pulsed lavage gun. The components were then installed. After the wound was sutured intradermally, a single dose of tranexamic acid was injected intra-articularly followed by application of a sterile dressing and a pressure dressing (elastic bandage). The tourniquet was then deflated. All of the components were fixed with bone cement. No patella was replaced, and no negative-pressure drainage system was used. The thickness of each resected bone block was measured with a vernier caliper.[20,45] Each resected specimen was then sectioned in the midsagittal plane, and the thickness of the remaining cartilage was measured with a steel ruler and recorded (Fig. 1).[26] The difference between the thickness of the applied tibial component and that of the lateral platform of the resected tibial specimen (including the thickness of the oscillating saw blade, which was 1.27 mm) was regarded as the changed value of the joint line (JL).

### 2.3. Postoperative management

The affected limb was iced locally for about 48 h. The combination of an opioid and a nonsteroidal anti-inflammatory drug was applied for pain control. During the perioperative period, antibiotics were given intravenously for 24 h to prevent infection. Rivaroxaban was administered orally for 14 days to prevent thrombotic events. All patients were asked to participate in functional exercise during and after hospitalization under the guidance of a senior surgeon. The same protocol was used for all patients.