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Original

Relationships of Posterior Condylar Offset Change to Condylar Length and Pre / Postoperative Range of Motion in Total Knee Arthroplasty

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Abstract: This study investigated the relationships of pre- to postoperative changes in posterior condylar offset (PCO) to differences in condylar length and range of motion in posterior stabilized (PS)-type total knee arthroplasty (TKA). Subjects and Methods: We studied 40 knees of 40 patients (10 males and 30 females) treated by PS-type TKA. Slide calipers were used to measure condyle lengths intraoperatively and PCO was measured by standard X-ray. The patients were divided into two groups based on a pre- to postoperative change in PCO of ≥ 3 mm or < 3 mm, with the differences in both condylar length and range of motion compared between groups. The mean differences in condyle lengths were 2.6 mm (33 knees) and 4.3 mm (7 knees) in cases with PCO changes of < 3 mm and ≥ 3 mm, respectively. The means in the respective groups were −6° and −7° for preoperative extension, 116° and 118° for preoperative flexion, −3° and −4° for postoperative extension, and 131° and 129° for postoperative flexion. There was no significant difference in the range of motion between the groups. Cases with a large difference in condylar lengths were likely to have a small PCO postoperatively; however, the postoperative range of knee flexion was not significantly related to a small postoperative PCO. These findings suggested that preoperative range of knee motion, age, and type of TKA could influence both the postoperative range of motion and PCO.

Key words: posterior condylar offset, range of motion, length of femoral condyle

Introduction

The posterior condylar offset (PCO) is the distance between the femoral bone cortex posterior to the bone axis and the most posterior margin of the condyle or femoral component in the lateral view on plain radiography (Fig. 1). Bellemans *et al*[1] reported that limiting postoperative reduction of the PCO to 3 mm or less favors the acquisition of knee flexion after cruciate retaining (CR)-type total knee arthroplasty (TKA). In addition, we found that the preoperative PCO reflects the side with a longer condyle in patients showing a difference in condylar length between the medial and lateral sides during posterior stabilized (PS)-type TKA, and that

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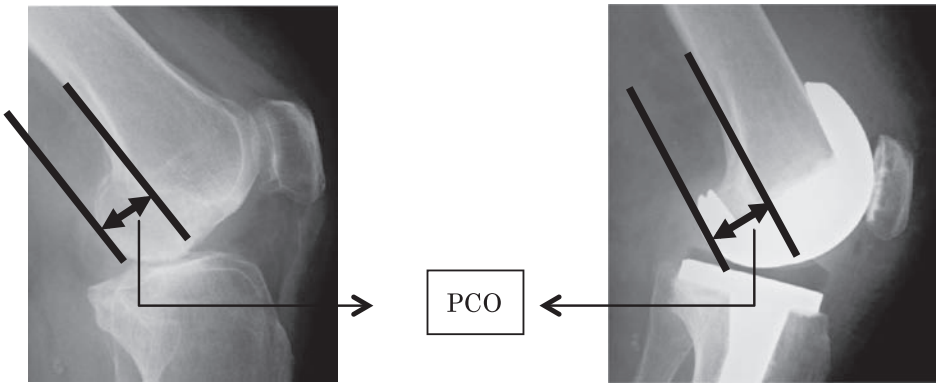

Fig. 1. Posterior condylar offset (PCO) is the distance between the femoral bone cortex posterior to the bone axis and the most posterior margin of the condyle or femoral component in the lateral view on plain radiography.

selecting a component smaller than the side with the larger condylar length tends to reduce postoperative PCO[2]. Limiting such a PCO change thus requires using a component close in size to that on the side with the larger condylar length, although this approach also has disadvantages. On disadvantage is that when using of a component similar to the side of the larger condyle lengths, the component size becomes proportionaly large. So the transverse width of the component also becomes too large for individual cases of condyle width. So we could not often use component with both length and width[2]. This study therefore investigated whether postoperative knee flexion is influenced by the decrease of postoperative PCO, particularly when there were large differences in condylar length during surgery and there was no choice but to use a small size component compared to the large side condyle length treated with PS-type TKA.

Subjects and methods

The subjects were 40 patients with varus-type osteoarthritis of the knee (40 knees : 10 men, 30 women) treated with TKA at our department from December 2012 to June 2013. The mean age at the time of surgery was 78.8 years (69–86 years). A PFCΣPS implant (DePuy Synthes Inc., New Brunswick, NJ, USA) was used in all patients, and surgery was performed using the measured resection technique, with the anterior reference method used for femoral osteotomy. The external rotation angle of the femoral component was set by subtracting 2° for the residual cartilage of the lateral posterior condyle from the angle formed by the clinical epicondylar axis and posterior condylar axis in the preoperative epicondylar view. The medial and lateral condylar lengths were measured after osteotomy of the distal and anterior femur using calipers (Fig. 2), and the femoral component was selected with reference to these values. The size was selected based on the distance between the reverse side of the anterior flange and posterior surface of the condyle of the femoral component, calculated for each side before surgery.

The evaluation items were the medial and lateral condylar lengths of the femur and differences in the condylar length measured during surgery, PCO values on lateral plain radiographs before and after surgery, change in PCO, ranges of motion of knee extension and flexion before

Fig. 2. Measurement of the length of the condyles. The length of each condyle was measured intraoperatively using slide calipers.

Table 1. Subject characteristics

Item	Mean (range)
Femoral condylar length (mm)	
Medial side	53.4 (45–58)
Lateral side	50.4 (46–55)
Absolute difference (medial–lateral side)	2.8 (0– 5)
PCO value (mm)	
Before surgery	26.3 (21.3–31.8)
After surgery	25.3 (20.1–29.9)
Absolute change (before–after surgery)	2.3 (0– 6.5)

The mean condylar length was 53.4±2.2 mm on the medial side and 50.4±2.4 mm on the lateral side; and the mean absolute difference in condylar length was approximately 2.8 mm. The mean posterior condylar offset (PCO) was 26.3 ±2.2 mm before surgery and 25.3±2.1 mm after surgery, and the mean absolute reduction after surgery was 2.3 mm.

and after surgery, and change in the flexion angle after surgery. The patients were divided into those with postoperative PCO changes of < 3 mm or ≥ 3 mm, and changes in the knee flexion angle after surgery were compared between the groups. For statistical analysis, a t-test and Spearman's correlation coefficient analysis were used, with P values of < 0.05 and < 0.01, respectively, regarded as significant.

Results

The mean condylar length was 53.4 ± 2.2 mm on the medial side and 50.4 ± 2.4 mm on the lateral side; and the mean absolute difference in condylar length was approximately 2.8 mm. The mean PCO was 26.3 ± 2.2 mm before surgery and 25.3 ± 2.1 mm after surgery; the

Table 2. Mean range of knee motion pre- and postoperatively (6 months after surgery) in subjects with a PCO change of < 3 or ≥ 3 mm

Motion	PCO change < 3 mm		PCO change ≥ 3 mm	
	Pre-op	Post-op	Pre-op	Post-op
Extension	−9 (−25-0)	−1.5 (−5-0)	−5.8 (−10-0)	−2.5 (−10-0)
Flexion	118.5 (80-140)	120.3 (90-140)	115 (100-135)	117.1 (105-130)

Comparison of mean ranges of motion between before surgery and 6 months after surgery showed that both extension and flexion were slightly improved after surgery in patients with PCO changes of < 3 mm or ≥ 3 mm after surgery. PCO, posterior condylar offset

Table 3. Pre- to postoperative change in knee flexion angle in subjects with a PCO change of < 3 or ≥ 3 mm

Number of knees	Absolute PCO change	Change in flexion angle*
33	< 3 mm	1.8° (−10-20)
7	≥ 3 mm	2.1° (−5-20)

PCO, posterior condylar offset
*There was no significant difference in the change in flexion angle between the groups

mean absolute reduction after surgery was 2.3 mm (Table 1). With respect to the mean range of motion before surgery and at 6 months after surgery, both extension and flexion were slightly improved after surgery in patients with PCO changes of < 3 mm or ≥ 3 mm after surgery (Table 2). The changes in flexion angle after surgery were 1.8 ± 0.9° and 2.1 ± 0.9° in patients with PCO changes of < 3 mm or ≥ 3 mm, respectively, indicating improvement in both groups and no significant difference between the groups (Table 3). There was a positive correlation between PCO changes after surgery and differences in condylar length (Fig. 3), but no correlation between PCO changes and changes in knee flexion angle after surgery (Fig. 4) or between differences in condylar length and changes in knee flexion angle (Fig. 5).

Discussion

A mutual influence of PCO and the PCO Ratio (PCOR : calculated by dividing PCO by the maximum anteroposterior diameter of the femoral condyle) on improvement in knee flexion angle after surgery has been found in many CR-type cases[1, 3-6]. In contrast, no such influence of PCO and PCOR has been noted for postoperative knee flexion angle in PS-type cases[7, 8]. In our study, the influence of PCO could have been larger when the difference in condylar length was larger, because the PCO might have reflected the side with the larger condylar length. Postoperative PCO tended to decrease in cases with a large difference in condylar length, but not the postoperative range of knee motion, suggesting that factors other than PCO were at play, such as the preoperative range of motion, age, obesity, and component-setting angle.

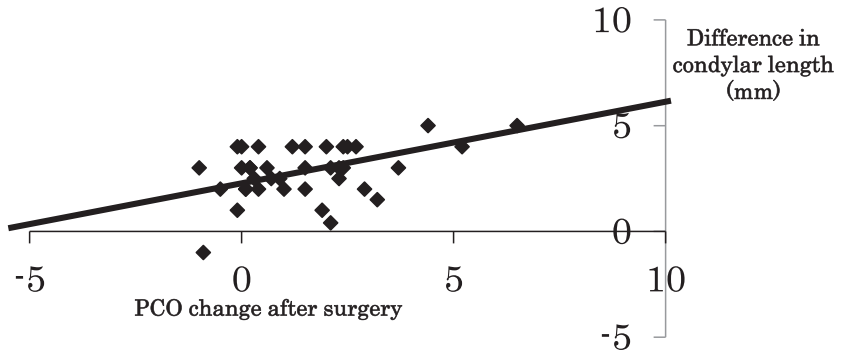

Fig. 3. Comparison of the pre- to postoperative change in posterior condylar offset (PCO) with the difference in length between condyles. There was a significant relationship between the PCO change and the difference in condyle length ($r = 0.3$, $P < 0.01$).

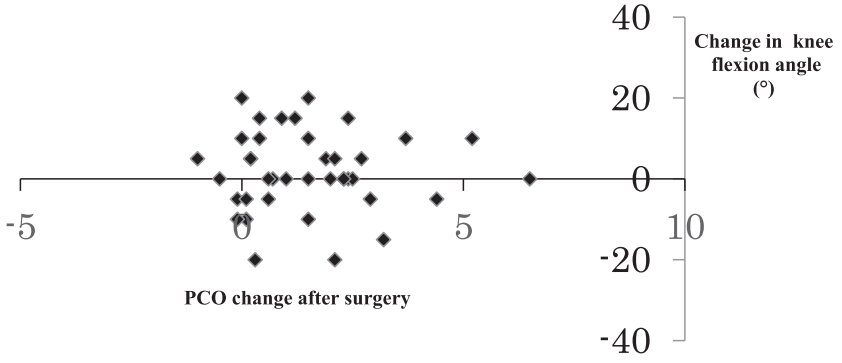

Fig. 4. Comparison of pre- to postoperative changes in posterior condylar offset (PCO) and the range of knee flexion. There was no significant relationship between the change in PCO change and the change in knee flexion ($y = 3.37 \times -1.87$, $P = 0.107$).

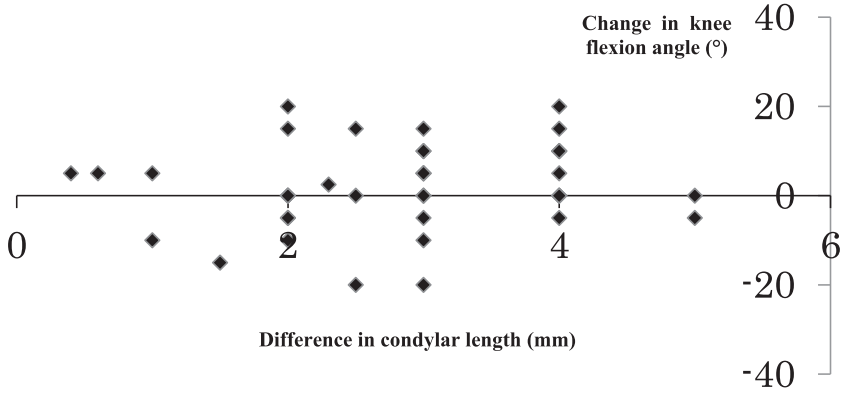

Fig. 5. Comparison of the difference in length between condyles and the pre- to postoperative change in range of knee flexion. There was no significant relationship between the difference in condyle length and the change in range of knee flexion ($y = 1.62 \times -2.48$, $P = 0.235$).

Bellemans *et al*[1] proposed the following mechanism for the influence of PCO on knee flexion. Since roll forward toward the anterior femur, which is opposite to the kinematics of physiological knee flexion, occurs in the CR-type procedure, posterior impingement is likely to occur and a large PCO is necessary to prevent such an outcome. Nevertheless, significantly favorable flexion is achieved even in CR-type cases in which the ligament balance was formed, and roll back toward the posterior femur and internal rotation of the crus is reproduced in flexion[9–11]. As in the above reports, the influence of PCO on flexion varies in strength based on differences in flexion kinematics, even in CR-type cases. In addition, Arabori *et al* reported that roll back toward the posterior femur is induced in flexion in many cases, even those treated by PS-type TKA, and that posterior impingement is less likely to occur compared with CR-type cases, suggesting that the PCO has a small influence on flexion[4]. Above reports indicates that the presence or absence of the influence of PCO is associated with differences in kinematics during flexion.

Limitations

1) small number of cases
2) PCO change was based only on pre- and postoperative range of motion

Conclusion

Cases with a large postoperative difference in condyle lengths were likely to have a small PCO postoperatively following PS-type total knee arthroplasty (TKA); however, the postoperative knee range of flexion was not significantly related to a small postoperative PCO.

Conflict of interest

The authors have declared no conflict of interest.

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