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Original Article

Posterior condylar offset influences the intraoperative soft tissue balance during posterior-stabilized total knee arthroplasty

Masanori Tsubosaka [a], Koji Takayama [a], Shinya Oka [c], Hirotsugu Muratsu [b], Ryosuke Kuroda [a], Tomoyuki Matsumoto [a, *]

[a] Department of Orthopaedic Surgery, Kobe University Graduate School of Medicine, Kobe, Japan
[b] Department of Orthopaedic Surgery, Steel Memorial Hirohata Hospital, Himeji, Japan
[c] Department of Orthopaedic Surgery, Kobe Kaisei Hospital, Kobe, Japan

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ABSTRACT

Purpose: This study aimed to clarify the influence of the posterior condylar offset (PCO) on intraoperative soft tissue balance including the joint component gap and varus ligament balance measured by an offset-type tensor during posterior-stabilized (PS) total knee arthroplasty (TKA).

Methods: In this study, 35 patients with osteoarthritis of the knee underwent PS TKA. Intraoperative soft tissue balance including the joint component gap and varus/valgus ligament balance were assessed at 0°, 10°, 45°, 90°, and 135° of flexion with an offset-type tensor that could be used with the femoral component placement and patellofemoral joint reduction. The correlations between the postoperative PCO and the intraoperative soft tissue balance parameters were assessed using simple regression analysis.

Results: The joint component gap at 0° extension was inversely correlated with the PCO ($R = -0.41$, $p < 0.05$). The joint component gap of 10°–0° was positively correlated with the PCO ($R = 0.35$, $p < 0.05$). No other soft tissue balance parameters were correlated with the PCO.

Conclusions: A larger PCO was confirmed to reduce joint component gap in extension but not always in flexion in PS TKA.

1. Introduction

Postoperative range of motion (ROM) is a component of the patient's satisfaction after TKA [1–3]. Many factors affect postoperative ROM, including the preoperative ROM, body mass index, gender, age, size and design of the prosthesis, and surgical technique [4–6]. Furthermore, surgical procedures change the bone alignment, articular configuration, and soft tissue balance of the lower extremity; these changes also influence the postoperative outcome. Recently, the effectiveness of maintaining a PCO has attracted researchers' attention [7–15]. Some authors have reported that a larger PCO increased postoperative knee flexion [10,11,13,15], while others reported changes such that the PCO had no significant effect on clinical results [8,14,16].

Accurate soft tissue balance is also essential for a successful postoperative outcome after TKA. To enable soft tissue balance in TKA under more physiological conditions, an offset-type tensor has been developed to allow surgeons to assess soft tissue balance after reduction of the patellofemoral (PF) joint and with femoral component in place [17,18]. This tensor clarified the difference of the intraoperative soft tissue balance between cruciate-retaining (CR) and PS TKA [19,20] and the relationship between the intraoperative soft tissue balance and flexion angles [21,22]. However, the influence of the PCO on the intraoperative soft tissue balance remains unclear.

In PS TKA, the flexion gap tends to be larger than the extension gap because of the resection of the posterior cruciate ligament [23,24]. To reduce this flexion–extension gap difference, surgeons in the clinical setting performing PS TKA using the anterior referencing technique may consider up-sizing the femoral component. However, the joint component gap is reported to be smaller than

Abbreviations: ROM, range of motion; TKA, total knee arthroplasty; PCO, posterior condylar offset; PF, patellofemoral; CR, cruciate-retaining; PS, posterior-stabilized.

* Corresponding author. Department of Orthopaedic Surgery, Kobe University Graduate School of Medicine, 7-5-1, Kusunoki-cho, Chuo-ku, Kobe, Hyogo 650-0017, Japan. Fax: +81 78 351 6944.

E-mail address: matsun@m4.dion.ne.jp (T. Matsumoto).

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the osteotomy gap due to the tension of the posterior structure [12,18]. In this study, therefore, we focused on the relationship between the intraoperative soft tissue balance assessed by the offset-type tensor and the PCO in patients undergoing PS TKA. The purpose of the present study was to test the hypothesis that increasing the size of the PCO by using a larger femoral component in PS TKA does not always reduce the flexion–extension gap difference.

2. Materials and methods

Thirty-five consecutive osteoarthritic knees implanted using PS TKA (NexGen LPS Flex; Zimmer, Inc, Warsaw, IN) between December 2009 and July 2010 were enrolled in this study. The patients comprised 27 females and 8 males with a mean age of 75.0 years (range, 55–85 years) at the time of surgery. All patients had a varus deformity, with the average preoperative hip–knee–ankle angle of 10.7 ± 1.5° and the average preoperative knee extension and flexion angles were −5.0°±°1.8°, 130.0°±°2.6° respectively. The average preoperative posterior inclination of the proximal tibia was 7.7°±°2.6°. The inclusion criteria were the presence of substantial pain and loss of function due to varus-type osteoarthritis of the knee. The exclusion criteria were the presence of knees with valgus deformity and severe bone defects. The hospital ethics committee approved the study protocol, and the patients provided informed consent for participation.

2.1. *Offset-type tensor*

As previously described, this device was designed to permit surgeons to measure the ligament balance (varus angle) and joint center gap (joint component gap) under a constant joint distraction force [12,22]. Joint distraction forces ranging from 20°lbs (9.1 kg) to 60°lbs (27.2 kg) can be exerted between the seesaw and platform plates, using a specially made torque driver that can change the maximum torque value. Once the joint is appropriately distracted, attention is focused on two scales that correspond to the tensor: the angle between the seesaw and platform plates (°, positive value in varus imbalance) and the distance (mm) between the center midpoints of the upper surface of the seesaw plate and the proximal tibial cut. The angular divisions and distance are graded in 1° and 1 mm increments, respectively. In primary in vitro experiments, the error of joint distraction was within ±3%.

2.2. *Intraoperative measurement*

TKAs were performed with the measured resection technique using a conventional resection block. After inflating the air tourniquet with 280 mmHg at the start of the procedure, a medial parapatellar arthrotomy was performed. Both the anterior cruciate ligament and posterior cruciate ligament were resected. A distal femoral osteotomy was performed perpendicular to the mechanical axis of the femur, according to preoperative long leg radiographs. Thereafter, a proximal tibial osteotomy was performed with the extramedullary cutting guide with 7° of posterior inclination to ensure that each cut was made perpendicular to the mechanical axis in the coronal plane and with 7° of posterior inclination along the sagittal plane; no bony defects were observed along the eroded medial tibial plateau in any case. After each osteotomy, all osteophytes were removed and any ligament imbalances were corrected. After femoral distal cut and tibial proximal cut were performed, 10 mm spacer block was inserted to confirm enough gap space and coronal plane alignment at extension. At this point, medial release including osteophyte removal, deep layer of MCL, and posterolateral capsule were performed. Care was also taken not to perform excessive release. We determined femoral component size with anterior referencing technique, and femoral external rotation was preset at 3°, 5°, or 7° relative to the posterior condylar axis, which were determined by preoperative computed tomography and epicondylar view radiograph. In this step, we aimed to achieve soft tissue balancing that the difference between extension gap and flexion gap was within 5 mm under 40 lbs joint distraction force by tensor measurement. After each bone cut and soft tissue release, the tensor was fixed to the proximal tibia and the femoral trial prosthesis was fitted. The joint distraction force was set at 40 lbs in all patients. This distraction force was chosen because it re-creates the joint gap in full extension with the femoral trial prosthesis, which corresponds to the insert thickness used in our preliminary clinical studies [25]. This joint distraction force was loaded several times until the joint component gap remained constant in order to reduce any error resulting from creep elongation of the surrounding soft tissues. Then, the ligament balance (varus angle; in °) and joint component gap (in mm) with the knee at 0° (full extension), 10° (extension), 45° (midrange flexion), 90° (flexion), and 135° (deep flexion) were measured with a reduced PF joint. The bending angle of the knee was measured using a goniometer. To perform these measurements with a reduced PF joint, the medial parapatellar arthrotomy was temporarily repaired with proximal and distal sutures to the connection arm of the tensor. During each measurement, the thigh and the knee were aligned in the sagittal plane to eliminate the external load on the knee at each flexion angle.

In addition to the ligament balance and the joint component gap obtained intraoperatively using the tensor, various values of the change in the joint component gap were calculated from the measured values: 10°–0°, 45°–0°, 90°–0°, and 135°–0°.

2.3. *Measurement of the posterior condylar offset*

As described by Bellemans et al., the preoperative and postoperative PCO were evaluated from true lateral radiographs by measuring the thickness of the posterior condyle projected posteriorly to the tangent of the posterior cortex of the femoral shaft [9] (Fig. 1). In order to obtain the true lateral view, direction of the roentgenographic projection was adjusted under fluoroscopic control.

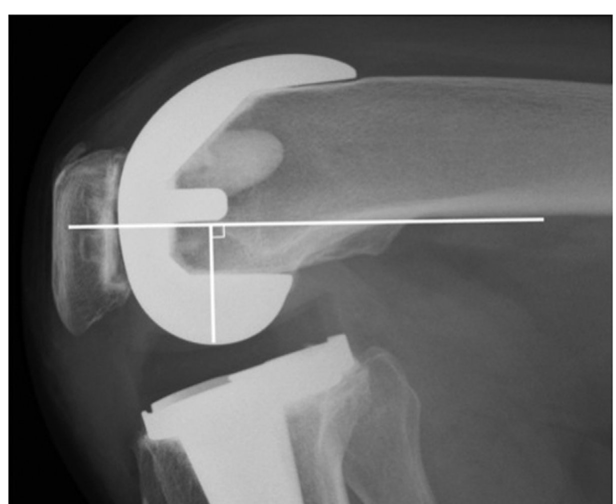

Fig. 1. Preoperative and postoperative posterior condylar offset were evaluated from true lateral radiographs by measuring the maximum thickness of the posterior condyle.