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The Influence of Postoperative Knee Stability on Patient Satisfaction in Cruciate-Retaining Total Knee Arthroplasty

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ABSTRACT

Background: Although knee stability is well known as an important element for the success of total knee arthroplasty (TKA), the direct relationship between clinical outcomes and knee stability is still unknown. The purpose of this study was to determine if postoperative knee stability and soft-tissue balance affect the functional outcomes and patient satisfaction after cruciate-retaining (CR) TKA.
Methods: Fifty-five patients with varus osteoarthritis of the knee who underwent CR TKA were included in this study, and their postoperative knee stability was assessed by stress radiography at extension and flexion 1 month postoperatively. Timed Up and Go test, patient-derived clinical scores using the 2011 Knee Society Score, and Forgotten Joint Score-12 were also assessed at 1 year postoperatively. The effects of stability parameters on clinical outcomes were analyzed using Spearman's rank correlation.
Results: Medial stability at both knee extension and flexion had significant correlations with the shorter Timed Up and Go test and the higher patient satisfaction. Moreover, lateral laxity at extension was significantly correlated with the better patient satisfaction and Forgotten Joint Score-12. However, these correlation coefficients in this study were low in the range of 0.32-0.51.
Conclusion: Medial stability and lateral laxity play an important role in influencing 1-year postoperative clinical outcomes after CR TKA. However, we should keep in mind that these correlations are weak with coefficients at 0.50 or less and the clinical results are also affected by various other factors.

One of the primary principles of a successful total knee arthroplasty (TKA) is balancing the ligaments in both flexion and extension positions. Failure to properly balance the ligaments results in unequal contact stresses in the medial and lateral compartments, thus increasing the risk of wear and/or premature failure of polyethylene insert [1,2]. Therefore, a rectangular and equal gap balance has been recommended. However, in varus-type osteoarthritic knee, excessive release of medial structures for achieving a rectangular gap balance is more likely to result in medial instability, which could deteriorate postoperative clinical results along with induction of persistent pain [3]. Previous authors have also reported that lateral laxity of the knee is physiological [4], necessary for medial pivot knee kinematics [5], and important for postoperative knee flexion angle [6] after cruciate-retaining (CR) TKA. However, it is not completely understood as to how medial stability and lateral laxity could influence clinical outcomes.

For clinical assessment of TKA, an objective scoring system is often used to assess patient function and residual pain, along with more objective factors. However, patient dissatisfaction has been reported to be as high as 19% among patients who have undergone TKA including CR and posterior-stabilized (PS) TKA [7], and several authors have highlighted that it is important to include patient-reported outcomes when evaluating the success of TKA, as there is a discordance between the outcomes assessed by clinicians and those reported by patients [8]. Therefore, surgeons should design their surgical procedures to improve patient outcomes, reduce postoperative complications, and, ultimately, improve the patient's quality of life and satisfaction [9].

Despite many investigations on knee stability using radiographs postoperatively [10–12], the effects of postoperative knee stability on functional outcomes and patient satisfaction are not clearly

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described in the literature. Therefore, the present study aimed to investigate postoperative medial stability and lateral laxity and identify whether these could influence postoperative functional outcomes and patient satisfaction in patients who underwent CR TKAs.

Material and Methods

The hospital ethics committee approved the study protocol, and the patients provided informed consent for participation in this study. The inclusion criteria were substantial pain and loss of function due to varus-type osteoarthritis (OA) of the knee. In addition to the knee condition, patients whose outcome scores could be measured in the outpatient clinic 1 year after their surgeries were included in the study. The exclusion criteria were knees with valgus deformity, severe fixed flexion contractures more than 15°, severe extra-articular deformities, severe bony defect requiring bone graft or augmentation, revision TKA, prior high tibial osteotomies, active knee joint infection, and bilateral TKA. In addition to this, we were often forced to release posterior cruciate ligament for control of severe fixed varus deformity and had to convert CR to PS TKA. We also excluded these patients. We retrospectively selected consecutive 55 cases who met the previously mentioned criteria and underwent primary CR TKA with asymmetric design (Persona CR, Zimmer Inc., Warsaw, IN) between 2014 and 2015. The patient population was composed of 41 women and 14 men (age, 73.1 ± 5.9 years; body mass index, 25.4 ± 3.3 kg/m^2). Among these patients, the average preoperative coronal plane alignment on standard weight-bearing anteroposterior radiographs was 12.1° ± 4.8° in varus. Preoperative range of motion was −3.7° ± 5.5° in extension and 119.2° ± 13.0° in flexion. All CR TKA procedures were performed by the same senior author.

Operative Procedures

TKAs were performed using the measured resection technique with a conventional resection block. After inflating the tourniquet with 280 mmHg of air at the beginning of procedure, a medial parapatellar arthrotomy was performed. The anterior cruciate ligament was resected. A distal femoral osteotomy was performed perpendicular to the mechanical axis of the femur using an intramedullary resection guide, based on preoperative long-leg radiographs. Thereafter, a proximal tibial osteotomy was performed perpendicular to the mechanical axis in the coronal plane and with 7° of posterior inclination along the sagittal plane using an extramedullary resection guide. No bony defects were observed along the eroded medial tibial plateau. After neutral alignment was confirmed with each cut of the distal femur and proximal tibia, a posterior femoral cut was made using the anterior referencing technique. Femoral external rotation was set at 3° or 5° relative to the posterior condylar axis, while referring to Whiteside's line and the transepicondylar axis, measured using preoperative computed tomography images. After each osteotomy, we removed the osteophytes and released MCL mainly using pie cluster technique [13] until spacer block corresponding the resected bone thickness from lateral tibial condyle could be inserted.

Postoperative Laxity Measurements

Knee stabilities at extension and flexion were assessed by stress radiographies at 1 month after TKA. Stability at extension was assessed by varus and valgus stress X-ray using a Telos arthrometer (10 kgf). We evaluated extension stability at 15° of flexion to perform fair measurement under the same condition even in patients who cannot extend the knee completely. We measured joint separation distance (mm) between the lower point of femoral prosthesis and the line in contact with the lower surface of tibial prosthesis at medial and lateral compartments and adjusted it using magnification based on the keel width of tibial prosthesis. We also calculated the distance between the lower point of femoral prosthesis and upper surface of the polyethylene insert as medial joint opening (MJO) and lateral joint opening (LJO) as follows: joint opening = joint separation distance (magnification adjusted) − insert thickness. The insert thickness means what was actually selected intraoperatively. On the varus and valgus stress radiographs, the angles between the line in contact with the bottom of femoral prosthesis and the line in contact with the lower surface of tibial prosthesis were measured. The valgus and varus angles indicated the values of medial laxity or lateral laxity, respectively. We calculated “varus angle − valgus angle” as “varus ligament balance at extension” (lateral laxity; positive value in varus) following a previously reported method [14] and used this value for the analysis (Fig. 1A, B).

Stability at flexion was assessed by the stress epicondylar view with 1.5 kg weight at the ankle [15,16], which enabled us to visualize the posterior condylar axis and the tibia articular line. We also calculated the MJO and LJO in the same way at extension. The angle between the line in contact with the bottom of femoral prosthesis and the line in contact with the lower surface of tibial prosthesis was measured, which defined varus angle as “varus ligament balance at flexion” (lateral laxity; positive value in varus). This value was for analysis (Fig. 1C).

In our hospital, source to image receptor distance was set to 120 cm at both knee extension and flexion uniformly.

Patient-Reported Outcome Scores

The 2011 Knee Society Score (KSS) was developed as a new patient-derived outcome measure to better characterize satisfaction, expectations, and physical activities after TKA [17]. The Forgotten Joint Score-12 (FJS-12) was intended for patients who forgot about the presence of their artificial joint and is reportedly a useful patient-reported outcome tool for artificial joints [18]. Its reliability and validity were demonstrated by a recent study [19]. We evaluated patient-reported measurements using the 2011 KSS and FJS-12 at 1 year after TKA. We evaluated 4 patient-reported sections (patient satisfaction, walking and standing, standard activities, advanced activities) of the 2011 KSS.

Performance Test

The Timed up and go test (TUG) measures the time it takes for a patient to rise from an arm-chair (seat height of 46 cm), walk 3 meters, turn, and return to the sitting position in the same chair. Patients were instructed to walk as quickly as they felt safe and comfortable. The use of arms of the chair was permitted to stand up and sit down. A stopwatch was used to measure the time to complete the TUG within the nearest one hundredth of a second. The TUG is widely used to measure mobility in older adults with excellent test-retest reliability (intraclass correlation coefficients = 0.97) [20]. The TUG was performed preoperatively and 1 year postoperatively to assess basic ambulatory function. A practice trial was completed, and the best time from 3 subsequent trials was used for analysis.

Statistical Analysis

All values are presented as mean ± standard deviation. The results were analyzed using a statistical software package (StatView 5.0, Abacus Concepts Inc, Berkeley, CA). We compared preoperative and postoperative TUG using paired t test and performed Spearman's rank correlation analysis to assess the correlations between