The Journal of Arthroplasty 29 (2014) 2331–2336

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Disparate Postoperative Results in the First and Second Knees on Simultaneous Bilateral Total Knee Arthroplasty

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ARTICLE INFO

Article history:
Received 12 February 2014
Accepted 19 July 2014

Keywords:
simultaneous
total knee arthroplasty
extramedullary reference
clinical outcome, osteoarthritis

ABSTRACT

We hypothesized that the circumstances of the two consecutive operations of a simultaneous bilateral total knee arthroplasty (TKA) are different, and could lead to different outcomes of overlapping bilateral TKAs. Both knees of 420 subjects were evaluated in the current study. In the second TKA, there were more incidence rates of outlier in mechanical femoro-tibial angle (16.2% vs. 9.0%), more blood loss (735 vs. 656 mL), and longer operation time (61, 58 minutes respectively), as compared to the first TKA, while no significant differences in clinical outcomes. In conclusion, there were no significant differences in the clinical outcomes even though few distinct outcomes due to different circumstances of the surgery. Awareness of these findings can help the continued success of bilateral TKA in an increasing patient population.

A large proportion of patients with osteoarthritis of the knee, present with bilateral symptoms at the outpatient department [1]. A simultaneous total knee arthroplasty (TKA) procedure is available for such patients [2] and has several advantages. Simultaneous surgery decreases the required duration of hospital stay as well as the number of hospital admissions, with concomitant decreased absence from work, at an overall less cost to the patient [3,4]. Furthermore, anesthesia during a simultaneous surgery minimizes the complications from multiple episodes of anesthesia [5,6], and period of total rehabilitation is expected to be shorter than a staged approach [7,8].

The first operation in a simultaneous surgery may provide information to the surgeon to determine component size, soft tissue balancing, and estimate gap size for the second operation. Capeci et al indicated a difference in component asymmetry, during bilateral TKA, although bilateral gonarthrosis is frequently symmetric in appearance and deformity [9]. Furthermore, the second team usually conducts an operation in a confined space on the contralateral side during closure for the first operation, which can disturb cooperation during the second operation and may lead to more intra-operative surgical errors.

We hypothesized that bilateral TKAs performed simultaneously would have different postoperative results due to disparate situations. We therefore addressed the following research questions to determine whether there would be differences in short-term clinical outcomes, radiographic results, and implanted component size between the two sides. We sought to: (1) determine whether there was a difference in the incidence and characteristics of outliers for postoperative whole limb mechanical axis angle outside the acceptable range of 180 ± 3° and component alignment angle outside the acceptable range of 90 ± 3°; (2) determine differences in clinical results including operation time, blood loss, and clinical outcome scales obtained from patient questionnaires (the American Knee Society [10], Western Ontario McMaster University Osteoarthritis Index [WOMAC] scales [11]), range of motion (ROM) and incidence of peri-operative surgical complications between bilateral TKAs performed simultaneously; and (3) determine how well femoral and tibial component sizes coincided, the correlation in component symmetry, and which factors were correlated with the asymmetry, in bilateral simultaneous TKA.

Materials and Methods

A retrospective review of 451 consecutive patients, who underwent simultaneous bilateral TKA between January 2011 and April 2012, was conducted. We excluded patients whose radiographic records were incomplete for analysis (n = 39), those with unilateral posttraumatic arthritis (n = 2), those whose knee was operated, using a constrained prosthesis due to severe bony defects in the proximal tibia (n = 7), and those patients who had follow-up data for a minimum of 1 year. After these exclusions, 420 patients were eligible for inclusion. The data were reviewed for demographic characteristics. A preoperative assessment was done according to Kellgren–Lawrence (K-L) classification for gonarthrosis [12]; 384 patients were included in K-L grade IV, 35 in grade III, and 1, who was diagnosed with osteonecrosis, in grade II. There was no significant

The Conflict of Interest statement associated with this article can be found at http://dx.doi.org/10.1016/j.arth.2014.07.025.

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http://dx.doi.org/10.1016/j.arth.2014.07.025
0883-5403/

side-to-side difference of preoperative K-L grade (3.9 ± 0.3 in each side respectively, $P = 1.000$) (Table 2) and ROM (122.4 ± 17.9 in right side, 122.9 ± 16.3 in "left" side, $P = 0.663$) (Table 3). There were 427 females and 24 males with a mean age of 69 years (standard deviation: 6.4 years, range: 55–85 years). The average body mass index (BMI) was 27.4 kg/m^2 (standard deviation: 3.2, range: 19–39) (Table 1). The current study obtained institutional review board approval from our institution (Samsung Medical Center, 2014-01-137) and informed consent was obtained from all participants.

The same surgical technique and rehabilitation protocol were used for both knees of all patients. All surgeries were performed by a single senior surgeon (one of the authors) using Insall's anteromedial approach with a tourniquet [13]. Bilateral TKAs were performed with the senior surgeon conducting the main procedure (from skin incision to implantation of prosthesis). The surgeon first operated on the right side just by implantation, then he switched to the contralateral "left" knee with a second team. The similar main procedure was progressed to the second knee during closure of right side.

All closures were done by the same assistant *i.e.* the first author's fellow. Ritter et al reported overlapped procedures reduced approximately twenty minutes in tourniquet elevation time between the two sides [14]. During the "left" side procedures, the operative team on right side did not provide any assistance to the other side. For this reason, the second operative team, with one operator and two assistants on the "left" side was confined to a restricted area. An extramedullary alignment system for both the femur and tibial guide system was used in all patients [15]. We determined the coronal and sagittal femoral resection planes using a customized graduated ruler for targeting the accurate location of femoral head center [16] the palpable anatomical landmark [17], reported previously. An extramedullary tibial guide with a perpendicular cut to the tibial anatomical axis, was used for the tibial cut [15,18]. Femoral components were sized to optimally match femoral anatomy and create balanced flexion and extension gaps with anterior referencing techniques. Tibial component sizing was performed to maximize coverage of the resected surface and maintain proper component rotation.

Two deep-flex designed total knee prostheses (LOSPA, Corentec, Inc. South Korea; Scorpio Non-Restrictive Geometry (NRG), Stryker, NJ, USA) were used. Two prostheses were used bimonthly during our study and each patient had bilateral surgeries with the same prosthesis. 233 patients underwent bilateral TKAs using Scorpio NRG, and 187 patients using LOSPA. Different versions were available designed to be compatible with the geometry of the femur and tibia implant size. All the components were cemented with Simplex P (Howmedica, Rutherford, NJ) bone cement, and all the patellae were resurfaced with an all polyethylene dome-shaped component, implanted with bone cement. Drains were put on both sides. The skin was closed using a metal stapler, and an elastic compression dressing was then applied. The drain on the right side was clamped during completion of the "left"-side operation. Drains were removed simultaneously the second day after surgery. The total volume of each drain was then recorded separately. A tourniquet was used for all surgical procedures, and the tourniquet was released only after skin closure. Tranexamic acid (0.1 mg/kg body weight) was used for all patients except those with a history of myocardial infarct or stroke. Tranexamic acid was administered via intravenous route just before surgery on both sides in all cases. All patients received a first-generation cephalosporin as antibiotic prophylaxis until postoperative day 3. Continuous passive motion exercises were started on postoperative day 1. Ambulation was allowed on postoperative day 2, after drainage removal. Thereafter, active and passive joint exercises were allowed within a comfortable range of motion (ROM).

Table 1
Demographic Data for the Study Population.

Parameters	Frequencies
Number of patients	420
Age (years)	69.2 ± 6.4 (50–89)
Body mass index (kg/m^2)	27.4 ± 3.2 (19–39)
Sex (number of patients)	
Male	23 (5.5%)
Female	397 (94.5%)
Diagnosis (number of patients)	
Osteoarthritis	413
Rheumatoid arthritis	5
Osteonecrosis	2
General/regional anesthesia	17/429
Kellgren–Lawrence classifications (2/3/4)	1/35/384
Used prosthesis (number of patients)†	
Scorpio NRG®	233
LOSPA®	187

* Values are mean ± standard deviation, with range in parentheses.
† Each patient was taken bilateral TKAs simultaneously with same company's prosthesis.

Clinical Evaluation

Clinical information was prospectively collected by an independent investigator. Parameters compared between the bilateral sides included postoperative blood loss, operation time (tourniquet time), implanted femoral and tibial component size, and peri-operative surgical complications. Blood loss was determined by the total volume of blood *via* a drain for 24 hours postoperatively. Tourniquet time was recorded at deflation after the dressing was applied. ROM recorded in all patients at 1 month preoperatively and 1 year postoperatively, was measured using a goniometer, with the patient in a supine position. Clinical outcome scores were measured using the Knee Society Knee and Function scores (KSKS and KSFS) [10] and WOMAC score [11,19] preoperatively and at 1 year after surgery. A peri-operative surgical complication was defined as a significant problem related to surgery that occurred within 3 months postoperatively. These included deep infection requiring a revision operation, patellar or quadriceps tendon rupture, peri-prosthetic fracture, or peroneal nerve palsy. The difference in the incidence rate of complications was compared between the sides.

Radiographic Evaluation

One of the authors (BHL) screened all full-length radiographs before analysis for excessive rotation of the limb or improper exposure, which would make the radiograph unsuitable for analysis. To determine excessive rotation of the limb on radiographs, the appearance of the lesser trochanter and the fibular head profile was used as landmarks. Radiographs that showed one of these two profiles in excess, were interpreted as malrotation of the limb, and those limbs were excluded from the study. Angles measured on full-length hip-to-ankle radiographs are reportedly reliable [20]. Hence, the radiographic assessment was done using preoperative and postoperative full-length standing hip-to-ankle and standing AP and lateral radiographs. The radiographs taken preoperatively and at one-year follow-up were used for analysis in this study. All digital radiographic images were analyzed using a picture archiving and communication system (General Electric, Milwaukee, WI, USA). The degree of preoperative and postoperative knee deformity or HKA angle was determined on the standing full-length radiographs as the angle between the mechanical axis of the femur (center of the femoral head to the center of the knee) and the mechanical axis of the tibia (center of the knee to the center of the ankle plafond). There was no significant side-to-side difference in preoperative alignment (10.3 ± 6.3° in the first TKA, right side, 10.7 ± 6.4° in the second TKA, "left" side) (Table 2). Postoperatively, coronal alignment of femoral and tibial components was measured using their respective mechanical axes on full-length radiographs. Two independent investigators (KYK, NRL) drew these angles on