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The Effect of Subluxation of Articulating Antibiotic Spacers on Bone Defects and Degree of Constraint in Revision Knee Arthroplasty

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ABSTRACT

This study investigated whether subluxation of articulating antibiotic spacers is associated with the bone defects found and constraint required when re-implanting the knee arthroplasty components. Staged revisions for infections of primary total knee arthroplasties between 2004 and 2012 were examined. Radiographic sagittal and coronal subluxations of 72 knees were measured prior to second stage revision. Coronal subluxation was found to be associated with increased requirement for constrained knee systems ($P < 0.035$). Sagittal subluxation was associated with greater tibia bone defects ($P < 0.037$). Careful surgical technique and monitoring of articulating spacers should be done to avoid subluxation after stage 1 revision. If subluxation of the articulating spacer is present, constrained revision knee systems as well as augments should be available at time of re-implantation.

Two stage revision is the standard of care procedure for the treatment of a chronically infected total knee arthroplasty (TKA). The first stage revision usually involves the removal of the infected implant and insertion of a cement spacer. Commercially available articulating spacers come in a limited number of sizes. Antero-posterior and medio-lateral dimensions often have poor patient fit and the implants may not fit prior bone cuts. During first stage revision, the bonding and strength of the high antibiotic concentration cement are lower, and the spacers are often cemented poorly to facilitate later removal. Bone loss and soft tissue laxity add to the complexity of balancing the knee during a first stage revision.

Struelens et al [1] reported that 57% of articulating spacers were associated with spacer specific problems. Of these 45% were minor problems such as spacer tilting and medio-lateral translation. 12% were spacer dislocations, spacer fracture and knee subluxation. This is not unexpected as bone and soft tissue management at the time of the first stage revision for infection can be clinically challenging, particularly when combined with the issues related to articulating spacer dimensions and high dose antibiotic cement. However, there is no published literature on the effect of spacer subluxation on what may be encountered operatively when re-implanting the patient with a revision TKA during a second stage procedure.

This paper investigated the relationship between the radiographic appearance of the articulating antibiotic spacer with the bone defects and degree of constraint implant required at time of re-implantation.

Materials and Methods

Ethics approval for the study was obtained from the institutional review board. One hundred fifty six cases underwent surgery for infection after TKA between 2004 and 2012. Eighty-four cases were excluded from this retrospective study. Reasons for exclusion included infected revision TKA [11], multiple two stage revisions [17], static spacers [11], multiple stage one surgeries [14], no suitable X-rays for measurement [7], single stage revision [1], irrigation and debridement [14], and amputation or fusion [9]. Seventy-two knees from 71 patients were included in the study. Of these, 40 were right knees and 32 were left knees. The mean age of these patients was 70.2 ± 10.8 years old, with 45 males and 26 females. The mean BMI of these patients was 32.4 ± 6.4 kg/m^2. The mean time between stage one revision (placement of the articulating antibiotic spacer) and stage two revision (implantation of a revision knee system) was 128.2 ± 80.8 days. The mean duration of follow up was 44.9 ± 29.8 months.

Stage one revision involved thorough debridement and synovectomy followed by careful implant removal. Fluid and tissue cultures were taken and medullary canals thoroughly debrided. The antibiotic cement used usually contained 2–3 g of vancomycin and 2.4–3.6 g of tobramycin in each 40 g of bone cement powder. If a specific culture specimen was known pre-operatively, directed antibiotic choices were made. Two types of articulating spacers were used in this study: preformed

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articulating spacers (Spacer K; Exactech; Gainesville, FL) or commercially available molds (StageOne; Biomet; Warsaw, IN). These spacers came in limited sizes. We applied the best possible size according to the trials available for these spacers. The femoral spacer was inserted first, followed by the tibial spacer, and these were cemented to the bone surfaces using high dose antibiotic cement as detailed above. The knee was then brought into extension and held in gentle traction and appropriate alignment to allow the cement to set. Excess cement, and cement between the articulating surfaces were removed.

Postoperatively, patients received a minimum of 6 weeks of intravenous antibiotics. After the intra-operative specimens taken had been cultured and sensitivities known, the post-operative antibiotics selected were tailored appropriately. Serial inflammatory markers were taken to review the clinical response to the treatment of the infection. In general, patients were allowed to fully weight bear, unless the specific clinical scenario would only allow limited weight bearing. The second stage revision was carried out based on the improvement of clinical features as well as inflammatory markers after the cessation of antibiotics. Where necessary, aspiration of the affected knee was performed to help with decision making. Prior to stage 2 revision, dedicated knee, standing full length hip-knee-ankle radiographs and lateral radiographs of the knee were obtained.

During the stage two revision, a thorough debridement and lavage was carried out. The Anderson Orthopaedic Research Institute classification [2] was used to evaluate the bone defects intraoperatively of the femur and tibia and recorded in a prospectively collected database. The surgical technique followed principles of revision TKA by one of seven fellowship trained arthroplasty surgeons at a high volume center.

There were 3 levels of constraint used, posterior stabilized, varus valgus constraint and rotating hinge implants. In cases where there was good balance of the flexion and extension gaps with good coronal stability, a posterior stabilized insert was used. Otherwise when there was substantive asymmetry of gaps or residual coronal instability, a varus valgus constrained implant was used. In the minority of cases where there was complete insufficiency of the medial collateral ligament, or in cases with genu recurvatum, the implant selected was a rotating hinge design.

Follow up evaluations were completed at two weeks, six weeks, three months, one year, and bi-yearly thereafter. Standing anteroposterior, lateral and skyline views of the knee were obtained at follow up visits. During the yearly visits, Medical Outcomes Study Short Form-12 (SF-12) [3], Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) [4] and Knee Society Score [5] were obtained via patient administered questionnaires. These were prospectively filled out during the patient's routine follow up visit and maintained in our institutional arthroplasty database. WOMAC scores were calculated based on a maximum score of 100, with a higher score representing better outcome. Electronic medical records for each patient were retrieved up to the last available visit, and the presence of complications such as reinfection, and periprosthetic fracture noted. Reinfection was defined according to the definition of periprosthetic joint infection according to the Workgroup of the Musculoskeletal Infection Society [6]. Any revisit back to the operating room for surgery related to infection treatment was also classified as reinfection.

Sagittal subluxation was measured using the lateral radiograph of the affected knee taken prior to the stage two revision. The measurement method was similar to that used to measure anterior tibia subluxation following anterior cruciate ligament deficiency [7]. A vertical line was drawn through the most posterior aspect of the tibia joint line. The horizontal distance from the most posterior aspect of the spacer or the femoral cut surface at the level of the femur cut to the above drawn line represents the sagittal subluxation. This was then expressed as a percentage of the AP measurement of the proximal tibia cut surface (Fig. 1).

Coronal subluxation was measured using the anterior posterior radiograph of the affected knee taken prior to stage 2 revision. The most distal cut surface of the femur and the most proximal cut surface of the tibia were marked. The midpoint of these two surfaces was marked.

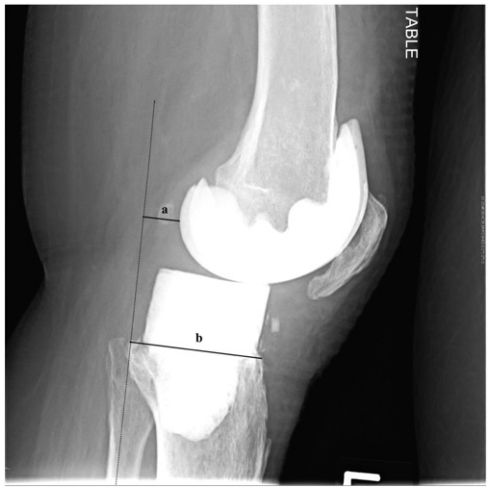

Fig. 1. Method of measurement of sagittal subluxation. a represents the sagittal subluxation. b is the width of the tibial cut surface. Sagittal subluxation (%) expressed as a/b × 100.

Vertical lines were then drawn through these midpoints. The horizontal distance between these vertical lines represents coronal subluxation. These were then expressed as a percentage of the width of the proximal tibia at the level of the cut surface (Figs. 2–4).

Statistical analysis was carried out using SPSS version 22 (IBM, Armonk, NY). Sagittal and coronal subluxation was plotted on a histogram, and divided into two groups. Patients whose knees fell within one standard deviation from the mean were assigned to group one and those whose subluxation was more than one SD away were designated group two. Categorical data were analyzed using chi square test or Fisher's exact test. Outcome scores were investigated for normality and found to be nonparametric. Outcome scores were tested for difference using Mann–Whitney U test and *P* values of less than 0.05 were considered significant.

Results

At second stage revision, 50 (69.4%) patients received a posterior stabilized insert, 19 (26.4%) patients received a varus–valgus constrained insert and three (4.2%) required use of a rotating hinge implant. Table 1 describes the bone defects of the femur and tibia prior to

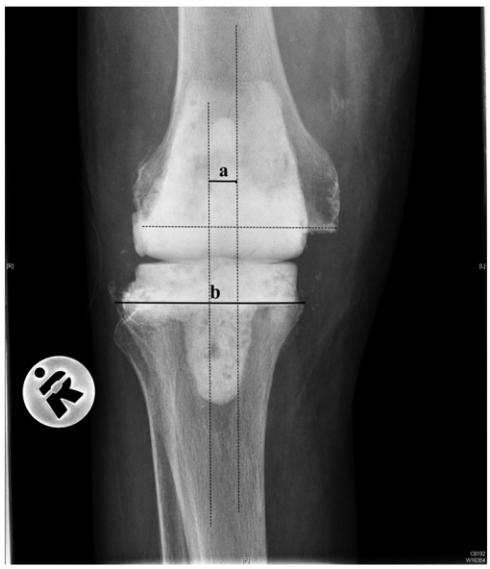

Fig. 2. Method of measurement of coronal subluxation. a represents the coronal subluxation. b is the width of the tibia cut surface. Coronal subluxation (%) is expressed as a/b × 100.