Metal-Backed Versus All-Polyethylene Tibias in Megaprostheses of the Distal Femur

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Abstract: In megaprostheses, the tibial component is rarely a source of failure. The evolution of these implants has followed standard arthroplasty trends moving from majority use of all-polyethylene tibias (APT) to high volume use of metal-backed tibial (MBT) components. We report the results of 72 endoprostheses using either MBT (n = 42) or APT (n = 30) implanted between 1994 and 2006. Failures of the implant related to the tibial component were isolated, and 5-year survival of the tibial implant of the MBT cohort was 94%, and for the APT cohort, 87% ($P = .39$). The difference in tibial component failures between the 2 groups was not statistically significant (Pearson $\chi^2 = 0.1535$, $P = .6952$). Revision rates for the entire implant and infection rates were not significantly different between the 2 groups. **Keywords:** distal femur, megaprosthesis, endoprosthesis, metal-backed, all-polyethylene, tibial component, oncology implant.

Megaprosthetic reconstruction after limb salvage procedures for bone tumor resection and for revision total knee arthroplasty (TKA) with massive bone loss has become standard of care [1-6]. As patients with these implants live longer, it is important to achieve maximum implant survival. Current 5-year survival for distal femur endoprostheses used following tumor resections ranges from 67% to 93% [7-11]. The most common causes for implant failure include infection, local tumor recurrence, implant fracture, and aseptic loosening [8,10,11]. Rarely is the tibia identified as the cause of implant failure [7,9]. The most commonly reported cause of implant failure was fracture of the tibial rotating component [8,10,11]. This complication declined dramatically after 2000 when the manufacturing process for this component changed from cast to forged cobalt chrome to increase its strength.

Many practices currently used in oncologic megaprosthetic reconstructions have been extrapolated from concepts used in conventional arthroplasty surgery. This practice has arisen because the arthroplasty literature is replete with prospective data, patient volume, and long-term follow-up of patients receiving megaprostheses [12-15]. This is due to a lack of volume and uniformity in musculoskeletal oncology. However, megaprostheses differ from conventional TKA in both the biomechanics of the hinged prostheses and the demographics of the patients receiving the implants, both of which divergently affect patient outcome and overall implant survival [16,17].

Our hypothesis was that a metal-backed, modular designed tibial implant would function equivalently to an all-polyethylene tibia when used for a megaprosthetic reconstruction. This concept clearly follows the evolution of knee arthroplasty implants. Originally, TKA implants were designed as all-polyethylene implants, but the load transmission from the polyethylene was better tolerated when the tibial tray had a metal back [18]. The trend in arthroplasty surgery has been to use metal-backed tibial base plates (MBT) and not all-polyethylene base plates (APT) [13]. In megaprostheses, the use of metal-backed base plates has allowed modular tibial components to accept a longer stem. This trend in oncology practices has gradually emerged but is not reported to date. The purpose of this study was to historically compare the outcomes of patients with fully cemented, all-polyethylene tibial components to those of patients with cemented, metal-backed tibial components in distal femoral megaprostheses.

Materials and methods

A retrospective review of a prospective database identified all patients receiving megaprostheses at our institution from January 1994 to December 2006. These

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dates were chosen based on the availability of archived x-rays for radiographic assessments. One-hundred fifty-two patients were identified who had undergone lower extremity distal femoral endoprosthetic reconstruction. Patients receiving custom implants, lacking adequate medical records, and lacking adequate radiographic data were excluded. A minimum of 1-year follow-up was necessary for inclusion. A total of 72 prostheses in 72 patients with adequate follow-up of both medical records and plain x-rays were included in the study. Fifty-eight of these were for tumor resections, 12 were revision TKA, and 2 were for massive bone loss following trauma. Forty-two patients were implanted with MBTs and 30 with APTs.

Patients were followed up longitudinally for implant survival and tumor recurrence after institutional review board approval. Charts were reviewed retrospectively, and patient age, height, weight, surgical indication, adjuvant treatment, comorbidities, and prosthetic outcome were recorded. Knee Society Scores (KSS) were obtained at the latest follow-up and included range of motion, extensor lag, and flexion contractures. KSS was chosen because no comparative megaprosthetic population exists for a historical reference when comparing APT to MBT components.

Tibial component failure was defined as either a defect requiring surgical removal of the original component or any other problem directly related to the tibial implant requiring operative intervention such as periprosthetic fractures. Failure due to the femoral component and infection requiring irrigation and debridement, but where the original implant was retained, were not considered implant failures. Overall prosthetic failure, defined as removal of the prosthesis for any reason, was analyzed as a separate subset. Time to failure was defined as the interval between the date of the original surgery and the date of implant failure diagnosis.

Radiographs were evaluated by a single, blinded reviewer (AAS) who was not a member of the surgical team. Radiographs were reviewed in the immediate postoperative period and at the most recent follow-up for loosening, periprosthetic fractures, tibial component wear, axial alignment and joint line variations. Before March 2001, printed x-rays were evaluated; after March 2001, x-rays were reviewed using picture archiving and communication systems (PACS) with calibrated digital measurements.

All reconstructions were performed using the Stryker Howmedica GMRS reconstruction system (Stryker, Rutherford, NJ). This system offers 2 options for tibial reconstruction. One is an all-polyethylene monoblock tibia intended for full cementation into the tibia. The other option is a metal-backed tibial base plate with modular stems of varying lengths. The base plate accepts a variety of polyethylene inserts of varying thicknesses. The stem may be cemented at the surface of the tibia only or throughout its length. Both base plates accept a tibial rotating component that links the hinge to the femoral component. The cost of the APT is approximately $1500, whereas the cost of the MBT is roughly $2800 depending upon the stem length/type (including insert). Between the years of 1994 and 2006, the tibial portion of the Stryker Howmedica GMRS reconstruction system was changed to increase component strength (3×) and durability. Before 2000, both the axle and tibial rotating component were cast. Beginning in 2000, the implants have contained components made of forged CoCr. The distal femoral bushing housings were also lateralized, and the polyethylene for the bushings was made thicker.

Distal femur resections were performed as needed for oncologic resection with negative margins. Femoral stems were cemented or press-fit at the surgeon's discretion. The tibial cuts for the APTs were made with an extramedullary guide, and plain x-rays intraoperatively were used to evaluate varus-valgus alignment. The APTs were fully cemented with pressurization of the prepared proximal canal and tibial surface. Intramedullary guided cuts were used for the MBTs. The surface of the tibia was cemented and the stems were press-fit. Before 2003, all patients at our institution were implanted with APTs, but this changed in 2003 with the arrival of the senior author (GEH), and most patients since have been reconstructed with MBTs if indications were met. Patients received intravenous antibiotics until drains were removed. Weight-bearing as tolerated was allowed in all groups, and a knee immobilizer was used at all times for the first 2 weeks postoperatively; thereafter, physical therapy was initiated and ROM was increased as tolerated.

Statistical analysis included Pearson's χ^2 test with Yates' continuity correction for comparing component failures and revisions, and a 2 tailed *t* test was used to compare Knee Society Scores. Tibial component and overall implant survival was calculated by a Kaplan-Meier analysis. All statistical analyses were done with Medcalc statistical software version 9.6.4.0 (Medcalc Software, Mariakerke, Belgium).

Results

A database search identified 72 patients meeting protocol criteria who had undergone distal femoral reconstruction with either an APT (n = 30) or MBT (n = 42) component at our institution between 1994 and 2006. The average duration of follow up was 23 months (range, 12-165). There were 31 men and 41 women. All reconstructions using APT were for tumor resections. Twenty-eight reconstructions using MBT were for tumor resections, 12 were for revision TKA, and 2 were for posttraumatic arthritis with massive bone loss. The average age was 49.4 years (range, 10-90 years), average weight was 81.9 kg (range, 34-147 kg) and