

# All-Polyethylene Tibial Components in Octogenarians: Survivorship, Performance, and Cost

Alexander van der Ven, MD, MBA, Richard D. Scott, MD, and C. Lowry Barnes, MD

## Abstract

The ideal recipient for an all-polyethylene tibial (APT) component continues to be controversial. Several recent randomized clinical studies have demonstrated clinical efficacy of APT when compared to metal backed tibial (MBT) components in relation to survival and clinical outcomes measures, particularly in an elderly population. In this retrospective series, 166 knees in 130 patients (age > 80 years) received an APT component. Average follow-up for the living and deceased was 5.7 and 5.2 years, respectively. There were no APT failures at the time of most recent follow-up. Knee Society function score improved from 30 to 48. Almost all respondents reported either good or excellent satisfaction with their outcome. The average cost savings of using APT instead of MBT component can be substantial. We believe octogenarian patients represent the ideal population for an APT component, that functional outcomes and satisfaction levels will be acceptable to those patients, and that the component will outlast the remaining life of the patient while also potentially providing a substantial cost savings, compared with the cost of MBT components.

Since its introduction into modern total knee replacement designs, the utility of the all-polyethylene tibial (APT) component has been a source for debate when compared to metal backed tibial (MBT) components. Early design failures,<sup>1</sup> a poor understanding of appropriate surgical technique,<sup>2</sup> and several biomechanical and finite element analysis studies<sup>3-5</sup> were all thought to contribute to the near abandonment of the APT in the early 1980s.<sup>6</sup> These studies questioned its role when used in weak, and likely older bone, and favored its use in younger and more supportive bone.

Several recent randomized clinical studies have questioned these earlier studies by demonstrating clinical efficacy of the APT compared to MBT components in relation to survival and clinical outcomes measures.<sup>7-9</sup> These series evaluated middle aged to elderly populations with the mean ages ranging from

69 to 72 years (range, 50-93), but did not adequately address the concern of durability in the osteopenic population. Conversely, the subgroup analysis by Bettinson and colleagues<sup>8</sup> revealed that younger patients (average, 62.5) may experience a higher need for revision than older patients (average, 68.9) when using an APT, compared with an MBT.

We agree with the concerns over durability in the younger population but believe that weaker and elderly bone should not be considered contraindications to an APT component. In fact, because elderly patients tend to put lower demands on their knee implants than do younger populations, they may be better candidates for APT components. We believe modern implant designs and improved surgical technique have addressed the design flaws and technical errors discussed by the early clinical and biomechanical studies. Not only do APT components offer a substantial cost savings over MBT components, but they also eliminate the concerns surrounding backside wear and locking-mechanism issues presented by MBT components.<sup>6</sup>

We believe octogenarian patients represent the ideal population for an APT component, that functional outcomes and satisfaction levels will be acceptable to those patients, and that the component will outlast the remaining life of the patient. Also, depending on the hospital contracted pricing structure, a substantial cost savings could be realized with APT components, compared with MBT components.

## Materials and Methods

We retrospectively reviewed all cases of a single surgeon (RDS) from 1992 to 2008. This data set consisted of a total of 3182 total knee replacements, of which 335 (10.5%) were implanted in patients with a minimum of 80 years of age. Of those 335 knees, 166 knees (130 patients) received an APT component, and the remaining 169 knees did not. Although all octogenarian patients were considered potential candidates for an APT component, many did not receive an APT for one of the following reasons.

- An APT component was usually not used in cases where the patient had previously undergone a successful metal-backed total knee arthroplasty (TKA) on the opposite side.
- Patients with an angular deformity greater than 10° of mechanical varus or valgus.

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- Patients with bone stock deficiency that might require modular wedge augmentation or extended tibial stems.
- If ligament balance after bone preparation indicated that the patient was possibly in between tibial thickness sizes at the time of cementation, we may have chosen to implant a modular metal-backed component instead of an APT.
- On rare occasion, a metal-backed component was used because the appropriate APT was not present in the hospital inventory.

### Osteopenia, not a Contraindication to APT

Using medical records, we collected baseline clinical information and preoperative and postoperative Knee Society function scores for each patient. We chose to use only the Knee Society function score as it is patient-centric, objective, and can be reproduced by an observer such as a next of kin. We used the Social Security Death Index to determine the dates of death and obtain follow-up contact information. Internal review board approval from the New England Baptist Hospital was obtained.

We attempted to contact all patients or their respective next of kin by mailed survey. For those not responding to our mailing, a second mailing was sent, followed by a telephone survey. Our survey consisted of 7 questions related to reoperations, Knee Society function scores, satisfaction, and expectations (Table I). For those deceased, the next of kin was asked to recall function at 6 months prior to death.

All procedures were performed by a single senior surgeon contributor (RDS) at either the New England Baptist Hospital or Brigham and Women’s Hospital, Boston, MA. From 1992 to 1996 the Johnson & Johnson PFC (Warsaw, Indiana) was used (22 knees), and later replaced by the Johnson & Johnson Sigma (Warsaw) from 1997 to 2008 (144 knees). All components were fully cemented using Stryker Simplex P cement (Mahwah, New Jersey) using pulsed irrigation and a tourniquet when otherwise not contraindicated. The patella was resurfaced in all patients. Tibial-component alignment was obtained with an extramedullary guide and femoral component alignment by an intramedullary guide. Tibial-bone resection was measured using the same technique as the MBT component. A posterior cruciate ligament retaining prosthesis was used in all patients with an average tibial insert thickness of 9.9 mm. The most commonly used thickness was a size 10 (45.5%) followed by size 8 (34.5%), size 12.5 (17.6%), and size 15 (2.4%). A sagittally-conforming APT component (‘curved’) was used in 145 knees (87.3%) with the remainder receiving a less conforming posterior lipped insert. Ligamentous and flexion/extension balancing was accomplished using conventional techniques similar to those used with MBT components.

Mechanical failure was defined as aseptic or septic loosening, progressive collapse or deformity, or polyethylene failure. Four major total knee replacement manufacturers were polled in April, 2011 in the United States for retail price differences between APT and MBT.

### Results

This series consisted of 99 women (76.2%) and 31 men (23.8%) with an average age of 84.0 (range, 80.0-97.1). The

average body mass index was 27.9 (range, 21.2-43.5). Ninety-four (72.3%) patients underwent a unilateral replacement, 14 (10.8%) were staged bilateral, and 22 (16.9%) were simultaneous bilateral. The preoperative diagnosis was osteoarthritis in 161 (97.0%) of knees, inflammatory arthritis in 4 (2.4%), and osteonecrosis in 1 (0.6%).

A minimum of 2-year follow-up, or follow-up until death was obtained in 87.3% of the knees (111 patients, 145 knees). Fifty patients (67 knees) died at the time of analysis. Of those

**Table I. Survey**

<b>1. Have you had any other surgeries on your knee after the initial procedure by Dr. Scott?</b>
a. No
b. Yes, if so...What type? When? By whom?
<b>2. How far can you typically walk?</b>
a. Unlimited
b. More than 10 blocks
c. 5 to 10 blocks
d. Less than 5 blocks
e. Housebound
f. Unable
<b>3. How are stairs usually for you?</b>
a. Normal up and down
b. Normal up, but down with a rail
c. Up and down with rail
d. Up with rail, unable down
e. Unable
<b>4. Do you regularly use walking aids?</b>
a. None
b. Single cane
c. 2 canes
d. Crutches or walker
<b>5. Were your expectations for the surgery met?</b>
a. Yes
b. Mostly
c. Partially
d. No, if not met, in what way?
<b>6. Would you have the surgery if given the choice again?</b>
a. Definitely
b. Most likely
c. Probably
d. No
<b>7. Overall satisfaction with the surgery?</b>
a. Excellent
b. Good
c. Fair
d. Poor
If not satisfied, why not?
<b>8. Any other comments?</b>

that died, follow-up with the next of kin occurred in 32 patients (44 knees), with another 5 patients (7 knees) who were not surveyed, but had a minimum 2-year follow-up from the clinical record (Table II). The average follow-up for the living and deceased was 5.7 (range, 2.3-15.5) and 5.2 years (range, 2.3-12.5), respectively.

There were no revisions for mechanical failure or any other reason, and no osteolysis was observed in any patients. One patient developed a late hematogenous prosthetic septic arthritis secondary to urosepsis at 2 years postoperatively. This was successfully treated at an outside institution with an arthroscopic irrigation and debridement with retention of all components and antibiotic therapy. The patient has been asymptomatic for 5 years following the debridement.

The average Knee Society Function score increased from 47.5 preoperatively to 58.5 postoperatively. Expectations were met fully in 87.8%, mostly in 4.1%, partially in 1.6%, and not in 4.1% of respondents. Satisfaction was considered excellent in 83.2%, good in 13.6%, fair in 2.4%, and poor in 0.8% of respondents.

In our hospital, the contract structure sets the prices of TKA components individually, and we realized a 30% cost savings when using an APT component instead of an MBT component.

## Discussion

Our findings indicate that an APT component in a TKA is likely to outlast the remaining life of octogenarians while providing functional outcomes and satisfaction levels that are acceptable to the patient. This is important given that, according to the most recent United States Census Bureau data (2008), the average years of life remaining for a person reaching 80 years of age is 8.8 years (men, 7.9 years; women, 9.4 years).<sup>10</sup> In our series of 166 knees, we had a minimum follow-up of 2 years or death in 87.9% of patients. No implants were revised or experienced mechanical failure, and all components had been retained at most recent follow-up. Similar success with knee implant performance and longevity in octogenarians was described in 2006 by Sah and colleagues<sup>11</sup> in their report on unicompartmental knee arthroplasty (UKA), where they noted that UKA implant survival typically exceeded the remaining life of the study patients.

Osteolysis was not seen in any of our study patients. Although this may in part be due to the APT design, it may also be partly due to the relatively short mean follow-up of approximately 5 years. Not only is the APT component less expensive than the MBT component, but locking mechanism issues are avoided also, as is backside wear.<sup>6</sup> However, these benefits need to be weighed against the shortcomings of APT components, which include lack of modularity and no option for liner exchange after the primary surgery.

In our study, 2 different APT component designs were implanted, and 2 different insert designs were used, either a sagittally conforming design or a posterior lipped design. Results published by Gioe and colleagues<sup>12</sup> in 2007 from a registry series of 12 surgeons and 443 patients demonstrated 99.4% survival with revision for any reason as the end point with an

**Table II. Patient Data With 2-Year Minimum Follow-Up**

	Patients (Knees)
Total number of patients in the study	130 (166)
Number of patients, > 2-year follow-up	111 (145)
Deceased patients, ≥ 2-year follow-up (Next of kin response)	32 (44)
Living patients, > 2-year follow-up (Responded)	74 (94)
Living patients, > 2-year follow-up (No response)	5 (7)

average patient age of 77 years. In that study, 3 different APT component designs were used. Cost-savings for this group, compared with those with a MBT component, was estimated at \$729 per case.

One limitation of our study is the lack of a direct comparison group (APT to MBT). However, a study by Najibi and colleagues<sup>13</sup> in a matched population comparing outcomes between the performance of APT and MBT components in elderly patients (average patient age, 78; range 59-91) showed no clinical differences between the 2 components.

In our survey, the majority of respondents were the patients themselves; 74 patients (93 knees) who responded had a minimum follow-up of 2 years. However, 50 patients (67 knees) were in patients who had died by the time the survey was conducted and of those we received responses for 32 knees from next of kin of patients who were deceased. Most series will typically exclude the deceased or will include outcomes to the last visit, thus leaving a large portion of the initial series unstudied.<sup>7</sup> Our objective was to offset—to the greatest extent possible—the effects of excluding that data by requesting and including responses from next of kin.

Many of the responses to our questionnaire indicated that patients were low demand and low functioning, which may have contributed to the success of the APT component in this series. Additionally, many of the returned surveys revealed that the patient suffered from multiple medical comorbidities that often limited their overall function. This also explains the low Knee Society functional scores.

We did not record bone quality or identify those being treated for osteoporosis. This would have required a much more extensive and costly analysis that we believe is beyond the objective of this study. Osteopenia observed preoperatively on radiographs, or intraoperatively at surgery, was not considered a contraindication to an APT component.

In the registry series by Gioe and colleagues,<sup>12</sup> discussed earlier, that showed excellent clinical results in an elderly population using 3 different APT component designs, the authors also estimated that if all patients in their registry over age 75 had received an APT component, the estimated savings for the implant alone would have been \$1.28 million. In a subsequent article by Gioe and colleagues<sup>6</sup> (2010), they noted an average

actual savings of between \$675 and \$957 per case when using an APT versus an MBT component. Although many institutions have incorporated pricing agreements that will substantially decrease unit costs for knee implant components, it should be noted that cost differentials vary considerably from vendor to vendor and from hospital to hospital as well as regionally, and this will directly impact the level of cost savings realized by each institution.

In 2009, over 620,000 TKAs were performed in the United States, and almost 17,000 (2.73%) of these were done in individuals over 85 years old.<sup>14</sup> By 2030, the volume of total knee replacements is expected to increase nearly 500% to 3.48 million procedures per year. This is attributed to increasing patient demands, an aging population, and increasing life expectancy.<sup>15</sup> The number of octogenarians is expected to rise from 3.7% of the population in 2011 to 5.1% in 2030, with an absolute rise of 163%.<sup>16</sup> Concerns over rising costs have led to major legislative changes in order to curb these costs while maintaining access. The only way to continue to provide high quality care to an expanding population is with reliable cost control measures.

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Dr. van der Ven is Assistant Professor of Orthopaedic Surgery, Florida International University, Herbert Wertheim College of Medicine, Doctors Hospital Center for Orthopedics & Sports Medicine, Coral Gables, Florida. Dr. Scott is Professor of Orthopaedic Surgery, Harvard Medical School, Department of Orthopaedic Surgery, New England Baptist Hospital, Boston, Massachusetts. Dr. Barnes is Professor in Orthopaedics, University of Arkansas for Medical Sciences, and Medical Director, HipKnee Arkansas Foundation, Little Rock, Arkansas.

Address correspondence to: C. Lowry Barnes, MD, Arkansas Specialty Orthopaedics, 600 S McKinley, Little Rock, AR 72205 (tel, 501-246-4439; fax, 501-246-4437; lbarnes@arspecialty.com).

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