Cementless Femoral Prostheses Cost More to Implant than Cemented Femoral Prostheses

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Abstract Prosthetic cost contributes greatly to the overall expense of THA. A key question, therefore, in the selection of implant technique is whether any price difference exists between a cementless and a cemented femoral prosthesis. We evaluated the price difference between the most commonly used cemented and cementless femoral stems at three high-volume academic medical centers. Each hospital's costs for prostheses from the manufacturers were recorded. The average cost of implanting a cementless femoral prosthesis was \$296 more than the average cost of implanting a cemented femoral stem, even with the additional expense of two batches of bone cement and the accessories commonly used to achieve a third-generation cementing technique. The price difference was less variable if the cost of the prostheses from only the primary implant supplier for each institution was considered. As the number of THAs performed per year continues to escalate, implantation of a cemented femoral component remains an attractive method of fixation from an economic standpoint.

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Level of Evidence: Level III, economic and decision analysis. See the Guidelines for Authors for a complete description of levels of evidence.

Introduction

THA is one of the most successful orthopaedic operations, with excellent long-term outcomes using either cemented or cementless fixation. Cemented fixation of the femur provides a durable, reproducible, and cost-effective technique. Fixation of the femoral stems with modern cement techniques can last 20 to 30 years without loosening in a high percentage of patients [3, 6, 7, 28, 31–34]. However, a growing body of evidence supports the use of cementless femoral components with many studies having long-term outcomes equal to those using contemporary cemented fixation [8, 23–25, 36]. Moreover, some authors suggest cementless implants benefit patients in terms of reduced operative time and reduced likelihood of fat embolism or venous thromboembolic disease [9, 11, 16, 30].

With the current number of THAs performed yearly and the expectation that this number will increase in the future, it is important to understand the costs associated with any procedure. Much effort has focused on lowering the expense for THA, such as using less invasive surgical technique (which theoretically should reduce the length of hospital stay after the operation) or using less costly implants [20, 29, 37]. Many surgeons assume cementless femoral components are more expensive than cemented femoral components owing to their increased design and manufacturing complexity [4]. If true, higher expense would be particularly important when surgeons are electing to use a cementless technique in elderly individuals undergoing THA because long-term implant survival in

this population is not a primary issue. Implanting cemented stems, however, requires the additional expense of cement and the accessories needed for cement fixation, and increases the potential for longer operative time.

We therefore hypothesized, for high-volume academic medical centers, the cost of a cemented stem, even with cement and cement accessories, is lower than the cost of a cementless femoral prosthesis.

Materials and Methods

We collected data from three academic medical centers: University Hospitals Case Medical Center, Cleveland, OH; Duke University Medical Center, Durham, NC; and Stanford University Medical Center, Stanford, CA. The three medical centers, located in different geographic areas, are considered high-volume joint arthroplasty centers, which are defined as centers in which more than 300 primary THAs are performed per year (Table 1) [21]. The hospitals' costs charged by their implant suppliers for the prostheses used in each institution were recorded and reported in a blinded and randomized fashion as Manufacturers A and B. In all three medical centers, these two manufacturers supplied 98% or more of the hip implants used during the study period. The institutional identification was randomized as 1, 2, and 3 for the three medical centers. This information is current as of January 2008.

The hospital cost was defined as the actual amount the hospital pays to the manufacturer for the implant. The prices (in US dollars, excluding taxes) were obtained from the hospital implant managers for the relevant prostheses. We obtained the price for only one design of cemented femoral prosthesis, which was the primary implant used in each institution. However, because various designs of cementless femoral prostheses are available, the data were collected for the most commonly used proximal porous-coated cylindrical stem, fully porous-coated cylindrical stem, and tapered stem from each manufacturer for that institution.

More than 1000 joint arthroplasty procedures are performed at each medical center per year and therefore each has volume discount contracts with the manufacturers.

Table 1. THAs performed at each institution in 2007

Mode of fixation	Number of THAs		
	Institution 1	Institution 2	Institution 3
Cementless	184 (56.4%)	357 (97.3%)	365 (84.5%)
Hybrid	139 (42.7%)	10 (2.7%)	67 (15.5%)
Cemented	3 (0.9%)	0 (0%)	0 (0%)
Total	326 (100%)	367 (100%)	432 (100%)

Volume discount contracting through vendors is a practice in which the implant supplier offers a discount or the hospital negotiates a discount with the manufacturers. Typically, the hospital administration in conjunction with the orthopaedic surgeons set a maximum price for the implants they will use and all vendors are free to bid for the contract. The process is open to all vendors who are willing to meet these price constraints. Because of confidentiality clauses and contract policy with the manufacturers, we could not disclose the actual hospital costs for the prostheses. Costs therefore are reported as the price difference between cementless and cemented femoral components for each institution. This price difference was calculated by subtracting the cost of the cemented femoral prosthesis, with and without the addition of cement and accessories, from the cost of the cementless femoral stem. The number was given as positive if the cost of the cementless component was more expensive than the cemented component and vice versa.

One of the medical centers (Institution 3) has two different contract policies with the vendors: a volume discount contract through the vendors and a single price/case price purchasing policy (only for cementless THA with one manufacturer). The single price/case price purchasing policy is a program in which the institution pays a single price per unit or case. A single price for cementless THA implants, for example, included the cost of a cementless hemispheric acetabular component, a 28- or 32-mm femoral head, a highly cross-linked polyethylene liner, and a cementless femoral prosthesis. To calculate the cost of the cementless femoral prosthesis for Institution 3, therefore, we used the range, from minimum to maximum, of the fractional cost of cementless femoral stems from the other two medical centers as the guide to best estimate the cost (Table 2).

Cement and cement accessories were the only equipment used for the third-generation cement technique; these included two 40-g bags of bone cement without antibiotics, a vacuum mixing cartridge, cement pressurizer, canal plug, proximal and distal cement centralizer, canal brush, and cement scrapers.

Table 2. Fractional cost of cementless femoral stem from overall cost for cementless THA*

Institution	Average (%)	Range (%)
Institution 1	60.6	59.5–61.7
Institution 2	56.1	54.8–57.4

* Overall cost for cementless THA included cementless hemispheric acetabular cup, cross-linked polyethylene liner, cobalt-chromium femoral head (size 28 or 32 mm), and various designs of cementless femoral stems.

Table 3. Average price difference between implantation of cementless and cemented femoral components

Manufacturer	Average price difference (US dollars)			
	Institution 1	Institution 2	Institution 3	Among three institutions
Manufacturer A				
Stem only	860.6 [†]	980	545.8 [†]	795.4
Stem + cement*	508.8 [†]	579.8	137.3 [†]	408.6
Manufacturer B				
Stem only	1311	577.5 [†]	−178.8	569.9
Stem + cement*	959.2	177.3 [†]	−587.3	183.1

* Cost of implantation of cemented femoral component after including two batches of bone cement without antibiotic and all accessories needed for third-generation cementing technique; [†] primary implant supplier in each institution.

The price differences between cementless and cemented femoral prostheses before and after the addition of cement and cement accessories were calculated and shown for each institution.

Results

Across all centers, the average cost of a cementless femoral prosthesis was approximately \$570 more expensive from Manufacturer B and \$795 more expensive from Manufacturer A than a cemented femoral prosthesis. The range of the price difference, however, was from \$179 less to \$1311 more expensive for the cementless stem. The average total cost to the hospital for two 40-g batches of bone cement and all accessories used to achieve a third-generation cement technique was \$386 (range, \$351–\$407) at the three institutions. When the costs of this bone cement and these cement accessories were added to the cemented femoral prosthesis, the actual price difference between cementless and cemented femoral stem implantation at the three institutions decreased to an average of \$409 and \$183 for Manufacturers A and B, respectively (Table 3).

The range of price difference was narrower for the primary implant supplier for each institution when compared with the other, lower-volume implant supplier to the medical center (Fig. 1).

Discussion

The cost of THA is an important issue for hospitals in today's healthcare market [5]. Based on Medicare and US Census data, the annual hospital charges for primary THA will likely increase to \$17.7 billion by 2015 [14]. The costs of the prosthesis are a major contributor to the overall costs of this procedure [1, 13, 26]. Therefore, hospitals must implement strategies to control THA implant costs. One of

Fig. 1 The range of the implant costs to medical centers varied considerably when comparing their primary implant supplier with their other, lower-volume implant supplier. The cost for implantation of a cemented femoral prosthesis included a cemented femoral stem, two batches of bone cement, and cement accessories.

the strategies is to use the least expensive implant design without jeopardizing the patient's functional outcome. There is an assumption that cementless femoral components are more expensive than cemented femoral components [4]. However, implanting cemented stems requires the additional expenses of cement and accessories. We therefore evaluated the cost difference between implanting the most commonly used cemented and cementless femoral stems at three high-volume academic medical centers.

There are several limitations in our study. First, our cost analyses captured only the costs for the prostheses. Professional charges, additional in-hospital component charges, and rehabilitation costs were not included. It is apparent that the length of hospital stay, postoperative nursing care, and cost after discharge play major roles in the overall expense to the healthcare system for primary THA. There is no evidence, however, that these costs would vary based on the types of femoral component

fixation used in our study. Second, the costs of the components obtained for this study were for commonly used, conventional THA. If surgeons choose to use antibiotic-loaded bone cement instead of nonantibiotic bone cement or use more costly technologies for femoral components, such as hydroxyapatite-coated femoral stems or modular cementless femoral stems, the price difference for implantation of cementless and cemented femoral components would differ from our results.

We have not reported the revision rate for each prosthetic design. However, long-term survivorship at a minimum of 10 years has been reported for each prosthetic design selected in this study [8, 10, 17, 22, 38]. In addition, the meta-analysis of Morshed et al. [27], which compared the implant survivorship between cemented and cementless fixation of the femoral component, showed no overall superiority in either mode of fixation as measured by a difference in survival rate. Because the method of implant fixation does not seem to affect the long-term outcome, the cost differential between cementless and cemented fixation, therefore, has become a more important factor in determining the choice for implant fixation for individuals undergoing THA.

We found the average price at the three high-volume orthopaedic institutions to be \$296 (range, \$183–\$409) higher for the cementless stem than for the cemented stem. Our data differ from those of Barrack et al. [2] and Yates et al. [39], who suggested the cost of implanting a modern cemented stem, including cement accessories, was greater than that of a corresponding cementless stem. The study of Barrack et al. [2], however, was a cost comparison of equipment used in 1996, whereas the study of Yates et al. [39] compared the cost of prostheses used primarily in Europe. Moreover, in our study, the costs of cement and cement accessories in all three medical centers were less than those reported by Barrack et al. [2] (\$386 versus \$710). This difference in cost for cement and cement accessories can be explained by competition among manufacturers and volume discounts. Although the average cost differential of \$296 (range, \$183–\$409) per patient represented only a small portion of the total expense for THA, this cost differential could result in almost ½-million dollars in savings for 1000 procedures per year.

The range of the implant costs to medical centers varied considerably when comparing their primary implant supplier with their other, lower-volume implant supplier. This cost variation can be explained by the fact that through the high-volume use of cementless implants from one primary implant supplier, a medical center can better negotiate and control the pricing than with lower-volume implant suppliers.

Decreased operative time is a theoretical advantage of cementless femoral fixation over cemented fixation.

Generally, the cementing process, including preparation of the femoral canal, can add 15 to 20 minutes to the THA [18]. Alternatively, with cementless implants, reaming the femoral canal is often performed. It is possible, therefore, that the overall costs of a hybrid THA will catch up with those of the cementless THA if the additional charges are included for the time of the operative room, staff nurses, and anesthesiologist. Although we have not reported the operative time at each institution, our review of these data from one of the medical centers (Institution 1) revealed a close overall operative time for cementless THA (121 ± 20 minutes) compared with hybrid THA (128 ± 17 minutes). The surgeons at that institution, however, perform approximately 40% cemented femoral components per year. This suggests, in an uncomplicated primary THA, a surgeon experienced with both techniques would take the same operative time implanting either a cemented or cementless femoral stem.

The surgical volume for joint arthroplasties influences the overall costs of the procedures [12, 19, 21, 35]. Martineau et al. [21] reported on the total costs of THA in Canadian hospitals. They reported the costs were 60% greater in low-volume centers compared with high-volume centers and the controlled unit costs of the implants may contribute to the lower direct and total costs in the high-volume centers [21]. Similarly, all three medical centers in our study have their own strategies to control the cost of the implants. Although we reported the cost difference in only high-volume centers, we recognize the important differences between high- and low-volume centers. Our data, therefore, may not represent the cost for prostheses in other hospitals across the United States.

Katz et al. [15] analyzed the data of Medicare patients during 1995 and 1996 and reported 82% of primary THAs in the United States were performed by surgeons who did 25 or fewer cases per year. Lower-volume medical centers, therefore, might want to consider implementing strategies and management plans to decrease the total costs for THA, such as forming purchasing consortiums to allow for higher-volume purchasing. Other strategies might include a uniform approach for implant selection and use by the surgeons at each institution. Savings also could be achieved not only from lowered prosthesis expense but also from lowered operating room, postoperative care unit times, and ancillary supply costs. With these efforts, we believe the overall hospital costs could be reduced, representing considerable savings as the need for THA increases in the coming years.

In high-volume joint arthroplasty centers and despite discounted contracts between manufacturers and these medical centers, the cost of implanting a cementless femoral prosthesis is still higher than that of a cemented femoral stem, even with the additional costs of cement and

accessories needed to achieve a third-generation cementing technique. From an economic standpoint, therefore, the use of cemented femoral prostheses remains an attractive method of fixation in THA.

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