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Polished Cemented Femoral Stems Have a Lower Rate of Revision Than Matt Finished Cemented Stems in Total Hip Arthroplasty: An Analysis of 96,315 Cemented Femoral Stems

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ABSTRACT

Background: Matt and polished femoral stems have been historically grouped together in registry assessment of the outcome of cemented femoral stems in total hip arthroplasty. This is despite differences in the mode of fixation and biomechanics of loading. The aims of this study are to compare the survivorship of polished tapered stems with matt finished cemented stems.
Methods: Data on primary total hip arthroplasty undertaken for a diagnosis of osteoarthritis from September 1999 to December 2014 were included from a National Joint Registry. Revision rates of the 2 different types of femoral components were compared.
Results: There were 96,315 cemented femoral stems included, of which 82,972 were polished tapered and 13,343 matt finish. The cumulative percent revision at 14 years of polished stems was 3.6% (3.0-4.2) compared to 4.9% (4.1-5.7) for matt finish stems. Polished tapered stems had a significantly lower revision rate of femoral revision (hazard ratio 0.56, $P < .001$). This difference is evident in patients aged <75, and becomes apparent in the mid-term and continues to increase with time. Aseptic loosening accounts for 75% of revisions of matt finish stems compared to 20% for polished tapered stems.
Conclusion: Although both polished and matt finish stems have excellent early to mid-term results, the long-term survivorship of polished stems is significantly better, with aseptic loosening becoming an issue with matt finish stems. In the future reports of cement fixation for femoral stems may benefit from separate analysis of polished and matt finish.

Cemented femoral stems have a long history in total hip arthroplasty (THA) [1]. When assessing the effect of fixation on the outcome of THA, national joint registries have typically grouped all cemented stems together. However, there are differences in design and surface finish. The role of surface finish on implant function can lead to variations in cement adhesion, abrasion properties, and the loosening process [2–6]. The mode of fixation and biomechanics of loading for polished (tapered) and matt finished (composite beam or I-Beam design) stems are very different [7], as is the theorized mechanism of failure [5,8].

Although many of the earliest cemented stems had a rough finish, most cemented stems today have a smooth, polished surface. Polished cemented stems have been shown to have excellent results in long-term prospective case series and joint replacement registries [9,10]. A smooth, polished surface finish has a lower cement-prosthesis interface fixation strength when compared to

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Table 1
Polished and Matt Finished Femoral Stems Used in the Analysis.

Polished Femoral Stems		Matt Finished Femoral Stems	
Model Name	Number Used	Model Name	Number Used
C-STEM	5481	Charnley	58
CPCS	6628	Elite Plus	2828
CPT	11,902	Omnifit	3509
E2	270	Spectron EF	8839
Exeter V40	68,293	VerSys	546
MS 30	3541		
Quadra-C	548		

matt finish stems. This initially led to the belief that there would be a higher rate of loosening and failure at this surface [11]. However, as the polished surface is not abrasive, there is low debris generated as a consequence of this motion. Polished stems are not bonded to the cement and as they load they create hoop stresses that maintain bone density without loss of fixation functioning on the "taper slip" or "force closed principle" [11,12]. Experimental work suggests that the taper slip stem can support substantially greater loads before failure than the composite beam under both static loading and cyclical loading [13].

In contrast, matt finish stems have a rougher surface. This improves fixation through the adherence and mechanical interlock of the implant to cement and requires greater force to disrupt this interface [7]. Although having a lower probability of interface motion, once micro-motion occurs, matt finish stems have a higher debris generation consequence [8] and this may ultimately lead to excessive osteolysis and loosening [4,14].

Several cohort studies suggest that femoral cemented fixation is more reliable with polished stems [15–18]. This includes case series with the same surgeons inserting the polished and matt finished stems with the same operative technique [3,4]. Differences between polished and matt finish stems become more pronounced in the mid-term to long-term [5], irrespective of stem design and the cementing technique [2]. This has led some authors to abandon the use of matt finish stems in THA [2,19]. However, differences in survivorship have not been demonstrated in 2 randomized controlled trials (RCTs) with mean 4.8 and 6.5-year follow-up [20,21]. Although early revisions have been demonstrated in published series using matt finish stems [22], not all series have resulted in decreased survivorship [23,24]. National joint registries provide information on large numbers of THA and can be used to compare the outcomes of many variables. The aim of this study is to compare the outcome of polished cemented stems to matt finished cemented stems using data from the Australian Orthopaedic Association National Joint Replacement Registry (AOANJRR).

Materials and Methods

The AOANJRR began data collection on September 1, 1999 and includes information on almost 100% of arthroplasty procedures performed in Australia since 2002. Registry data are validated against patient level data provided by each of the State and Territory Health Departments in Australia with the use of a sequential, multi-level matching process. A matching program is run monthly to search for all primary and revision arthroplasty procedures recorded in the registry that involved the same side and joint for the same patient, thus enabling each revision to be linked to the primary procedure. Data also matched by the Australian Institute of Health and Welfare's National Death Index to obtain information on the date of death. The registry records the reasons for revision and the type of revision on THA. All cemented stems were evaluated and divided into polished and matt finished depending on their characteristics and range description. Only primary conventional hip procedures recorded for a diagnosis of osteoarthritis were included. All procedures with a large head metal-on-metal bearing surface or with a modular neck prosthesis were excluded because of their known higher rate of revision. Stratified analyses of gender and 4 different age groups (<55, 55-64, 65-74, and ≥75) were also undertaken.

Statistics

Time to first revision of the femoral component was described using Kaplan-Meier estimates of survivorship, with right censoring for death or closure of the database at the time of analysis. Unadjusted cumulative percent revision was estimated at each of the first 11 years with 95% confidence intervals (CI) using unadjusted point-wise Greenwood estimates.

Hazard ratios (HR) from Cox proportional hazard models, adjusting for age and gender, were used to compare the rate of revision between groups. The assumption of proportional hazards was checked analytically for each model. If the interaction between the predictor and the log of time was statistically significant in the standard Cox model, then a time varying model was estimated. Time points were iteratively chosen until the assumption of proportionality was met and the HRs were calculated for each selected time period. In our results, if no time period was specified then the HR was proportional over the entire follow-up period. All tests were 2 tailed at the 5% level of significance. Analysis was performed using SAS version 9.3 (SAS Institute Inc, Cary, NC).

Results

There were 7 polished stem designs and 5 matt finished femoral stems designs included. Table 1 presents the polished and matt finished cemented femoral stems included in this analysis. The cumulative percent revision for the femoral component at 14 years was 3.6% (95% CI 3.0-4.2) for polished stems and 4.9% (95% CI 4.1-5.7) for matt finished stems (Table 2, Fig. 1). The main reason for the reduced rate of revision was due to a reduction in revisions for loosening and lysis for polished stems (Table 3, Fig. 2). The differences in rates of revision for polished and matt finished stems were evident for both women and men ($P < .001$).

Data were also analyzed by 4 age groups: <55, 55-64, 65-74, and ≥75. There was a significantly lower rate of revision for

Table 2
Yearly Cumulative Percent Revision of Primary Total Conventional Hip Replacement by Model (Primary Diagnosis Osteoarthritis).

Cumulative Percent Revision	1 y	2 y	3 y	4 y	5 y	6 y	7 y
Matt	0.1 (0.1-0.2)	0.4 (0.3-0.5)	0.6 (0.5-0.8)	0.9 (0.7-1.0)	1.2 (1.0-1.4)	1.5 (1.3-1.8)	1.9 (1.6-2.2)
Polished	0.3 (0.3-0.4)	0.5 (0.4-0.6)	0.6 (0.6-0.7)	0.8 (0.8-0.9)	1.0 (0.9-1.1)	1.2 (1.1-1.3)	1.4 (1.3-1.5)
Cumulative Percent Revision	8 y	9 y	10 y	11 y	12 y	13 y	14 y
Matt	2.2 (1.9-2.5)	2.7 (2.3-3.0)	3.1 (2.8-3.6)	3.7 (3.2-4.2)	4.1 (3.6-4.6)	4.5 (3.9-5.2)	4.9 (4.1-5.7)
Polished	1.6 (1.5-1.7)	1.8 (1.7-2.0)	2.1 (1.9-2.3)	2.3 (2.2-2.6)	2.7 (2.4-3.0)	3.2 (2.8-3.6)	3.6 (3.0-4.2)