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Original Article

A short-term follow-up study of a surgeon-customised fully-coated hydroxyapatite femoral stem using a nation-wide joint registry

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ABSTRACT

Objective: To compare revision rates between otherwise-identical fully-coated and proximally-coated hydroxyapatite (HA) femoral stems using a nation-wide registry.
Methods: 249 proximally-coated stems (50 μm HA) and 225 fully-coated stems (100 μm HA and 50 μm titanium) were followed over a mean of 34.9 and 23.2 months respectively.
Results: Four proximally-coated (rate: 1.61%) and five fully-coated stem revisions (rate: 2.20%) were reported, with no statistical difference between groups ($p = 1.0$, OR 0.90, 95% CI 0.20–3.97). Registry data showed no difference in performance between fully-coated and proximally-coated stems nationwide (rate: 2.22%, $p = 0.82$).
Conclusion: There is no statistical difference in survival between fully-coated and proximally-coated HA prostheses in the short-term.

1. Introduction

Since its development by Furlong and Osborn[1] in 1985 and by Geesink[2] in 1986, hydroxyapatite (HA) coating has become a widely used form of fixation in total hip arthroplasty (THA). The development of this technique has sought to improve performance of implants in younger, more active patients in whom cemented stems tend to fail.[3–5] Given this benefit, the use and research of cementless fixation in THA has increased in the last decade. Most notably, in 2014 the Australian Orthopaedic Association National Joint Replacement Registry[6] (AOA NJRR) reported that cementless fixation had a lower rate of revision 3 years after surgery compared to cemented THA, particularly in younger patients. A significant volume of literature has been dedicated to laboratory-based studies

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Abbreviations: HA, hydroxyapatite; THA, total hip arthroplasty; AOANJRR, Australian Orthopaedic Association National Joint Replacement Registry; SOCRATES, Standardised Orthopaedic and Cartilage Repair and Treatment Evaluation Software; SD, standard deviation; CI, confidence intervals; OR, odds ratio.
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investigating the use of HA as a coating material. In histological analysis, HA coatings have been shown to achieve early implant stabilisation,[7] and compensate for stem micromotion[8] by encouraging bone formation across large gaps.

In contrast, the clinical role of HA coatings is still under some debate, with several trials reporting a potential clinical benefit,[7,9–11] whereas others report no significant difference in stem performance.[12–15] In 2015, a meta-analysis[16] was performed to compare proximally-coated HA and porous-coated non-HA femoral stems. It showed a significant improvement in Harris Hip Scores and patient reported thigh pain in favour of HA-coated stems, though no difference in rates of aseptic loosening.

Evidently, most of the literature is focussed on the use of proximally-coated HA stems. A comparatively small level of research has been dedicated to the impact of fully-coated HA stems on implant survival. The fully-coated HA stem may provide potentially significant clinical advantage over a proximally-coated stem by increasing distal stability, reducing stem micromotion and improving performance in poor quality bone. There are several long-term studies reporting on the success of these stems, however there is a paucity of literature which directly compares implant survival between partially- and fully-coated HA stems. Hence, this study aims to directly compare implant survival of a novel, surgeon-customised fully-coated HA stem to a widely-used proximally-coated HA stem, using a surgeon's database. The AOA NJRR was also used to minimise loss of patient follow-up, examine nationwide implant survival and to verify the accuracy of the surgeon's database.

2. Materials and methods

2.1. Operative methods

445 patients received 474 primary hip replacements, either a standard or modified Anthology Primary Hip System femoral stem (Smith & Nephew Inc., Memphis, USA) using standard operative procedure. All operations were performed by a single surgeon under spinal anaesthesia using a standard posterior approach in an operating theatre with laminar flow. A femoral neck osteotomy was performed, followed by reaming of acetabulum and broaching of the femoral canal. Trial implants were inserted and the joint was reduced. Final implants were then inserted and the wound was closed in a traditional fashion over a drain. Patients were routinely allowed to weight bear from day 1 post-operatively, and underwent a rehabilitation programme before discharge.

2.2. Follow-up and data collection

249 proximally-coated HA femoral stems were inserted in 233 patients between June 2006 and October 2013 (Group A). 225 modified fully-coated HA femoral stems were inserted in 212 patients from May 2008 to May 2013 (Group B). Implants were inserted consecutively, except in the rare instance where an appropriate implant size was not available. Patients followed up with the surgeon at standard post-operative intervals (6, 12, 24, 52 weeks and then annually). Mean follow-up in Groups A and B were 34.9 months and 23.2 months respectively. Using the AOA NJRR, there was complete follow-up of patient revisions in both stem groups.

Ethics approval was obtained from Sydney Local Health District Human Research Ethics Committee, Concord Hospital (Reference Number: CH62/6/2014-07). Data were collected from the surgeon's database, SOCRATES (Standardised Orthopaedic and Cartilage Repair and Treatment Evaluation Software, Ortholink, Sydney, Australia). Patient demographics, procedural records, intraoperative notes and post-operative follow-up consultation information were recorded for each implant inserted. The primary outcome measured was revision surgery. As per the AOA NJRR, revisions were classified as major revisions (removal of femoral stem or acetabular cup) or minor revisions (removal of any prosthesis not directly fixed to bone). These data were then forwarded to the AOA NJRR for verification. Any discrepancies between the two databases were recorded.

2.3. Stem design

The standard stem features a 50 μm HA coating as well as a 300 μm sintered bead coating along its proximal surface (Fig. 1A). The primary surgeon led a design team of orthopaedic engineers to modify the existing femoral implant with the aim of improving implant survival. The modified stem (Fig. 1B) is composed of a titanium alloy (Ti–6Al–4V). It is the first cementless stem design to the best of our knowledge that has a *Taperloc* blade stem design with extensive HA coating. The coating features a combination of 100 μm HA and 50 μm titanium along the entire stem surface, both applied by plasma spray. This dual layer is thought to enhance adhesive properties of the coating. Horizontal steps were inserted onto all faces of the stem to convert hoop tension into compression. Vertical grooves at the distal stem were inserted to allow give of medullary contents during stem insertion. This stem has a narrower cross-sectional profile than other fully-coated HA stems, giving better torsional stability. Most notably, both the stems used in this study had an identical geometrical footprint, such that one broach could be used on either stem.

2.4. Patient demographics

There was no statistically significant difference in patient demographics using standard T-tests (Table 1).

3. Results

3.1. Revision rates

According to the primary surgeon's database, there were 4 revisions of the 249 primary procedures in 233 patients within Group A (revision rate: 1.61%). One of these revisions was not recorded on the surgeon's database as it was performed by another surgeon. Of these, two were major revisions (major revision rate: 0.80%), and only one required removal of the femoral stem (femoral stem revision rate: 0.40%). In Group B, there were five revisions of the 225 primary procedures in 212 patients (revision rate: 2.20%). Of these, there was only one