The use of cementless stems to perform total hip arthroplasty (THA) has increased in popularity during the past 2 decades. In the 1970s, cementless press-fit THA designs were created to optimize implant survival rates. It has been reported that 60% to 90% of THAs performed in the United States involve the use of a cementless stem, cup, or both. However, because the mean age of patients undergoing THA continues to decline, earlier stems may not accurately mimic the geometry of the femur. These first-generation cementless stems may produce prominent gaps between the endosteal bone and the surface of the femoral component. They may inhibit stable fixation, or lead to insufficient canal filling, which may result in prosthetic loosening, implant failure, and/or thigh pain.

Some of the newer generation femoral stems have attempted to more accurately imitate the anatomy of the native femur. This is done by creating a size-specific medullary curvature of the stem that can accommodate more bone sizes and shapes, particularly for younger patients (age <65 years) undergoing THA. This more closely mimics the femoral canal, potentially providing a more stable fixation, as described in a cadaver study performed on a cohort of diverse individuals. To allow this second-generation stem to be slightly shorter and to accommodate a greater variety of morphologies, a modeling and analytics system was used in the design process. This system offers a large database of different bone sizes and shapes taken from diverse populations along with automated analysis and implant fitting tools.

Although there have been several studies comparing cementless prostheses, it may be important to compare earlier (first-generation) with newer (second-generation) cementless designs. Some designs have demonstrated difficulty in fitting an implant with a wide metaphyseal anatomy. This second-generation design significantly increases diaphyseal fill, and implant fit is performed with simple bone preparation, using a “broach only” technique.

The purpose of this study was to compare the clinical outcomes of a new second-generation proximally coated, tapered wedge cementless stem were compared with those of its predecessor regarding (1) all-cause implant survivorship; (2) objective and subjective outcomes; (3) complications; and (4) radiographic features. Patients who underwent a primary total hip arthroplasty with the second-generation stem (68 hips) were compared with those who received the first-generation stem (136 hips) at a mean follow-up of 3.5 years. Although the first-generation stem was designed in the traditional manner, the second-generation stem was shortened to accommodate all surgical approaches and designed using a computed tomography scan-based database to enhance fit. The second-generation stem had survivorship, functional, and subjective outcomes similar to those of the first-generation stem. [Orthopedics. 2015; 38(9):550-554.]
outcomes of a new second-generation proximally coated, tapered wedge cementless stem with those of its predecessor regarding (1) all-cause implant survivorship; (2) objective outcomes and subjective outcomes as measured by (a) Harris Hip Score (HHS), (b) patient satisfaction, (c) activity level, (d) quality of life, and (e) pain level; (3) complications; and (4) radiographic outcomes, including (a) radiolucentencies and (b) stem subsidence.

**Materials and Methods**

A prospective cohort study was performed in which consecutive patients who underwent a primary THA using the second-generation Accolade II (Stryker Orthopaedics, Mahwah, New Jersey) femoral stem (67 patients; 68 hips) were matched (1:2) to patients from a database of 200 THAs who received the first-generation tapered, proximally coated titanium cementless stem design, the Accolade TMZF (Stryker Orthopaedics) (134 patients; 136 hips) (Figure). All patients who had a revision secondary to periprosthetic joint infection were excluded. Each cohort had a mean follow-up of approximately 3.5 years (range, 2.8 to 4.7 years and 2.6 to 4.8 years, respectively). Similarly, there were no significant differences among multiple demographic variables, including gender (53% vs 63% female; \( P=.15 \)), primary diagnosis of osteoarthritis (88% vs 86%; \( P=.66 \)), mean age (57 vs 55 years; \( P=.34 \)), and mean body mass index (30.5 vs 30.6 kg/m\(^2\); \( P=.92 \)).

All operations were performed at a high-volume institution by 3 joint reconstruction fellowship-trained orthopedic surgeons using an anterolateral approach. The first-generation stem was a proximally coated, tapered titanium alloy cementless stem. The second-generation stem was similar but was shortened and had a morphometric wedge taper and a medial curvature. These modifications were designed to allow it to fit a broad range of bone sizes to suit variations in the population. For both cohorts, the cementless Trident Acetabular Cup System (Stryker Orthopaedics) was used.

Data collected included pre- and postoperative HHS, Short-Form 36 (SF-36) questionnaire responses, University of California Los Angeles (UCLA) activity scores, visual analog scale (VAS) pain scores, and patient satisfaction scores (postoperative only). The HHS involves a validated 100-point scale used to evaluate hip joint function, range of motion, pain, and the presence of deformities following THA. The SF-36 is a questionnaire that assesses patient-perceived physical and mental quality of life after THA. The UCLA activity score is a 10-point Likert scale commonly used and validated following THA that allows the patient to indicate subjective activity level. The VAS is a 10-point Likert pain scale that has been validated as a measure of pain level following THA.

When assessing for complications, the authors specifically looked for surgical complications such as surgical site infection, venothromboembolic disease, instability, periprosthetic fracture, limb length discrepancy, and osteolysis until patients' latest follow-up. In addition, both cohorts were evaluated for perioperative medical complications within 30 days of their initial arthroplasty such as urinary tract infection, myocardial infarction, atelectasis, and respiratory complications (asthma, chronic obstructive pulmonary disease exacerbations). Radiographs were obtained at 2-week, 6-week, 3-month, 6-month, and 1-year follow-up and then annually. Two of the authors (B.H.K., J.J.C.) assessed the radiographs for radiolucentencies around the acetabular or femoral components, stem subsidence, or cup migration.

After de-identifying all data, the outcome measures were entered into a Microsoft Excel spreadsheet (Excel 2011; Microsoft Corporation, Redmond, Washington). Fisher’s exact and \( t \) test were used to compare subjective and objective functional outcomes between the cohorts at latest follow-up. A Kaplan-Meier survivorship curve was produced from the raw data to evaluate survivorship. All statistical calculations were conducted with GraphPad Prism version 5.01 software (GraphPad Software Inc, La Jolla, California). A \( P \) value of less than .05 was used to determine significance.

**Results**

**Survivorship**

All-cause survivorship was similar between the cohorts (98.5% vs 99.2%; \( P=.61 \)).
### Table

Comparison of Outcomes Between the Cohorts

<table>
<thead>
<tr>
<th>Component</th>
<th>Mean (Range), points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All-Cause Survivorship</strong></td>
<td>83 (36-100)</td>
</tr>
<tr>
<td><strong>HHS</strong></td>
<td>46 (17.4-59.6)</td>
</tr>
<tr>
<td><strong>SF-36 Physical Component</strong></td>
<td>50 (30.4-74.9)</td>
</tr>
<tr>
<td><strong>SF-36 Mental Component</strong></td>
<td>5.8 (1-10)</td>
</tr>
<tr>
<td><strong>UCLA Activity Score</strong></td>
<td>1.9 (0-8)</td>
</tr>
<tr>
<td><strong>VAS</strong></td>
<td>14 (2-16)</td>
</tr>
<tr>
<td><strong>Satisfaction</strong></td>
<td>99.2%</td>
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<td><strong>All-Cause Survivorship</strong></td>
<td>83 (35-100)</td>
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<tr>
<td><strong>HHS</strong></td>
<td>45 (23.7-60.6)</td>
</tr>
<tr>
<td><strong>SF-36 Physical Component</strong></td>
<td>52 (26.8-67.2)</td>
</tr>
<tr>
<td><strong>SF-36 Mental Component</strong></td>
<td>5.2 (2-9)</td>
</tr>
<tr>
<td><strong>UCLA Activity Score</strong></td>
<td>2.1 (0-9)</td>
</tr>
<tr>
<td><strong>VAS</strong></td>
<td>14 (4-16)</td>
</tr>
<tr>
<td><strong>Satisfaction</strong></td>
<td>98.5%</td>
</tr>
</tbody>
</table>

### Complications

A 41-year-old man in the second-generation stem cohort was diagnosed with an acute asthma exacerbation. She was treated successfully with rescue inhalers and nebulizer treatments during her hospital stay and had no further complications.

### Radiographic Outcomes

There was 1 episode of asymptomatic radiographic loosening within the first-generation cohort. There were no instances of loosening within the second-generation cohort; however, there was no significant difference in the incidence of loosening between the 2 cohorts (0.7% vs 0%; \( P = .48 \)). The loosening occurred in a 42-year-old woman and was noticed at her 1-year follow-up appointment. The patient was radiographically and clinically assessed every 3 to 6 months up to her 3-year follow-up, and the radiographic lucency showed no signs of progression. Furthermore, she achieved an HHS of 86 points and was pain free.

### Discussion

Because cementless stems are becoming more popular models for THA, various prosthesis stems are being developed with the goal of maintaining implant survivorship. More specifically, shorter stem designs have been explored that may be easier to use in certain surgical approaches, and it is important to know if these second-generation stems are allowing for good patient-reported outcomes. The current authors’ results show that this second-generation proximally coated, tapered wedge cementless stem had short-term survivorship as well as functional and patient-reported outcomes similar to those of its previous first-generation design.

This study is not without limitations. It was conducted at only 1 high-volume institution and involved only 3 fellowship-trained joint reconstruction surgeons. Although these limitations may lead some to question the ability to extrapolate these results to medical centers with lower volume, this allows for some consistency in intra- and postoperative care to prevent confounding the results. In addition, although the sample size

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(Table). There was 1 revision in the second-generation stem cohort due to a periprosthetic fracture in a 50-year-old man. He achieved an HHS of 80 points at 4-year follow-up and was performing all activities of daily living without difficulty. There was 1 revision in the first-generation stem cohort due to instability. Approximately 2 years after this 60-year-old woman’s revision, she was pain free and radiographs showed no signs of instability or loosening. There were no revisions secondary to aseptic loosening in either cohort.

Objective and Subjective Outcomes

As measured by HHS, there was no difference in the mean objective outcomes between the first- and the second-generation femoral stems (83 vs 83 points; \( P = .97 \)). There were also no significant differences between the cohorts in UCLA activity scores (6 vs 5 points; \( P = .97 \)), VAS scores (2 vs 2 points; \( P = .55 \)), and SF-36 physical (46 vs 45 points; \( P = .55 \)) or mental (50 vs 52 points; \( P = .1 \)) scores. Moreover, the satisfaction scores were also similar between the cohorts (14 vs 14 points; \( P = .3 \)) (Table).

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was relatively small, the authors believe it is adequate for generalizability. Despite these limitations, the authors believe the outcomes of this study are valid.

Although there are few studies regarding this particular press-fit design, Issa et al. compared the in vivo fit of this second-generation cementless stem (Accolade II) with that of its previous first-generation design (50 vs 50 arthroplasties). After a 6-week radiographic follow-up, they found a substantially better fit in the Accolade II cohort, with significantly more of these patients achieving both proximal and distal engagement of the stem (84% vs 56%; P=.001). In addition, the control cohort had significantly more implants that could only achieve proximal engagement (38% vs 14%; P=.001). Although they could not conclude the clinical significance of this enhanced fit, they postulated that a better fit may reduce the risk of loosening by limiting the micromotion of the tip of the stem.

Additionally, other studies have shown positive patient-reported outcomes and implant survivorship. Kim assessed the outcomes of a cementless anatomic femoral component with a polished and tapered stem (601 hips). After a mean follow-up of approximately 9 years (range, 5 to 12 years), the mean HHS was 96 points (range, 68 to 100 points) and the implant survivorship was 99.5%. Archibeck et al. evaluated outcomes in a similar manner (72 hips). After a mean follow-up of 10 years (range, 8 to 11 years), the stem showed a 100% survivorship and a mean HHS of 94 points (range, 48 to 100 points). In addition, after a mean follow-up of approximately 8 years (range, 5 to 11 years), Harris et al. found an implant survivorship of 96% and a mean HHS of 95 points (range, 84 to 99 points). Thus, all of the authors concluded that this implant design offers outcomes and survivorship similar to those of its predecessors.

This second-generation stem was developed using a 3-dimensional modeling and analytical technology (SOMA) (Stryker Orthopaedics), which is a computerized technology that provides a database of different bone morphologies from diverse populations. These 3-dimensional data include varieties in size, shape, density, and cortical boundaries, as well as age, sex, and demographic related variations, which aid in preoperative planning and the development and modeling of new designs, such as this stem.

Using the SOMA database library, Wuestemann et al. evaluated the effect of femoral canal morphology on the contact area of a variety of tapered stems, including the second-generation design described in this study. In the 3-dimensional analysis of the surface contact of the various designs, the authors noted that only this second-generation cementless press-fit femoral stem provided uniform proximal and distal contact. So although this second-generation design yielded results similar to those of the first-generation stem, it offers a better overall canal fit, as demonstrated by this anatomical software.

Despite this, it is important to note that these earlier generation prostheses can achieve satisfactory outcomes. Most recently, Pierce et al. evaluated the outcomes and survivorship of the same prostheses used in the control cohort of this study (194 arthroplasties). After a 5-year follow-up, there was a Kaplan-Meier aseptic survivorship of 99.4% (95% confidence interval, 96.3% to 99.9%) and all-cause survivorship of 98% (95% confidence interval, 94.6% to 99.2%). Moreover, they achieved a mean HHS of 92 points (range, 26 to 100 points). Therefore, it is important that patients and practitioners know that earlier implant designs can still achieve good outcomes and survivorship.

**Conclusion**

Although patients can achieve positive outcomes with the first-generation cementless implants, the authors’ results indicate that this second-generation cementless press-fit femoral stem with a morphometric wedge taper offers results similar to its predecessor and may decrease the risk of aseptic loosening. Despite these similar outcomes, the results may be different if examined in mid- and long-term studies. As such, future research should examine the long-term survivorship and patient-reported outcomes of cementless designs containing this morphometric medial curvature.

**References**


