Revision total knee arthroplasty (TKA) is becoming increasingly common as the population ages and the number of existing primary TKAs continues to increase. Revision TKA systems use a greater range of component modularity than primary TKA systems, including stems, augments, and varying levels of constraint. The purpose of this study was to retrospectively review the authors’ institution’s use of one specific revision knee implant system and its midterm results. The Vanguard SSK Revision Knee System (Biomet, Warsaw, Indiana) was implanted 297 times in 272 patients between 2005 and 2013. Average patient age was 67.2 years, average body mass index was 33 kg/m², and average follow-up was 4.8 years. The most common diagnoses leading to use of this system were failed previous TKA (45.5%) and periprosthetic infection (23.2%). The SSK system was used in 78 (26.3%) complex primary TKAs at the discretion of the operating surgeon. There were 22 failures: 12 septic and 10 aseptic. Of the 12 infections, 6 occurred after 2-staged treatment of periprosthetic joint infection, with all 6 of these reinfections having a different causative organism. Aseptic failures included aseptic loosening (n=3), periprosthetic fracture (n=2), patellar maltracking (n=2), instability (n=1), arthrofibrosis (n=1), and extensor mechanism disruption (n=1). Aseptic implant survivorship was 97.2%, 95.6%, 93.1%, and 93.1% at 1, 3, 5, and 7 years postoperatively, respectively. The Vanguard SSK demonstrates excellent performance at medium-range follow-up with respect to complications, clinical scores, and prosthesis survivorship. [Orthopedics. 2016; 39(5):e833-e837.]

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for tibial and femoral components. Modular polyethylene provides a continuum of constraint from posterior stabilized (non-constrained) to varus/valgus constrained polyethylene (constrained). All components were cemented at the metaphyses, whereas the stems could be cemented or cementless. Cemented stems were matte-finish titanium, whereas cementless stems were grit-blasted titanium. Implant choice was based on bony and soft tissue deficiencies matched with surgeon preference. Due to the wide variety of modularity combinations, these implant choices were not quantified in the current study.

Intraoperative data and follow-up radiographic and Knee Society Score (KSS) data were reviewed. Failure included re-operation for any reason.

The Vanguard SSK Revision Knee System was implanted 297 times in 272 patients between March 30, 2005, and May 21, 2013. Average patient age was 67.2±9.8 years (range, 35-94 years). Average body mass index (BMI) was 33.2±6.7 kg/m$^2$ (range, 21.8-60.1 kg/m$^2$). There were 155 (57.0%) females and 117 (43.0%) males. Average follow-up was 4.8±1.7 years (range, 2.0-8.9 years). Eighteen patients were deceased at the time of the current study. All components were cemented at the metaphyseal interface, but cemented and cementless stems were used according to surgeon preference.

Diagnoses included failed previous TKA (Figure 1), complicated primary TKA (Figure 2), periprosthetic infection status-post excisional arthroplasty (Figure 3), periprosthetic fracture, and arthrofibrosis (Table 1).

Primary TKAs with the Vanguard SSK Revision Knee System were more deformed than typical primary TKAs from the database, particularly in the case of preoperative valgus deformity (22.5% vs 8.6%) ($P<.0001$, chi-square test). Statistical analysis was performed with SAS 9.3 statistical software (SAS Institute Inc, Cary, North Carolina). Survival analysis was determined by the Kaplan-Meier method, with failure defined as aseptic loosening of the prosthesis for any reason. The Cochran-Mantel-Haenszel statistic was calculated to quantify the risk of reinfection for those knees with an infection diagnosis at the index operation, and the odds ratio was determined by the logit method. A $P$ value less than .05 was considered significant.

**RESULTS**

Of the 297 prostheses, 22 (7.9%) had been revised at the time of this study. The reasons for failure were infection, aseptic loosening, early periprosthetic fracture, extensor mechanism problems, instability, and arthrofibrosis (Table 2). There were no revisions for polyethylene wear at the time the study was conducted.

The infection rate was 4.0% (n=12), of which 6 were reinfections. The aseptic failure rate was 3.4% (n=10) (Table 3). Kaplan-Meier survival analysis was performed (Table 4).

Revisions due to infection were at increased risk of reinfection (6 of 74; 8.1%) (odds ratio=3.2; $P=0.0403$, Cochran-Mantel-Haenszel statistic) compared with all other diagnoses (6 of 223; 2.7%).
Of the 297 implants, 159 (53.5%) were constrained and 138 (46.5%) were non-constrained. At last follow-up, the aseptic survival was 94% and 92% for constrained vs nonconstrained, respectively ($P=.2879$). However, regarding infection, survivorship was 86% and 97% for constrained vs nonconstrained, respectively ($P=.0061$).

Knee Society Scores were established at each follow-up visit. Average KSS at final follow-up 2 or more years postoperatively was 77.4±15.8 (range, 24-95); average function score was 66.3±25.8 (range, 0-100); average pain score was 43.1±11.1 (range, 10-50); and average stair score was 32.5±12.5 (range, 0-50).

**DISCUSSION**

Survivorship of the Vanguard SSK Revision Knee System is excellent at midterm follow-up. Previous studies have shown survivorship of revision TKA to be inferior to that of primary TKA.\(^\text{13}\) This is consistent with the authors’ institution’s experience; however, the survivorship of the Vanguard SSK Revision Knee System met or, more often, exceeded the reported survivorship with other systems.\(^\text{13-15}\)

There were 12 (4.0%) infections in 297 cases of Vanguard SSK Revision Knee System implantation, which is significantly higher than the 0.5% rate of infection of primary TKAs in the authors’ institution.\(^\text{16,17}\) Six of 12 failures for infection were actually reinfections, where the knee had already undergone 2-stage exchange for treatment of periprosthetic joint infection. This leaves 2 infections in primary implantations and 4 infections in aseptic revision knees. The reinfection rate after 2-stage exchange was 9% (6 of 67). Thus, knees that have undergone 2-stage exchange for infection at the authors’ institution have 3.2 times the risk of reinfecting compared with knees with no history of infection ($P=.0403$). This reinfection rate is consistent with previous studies that showed reinfection rates of 9% after reimplantation.\(^\text{18,19}\) In all 6 cases, the second infection was caused by a different cultured pathogen. Although no statistical conclusions can be made from this finding, it suggests that initial treatment of the infection was successful and further supports the importance of host factors in periprosthetic knee infections.

![Figure 3: Bilateral primary total knee arthroplasties. The left knee has a late hematogenous periprosthetic infection (A). Postoperative radiograph showing articulating antibiotic cement spacer (B). Postoperative radiograph showing Vanguard SSK with cementless stems (Biomet, Warsaw, Indiana) used for reimplantation after staged treatment of periprosthetic joint infection (C).](image)

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Table 2</th>
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<tr>
<td><strong>Diagnoses</strong></td>
<td><strong>Mechanisms of Failure</strong></td>
</tr>
<tr>
<td>Diagnosis</td>
<td>No. (%)</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>78 (26.3)</td>
</tr>
<tr>
<td>Failed previous non-TKA</td>
<td>8 (2.7)</td>
</tr>
<tr>
<td>Failed previous TKA</td>
<td>133 (44.8)</td>
</tr>
<tr>
<td>Infection</td>
<td>74 (24.9)</td>
</tr>
<tr>
<td>Periprosthetic fracture</td>
<td>2 (0.7)</td>
</tr>
<tr>
<td>Arthrofibrosis</td>
<td>2 (0.7)</td>
</tr>
<tr>
<td>Total</td>
<td>297 (100.1)</td>
</tr>
<tr>
<td>Extensor mechanism disruption</td>
<td>1 (0.3)</td>
</tr>
</tbody>
</table>

Abbreviation: TKA, total knee arthroplasty.

Both cemented and cementless stems have been shown to provide excellent radiographic and clinical stability.\(^\text{20-22}\) In the current study, which stem design was used varied by surgeon preference and experience. Two of 3 aseptic loosening failures involved cementless stems (the third was a primary-
type tibial implant), although no conclusions may be drawn from that finding.

There was no statistically significant difference in terms of aseptic failure with regard to aseptic loosening, but there was a statistically significant difference with regard to infection. This difference in infection rates is consistent with the need for constraint in knees with more deformity, more soft tissue deficiency, and more previous operations. The data did not show an increase in prosthesis loosening as the level of constraint increased.

There are several limitations to this study. The study is retrospective and includes 5 surgeons. The broad range of components, modularity, augments, and stems offered in the Vanguard SSK Revision Knee System allows the surgeon to reconstruct a variety of bony defects, as well as to compensate for soft tissue deficiencies. The degree of patient and implant variability in revision TKA prohibits high-level clinical trials for comparison of implants and outcomes. However, the Vanguard SSK Revision Total Knee system has shown excellent midterm results in the authors’ institution, with few failures directly related to the implant.

### CONCLUSION

In the current study, the Vanguard SSK Revision Total Knee system had excellent performance at medium-range follow-up with respect to complications, clinical scores, and prosthesis survivorship. Based on the failure modes seen in the current study, the authors expect long-term survivorship to be high as well.

### REFERENCES


