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Original Article

Results of a Modular Revision System in Total Knee Arthroplasty

David A. Crawford, MD [a, b, *], Keith R. Berend, MD [a, b], Michael J. Morris, MD [a, b], Joanne B. Adams, BFA [a], Adolph V. Lombardi Jr., MD, FACS [a, b, c]

[a] Joint Implant Surgeons, Inc, New Albany, Ohio
[b] Mount Carmel Health System, New Albany, Ohio
[c] Department of Orthopaedics, The Ohio State University Wexner Medical Center, Columbus, Ohio

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ABSTRACT

Background: Revision total knee arthroplasty (TKA) poses unique challenges compared with primary TKA such as bone loss, deformity, and ligament instability. Modular component options allow flexibility to deal with these complexities. The purpose of this study was to evaluate midterm outcomes for revision TKA using a modular revision knee system with complete interchangeability and multiple options for augmentation, offset, constraint, and stem extensions.

Methods: A query of our practice registry revealed 257 consented patients (274 knees and 278 TKA) with minimum 2-year follow-up who underwent aseptic revision TKA with a modular system (Vanguard Super Stabilized Knee; Zimmer Biomet, Warsaw, IN) between 2005 and 2013. Four patients were rerevised to a second Vanguard Super Stabilized Knee within the study period. Mean age was 68 years, and mean number of previous surgeries was 2 (1-14).

Results: At mean follow-up of 6.0 years (range, 2-11 years), there have been 25 aseptic revisions involving one or more components (9.0%): 15 aseptic loosening with concomitant instability in 2, 8 others with instability, 1 with hypersensitivity, and 1 revised elsewhere for unknown cause. Ten knees were revised for infection. Range of motion improved from 100° preoperatively to 105° most recently. Knee Society clinical scores improved from 45 to 79, and function scores from 46 to 56. Radiographic evaluation revealed satisfactory position, fixation, and alignment in 97% and abnormal findings in 7 knees: 4 limited to the patella, 1 tibial radiolucency, 1 femoral and tibial radiolucency, and 1 tibial subsidence.

Conclusion: The results of this modular TKA revision system at 6 years mean follow-up are promising for use in complex scenarios, with a low frequency of aseptic rerevision, good knee stability, and substantial improvements in range of motion and clinical and functional outcomes.

It is projected that the demand for primary total knee arthroplasty (TKA) in the United States will grow to 3.48 million procedures by the year 2030 [1]. This 637% increase in primary TKA correspondingly will follow with a 601% growth in revision TKA [1]. There are many reasons for revision of TKA including infection, aseptic loosening, and instability. With each of these indications come surgical challenges of dealing with bone loss, deformity, and instability. Modular knee revision systems afford the surgeon the flexibility to augment for bone loss, adjust constraint, and add stemmed components. The purpose of this study was to evaluate outcomes using such a system, the Vanguard Super Stabilized Knee (SSK; Zimmer Biomet; Warsaw, IN) modular revision system.

Methods

A query of our practice arthroplasty registry from 2005 to 2013 revealed 331 consecutive patients (352 knees and 357 TKA) who underwent aseptic revision TKA performed by one of 3 fellowship-trained arthroplasty surgeons (AVL, KRB, MJM) using the Vanguard SSK modular revision system (Zimmer Biomet, Warsaw, IN; Fig. 1A,B). The SSK is a posterior-stabilized (PS) constrained (PSC) component, which provides varus-valgus constraint. It is indicated in

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* Reprint requests: David A. Crawford, MD, Joint Implant Surgeons, Inc, 7277 Smith's Mill Road, Suite 200, New Albany, OH 43054.

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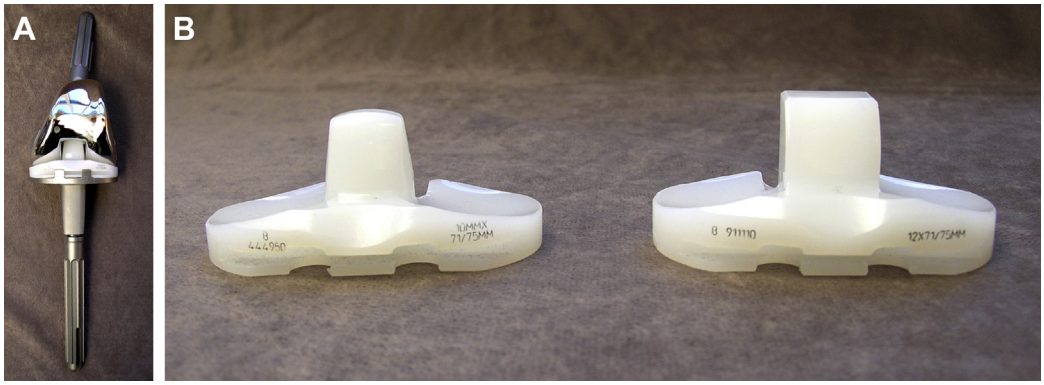

Fig. 1. (A) The Vanguard Super Stabilized Knee (Vanguard SSK; Zimmer Biomet, Warsaw, IN) modular revision system has complete interchangeability within the Vanguard system, including a variety of stem lengths and options. (B) Two options of constraint are available for the Vanguard SSK: a less-constrained posterior-stabilized option shown on the left, and a super-stabilized posterior-stabilized constrained option shown on the right.

cases where there is attenuation of the medial or lateral collateral ligament, and a PS bearing will not provide varus-valgus stability. Specific indications for a PSC device are in knees compromised by attenuation of the medial collateral ligament secondary to valgus malalignment with inability to obtain satisfactory varus/valgus stability in both flexion and extension, in knees complicated by an incompetent posterior cruciate ligament and inability to obtain symmetry in both flexion and extension, in knees complicated by varus/valgus instability with or without flexion-extension gap symmetry and in cases of recurrent dislocation of a PS TKA. A rotating hinge is indicated in salvage situations for gross instability, where both the medial and lateral collateral ligaments are compromised and incompetent. The cohort of revision TKA patients with Vanguard SSK implants represents 44% of aseptic major component revision TKA (357 of 816) performed during the study period, with major component defined as the femoral component with or without revision of the tibial tray or patella. During the study interval, other types of constrained condylar devices were used in 127 aseptic revision TKAs, for a total proportion of 59% constrained condylar. Cruciate-retaining implants were used in 165 aseptic revisions (20%), PS in 78 (10%), rotating hinge in 88 (11%), and a single rigid hinge in an oncology patient revised for polyethylene wear. The majority of the other constrained condylar devices used were Vanguard SSK 360 (Zimmer Biomet) in 103 knees, introduced in May 2011 as the successor to the SSK with additional options for modularity. In the Vanguard SSK group, 4 patients (5 TKAs) declined to sign our independent institutional review board (Western Institutional Review Board, Puyallup, WA)—approved general research consent allowing a retrospective review. Nine patients (9 TKAs) died during the study period and had not signed the general research consent, and 5 presumed living patients (5 TKAs) have not responded to our request to participate. Thirty-three consented patients (35 TKAs) with no known failures or complications died before returning for a 2-year follow-up, and 23 presumed living consented patients (25 TKAs) with no known failures or complications were lost to contact before returning for the 2-year follow-up, yielding a cohort for review of 257 patients (278 TKAs and 274 knees) with a minimum 2-year follow-up. Five patients underwent a subsequent aseptic revision of their knee during the study period to a second Vanguard SSK device. Four of these second TKAs had a minimum 2-year follow-up and are included in the review. All available patient records were reviewed for demographics, component constructs, clinical assessment, complications, and subsequent surgeries. Clinical assessments were performed with Knee Society clinical rating system scores [2] and University of California, Los Angeles, activity scores [3]. Patients were assessed preoperatively, at 6 weeks postoperatively, and annually, thereafter. Kaplan-Meier survivorship analysis [4] was performed using MedCalc Statistical Software, version 16.8.4 (MedCalc Software bvba, Ostend, Belgium; https://www.medcalc.org; 2016), to assess survival portion to endpoints of revision of any component for aseptic causes. Patients with failed TKA were censored at the time of failure and nonfailed patients were censored at the time of last clinical contact. All implants used in this study have been approved by the US Food and Drug Administration and were used in accordance with the manufacturer's labeling.

There were 103 (40%) male patients (111 TKAs) and 154 (60%) female patients (167 TKAs). Mean patient age at surgery was 67.0 years (range, 39-88 years). Mean body mass index (BMI) was 33.6 kg/m^2 (range, 19.9-54.5 kg/m^2). Patients often had multiple indications for revision TKA, with aseptic loosening in 130 (47%) and instability in 84 (30%) patients being the most frequent (Table 1). Patients had undergone a mean of 1.9 previous surgeries (range, 1-14).

Standard cobalt chromium Vanguard SSK implants were used in 265 TKAs (95%) and custom ion-bombarded titanium Vanguard SSK were used in 13 TKAs (5%) in patients with history or suspicion of metal sensitivity. Mean femoral implant size was 66.3 mm with size 55 mm used in 2 knees, size 57.5 mm in 1, size 60 mm in 66 (24%), size 65 mm in 107 (38%), size 70 mm in 65 (23%), size 75 mm in 33 (12%), and size 80 mm in 4. Femoral augments were used in 154 knees (55%) including 2 porous metal cones. Femoral stem extensions used were splined in 252 knees (91%), smooth in 23 (8%), and

Table 1
Indications for Revision Total Knee Arthroplasty (N = 278).

Indication	Frequency, n (%)
Arthrofibrosis	32 (12)
Aseptic loosening	130 (47)
Dislocation	2 (1)
Failed fracture fixation due to pain	2 (1)
Instability	84 (30)
Malalignment	9 (3)
Metallosis	8 (3)
Metal hypersensitivity	1 (<1)
Osteolysis	35 (13)
Painful unresurfaced patella	5 (2)
Patellar avascular necrosis	2 (1)
Patellar clunk or crepitation	2 (1)
Patellar dislocation	2 (1)
Periprosthetic fracture	6 (2)
Polyethylene wear	60 (22)
Tibial collapse	4 (1)