

## **Stemmed Total Knee Arthroplasty Implants: A Retrospective Cohort Study**

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### **INTRODUCTION:**

The increasing rates of complex primary and revision total knee arthroplasty (TKA) has led to an increased use of stemmed implants, which may place greater strain on the bone-implant interface. The purpose of this study was to evaluate the long-term performance of stemmed TKA implants, including the evaluation of a novel distal femoral morphology classification index. Our primary objective was to assess the survival rate of stemmed TKA implants in both primary and revision TKA at a tertiary referral site for complex arthroplasty procedures. Our secondary objective was to compare outcomes based on the Citak Index classification.

### **METHODS:**

We retrospectively reviewed our database to include all patients that underwent primary or revision TKA with a stemmed femoral implant between July 2000 and October 2021, with a minimum two-year follow-up time. Patients were classified according to the novel Citak Index, which is calculated as a ratio between the inner femoral canal diameter 2 cm proximal to the adductor tubercle, and 20 cm proximal to the joint line Kaplan-Meier survival analyses with a 95% confidence interval (CI) were used to evaluate the overall survivorship of patients, with failure defined as the revision of the index surgery for any reason. Chi-square testing was used to compare revision rates across groups. A *P*-value of <0.05 was considered significant.

### **RESULTS:**

A total of 691 patients were included in the study with a mean age of 67.0 years old (range 36-92) (Table 1). Among these patients, 370 (53.5%) were women. A total of 37 patients (5.4%) underwent primary stemmed knee arthroplasty, while the remaining 654 patients (94.6%) underwent revision stemmed knee arthroplasty. The mean follow-up was 8.0 years (standard deviation [SD] 4.4), mean ASA was 2.8 (range 1-4), median Charlson score was 0 (IQR: 0.00–1.00), 6 (0.9%) patients received a cemented stemmed implant, and 24 (3.5%) patients were previously diagnosed with osteoporosis. The three most common indications for surgery were instability (166), aseptic loosening (151), and infection (118). With respect to the Citak Index, patients were classified as: 15.5% in Group A, 32.6% in Group B, and 51.7% in Group C. There was no significant difference in mean age between groups. Kaplan-Meier survivorship due to all-cause failure in primary stemmed TKAs was 80.0% at 10 years (95% CI: 44.9 to 100) with 8 knees at risk (Figure 1), whereas in revision stemmed TKAs it was 83.0% at 15 years (95% CI: 78.7% to 87.3%), with 55 knees at risk (Figure 2). The overall all-cause revision rate was 13.2% and the aseptic revision rate was 7.5% (Table 2). In primary TKA, both rates were 2.7%, whereas in revision TKA, all-cause and aseptic revision rates were 13.8% and 7.8%, respectively. The two most common complications leading to revision surgery were infection (38) and aseptic loosening (18). All cause revision rates in each group were: 11.9% in Group A, 12.4%, in Group B, and 14.0% in Group C. Aseptic revision rates were: 7.3% in Group A, 8.0% in Group B, and 7.3% in Group C. There were no significant differences across groups.

### **DISCUSSION AND CONCLUSION:**

This study demonstrates the experience of a high-volume and complex revision tertiary arthroplasty referral center. Although there are select studies which have evaluated outcomes related to stemmed TKAs, to our knowledge, this is one of the largest single-center retrospective review of stemmed TKA implants in both complex primary and secondary revision surgeries. Very few studies have also evaluated survivorship in this patient cohort. This is also the largest study to date which compares revision rates according to the novel Citak Index, demonstrating an upwards trend when comparing all-cause revision rates across groups A to C. In our cohort of 691 patients, the 10-year survival due to all-cause failure in primary TKAs was 80.0% and the 15-year survival in revision TKAs was 83.0%. The overall all-cause revision rate was 13.2% and the aseptic revision rate was 7.5%. While these revision rates are low-moderate, the patient population is also complex, and all surgeries were performed at a tertiary arthroplasty referral center. An investigation of distal femur morphology was also performed based on the novel Citak Index. Our study demonstrated that there were no significant differences between the different groups, although there was a clear upwards trend from group A to C with respect to all-cause revision rates. This trend may indicate a potential relationship between distal femur morphology and implant longevity. This measurement may serve as a predictor of implant failure. Future studies with larger cohorts and longer follow-up should further explore associations with the Citak Index and patient reported outcomes.

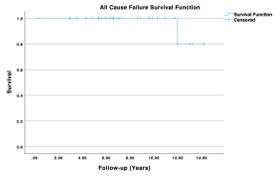


Figure 1. Kaplan Meier survival curve (95% confidence intervals) of primary stemmed total knee arthroplasty that failed due to any cause.

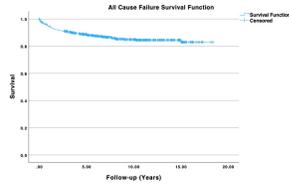


Figure 2. Kaplan Meier survival curve (95% confidence interval) of revision stemmed total knee arthroplasty that failed due to any cause.

Category	Value
<b>Primary Stemmed Knee Implants</b>	
Number of patients, n	691
Number of female patients, n (%)	376 (54.3)
Number of male patients, n (%)	321 (46.5)
Mean age at surgery, yrs (SD)	67.6 (7.6)
Mean surgery follow-up, yrs (SD)	8.6 (4.4)
Mean ASA (range)	2.8 (1-4)
Mean Charlson score (SD)	0.0 (0.1)
Number of patients with osteoporosis, n (%)	24 (3.5)
Number of cemented implants, n (%)	4 (0.6)
<b>Chalk Index Classification, n (%)</b>	
A	109 (15.8)
B	325 (47.0)
C	357 (51.3)
<b>Revision Stemmed Knee Implants</b>	
Number of patients, n	22
Number of female patients, n (%)	15 (68.2)
Number of male patients, n (%)	7 (31.8)
Mean age at surgery, yrs (SD)	7.4 (3.1)
<b>Primary Stemmed Knee Implants</b>	
Number of patients, n	654
Number of female patients, n (%)	348 (53.2)
Number of male patients, n (%)	306 (46.8)
Mean age at surgery, yrs (SD)	67.2 (7.5)
Mean surgery follow-up, yrs (SD)	8.6 (4.5)

Category, n (%)	Value	P-value
<b>All-cause Revision Rates</b>		
All-cause revision rate (n=691)	91 (13.2)	
Agnostic revision rate (n=691)	25 (3.6)	
Primary stemmed knee implant all-cause revision rate (n=77)	1 (1.3)	
Revision stemmed knee implant all-cause revision rate (n=654)	90 (13.8)	
Primary stemmed knee implant agnostic revision rate (n=77)	1 (1.3)	
Revision stemmed knee implant agnostic revision rate (n=654)	51 (7.8)	
<b>All-cause Revision According to Chalk Index Classification, n (%)</b>		
A	13 (11.9)	0.791
B	28 (43.4)	
C	50 (14.0)	
<b>Agnostic Revision According to Chalk Index Classification, n (%)</b>		
A	8 (7.3)	0.947
B	18 (6.0)	
C	26 (7.3)	
<b>All-cause Revision According to Femoral Canal Diameter 20 cm Proximal to Joint Line, n (%)</b>		
A	21 (9.2)	0.161
B	28 (16.0)	
C	42 (14.7)	
<b>Agnostic Revision According to Femoral Canal Diameter 20 cm Proximal to Joint Line, n (%)</b>		
A	14 (6.1)	0.428
B	18 (10.3)	
C	20 (10.4)	