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Rotating platform versus fixed bearing total knee arthroplasty at mid-term follow-up

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ABSTRACT

Background: Rotating platform posterior stabilized (RP) total knee arthroplasty (TKA) was initially developed in part to decrease polyethylene wear and to improve patellar tracking. There have been limited studies evaluating the longevity and causes of reoperation or revision for this implant. The following study compares mid-term survival rates and causes for reoperation between fixed bearing (FB) TKAs.
Methods: We identified 11,416 patients who underwent a primary posterior stabilized TKA between 2001 and 2013. This group was stratified to include patients with a RP (n = 926) and FB (n = 10,490) TKA design. Kaplan–Meier survival rates for each complication that led to reoperation were determined at five- and 10-years. Univariate hazard ratios were determined for the most common causes for reoperation and overall implant survival rates. A multivariate analysis was performed to account for the age, gender and preoperative diagnosis discrepancy between groups.
Results: The reoperation data demonstrated statistically increased all-cause reoperation rate ($p = <0.001$) and reoperation rate for stiffness in the RP group ($p = 0.001$). After adjusting for demographic variables we noted no statistically significant differences in reoperation rate and reoperation for stiffness. Additionally, a statistically significant decrease was noted in all-cause revision ($p = 0.024$) and revision for aseptic loosening or osteolysis in the RP group ($p = 0.029$).
Conclusion: After adjusting for patient demographic differences, we noted a statistically significant decrease in the overall revision and revision for aseptic loosening or osteolysis rates in the RP group.

1. Introduction

Total knee arthroplasty (TKA) is an effective and durable procedure with indications that have expanded to include younger patients with end-stage arthritis. The increase in demand has led to innovative implant designs and instrumentation in an effort to improve knee kinematics, functional outcome, and long-term durability. While many factors contribute to these outcomes, implant design is considered to be particularly important in determining long-term durability. Rotating platform (RP) posterior stabilized TKA was in part introduced to potentially decrease polyethylene wear [1]. The dual articulating surfaces, femoral component on polyethylene and polyethylene on the tibial tray, theoretically decrease the peak stresses occurring on the articular surface of the polyethylene, as well as decrease stresses acting on the tibial tray/bone interface.

There has been a paucity of literature on the long-term outcomes and complications that have led to reoperations in patients with RP TKA. In general, the clinical results have not been statistically different from the fixed bearing (FB) TKA design [2,3]. These studies have mainly represented small patient populations with relatively short-term follow-up. Our study aimed to compare the relatively mid-term survival rates in patients with RP versus FB TKA at one institution. To our knowledge, we report the largest single institution series directly comparing survival rates of RP and FB designed TKA. The purpose of this study was to determine the 10-year survival rates for various outcomes following RP TKA including aseptic loosening, patellar instability, as well as other common causes of revision or reoperation. Additionally, we wanted to determine how these mid-term results of the RP TKA described above compared with the FB TKA design.

2. Methods

The Total Joint Registry at our institution was evaluated from 2001 to 2013 to identify all cases of primary RP and FB posterior stabilized TKA (18 years or older). IRB approval was obtained per institutional guidelines and patients who denied research authorization were excluded. Selection criteria for our study included 1) primary TKA, 2) minimum

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follow-up of 2 years, and 3) a posterior stabilized implant design was utilized. Utilizing these criteria 11,416 patients was identified. This group included 926 RP TKA and 10,490 FB TKA. All rotating platform implants were DePuy Sigma (Warsaw, IN) RP posterior stabilized TKA designs. The fixed bearing cohort included DePuy Sigma (Warsaw, IN), Zimmer NexGen (Warsaw, IN), and Stryker Triathlon (Kalamazoo, MI) posterior stabilized designs. Nine arthroplasty trained orthopedic surgeons performed all of the surgeries included in this study. All TKAs were performed utilizing a similar measured resection technique.

Demographic data was recorded for each implant type (RP versus FB TKA) including patient age at the time of the index surgery, sex, body mass index (BMI), and preoperative diagnosis. Underlying diagnoses were recorded for each patient. Standard patient follow-up included a three month, one-year, two-year, five-year, and every five-year recheck with clinical and radiographic evaluation at each time interval. Complications and reoperations were recorded on a continuous basis throughout the duration of the study. Complications were separated into intraoperative and post-operative as well as type of complication. An all-cause complication rate as well as the most common complication diagnoses that led to reoperation within three weeks was recorded for each implant.

2.1. Statistical methods

Baseline characteristics were compared between groups using a chi square test or two-sample *t*-test as appropriate. Kaplan–Meier implant revision and reoperation survival rates for each implant type were estimated at five- and 10-years. Hazard ratios which were assessed for the most common mechanisms for revision for each implant multivariable cox regression model include age as well as mechanism. The alpha-level was set at 0.05 for statistical significance.

3. Results

Overall, this study included 926 RP TKA and 10,490 FB TKA designs. Patient demographic data for each implant type have been listed in Table 1. The mean age of patients in the RP group was statistically lower than the mean age in the FB patient group (58.0 and 68.5 years respectively, $p < 0.001$). There were similar numbers of males and females in the RP group (51% males and 49% females), however the FB group had a statistically higher percentage of females (42.5% males and 57.5% females, in $p < 0.001$). The mean BMI in the RP and FB groups were comparable (RP 32.6 versus FP 32.4, $p = 0.33$). The most common predisposing condition for the RP group was degenerative joint disease (53.9%) and in the FB group was also degenerative joint disease (56.7%). Median follow-up for the FB group was 4.97 years compared to 4.89 years for the RP group.

3.1. Prior to adjusting for patient demographic data

Ten year Kaplan–Meier survival curves on the entire cohort of patients prior to adjusting for age, gender and preoperative diagnosis. The survival curves demonstrated a significant increase in all-cause reoperation and reoperation for stiffness in the RP group. The survival curves show no significant difference between the groups in wound complications, infections, patellar instability, or periprosthetic fracture. The hazard ratio for the all-cause reoperation rate was 1.57 ($p < 0.001$) in the RP group (Figure 1). The hazard ratio for reoperation for stiffness was 1.79 (<0.001) in the RP group (Figure 1). The univariate cox regression analysis showed no other statistically significant difference between the two groups when evaluating for infection, patellar instability, periprosthetic fracture, all-cause revision, and revision for aseptic loosening or osteolysis.

3.2. After adjusting for patient demographic data

We noted a statistically significant difference between the patient populations in the two groups. The preoperative patient demographic data had a statistically significant difference in patient age, gender, and preoperative diagnosis. A multivariate cox linear regression model adjusting for age, gender and preoperative diagnosis was performed on the entire cohort of patients. Prior to this adjustment we noted a statistically significant increase in the overall implant reoperation and reoperation for stiffness rates in the RP group. However, after adjusting for these variables, we no longer noted a statistical difference. Additionally, two previously non-significant differences became significant. First, the RP group had a statistically significant decrease in the all-cause revision rate with a hazard ratio of 0.043 ($p = 0.024$). Second, a statistically significant decrease was also calculated in the revision for aseptic loosening or osteolysis in the RP group with a hazard ratio of 0.32 ($p = 0.029$). A trend towards decreased periprosthetic fracture was noted in the RP group with a hazard ratio of 0.16 ($p = 0.67$) but this did not reach statistical significance. No other statistically significant differences were noted (Table 2).

4. Discussion

The RP TKA design was initially introduced to potentially decrease polyethylene wear by utilizing a polished second articular surface [1,4]. The second articular surface theoretically decreases the peak forces encountered at the level of the femoral component on the tibial polyethylene [5,6]. Additionally, this decrease in peak stresses may decrease forces at the tibial implant/bone interface secondary to translation and rotational motions from the femoral tibial articulation [7]. In a recent meta-analysis, the RP design showed excellent 15-year results [1]. However, the clinical data from multiple studies has yet to show a statistical difference in implant survivorship or aseptic loosening [3,4,8,9]. Reviewing the literature, our study similarly compared the RP and FB cohorts as many of the other studies have. However, our study differs secondary to longer follow-up, greater patient numbers, and a more thorough assessment of the reasons for reoperation and revision.

Patient demographic data between the RP and FB TKA designs were statistically different in regard to age, gender, and preoperative diagnosis, but not BMI. The three most common preoperative diagnoses were the same; however, the percentages were different within each category with the biggest discrepancy being post-traumatic arthritis. This is likely related to a younger patient population requiring TKA secondary to early onset arthritis.

Although reoperation rates for both groups were low at five- and 10-years post-operatively, the reoperation rate for RP TKA was found to be significantly higher than the FB group prior to adjusting for the

Table 1
Demographic data by implant type.

	Posterior stabilizing (N = 10,490)	Rotating platform p/s (N = 926)	Total (N = 11,416)	p-Value
Age				<0.001
N	10,490	926	11,416	
Mean (SD)	68.5 (10.0)	58.0 (10.2)	67.6 (10.4)	
Gender				<0.001
Male	4462 (42.5%)	472 (51.0%)	4934 (43.2%)	
Female	6028 (57.5%)	454 (49.0%)	6482 (56.8%)	
BMI				0.33
N	10,475	918	11,393	
Mean (SD)	32.4 (6.9)	32.6 (6.7)	32.4 (6.8)	
Diagnosis				<0.001
Degenerative joint disease	5946 (56.7%)	499 (53.9%)	6445 (56.5%)	
Post-traumatic	652 (6.2%)	112 (12.1%)	764 (6.7%)	
Inflammatory arthritis	187 (1.8%)	20 (2.2%)	207 (1.8%)	
Other	3705 (35.3%)	295 (31.9%)	4000 (35.0%)	

p/s, posterior stabilizing; SD, standard deviation; BMI, body mass index; DJD, degenerative joint disease.

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