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Original Article

Total knee arthroplasty in young patients: Factors predictive of aseptic failure in the 2nd–4th decade

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ABSTRACT

Objective: In a recently published article we reviewed our long term outcomes of TKA in young patients (< 55) with end stage OA. The purpose of this study was to identify what additional factors may predict aseptic failure in these young patients.
Methods: A retrospective review of all patients in our young TKA database was performed, and included failure only for mechanical wear and loosening.
Results: The IB-II prosthesis, a thin polyethylene (< 9 mm), and higher Knee Society functional class at midterm follow-up was associated with higher failure rate.
Conclusion: This study helps better identify the etiology of failed young patient TKA.

1. Introduction

There has been a substantial growth in the number of total knee arthroplasties being performed in young patients (under 55 years of age). A recent study predicted that between 2006 and 2030 there will be a 17-fold increase in the number of TKA's performed in this age group.[1] A number of surgical procedures exist for the treatment of osteoarthritis (OA) in the young patient, such as arthroscopic debridement, realignment osteotomy, or arthrodesis, but these options typically only provide temporary relief of symptoms, and are fraught with functional limitations.[2] Several studies have shown that TKA in the younger patient provides better function and lasting pain relief.[2,9] The concern of course is that these more active patients will demonstrate accelerated component wear or loosening, subsequently requiring a more difficult revision procedure. There has been little longterm follow up on this patient subset, but those studies that are available have shown variable results. Kim et al. 3 demonstrated survivorship of posterior-substituting implants as high as 97 percent at 16.8 year follow up in younger patients, which is comparable to 15 year survival rates in older patients. Using data from the Swedish Registry, W-Dahl et al. 4 found a 9 percent 10-year cumulative revision rate for patients younger than 55 years. Julin et al. 5 examined the Finnish Arthroplasty Registry, and follow-up of 32,019 patients showed that 5-year survival rates were only 92 and 95 percent in patients aged ≤55 and 56–65 years, respectively, compared to 97 percent in patients who were > 65 years of age ($P < 0.001$). Odland et al. 6 present 10-year outcomes from a cohort of 59 active patients (67 knees) aged 55 years or younger, and show a 16 percent revision rate for aseptic loosening or component wear. Interestingly, a total of 65 percent of patients were still performing moderate labor or sport activities, which addresses the second potential pitfall of TKA surgery in this patient population; not only are patients aged 55 years or younger more likely to outlive their prothesis and require revision surgery, but their higher activity level predisposes the implant to early failure.

Many studies suggest that implant failure is primarily related to joint use, rather than duration of implantation.[7] That said, function following TKA is a significant concern for younger patients, whose activity expectations are substantially greater than their older counterparts. Although evidence exists to suggest that certain host factors, such as high activity level, and male sex, may predispose to higher rates of aseptic loosening in the total hip arthroplasty (THA) population, no such host factors have been shown to be associated with loosening after TKA.[8] There is a paucity of evidence to guide advice on young patient activity level following TKA, and no good evidence to suggest if closer follow up is merited in those patients partaking in higher-level activities, or high-impact activities.[9]

In a recently published article we reviewed our long term outcomes of TKA in young patients with end stage osteoarthritis and post traumatic arthritis.[10] The original cohort for that study, as described by Diduch et al. 11 in 1997, consisted of 114 total knee arthroplasties performed in eighty-eight patients with an average age of fifty-one years (range, twenty-two to fifty-five years) from 1977 to 1992 by one

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of two surgeons.

We obtained follow-up in 95 percent of the 88 patients with 114 TKAs. A 70.6 percent survivorship for all cause failure was noted at 30 years. As part of our analysis we examined the differences in survivorship of the two implants used for the majority of the cases in this series. A statistically significant difference in survivorship was noted with the Insall Burstein I (IB-I; Zimmer, Warsaw IN) outperforming the Insall Burstein II (IB-II; Zimmer, Warsaw IN) with tibial or femoral aseptic loosening as the endpoint. The purpose of this study was to identify what other factors may predict failure in these young patients.

2. Materials and methods

Data collected in our previous study[10] was reviewed, and for the purposes of this study was examined specifically for predictors of TKA failure, including prosthetic factors, patient factors, and Knee Society outcome scores.[12,13] For this study we included failure only for mechanical wear and loosening. Other factors responsible for failure, including infections, were excluded. Patients were categorized based on a modified Charnley classification,[14] which was assigned at the follow-up appointment in 1997. These classes are; A (a unilateral or successful bilateral TKA without symptoms in the contra-lateral knee), B (symptoms in the contra-lateral knee), or C (associated medical conditions that limited function).

2.1. Statistical analysis

For descriptive statistics, comparisons were made across knee scores using Student *t*-tests. Time to failure up to thirty years following total knee arthroplasty was analyzed using the method of Kaplan and Meier.[15] Failure was defined in three ways: aseptic revision of the femoral or tibial component, aseptic revision of the femoral or tibial component, and revision of the femoral, tibial, or patellar component or any subsequent operation about the knee. Significance was defined at $p < 0.05$.

2.2. Source of funding

This study was funded by the Insall Scott Research Foundation. Funds were used to pay for the salaries for a research assistant and a biostatistician and for supplies and mailings. Also, one author (W.N.S.) received royalties from Zimmer, but not for the Insall Burnstein prostheses.

Institutional review board approval was obtained for this study.

3. Results

3.1. Implant factors

The average time to revision was 14.7 years (range 11–22).

As demonstrated in our previous study,[10] there was a statistically significant difference (P = 0.035) in the rate of failure among the three implants used in the study, with the IB-II prosthesis showing a higher rate of failure than the IB-I and CCK (Table 1).

Table 1
Comparison of failure rates between IB-1, IB-II, and CCK components. P = 0.035.

			Implant			
			CCK	IB-I	IB-II	Total
Failure	No	Count	8	38	40	86
		% Patients	9.3	44.2	46.5	100
	Yes	Count	0	2	11	13
		% Failure	0	15.4	84.6	100
Total		Count	8	40	51	99

Table 2
Comparison of failure rates between KS A, B, and C patients. P = 0.047.

			Transformed KS Category 1997			
			A	B	C	Total
Failure	No	Count	44	10	32	86
		% Patients	51.2	11.6	37.2	100
	Yes	Count	8	4	1	13
		% Failure	61.5	30.8	7.7	100
Total		Count	52	14	33	99

The IB-II implant had a significantly higher failure rate than the IB-I implant and the Constrained Condylar Implant (CCK; Zimmer, Warsaw IN). In fact despite the increased conformity of the articulation, the non-engaging metaphyseal dangle stems used at this time, and the presumed increased complexity of the reconstruction, there were no failures associated with the CCK implant in this series.

3.2. Patient factors

Patient factors were examined, including age, sex, the number of previous procedures, and Knee Society class.[13] A significantly increased rate of failure was seen in patients with a higher Knee Society (KS) Class (Table 2). If we infer that KS class A patients are more active, then this finding suggests that those patients with fewer co-morbidities, and who were more active, had a higher chance of implant failure due to wear, loosening and osteolysis.

3.3. Insall Burstein II implant sub-set analysis

As the IB-II implant had higher rates of failure, (all but 2 of the failures in our previous study,[10]), we examined all of the patient, outcome, and implant related factors for this subset of patients separately.

The first finding was of a trend towards increased rates of revision in women (Table 3). Although this was a trend, and did not reach statistical significance with the number of patients in the study, it does present data that differs from other studies and joint registries which have pointed to a higher rate of failure in young men. These other studies, however, have shorter follow-up, focusing on the first decade and not the 2nd-4th decades, which may account for the different trend identified in our study.

The second finding was that of a significantly increased failure rate in the IB-II design with thinner polyethylene (Table 4). As thicker polyethylene inserts are typically associated with more severe pre-operative malalignment, it is interesting to note that the poorer mechanical properties of the thinner inserts were more likely to lead to failure than the overall complexity of the reconstruction. The mean thickness in the failed polyethylene inserts was a mere 2 mm thinner than the non-failures, which suggests that the polyethylene used in this implant was particularly sensitive to thickness.

Table 3
Comparison of failure rates between male and female patients. P = 0.072.

			Gender		
			Female	Male	Total
Failure	No	Count	23	17	40
		% Patients	57.5	42.5	100
	Yes	Count	10	1	11
		% Failure	90.1	9.9	100
Total		Count	33	18	51