Creation of Data-Driven Age Strata to Stratify Complication Risk after Total Knee Arthroplasty

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INTRODUCTION: Total knee arthroplasty (TKA) is a highly effective treatment for end-stage knee osteoarthritis (OA), with utilization increasing across all age groups. Notably, patients under 65 years old now represent a growing proportion of TKA recipients. However, the influence of patient age on TKA outcomes remains unclear, with mixed findings regarding revision and complication risks. Given the expanding demographic and variation in previous methodologies, this study aimed to identify data-driven age thresholds associated with significant differences in the likelihood of complications, specifically revision within 5 years following primary TKA. We hypothesized that younger populations would experience a higher risk of revision.

METHODS: A retrospective cohort study was conducted using the Mariner dataset within the PearlDiver database, which spans 2010–2022 and contains over 165 million patient records. Patients undergoing primary TKA (CPT 27447) with at least 5 years of active follow-up were included. Patients with malignancy, who underwent TKA for fracture indications, or received multiple TKAs were excluded. Stratum-specific likelihood ratio (SSLR) analysis was utilized to define age strata based on differences in revision likelihood. Outcomes analyzed included revision TKA, instability, loosening, periprosthetic joint infection (PJI), and periprosthetic fracture (PPF). Multivariable logistic regression adjusted for sex, Charlson Comorbidity Index (CCI), obesity, tobacco use, and diabetes mellitus.

RESULTS: A total of 694,111 patients met inclusion criteria. SSLR analysis identified nine age strata: 18-45, 46-52, 53-56, 57-60, 61-62, 63-68, 69-71, 72-73, and 74+. Revision rates decreased with increasing age: 7.7% (18-45 years), 5.8% (46-52), 4.8% (53-56), 4.1% (57-60), 3.5% (61-62), 2.9% (63-68), 2.3% (69-71), 2.1% (72-73), and 1.8% (74+) (P<0.001). Younger age strata demonstrated significantly higher odds of revision compared to those aged 74+. Odds for each age cohort can be found in Table 2. Similarly, instability, loosening, and PJI rates were significantly higher among younger cohorts, while PPF rates were lower in most younger groups compared to patients aged 74+.

DISCUSSION AND CONCLUSION: Data-driven analysis demonstrated that younger patients undergoing primary TKA experience significantly increased odds of revision within 5 years, with risk highest among patients aged 18-45. Younger patients also showed increased rates of instability, loosening, and PJI. These findings suggest that younger age is an independent risk factor for early TKA failure. Improved patient selection, counseling, and potentially novel surgical strategies may be warranted in managing younger TKA patients to optimize outcomes.

Table 1: Incidence of Revision and Indications by Age Strata (n, %)

Age	Total Patients	Revision		Instability		Loosening		PJI		PPF	
18-45	12,632	974	7.7	376	3.0	480	3.8	619	4.9	82	0.6
46-52	46,338	2,709	5.8	1,019	2.2	1,484	3.2	1,834	4.0	245	0.5
53-56	60,342	2,878	4.8	1,010	1.7	1,707	2.8	2,041	3.4	320	0.5
57-60	86,388	3,527	4.1	1,287	1.5	1,975	2.3	2,603	3.0	468	0.5
61-62	52,741	1,824	3.5	659	1.2	1,043	2.0	1,444	2.7	296	0.6
63-68	169,034	4,820	2.9	1,791	1.1	2,658	1.6	3,980	2.4	841	0.5
69-71	87,056	2,028	2.3	773	0.9	1,165	1.3	1,711	2.0	448	0.5
72-73	94,259	2,001	2.1	772	0.8	1,137	1.2	1,897	2.0	605	0.6
74+	119,836	2,111	1.8	802	0.7	1,053	0.9	2,290	1.9	861	0.7

Table 2: Multivariable Logistic Regression for Revision and Indications by Age Strata (OR, 95% CI)

Age	Revision		Instability		Loosening		PJI		PPF	
18-45	5.1	4.7-5.5	5.0	4.4-5.7	4.8	4.3-5.4	3.1	2.8-3.4	1.0	0.8-1.3
46-52	3.8	3.5-4.0	3.7	3.3-4.1	4.0	3.7-4.3	2.4	2.3-2.6	0.8	0.7-0.98
53-56	3.0	2.8-3.2	2.8	2.5-3.1	3.5	3.2-3.8	2.0	1.9-2.2	0.9	0.7-0.98
57-60	2.5	2.4-2.7	2.5	2.3-2.7	2.8	2.6-3.0	1.8	1.7-1.9	0.9	0.8-0.98
61-62	2.1	2.0-2.3	2.1	1.9-2.3	2.4	2.2-2.6	1.6	1.5-1.7	0.9	0.8-1.0
63-68	1.7	1.6-1.8	1.7	1.6-1.9	1.9	1.8-2.0	1.4	1.3-1.4	0.8	0.7-0.9
69-71	1.4	1.3-1.5	1.5	1.3-1.6	1.6	1.5-1.8	1.1	1.1-1.2	0.8	0.7-0.9
72-73	1.3	1.2-1.4	1.4	1.2-1.5	1.5	1.4-1.6	1.2	1.1-1.3	1.0	0.9-1.1

OR: Odds Ratio; 95% CI: 95% Confidence Interval