Coronal Plane Deformity in Total Knee Arthroplasty is Associated with Increased Operative Time and Disposition to Skilled Nursing Facility

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INTRODUCTION: Prior studies have demonstrated that long-term clinical outcomes of Total Knee Arthroplasty (TKA) are similar in patients with significant vs minimal preoperative coronal plane deformity. However, little data exists on short-term outcomes, which could impact costs of care. We explored the impact of preoperative coronal plane deformity on operative time, length of stay (LOS), and discharge to skilled nursing facility (SNF) in patients undergoing TKA.

METHODS: This retrospective cohort study analyzed preoperative knee radiographs from patients who underwent a unilateral primary TKA from 2014-2019 at our institution. A total of 3,964 patients were included (1,158 >10˚ deformity: mean age 67.2 years, 47% male; 2,806 <10˚ deformity: mean age 67 years, 37.4% male). The degree of coronal plane deformity, measured via mechanical axis deviation on preoperative radiographs, was recorded for each patient. Patients with no knee radiographs within 3 years preoperatively were excluded. Statistical analysis included the Chi-Square test for categorical variables, Student's t-test for continuous variables, Mann-Whitney U test for length of stay, and univariate and multivariate linear and logistic regressions.

RESULTS: The >10˚ deformity cohort had a longer time from procedure start to finish (113.56 vs 110.68 minutes;p=0.020), deviation from surgeon mean operative time (+6.19 vs +0.69 minutes;p<0.001), and proportion of cases requiring >15 (26.8% vs 22%;p=0.001) or >30 (12.3% vs 7.8%;p<0.001) additional minutes. LOS was similar between the two cohorts, both with a median of 2 days (interquartile range 1-3), despite appropriate statistical power. The deformity cohort was more likely to be discharged to SNF (19.9% vs 15.8%;p=0.002). For every 1˚ increase in coronal plane deformity, the operative time increased by 0.566 minutes (p=0.000). The odds of SNF discharge increased with increasing degree of coronal plane deformity (OR 1.029 [1.009,1.050];p=0.004).

DISCUSSION AND CONCLUSION: Greater preoperative coronal plane deformity is significantly associated with increased operative time and odds of discharge to SNF in patients undergoing TKA. This may be because bigger deformities require more surgical steps to balance the knee, which is time consuming. As the healthcare system moves toward a bundled payment model, these data support the argument for a new complexity modifier for TKA to assist in complexity categorization by the Centers for Medicare & Medicaid Services as well as the RVS Update Committee.

Table 1 – Patient demographics

Variable	Deformity >10 degrees	Deformity < 10 degrees	P value
Number of patients	1,158	2,806	
Age (mean (SD))	67.24 (8.768)	66.96 (9.050)	0.366
Gender (male)	544 (47%)	1049 (37.4%)	<0.001**
Race			0.014*
African-American	250 (21.6%)	531 (18.9%)	0.015*
Asian	34 (2.9%)	50 (1.8%)	
Caucasian	854 (73.7%)	2185 (77.9%)	
Other	20 (1.7%)	40 (1.4%)	
Married	750 (65.7%)	1888 (67.4%)	0.302
History of Smoking	467 (40.3%)	1251 (44.6%)	0.014*
ASA (median, IQR)	3 (2-3)	3 (2-3)	0.194
Laterality (Right)	563 (48.6%)	1445 (51.5%)	0.099
Degree of Deformity (mean (SD))	13.01 (5.302)	5.13 (2.637)	<0.001**
Valgus Alignment	19.4% (225/1158)	20.7% (412/1990)^	0.391

^Excluding "neutral" cases, defined as coronal plane deformity less than 3 degrees
IQR interquartile range
BMI body mass index

Table 2 – Patient comorbidities

Variable	Deformity >10 degrees	Deformity < 10 degrees	P value
Number of patients	1,158	2,806	
Congestive heart failure	30 (2.6%)	87 (3.1%)	0.388
Chronic pulmonary disease	151 (13.0%)	446 (15.9%)	0.022*
Diabetes	171 (14.8%)	381 (13.6%)	0.326
Renal Failure	127 (11.0%)	248 (8.8%)	0.037*
Psychoses	22 (1.9%)	57 (2.0%)	0.788

Table 3 – Comparing operative time, length of stay and discharge disposition based on degree of preoperative coronal plane deformity in total knee arthroplasty

Variable	Deformity >10 degrees	Deformity < 10 degrees	P value
Number of patients	1,158	2,806	
Operative time			
Procedure start to finish (minutes; mean (SD))	113.56 (36.97)	110.68 (34.50)	0.020*
Deviation from surgeon mean (minutes)	+6.19 (24.53)	+0.69 (22.31)	<0.001**
Proportion of cases requiring more than 15 additional minutes	310 (26.8%)	616 (22.0%)	0.001*
Proportion of cases requiring more than 30 additional minutes	142 (12.3%)	220 (7.8%)	<0.001**
Length of Stay median (IQR)	2 (1-3)	2 (1-3)	0.108
Length of Stay 1+ days	719 (62.1%)	1,702 (60.7%)	0.400
Discharge to SNF	230 (19.9%)	444 (15.8%)	0.002*
SNF skilled nursing facility			

Table 4 – Univariable and multivariable regression analysis predicting operative time

Variable	Univariable linear regression analysis B coefficient, (95% Confidence Interval)	P value	Multivariable linear regression model B coefficient, (95% Confidence Interval)	P value
Number of patients	1,158		2,806	
Age	-0.430 (-0.552, -0.308)	0.000	-0.170 (-0.248, -0.093)	0.000
Gender (Male)	2.405 (0.167, 4.643)	0.035	5.766 (4.387, 7.146)	0.000
BMI	0.881 (0.683, 1.079)	0.000	0.492 (0.366, 0.618)	0.000
Caucasian Race	-18.325 (-20.857, -15.792)	0.000	-2.747 (-4.401, -1.093)	0.001
Married	-7.557 (-9.880, -5.234)	0.000		
History of Smoking	2.420 (0.209, 4.635)	0.032		
ASA	-0.088 (-2.131, 1.954)	0.933		
Laterality (Right)	-0.616 (-2.613, 1.780)	0.710		
Degree of Deformity	0.297 (0.058, 0.537)	0.015	0.566 (0.418, 0.713)	0.000
Valgus Alignment	1.423 (-1.567, 4.413)	0.351		

*Excluded "neutral" cases, defined as coronal plane deformity less than 3 degrees
BMI body mass index

Table 5 – Univariable and multivariable logistic regression analysis predicting discharge to SNF

Variable	Univariable logistic regression analysis EXP(B), (95% Confidence Interval)	P value	Multivariable logistic regression model EXP(B), (95% Confidence Interval)	P value
Age	1.100 (1.087, 1.112)	0.000	1.102 (1.089, 1.116)	0.000
Gender	0.396 (0.327, 0.479)	0.000	0.527 (0.424, 0.656)	0.000
BMI	1.009 (0.993, 1.024)	0.268		
Caucasian Race	0.496 (0.414, 0.599)	0.000	0.491 (0.398, 0.607)	0.000
Married	0.231 (0.194, 0.274)	0.000	0.318 (0.261, 0.386)	0.000
History of Smoking	0.939 (0.845, 1.181)	0.992		
ASA	2.038 (1.732, 2.398)	0.000	1.752 (1.457, 2.106)	0.000
Laterality (Right)	1.134 (0.961, 1.339)	0.157		
Degree of Deformity	1.026 (1.009, 1.045)	0.004	1.029 (1.009, 1.050)	0.004
Valgus Alignment	1.440 (1.167, 1.776)	0.001		
Congestive heart failure	2.235 (1.496, 3.341)	0.000		
Chronic pulmonary disease	1.427 (1.151, 1.770)	0.001	1.237 (0.968, 1.582)	0.089
Diabetes	1.326 (1.058, 1.660)	0.014		
Renal Failure	2.033 (1.594, 2.592)	0.000	1.300 (0.982, 1.720)	0.067
Psychoses	2.040 (1.247, 3.339)	0.005	2.066 (1.170, 3.648)	0.012

*Excluded "neutral" cases, defined as coronal plane deformity less than 3 degrees
BMI body mass index
SNF Skilled Nursing facility