Morbid Obesity and Mechanical Alignment: A Retrospective Study of 940 Knees

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INTRODUCTION: A widely accepted goal in total knee arthroplasty (TKA) is to restore mechanical alignment of the femoro-tibial angle to 0º. Although the value of perfect alignment is disputed, it is accepted that mechanical alignments that sway too far from neutral produce additional stress on the knee. TKA is often performed on obese (body mass index, BMI > 30kg/m^2) individuals due to this condition's relationship with osteoarthritis, but traditionally surgeons have declined surgery on morbidly obese patients (BMI ≥40 kg/m^2) due to the many complications associated with doing so. During TKA, a deeper soft tissue envelope at the knee in obese individuals can obscure bony landmarks, make exposure difficult, and increase the overall difficulty of the procedure. Due to the increased difficulty in implant positioning, obesity may affect the post-operative mechanical alignment of the TKA. This retrospective study aims to see if class III morbid obesity (BMI ≥40kg/m^2) has an impact on the restoration of mechanical alignment in TKA.

METHODS: This review was approved by our institution's IRB. This study aims to review 940 patient records by completion. Records for TKA performed by fellowship trained arthroplasty surgeons who aim to restore mechanical alignment were reviewed from 2013 to 2023. Patient demographics, Procedure laterality, procedure length, BMI, Pre- and post-operative mechanical alignment of the operative extremity, and pre- and post-operative joint width were recorded. All x-ray measurements were made on the coronal plane on full length EOS X-Ray Radiographs in Carestream Vue Motion. Absolute post-operative alignment was found by taking the total number of degrees away from 0. Statistical analysis including descriptive statistics, chi-square, and t-tests was done on GraphPad Prism. A Mal aligned mechanical alignment was defined as an alignment more than 3 degrees varus or valgus from neutral.

RESULTS SECTION: Upon submission, 177 patient records were reviewed. 86 patients were male (48.6%). 58 had a DOS BMI < 30 kg/m^2, 48 had BMI between 30-35 kg/m^2, 28 had BMI between 35-40 kg/m^2, and 43 had BMI ≥ 40 kg/m^2. Kruskal-Wallis ANOVA tests were done to analyze the differences between continuous variables (**Table 1**). No significant differences were found between any of the BMI cohorts and their absolute pre-operative alignment or absolute average post-op alignment. Non-parametric Spearman correlations were done to quantify correlations between various variables recorded, pre-operative alignment vs post operative alignment (P<0.0001), Joint Width and Post-operative alignment in BMI < 40kg/m^2 Females (P=0.031), and Absolute Pre-op Alignment vs BMI (P=0.0011) (**Table 2**).

DISCUSSION: With data collection ongoing, this study presents one of the largest retrospective reviews analyzing the correlations between BMI and TKA mechanical alignment. Surprisingly, current data shows no significant difference in the average absolute post-operative mechanical alignment between the four cohorts. Analysis of prevalence of preoperative mal alignment revealed significant differences between the 4 cohorts (P=0.0161) (**Table 1**). Current data shows pre-operative femoro-tibial alignment to be the greatest predictor of post-operative alignment, with a spearman r value of 0.4. No significant correlation between postoperative alignment and BMI was detected. However, absolute pre-operative alignment was found to correlate with BMI with a Spearman r value of 0.24 (P=0.0011). An interesting result seen in this study is the correlation between joint width and post operative alignment in females BMI <40 kg/m^2 (r=0.28). This correlation was not seen in any of the other cohorts (**Table 2**). With differences in alignment being subtle, completion of the full review is needed to declare a true relationship between BMI and TKA mechanical alignment.

SIGNIFICANCE/CLINICAL RELEVANCE: This retrospective study presents one of the largest collections of mechanical alignment data to date. While previous studies have suggested higher BMI correlating with poor postoperative alignment, focusing on mechanical alignment in primarily BMI <40 kg/m^2 cohorts, this study contains more data from morbidly obese (BMI > 40kg/m^2) cohorts, suggesting there may be no correlation with BMI and postoperative mechanical alignment.

IMAGES AND TABLES:

	BMI < 30 kg/m^2	BMI 30-35 kg/m^2	BMI 35-40 kg/m^2	BMI ≥ 40kg/m^2
Total Number of TKA	58	48	28	43
Female/Male	25/33	23/25	12/16	30/13
Average Absolute Pre-op Alignment (Degrees) (SD)	8.32±85.41	6.67±3.69	8.9±4.67	9.63±4.52
Average Absolute Post-op Alignment* (Degrees) (SD)	2.68±2.36	1.8±1.69	2.43±1.85	3.07±2.35
Number of Pre-op Mal Aligned (%)	43 (74.1%)	39 (81.2%)	26 (92.9%)	41 (95.3%)
Number of Post-op Mal Aligned (%)	20 (34.5%)	9 (18.8%)	5 (17.9%)	13 (30.2%)

Table 1. Overview of Total Knee Arthroplasty cases reviewed with BMI <30kg/m^2, BMI 30-35 kg/m^2, BMI 35-40 kg/m^2, BMI ≥40kg/m^2. * Indicates p value is less than 0.05.

	Spearman r	P value
BMI and Post-op Alignment	0.079	0.29
Pre-op Alignment vs Post-op Alignment****	0.40	<0.0001
Joint Width and Post-op Alignment	0.061	0.42
-BMI < 40 kg/m^2 Females*	0.28	0.031
-BMI > 40 kg/m^2 Females	-0.01	0.944
-BMI < 40 kg/m^2 Males	-0.06	0.588
-BMI > 40 kg/m^2 Males	-0.12	0.69
Absolute Pre-op Alignment vs BMI**	0.24	0.0011
Absolute Post-op Alignment vs BMI	0.04	0.59

Table 2. Spearman's correlations (r) for various variables. ***** Indicates p value is less than 0.0001. * Indicates p value is less than 0.05. ** Indicates p value is less than 0.01.