Definition of the Laxity Goals During Total Knee Arthroplasty Tends To Be Surgeon Specific

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INTRODUCTION: Alignment techniques in total knee arthroplasty (TKA) continue to evolve as technologies aiding in implantation progress. Reliable characterization of the soft-tissue envelope enabled the development of techniques such as functional alignment, allowing the possibility of restoring the constitutional alignment while achieving proper soft-tissue balance. While varying techniques offer guidelines for the bone cut parameters in terms of boundaries, the proper amount of laxity is still largely subjective and unclear. In this regard, the objective of this study was to evaluate the variability in laxity signatures among surgeons at the time of the planning of the bone cut parameters.

METHODS: A retrospective review was performed on a proprietary cloud-based web database that archives technical logs of cases performed using an instrumented computer-assisted surgery system. A total of 631 cases performed by 9 individual surgeons with at least 30 cases each were considered without any exclusions. The surgical technique encompassed the possibility of setting up the femoral planning based on alignment and size, but also soft-tissue consideration based on laxity information acquired by placing an intra-articular tensioner between the proximal tibial cut and the native femur while manipulating the limb from extension to flexion. Based on the potential impact of the conservation of the posterior cruciate ligament (PCL) or not, the cases were separated between posterior-stabilized (PS) and cruciate-retaining (CR) cases with 6 surgeons and 4 surgeons, respectively. For each case, the planned laxities were referenced relative to the planned medial laxity at 10° of flexion. Relative planned laxities were calculated for both the medial and the lateral compartments from 10° to 120° of flexion. In some cases, measurements corresponding to certain flexion angles were found missing due to assumed lack of visibility of the active trackers. For such limited occurrences, second-order polynomial interpolation and linear extrapolation methods were employed to fill the missing values for medial and lateral laxity curves separately based on available planned laxity measurements for other flexion angles for a specific case. Two Way ANOVA (Analysis of Variance) was used to compare the effect of the surgeon on the laxity definition. If the effect was significant, Tukey multiple comparisons of means were used to compare pair-wise differences of laxity between surgeons. Significance level was set to 0.05.

RESULTS SECTION: Regardless of the conservation of the PCL and the side of the compartment, the relative laxities were significantly different between the 9 surgeons. The box and whisker charts are plotted displaying both medial and lateral laxity for each PS surgeon in Figure 1. Also, the median medial and lateral laxity curves are compared and plotted between the PS surgeons to observe the differences in Figure 2. It can be seen from these figures that median values at each flexion angle and overall medial and lateral laxity signatures appear surgeon specific. A further statistical analysis performed with Tukey multiple comparisons (Figure 3) inferred that for most of the pairwise comparisons, the laxity difference was found to be statistically significant which is marked in bold.

DISCUSSION: The exact laxity required in TKA is yet to be determined[1]. Some surgeons aim for equal rectangular gaps in both flexion and extension, some target trapezoidal gaps with added laxity on the lateral compartment compared to medial compartment, while others plan for larger flexion gap than extension gap. Even though our study only considered cases using the same knee system and the same surgical technique, the laxity goals were found to be surgeon specific. As recent studies suggest that laxity as small as 2mm may impact the outcomes[2-3], there exists an opportunity to develop solutions to further define the optimal laxity for a given patient.

SIGNIFICANCE/CLINICAL RELEVANCE: This study demonstrated that the definition of the targeted joint laxities during TKA tends to be influenced by the surgeon. Future developments may enable diagnostic capabilities to personalize the laxity targets based on patient's inputs too.

REFERENCES:

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2. Nielsen ES et al. Second-Generation Electronic Ligament Balancing for TKA: A Cadaver Study; J Arthroplasty. 2018;33(7):2293-2300
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IMAGES AND TABLES:

Figure 1: Box and wisker plots for the 6 PS surgeons

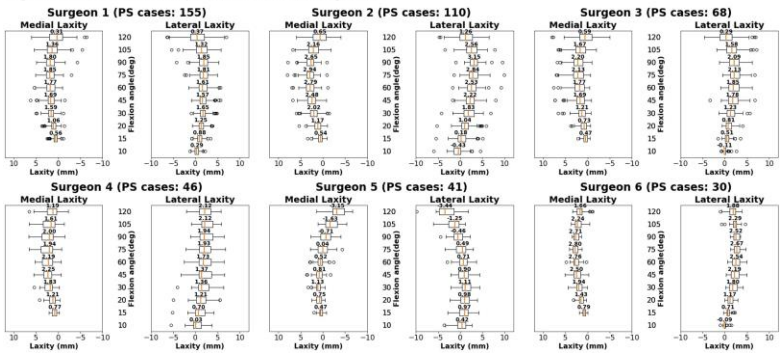

Figure 2: Comparison of laxity curves with median values for the 6 PS surgeons

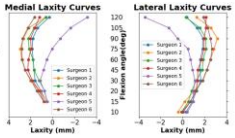

Figure 3: Tukey multiple comparison analysis for PS and CR cases

PR cases	Medial Laxity		Lateral Laxity	
	difference (mm)	adjusted P-value	difference (mm)	adjusted P-value
Surgeon5-Surgeon4	**-2.149**	**< 0.001**	**-1.801**	**< 0.001**
Surgeon2-Surgeon4	0.111	0.791	0.075	0.964
Surgeon1-Surgeon4	**-0.567**	**< 0.001**	**-0.446**	**< 0.001**
Surgeon3-Surgeon4	**-0.38**	**< 0.001**	**-0.352**	**0.005**
Surgeon6-Surgeon4	0.073	0.989	0.073	0.991
Surgeon2-Surgeon5	**2.26**	**< 0.001**	**1.876**	**< 0.001**
Surgeon1-Surgeon5	**1.582**	**< 0.001**	**1.355**	**< 0.001**
Surgeon3-Surgeon5	**1.768**	**< 0.001**	**1.449**	**< 0.001**
Surgeon6-Surgeon5	**2.221**	**< 0.001**	**1.874**	**< 0.001**
Surgeon1-Surgeon2	**-0.678**	**< 0.001**	**-0.52**	**< 0.001**
Surgeon3-Surgeon2	**-0.491**	**< 0.001**	**-0.427**	**< 0.001**
Surgeon6-Surgeon2	-0.038	0.999	-0.001	1
Surgeon3-Surgeon1	0.187	0.094	0.093	0.819
Surgeon6-Surgeon1	**0.639**	**< 0.001**	**0.519**	**< 0.001**
Surgeon6-Surgeon3	**0.453**	**< 0.001**	**0.426**	**0.003**

CR cases	Medial Laxity		Lateral Laxity	
	difference (mm)	adjusted P-value	difference (mm)	adjusted P-value
Surgeon9-Surgeon8	0.011	0.999	**-0.639**	**< 0.001**
Surgeon4-Surgeon8	**0.895**	**< 0.001**	-0.14	0.487
Surgeon7-Surgeon8	**0.595**	**< 0.001**	**-0.537**	**< 0.001**
Surgeon4-Surgeon9	**0.884**	**< 0.001**	**0.499**	**< 0.001**
Surgeon7-Surgeon9	**0.584**	**< 0.001**	0.102	0.8
Surgeon7-Surgeon4	**-0.3**	**0.001**	**-0.397**	**< 0.001**