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

Laurent Angibaud[1], Prudhvi Tej Chinimilli, François Boux De Casson[2], Amaury Jung[2], James Irvin Huddleston[3]
[1]Exactech, [2]Blue-Ortho, [3]Stanford Medicine

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 1762 cases performed by 20 individual surgeons with at least 15 cases each were considered without any exclusions. The cases were stratified based on the bearing type into three classes: posterior-stabilized (PS) with 15 surgeons, cruciate-retaining constrained (CRC) with 6 surgeons, and cruciate-retaining (CR) with 3 surgeons. Additionally, some surgeons were considered as hybrid, utilizing more than one type of bearing and thus included in multiple classes. 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. 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:

ANOVA analysis indicated significant differences ($p < 0.05$) in relative laxities among the 20 surgeons, regardless of the bearing type class and compartment side. The box and whisker charts (Figures 1 and 2) illustrate the medial and lateral laxity curves for each surgeon across PS, CRC, and CR classes. Also, median medial and lateral laxity curves are plotted in Figures 1 & 2 to visually observe the overall laxity signatures differences between the surgeons. Tukey multiple pairwise comparison results in Figure 3 reveal that most pairwise comparisons are statistically significant across three bearing type classes and two compartment sides. For medial side, the percentage of significant pairs for PS, CRC, and CR are 73.3%, 66.7%, 100%, respectively. For the lateral side, the percentages are 72.4%, 46.7%, and 66.7%. The results indicate laxity signatures differ more on the medial side compared to the lateral side, highlighting surgeon-specific laxity signatures differences are more pronounced in the medial compartment.

DISCUSSION AND CONCLUSION:

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. 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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Figure 1: Box and whisker plots for 15 PS surgeons

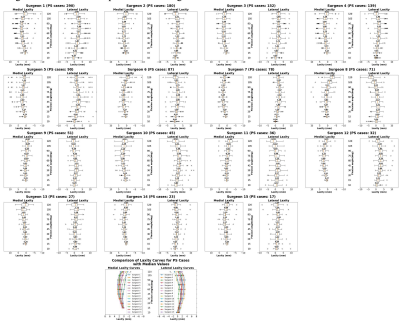

Figure 2: Box and whisker plots for 6 CRC surgeons (top) and 3 CR surgeons (bottom)

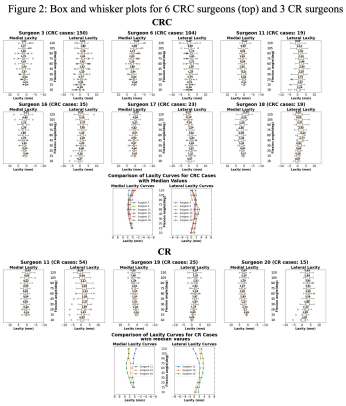

Figure 3: Tukey multiple comparisons results comparing pairwise laxity differences between 15 surgeons (PS), 6 surgeons (CRC), and 3 surgeons (CR)

Laxity	Number of surgeons*	Type of bearing	Number of cases	Total number of comparisons	Number of comparisons (p<0.05)	% comparisons (p<0.05)
Medial laxity	15	PS	1330	105	77	73.3%
Lateral laxity	15	PS	1330	105	76	72.4%
Medial laxity	6	CRC	350	15	10	66.7%
Lateral laxity	6	CRC	350	15	7	46.7%
Medial laxity	3	CR	94	3	3	100%
Lateral laxity	3	CR	94	3	2	66.7%

* Some surgeons were considered hybrid (i.e., used more than 1 type of bearing), explaining the sum being more than 20