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

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Abstract

Recent alignment techniques for total knee arthroplasty (TKA) allow the possibility of targeting knee joint laxity goals at the planning stage. In the absence of clear guidance in terms of the definition of these goals, surgeons tend to set-up the laxity goals based on their individual preferences. This retrospective review based on the same knee system and the same surgical technique established that the laxity goals were found to be surgeon specific.

1 Introduction

With the evolution of technologies of implantation for total knee arthroplasty (TKA), the surgical alignment techniques have morphed from a two dimensional referential limited to the frontal plane to a three dimensional referential where the interdependencies between the femoral and tibial resections are evaluated in both the frontal and the sagittal planes [1].

The recent possibility of reliably characterizing the soft-tissue envelope [2-3] enabled the development of alignment techniques for TKA such as functional alignment allowing the possibility of restoring the constitutional alignment of the limb while achieving proper soft-tissue balance [4].

While these techniques offer well-defined guidelines for the bone cut parameters in terms of resection levels and orientation, the definition of the laxity goals for the medial and lateral compartments is still unclear or inconsistent [4-6]. In this regard, the objective of this study was to evaluate the laxity targets set-up by surgeons at the time of the planning of the bone cut parameters.

2 Material and Methods

A retrospective review was performed on a proprietary cloud-based web database that archives technical logs of TKA cases performed using an instrumented computer-assisted surgery (CAS) 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, size, but also soft-tissue consideration based on laxity information previously 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.

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. Surgeon 4 data was included in both PS and CR analysis due to more than 30 cases in both.

Relative planned laxities were calculated for both the medial and the lateral compartments from 10° to 120° of flexion. In some cases, 1 to 2 values of both lateral and medial laxity measurements corresponding to certain flexion angles were found missing due to the assumed lack of visibility of the active trackers of the CAS system during the acquisition step. For such limited occurrences, the 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.

2.1 Statistical analyses

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. The significance level was set to 0.05.

3 Results

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 surgeon separately for PS and CR cases in Figure 1. Also, the median medial and laxity curves are compared and plotted between the surgeons to observe the differences in Figure 1. It can be seen from these figures that median values at each flexion angle and overall medial and lateral laxity signatures look surgeon specific.

A further statistical analysis performed with Tukey multiple comparisons (Figure 2) inferred that for most of the pairwise comparisons, the laxity difference was found to be statistically significant which is marked in bold.

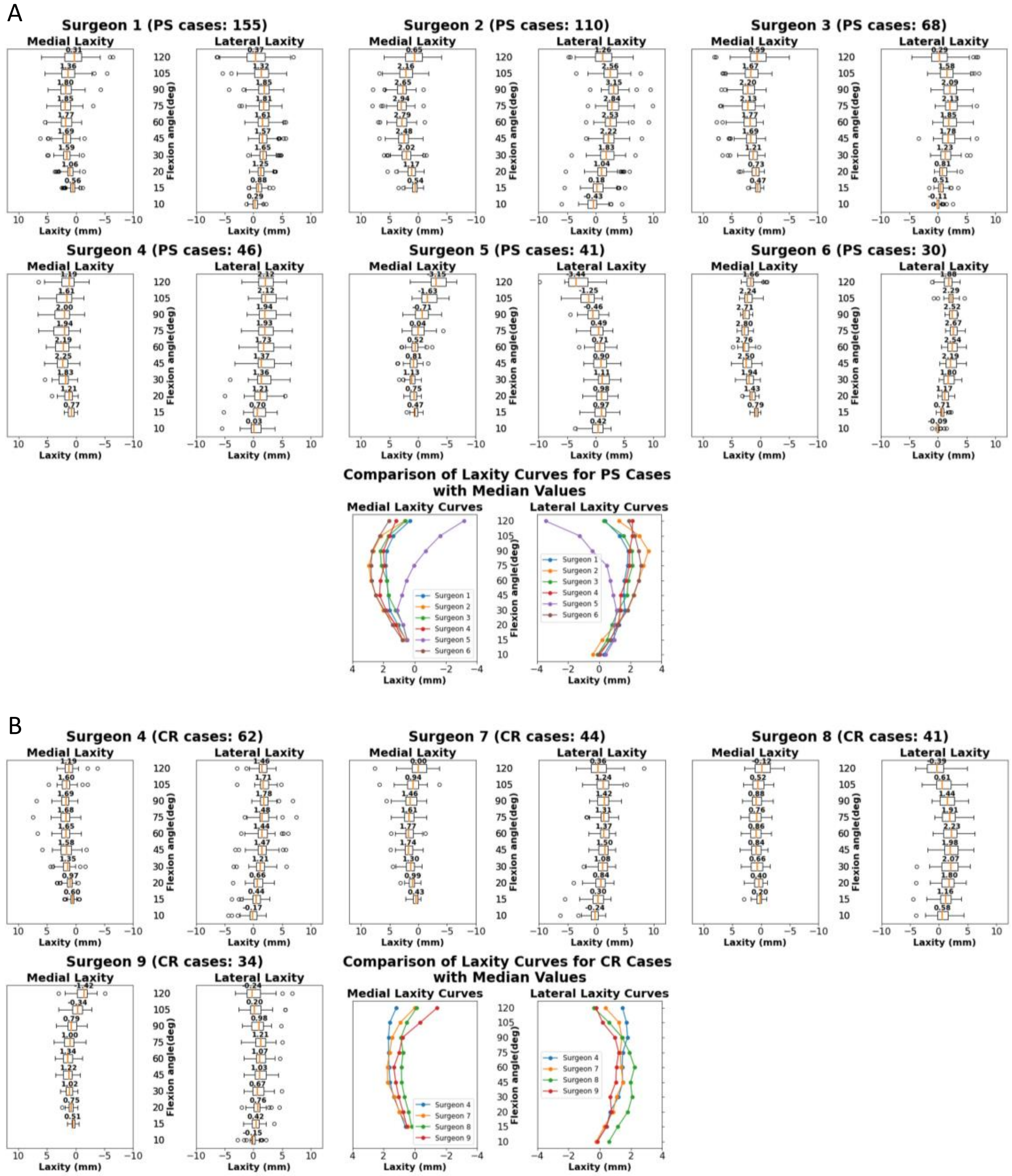

Figure 1: Box and whisker plots for 6 surgeons related to PS cases (A) and CR cases (B)

PR cases	**Medial Laxity**		**Lateral Laxity**	
	difference (mm)	**adjusted P-value**	**difference (mm)**	**adjusted P-value**
Surgeon5-Surgeon4	**-2.1**	**< 0.001**	**-1.8**	**< 0.001**
Surgeon2-Surgeon4	0.1	0.791	0.1	0.964
Surgeon1-Surgeon4	**-0.6**	**< 0.001**	**-0.4**	**< 0.001**
Surgeon3-Surgeon4	**-0.4**	**< 0.001**	**-0.4**	**0.005**
Surgeon6-Surgeon4	0.1	0.989	0.1	0.991
Surgeon2-Surgeon5	**2.3**	**< 0.001**	**1.9**	**< 0.001**
Surgeon1-Surgeon5	**1.6**	**< 0.001**	**1.4**	**< 0.001**
Surgeon3-Surgeon5	**1.8**	**< 0.001**	**1.4**	**< 0.001**
Surgeon6-Surgeon5	**2.2**	**< 0.001**	**1.9**	**< 0.001**
Surgeon1-Surgeon2	**-0.7**	**< 0.001**	**-0.5**	**< 0.001**
Surgeon3-Surgeon2	**-0.5**	**< 0.001**	**-0.4**	**< 0.001**
Surgeon6-Surgeon2	0	0.999	0	1
Surgeon3-Surgeon1	0.2	0.094	0.1	0.819
Surgeon6-Surgeon1	**0.6**	**< 0.001**	**0.5**	**< 0.001**
Surgeon6-Surgeon3	**0.5**	**< 0.001**	**0.4**	**0.003**

CR cases	**Medial Laxity**		**Lateral Laxity**	
	difference (mm)	**adjusted P-value**	**difference (mm)**	**adjusted P-value**
Surgeon9-Surgeon8	0	0.999	**-0.6**	**< 0.001**
Surgeon4-Surgeon8	**0.9**	**< 0.001**	-0.1	0.487
Surgeon7-Surgeon8	**0.6**	**< 0.001**	**-0.5**	**< 0.001**
Surgeon4-Surgeon9	**0.9**	**< 0.001**	**0.5**	**< 0.001**
Surgeon7-Surgeon9	**0.6**	**< 0.001**	0.1	0.8
Surgeon7-Surgeon4	**-0.3**	**0.001**	**-0.4**	**< 0.001**

Figure 2: Tukey multiple comparison analysis for both PS and CR cases

4 Discussion and conclusion

For the different alignment techniques, there exists well established guidance for the surgical parameters associated with the tibial and femoral resections during TKA [6]. In contrast, the guidance in terms of joint laxity tends to be more subjective. Force is to recognize that the exact laxity required in TKA is yet to be determined [7]. 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 the medial compartment, while others plan for larger flexion gaps than extension gaps.

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 [8-9], there exists an opportunity to develop solutions to further define the optimal knee joint laxity for a given TKA patient.

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