Reliability of Laxity Acquisitions During Navigated Total Knee Arthroplasty – Comparison of Two Techniques

Laurent Angibaud[1], Wen Fan[1], Philippe Dubard[2], Matt Rueff[1], Hernan A. Prieto[3], Hari Parvataneni[3]
[1]Exactech, Gainesville, FL, USA, [2]Blue-Ortho, Meylan, FR, [3]University of Florida - Department of Orthopaedic Surgery, Gainesville, FL, USA
Laurent.angibaud@exac.com

Disclosures: Laurent Angibaud (3A-Exactech), Wen Fan (3B-Exactech), Philippe Dubard (3A-Blue Ortho), Matt Rueff (3A-Exactech), Hernan A. Prieto (N), Hari Parvataneni (N)

INTRODUCTION: Total knee arthroplasty (TKA) continues to be one of the most successful surgical interventions in medicine. While patient outcomes after TKA are shown to improve dramatically with respect to pain and function; there are still approximatively 20% of patients that report dissatisfaction. With an attempt to improve patient's satisfaction, more recent developments have focused on the intra-operative management of soft-tissue balancing surrounding the knee joint throughout the full arc of motion when using a computer-assisted orthopedic surgery (CAOS) system. The aim of this study was to determine and compare the inter- and intraobserver reliabilities of acquiring knee joint laxities during navigated TKA using different techniques.

METHODS: We performed bilateral TKAs using a CAOS system (ExactechGPS, Blue-Ortho) on a fresh-frozen human cadaveric specimen. After the incision, the anatomical landmarks were acquired by inducing motion (hip center) and probing (other landmarks) to generate a patient-specific coordinate system for both the tibia and the femur. At this stage (i.e., prior to any bone cuts), the joint laxities were acquired by the CAOS system according to the conventional technique, by applying a varus stress test to the knee joint while flexing the limb to acquire the lateral laxities, and then, a valgus stress test to consecutively acquire the medial laxities. Once completed, the proximal tibial cut was performed neutral to the mechanical axis and then an intra-articular tibial distractor (Newton, Exactech) was introduced into the joint space between the tibial resection and the native femur. The distractor features 2 independent mechanically actuated compartments intended to apply a quasi-constant distraction force regardless of the joint gap. Then, the joint laxities were acquired by the CAOS system according to the proposed instrumented technique, by manually manipulating the limb through a full arc of motion with the knee joint being stabilized due to the distraction force of the intra-articular tibial distractor. For each technique, the manipulations were successively performed by a total of 4 surgeons (2 senior and 2 junior surgeons) on 6 occasions on both knees across both medial and lateral compartments. The inter- and intraobserver reliabilities were assessed using intraclass correlation coefficients (ICCs) and 95% confidence intervals (CIs).

RESULTS: A total of 96 laxity acquisitions throughout the arc of motion were performed for each evaluated technique. Regardless of the considered compartment (i.e., medial or lateral), the instrumented technique was associated with a higher reliability than the conventional technique for the laxity acquisitions ($p=0.017$) (Figure 1). For the instrumented technique, the interobserver reliability ranged from moderate to good (Mean ICC=0.72), while for the conventional technique, the interobserver reliability ranged from poor to moderate (Mean ICC=0.35) (Table 1). Similarly, the intraobserver reliability was consistently higher for the instrumented technique (Mean ICC=0.66) than the conventional technique (Mean ICC=0.41). Regardless of the considered technique, there was no significant difference in the reliability associated with the acquisition of the laxities between the medial compartment and the lateral compartment ($p=0.453$). Similarly, the experience level of the user had no statistically significant impact on the reliability of the acquisitions ($p>0.05$).

DISCUSSION: It has been previously established that soft-tissue balance, while being a key determinant in improving outcomes in TKA, is difficult to objectively assess at the time of the surgery. In this regard, the acquisition of the laxities using a CAOS system has the potential to provide valuable quantitative information to ultimately guide the definition of the femoral planning parameters in terms of size, alignment, as well as soft-tissue considerations. This being said, the reliability and predictability of the acquisition technique is key to provide proper input data. This study established that the acquisition of the knee joint laxities using an instrumented technique was consistently associated with a significantly higher reliability than the conventional manual varus/valgus stress test technique. One aspect relates to the application of a distraction force to the knee joint, which tends to greatly stabilize the joint during the manipulation of the limb. Another consideration relates to the manipulation of the limb in neutral alignment for the instrumented technique, which is easier to consistently apply relative to manual application of valgus or varus stress. Additionally, the instrumented technique yielded consistent reliability across all four surgeons regardless of experience level. Finally, while not relevant to the purpose of this study, the instrumented technique allows the acquisition of both the medial and lateral laxities during the same manipulation, a gain of time compared to the need for consecutive manipulation with the conventional varus and valgus stress technique.

SIGNIFICANCE/CLINICAL RELEVANCE: The study demonstrated higher reliability of laxity acquisitions during navigated TKA using the instrumented technique than the conventional manual varus/valgus stress test technique.

IMAGES AND TABLES:
Figure 1: Examples of laxity acquisitions throughout the arc of flexion for the conventional technique (Left) and the instrumented technique (Right)

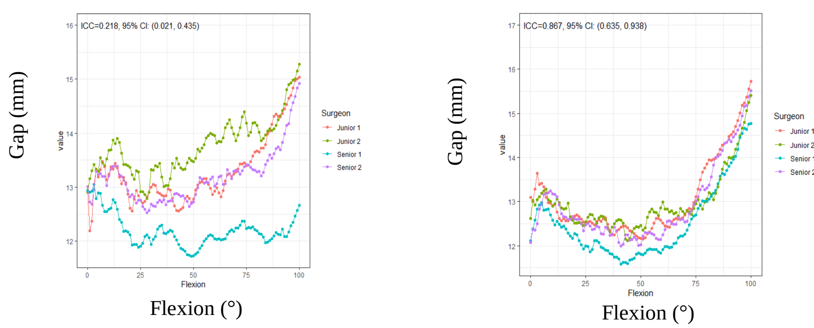

Table 1 Interobserver and intraobserver reliability for the conventional and instrumented techniques

		Interobserver	Intraobserver			
			Junior #1	Junior #2	Senior #1	Senior #2
Conventional technique	Mean ICC 95% CI	0.35 (0.04, 0.67)	0.59 (0.36, 0.82)	0.34 (0, 0.77)	0.31 (0, 0.68)	0.39 (0, 0.84)
Instrumented technique	Mean ICC 95% CI	0.72 (0.43, 1)	0.63 (0.2, 1)	0.62 (0.37, 0.86)	0.71 (0.26, 1)	0.69 (0.46, 0.93)