INTRAOPERATIVE EVALUATION OF ACHIEVED BONY RESECTIONS DURING TKA – IS IT CAOS SYSTEM-DEPENDENT?

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INTRODUCTION

Computer-assisted orthopaedic surgery (CAOS) has been shown to assist in achieving accurate, reliable and reproducible prosthesis position and alignment during total knee arthroplasty (TKA) [1,2]. A typical procedure involves inputting target resection parameters at the beginning of the surgery and measuring the achieved resection after bone cuts. There exist differences across the different CAOS systems, such as software/hardware design, mechanical instrumentation, and system-dependent work flow. All can potentially affect the intraoperative measurement of the achieved resection, with the cumulative effect of these differences remains unclear. This study assessed system-dependent differences between two contemporary CAOS systems by comparing the alignment deviation between the measurement of the achieved resection and the targeted parameters.

MATERIALS AND METHODS

Computer-assisted TKA resections were performed on 10 neutral whole leg assemblies (MITA knee insert and trainer leg, Medial Models, Bristol, UK) by a board-certified orthopaedic surgeon (BH) using System I (5 legs, ExactechGPS®, Blue-Ortho, Grenoble, FR) and System II (5 legs, globally established manufacturer). The surgeon used both systems in his practice and was deemed as “experienced” (>30 surgeries) with both systems. The target parameters for the TKA resections, as well as major differences between the two systems are summarized in Table 1A. The deviations of the intraoperative alignment measurements on the achieved distal femoral and proximal tibial resection from the target were calculated and compared between the two CAOS systems with significance defined as $p<0.05$.

RESULTS

The alignment deviations (signed and unsigned) are presented in Table 1B. System II had significantly higher deviation towards varus (on average 2.2°) than System I (on average 0.83° valgus) for the tibia ($p<0.01$, Table 1B). System I tended to measure slightly more in flexion (~1°) than System II (~0.5° extension) ($p=0.03$). System I demonstrated lower variability of the signed deviation (SD) than System II in tibial varus/valgus alignment, femoral flexion/extension, and femoral varus/valgus alignment (Table 1B, Fig. 1). No significant differences were found in between systems in the unsigned errors (N.S.).

DISCUSSION

Intraoperative measurement of the achieved TKA resections is important as it allows for further intraoperative adjustment if the resections are not deemed suitable. This study demonstrated that there exists system-dependent variability associated with intraoperative measurement of the achieved resection during TKA. Assuming a consistent surgical variability exhibited by the same surgeon with equal experience on both systems, the data from this study showed that both systems had measurement within the perceived acceptable range (within 3°) [5,6]. However, some systems (System II) may have higher variability than others (System I), and exhibit clinically meaningful bias (tibial varus/valgus) while achieving or quantifying the resections. The variability may be caused by the cumulated effect of the differences between the two CAOS systems (Table 1A). As clinical alignment accuracy has been found to be system-dependent in a previous study [3], and archived resection parameters in the surgical report has been used as key inputs in relevant studies [4], the results here emphasizes the importance of taking into account the specific CAOS system in both clinical application and CAOS research.

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DISCLOSURES

Yifei Dai and Laurent Angibaud are current employees of Exactech Inc.

Barton Harris is a paid surgeon consultant of Exactech Inc.

A

	System I	System II
Resection Target	Tibia: Varus/Valgus = 0°, Posterior Slope = 3° Femur: Varus/Valgus = 0°, Flexion/Extension = 0°	
Differences		
Sterile Field	Inside	Outside
Software/Hardware	System Specific	System Specific
Mechanical Instrumentation	One-step assembly and adjustment	Multi-step assembly and adjustment
Resection Check	Direct placement of checker onto the resection plane	Pinning of the checker onto the resection plane Re-identification of the landmarks

B

	Tibia		Femur	
	Varus/Valgus Alignment (°)*	**Posterior Slope (°)**	**Varus/Valgus Alignment (°)***	**Flexion/ Extension (°)****
System I				
Signed	-0.83 ± 0.29	0.91 ± 1.39	-0.49 ± 0.58	1.19 ± 0.71
Unsigned	0.83 ± 0.29	1.49 ± 0.46	0.61 ± 0.42	1.19 ± 0.71
System II				
Signed	2.20 ± 1.43	0.19 ± 1.19	-0.12 ± 0.90	-0.54 ± 1.21
Unsigned	2.20 ± 1.43	0.93 ± 0.61	0.74 ± 0.39	0.93 ± 0.87

* Positive values indicate measured resection is more varus compared to the target
** Positive values indicate measured resection is more flexed compared to the target

Table 1. A) Resection target for the CAOS surgeries and a summary of differences between the two CAOS systems. B) Deviations in the measurements of the achieved resection relative to the resection target.

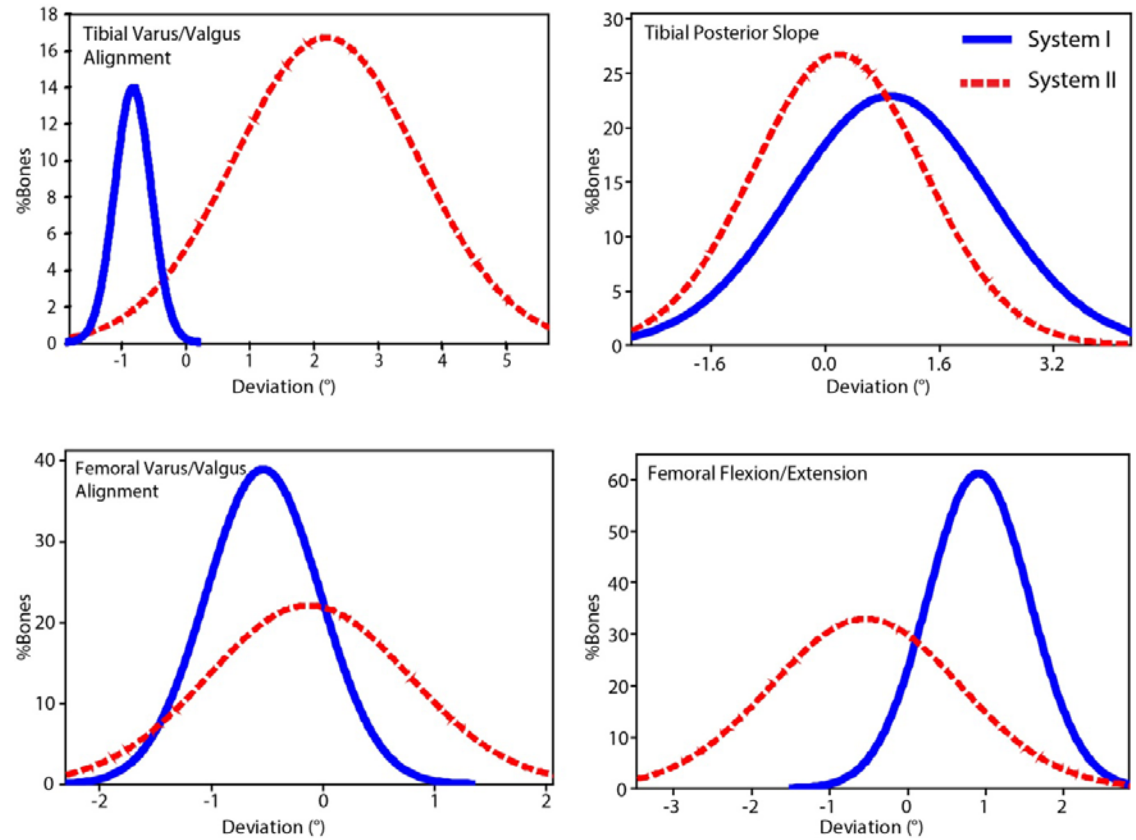

Figure 1. Distribution of the alignment deviation between the measured achieved resection and the resection target. Positive values indicate the measured achieved resection had more varus alignment in the tibia/femur, and more flexion in the femur.