# EVALUATION OF TRACKER VISIBILITY DURING COMPUTER-ASSISTED TOTAL KNEE ARTHROPLASTY

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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]. The most prevalent modality of navigator tracking is optical tacking, which relies on clear line-of-sight (visibility) between the localizer (camera) and the instrumented trackers attached to the patient. During surgery, the trackers may not always be optimally positioned and orientated for the establishment of line-of-sight, sometimes forcing the surgeon to move the patient's leg or adjust the camera in order to maintain tracker visibility. Although alignment outcomes and accuracy of the CAOS systems have been studied [3-5], less is known about tracker visibility under clinical settings. This study quantified the rotational limits of the trackers in a contemporary CAOS system for maintaining visibility across the surgical field.

## MATERIALS AND METHODS

A CAOS system (ExactechGPS®, Blue-Ortho, Grenoble, FR) was set up in an operating room by a standard surgical table according to the manufacture's recommendation. A grid with 10x10 cm sized cells was placed at the quadrant of the surgical table associated with the TKA surgical field (Fig. 1A,B). The localizer was set up to aim at the center of the grid. A TKA surgical procedure was then initiated using the CAOS system. Once the trackers-localizer connection was established, the CAOS system constantly monitored the accuracy by measuring the root mean square error (RMS) of each tracker based on the pattern of the light-emitting diodes (LEDs) located on its front face. The connection was immediately aborted if the measured RMS was above the defined threshold. Therefore, "visibility" was defined as the tracker-localizer connection with proper accuracy level. An F tracker from the tracker set (3 trackers with similar characteristics) was placed at the center of each cell on the grid by a custom fixture, facing along the +Y axis (Fig. 1). The minimum and maximum angles of rotation around the Z axis ($RA_{Z\_MIN}$ and $RA_{Z\_MAX}$) and X axis ($RA_{X\_MIN}$ and $RA_{X\_MAX}$) for maintaining tracker visibility were identified. For each cell, the rotational limit of the tracker was calculated for each axis of rotation as the difference between the maximum and minimum angles ($RL_X$ and $RL_Z$).

## RESULTS

The tracker rotation limits were 144.7±3.9° for $RL_Z$ (ranging from 136° to152°), and 150.5±3.9° for $RL_X$ (ranging from 143° to 158°). $RL_X$ was significantly higher than $RL_Z$ across the field (difference in means = 5.8°, $p<0.01$). Along the X axis, the rotational limit decreased slightly for $RL_Z$, but increased slightly for $RL_X$ (Fig. 2).

## DISCUSSION

Studies have pointed out that the need for maintaining line-of-sight can be a limitation for the use of optical tracking based CAOS systems [6,7]. The results here demonstrated that ExactechGPS provides tracker visibility for more than 135° rotation across the surgical field.

Moreover, the system is placed inside the sterile field, eliminating the potential blockage of the optical localizer by the surgical staff, further ensuring tracker visibility. The slight rotational limits trends along the X axis may be due to camera placement at one side of the surgical table. The current methodology may be applied to other CAOS systems to quantify the tracker visibility in a clinical environment.

The methodology presented in this study may be applied to other contemporary CAOS systems to provide additional information on the performance of the systems under the clinical environment.

## REFERENCES


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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.

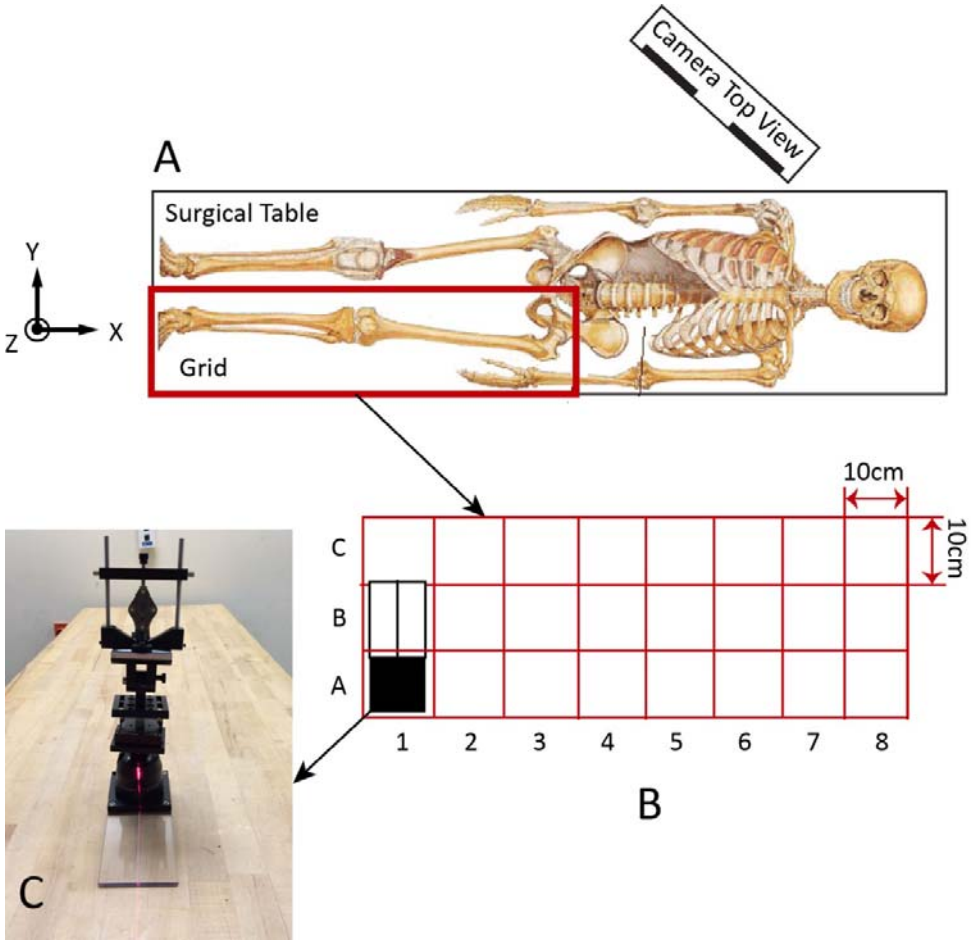


**Figure 1. A) Setup for the test. A grid was placed on the surgical table according to the leg location of the patient (illustrated). A coordinate system was defined to provide axis references for tracker rotation. B) The F tracker was placed in cell A1 using a custom fixture (each cell on the grid was marked using a combination of a numerical number and an alphabetic letter). C) Photograh of the custom fixture for holding the F tracker.**

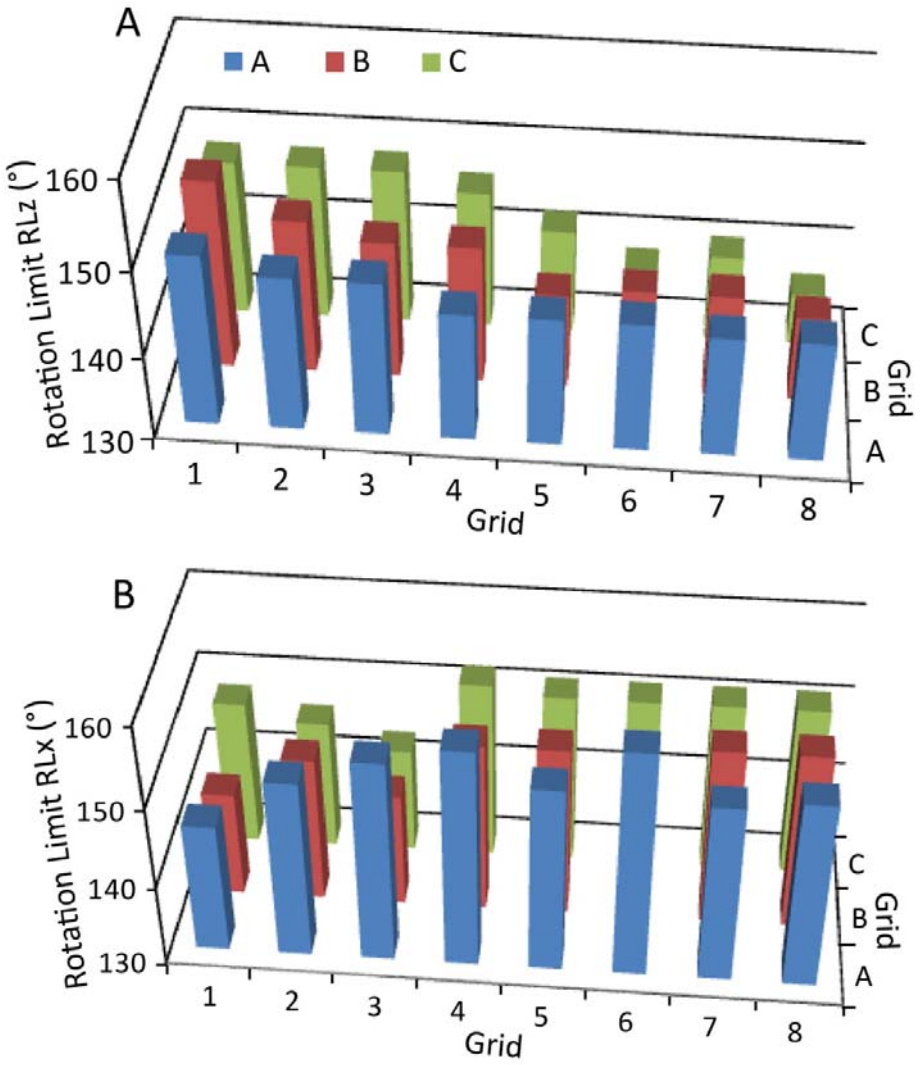


**Figure 2. Rotational limits (maximum - minimum angles of rotation) about A) Z axis and B) X axis for maintaining tracker visibility, plotted for each cell located on the grid.**