

Accuracy and Precision of a Novel 2D-3D Registration System following Direct Anterior Approach Total Hip Arthroplasty

Roham Borazjani, MD¹, Christopher Plaskos, PhD², Linden Bromwich, MEng², Jim W. Pierrepont, PhD², Stefan Kreuzer³
 1= INOV8 Research, Houston, Texas; 2= Corin Group, Cirencester, UK.; 3= INOV8 Healthcare, Houston, Texas.
 Email Presenting Author: rborazjani@inov8hc.com

Disclosure: Roham Borazjani (N); Christopher Plaskos, Linden Bromwich and Jim Pierrepont: Employee of Corin with stock/options; Stefan Kreuzer [(consulting or advisory, speaking and lecture fees, and travel reimbursement) (Restore 3D, Corin Group USA, Naviswiss Inc., Medtrade Products Ltd, CeramTec GmbH), board membership (ISTA, PAS, Cairra Surgical, IMACx)]

Introduction: Two-dimensional (2D) intraoperative fluoroscopy (IF) is commonly used to measure component position, leg length (LL) and offset (OS) in direct anterior approach Total Hip arthroplasty (DAA-THA). However, 2D-IF is known to have variable and limited accuracy due to pelvic tilt and rotation, central beam effects, and manual measurements. Although CT- assisted preoperative planning is common in THA, no technologies are available yet to integrate preoperative 3D CT planning with IF. This study aims to evaluate the accuracy of a new 2D-3D hip software for intraoperative measurement of cup position, LL, and OS based on early clinical results.

Methods: This prospective, single-center study evaluated 37 consecutive primary DAA-THA procedures performed at a tertiary orthopedic center using a CT-based, stereoscopic navigation system. Preoperative planning, intraoperative navigation data, and postoperative measurements were collected for each case. Intraoperative data were also captured using our novel 2D-3D Registration System. Postoperative radiographs underwent 2D-3D registration by a reviewer blinded to intraoperative results. All registrations were independently reviewed by a second, blinded reviewer, and final radiographic measurements were generated using custom Python scripts. Statistical analyses and graphing were performed using R statistical software (version 4.5; R Foundation for Statistical Computing, Vienna, Austria). Errors between intraoperative navigation values and postoperative measurements were calculated using the convention: Error = Intra-Op – Post-Op.

Results: A total of 37 hips were analyzed. 2D3D navigation demonstrated lower mean absolute errors (MAE) in both leg length and offset compared with the image-based navigation system (LL: 1.9 ± 1.5 mm vs 2.8 ± 1.7 mm; OS: 2.3 ± 1.5 mm vs 2.4 ± 2.0 mm). For leg length, 77.4% and 93.5% of 2D3D cases were within ±3 mm and ±5 mm of postoperative measurements, respectively, compared with 42.3% and 88.5% for image-based navigation. For offset, 71.0% and 96.8% of 2D3D cases were within ±3 mm and ±5 mm, compared with 69.2% and 84.6% (**Figure 1**).

Cup orientation accuracy was also higher with 2D3D. MAE for inclination and anteversion was 1.2 ± 0.9° and 1.2 ± 1.3 with 2D3D, compared with 2.3 ± 2.2° and 2.2 ± 2.2°, respectively, for the image-based navigation device. Across all cases, 94.6% to 100% of 2D3D-navigation measurements were within ±3° and ±5°, whereas the image-based navigation system achieved 68.6% to 94.3% (**Figure 2**).

Discussion: A 2D3D registration demonstrated high accuracy for assessing acetabular cup position, leg length, and offset in direct anterior approach total hip arthroplasty. In this cohort, 100% of cases were within ±5° for inclination and 97% were within ±5° for anteversion when compared with postoperative measurements, outperforming previously reported 2D fluoroscopic- or image-based navigation methods. This technique integrates intraoperative fluoroscopy with 3D CT-based preoperative planning and may overcome accuracy limitations associated with conventional 2D imaging or digital ellipse measurements.

Significance: The higher accuracy of the 2D-3D registration approach during DAA-THA can translate into more precise component positioning and improved restoration of hip biomechanics. This, in turn, may reduce postoperative complications, including but not limited to dislocations and implant wear.

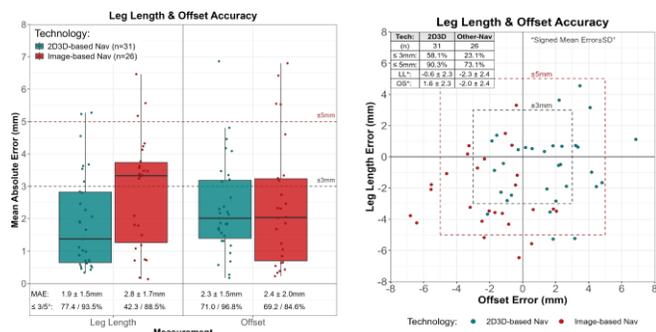


Figure 2. Accuracy of Leg Length and offset measurements in the novel 2D-3D measurements compared with CT-based Navigation System.

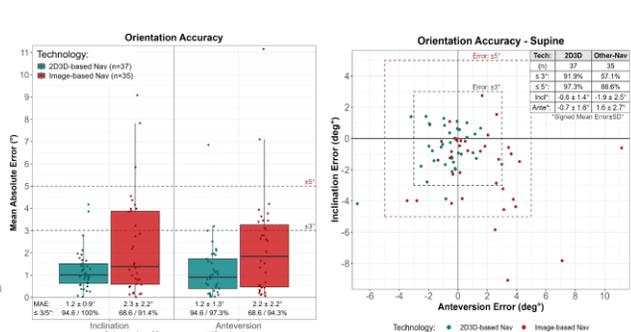


Figure 1. Accuracy of Acetabular Cup Position in the novel 2D-3D measurements compared with CT-based Navigation System.