

# Accuracy of Acetabular Cup Positioning using Patient-Specific Mixed Reality Guidance

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## INTRODUCTION:

Malposition of the acetabular cup has been shown to contribute to postoperative complications following Total Hip Arthroplasty (THA), including dislocations and revisions [1]. Surgeons have used many methods to achieve optimal placement of the acetabular cup, including preoperative planning, traditional navigation, robotics, and intraoperative radiography. More recently, a patient-specific Mixed Reality guidance solution has been developed that allows the surgeon to see 3D models of patient anatomy, surgical instruments, and implants in relationship to the patient during surgery using a head-mounted device. The purpose of this study was to evaluate the accuracy of cup placement relative to the goal for surgeries performed using the Mixed Reality guidance platform.

## METHODS:

Fifty-seven patients underwent CT based preoperative planning for use of the Mixed Reality guidance system. This includes the generation of 3D models of the patient's pelvis and femur and planned placement of 3D models of the components. 3D holograms were created for display during surgery. At the time of the procedure, a smart mechanical navigation tool was docked to the patient with a tracking image target located outside of the body in a predicted position. The holograms were then displayed into the patient during surgery on a headmounted device by anchoring and tracking the image target. The surgeon then aligned the real cup handle as closely as possible to the projection of the cup handle. All cases were performed by the senior author.

After surgery, all patients underwent standing EOS biplanar imaging at their postoperative appointment [2]. These two images were used to calculate the achieved cup orientation using a validated methodology [3]. This was compared to the planned cup orientation.

## RESULTS:

The mean error in achieved vs planned operative anteversion of the acetabular cup was  $-1.3^\circ$  (SD:  $2.0^\circ$ , Min  $-7.0^\circ$ , Max  $2.0^\circ$ ), the mean error in operative inclination was  $-1.2^\circ$  (SD:  $2.5^\circ$ , Min  $-6.0^\circ$ , Max  $5.0^\circ$ ). The mean absolute error was  $1.8^\circ$  (SD:  $1.6^\circ$ ) for operative anteversion, and  $2.2^\circ$  (SD:  $1.7^\circ$ ) for operative inclination. Demographic information for patients is summarized in table 1.

## DISCUSSION AND CONCLUSION:

The Mixed Reality guided acetabular components were well placed with low mean error, and all cases within  $\pm 7$  degrees in both planes. Further studies may provide additional data on the accuracy of Mixed Reality guidance for accurate acetabular component placement in total hip arthroplasty.

Component placement from target (degrees)

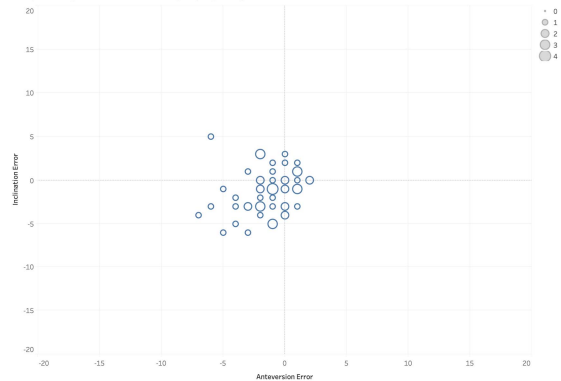


Table 1: Results and demographics

	Accuracy	Degrees	Patient demographics	
Operative anteversion	Mean error	-1.3	N	57
	SD error	2.0	Average age at surgery	62
	Max error	2.0	SD age at surgery	9.1
	Min error	-7.0	Min age at surgery	38
	Mean absolute error	1.8	Max age at surgery	82
	SD absolute error	1.6		
Operative inclination	Mean error	-1.2	Male	30
	SD error	2.5	Female	28
	Max error	5.0	Male (%)	52%
	Min error	-6.0	Female (%)	48%
	Mean absolute error	2.2		
	SD absolute error	1.7		