Throwing Darts with the Aid of 3D Imaging: A New Advancement in Percutaneous Pelvis Operations

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INTRODUCTION: Percutaneous pelvic fixation requires extensive anatomical knowledge and preoperative planning to safely place screws in appropriate corridors. Obtaining appropriate fluoroscopic views intraoperatively is paramount to successful screw placement but does not guarantee screw safety. Previous studies have shown that use of intraoperative 3D imaging can be a helpful tool in determining screw safety, but current imaging capture techniques (including CT imaging) increases operative time and comes at an increase cost of irradiating the patient at high dosages. Manual Tomography is another method of acquiring 3D images using a mobile C arm. This method acquires 2D fluoroscopic projections by manually rotating a suitably instrumented C arm through one or more short arcs. This method develops 3D reconstructed images by employing algebraic reconstruction techniques for limited angle cone-beam CT (LA-CBCT). The purpose of this study is to demonstrate the feasibility of using an LA-CBCT system to provide convenient intraoperative visualization of screw boundaries relative to the bony corridors.

METHODS: Using a geriatric cadaveric pelvic model, 6.5 mm Stainless steel cannulated percutaneous screws (JJ MedTech©) were placed at the margin of safe corridors in the S1 body, S2 body, and anterior column using traditional 2D fluoroscopic guidance. A total of 87 fluoroscopic images (1024x1024 pixels) from ~60° transverse and cranial/caudal manual arcs were used with 150 iterations of a conjugate gradient/least squares reconstruction algorithm to create a 512x512x512 voxel image with 1mm spacing. Post-instrumentation, a thin cut bony CT was obtained with hardware in place to confirm hardware location, and the cadaveric model was stripped of all soft tissues to verify the anatomic relationship of the hardware to the bony corridors.

RESULTS: The traditional CT correlated with the anatomic dissection to demonstrate that the anterior column screw exited the corroder in the cranial and anterior quadrant and 2/3 sacral screws were too cranial and posterior in the corridor (resulting in perforation of the neural space (Figure 1)). This was also accurately demonstrated on the 3D rendering created by the LA-CBCT system (Figure 2).

DISCUSSION: 3D rendering from the LA-CBCT system adequately identified the anatomic location of percutaneous pelvic fixation within the chosen corridors. The system was as easy to manipulate and utilize as traditional C-arm fluoroscopy. Visually, the image quality was superior in real-time. It also comes at a decreased cost in radiation and has less of an increase in operative time in comparison to historically reported values from other 3D imaging counterparts.

SIGNIFICANCE/CLINICAL RELEVANCE: Intraoperative 3D rendering using LA-CBCT is a viable option for future surgical innovation and now can be validated clinically. Technology that improves the safety margin of surgical technique is a significant improvement in patient safety.

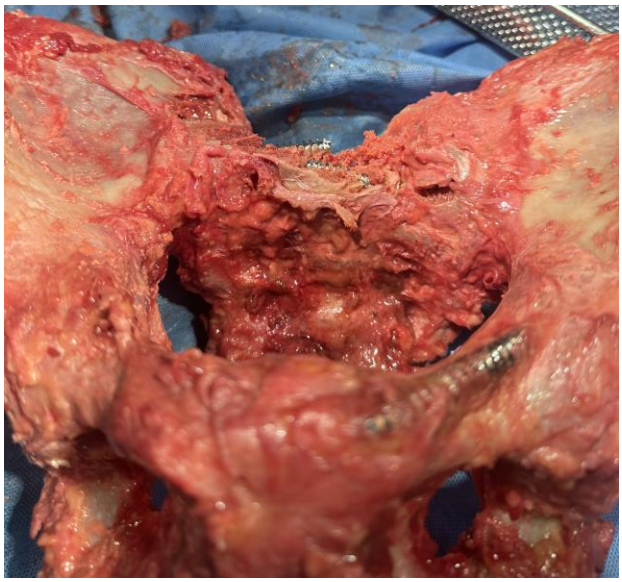

Figure 1. Postoperative dissection confirmed screw placement.

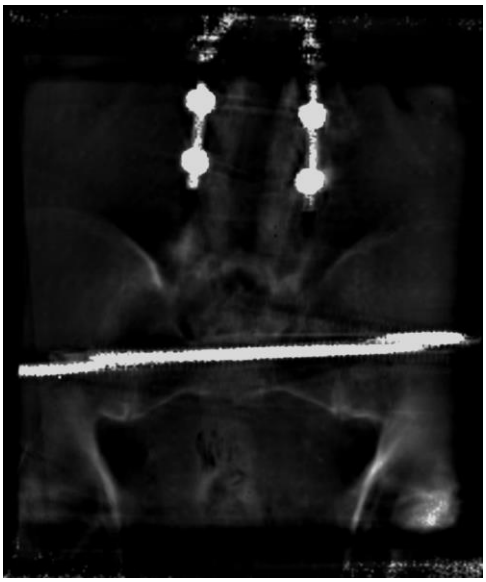

Figure 2. LA-CBCT provided adequate resolution of hardware and bony corridors to confirm screw placement intraoperatively.