Patient Radiation Exposure With 3-Dimensional Intraoperative Imaging Is Significantly Less When Compared to Conventional Pelvic CT in Pelvic and Acetabular Surgery

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Purpose: Reduction quality and accurate implant positioning are paramount in pelvic and acetabular surgery. These critical parameters are usually assessed intraoperatively with multiplanar pelvic fluoroscopy and plain radiographs. Postoperative pelvic CT scans remain the best option to reveal reduction and implant details. Ziehm Vision RFD 3D C-Arm (Orlando, FL) fluoroscopy provides intraoperative high-resolution axial, coronal, and sagittal reconstructed images similar to a CT scan. These images are obtained at any time during the operation so that any necessary implant repositioning or reduction changes can be made during the surgery. Our study measures and compares the radiation doses of patients undergoing intraoperative pelvic and acetabular fluoroscopy using the Ziehm RFD 3D C-arm with conventional postoperative pelvic CT scanning (POCT).

Methods: We placed nanodot dosimeters (Landauer, Glenwood, IL) on 40 consecutive patients undergoing pelvic or acetabular fracture operations. The dosimeters are the most effective tool to independently verify the quantity of dose delivered from radiation-producing devices in medical imaging. They only measure the direct dose while ignoring scatter. Four dosimeters were placed around each pelvis in standardized locations while undergoing intraoperative 3-dimensional (3D) scanning, and then a second set of 4 dosimeters were placed while undergoing POCT. The dosimeters were subsequently read to determine the overall radiation dose. A 2-sample t test was used to analyze the cohort while a paired t test was used to analyze the Ziehm dose compared to the CT dose for each patient. Significance was set at $P < 0.05$.

Results: 40 patients with pelvic or acetabular injuries were included for analysis. The average age was 42.07 years (range, 8-85). The average body mass index (BMI) was 29.5 (range, 17.4-40.8). The average Ziehm dose was 22.5 mGy compared to 74.8 mGy for the POCT dose ($P < 0.001$). The average Ziehm dose for patients with a BMI <25 was 9.8 mGy compared to 24.7 mGy for patients with a BMI ≥25 ($P < 0.001$). The average CT dose for patients with a BMI <25 was 55.9 mGy compared to 79.2 mGy for patients with a BMI ≥25 ($P = 0.11$). For patients with a BMI <25, the average Ziehm dose was 9.0 mGy compared to 55.1 mGy for the POCT dose ($P < 0.05$). Finally, for patients with a BMI ≥25, the average Ziehm dose was 24.8 compared to 77.5 mGy for the POCT dose ($P < 0.001$).

Conclusion: This study demonstrates that the Ziehm Vision RFD 3D C-arm exposes the patient to significantly less radiation than conventional pelvic CT scanning. Additionally, we have demonstrated that patients with a BMI ≥25 sustain a significantly higher radiation dose when undergoing 3D reconstructions with the Ziehm 3D C-arm. As this technology continues to evolve, it may eliminate the need for POCT scanning in pelvic and acetabular surgery.