Reduction of Radiation Exposure From C-Arm Fluoroscopy During Orthopaedic Trauma Operations With Introduction of Real-Time Dosimetry

***Rita Baumgartner, MD*[1]**; *Kiley Libuit, BS*[2]; *Dennis Ren, BA*[2]; *Omar Bakr, BS*[2];
Nathan Singh, MD[2]; *Utku Kandemir, MD*[2]; *Meir Tibi Marmor, MD*[2]; *Saam Morshed, MD PhD*[2];
[1]*Duke University, Durham, North Carolina, USA;*
[2]*University of California, San Francisco, San Francisco, California, USA*

Purpose: The use of fluoroscopy for indirect visualization and closed reductions in orthopaedic trauma surgery has dramatically increased. Approaches to decrease radiation exposure in orthopaedic trauma surgery have been limited. The purpose of this investigation is to assess how real-time visualization of radiation exposure impacts radiation dose levels during orthopaedic trauma operations.

Methods: This was a 2-phase observational comparative study of radiation dosing to operating room staff before and after blinding to real-time, intraoperative information reported by a dosimetry device. In each phase, operations on 54 patients with fractures of the distal radius, ankle, tibia, femur, and acetabulum were included. Real-time dosimetry badges were worn by the primary surgeon, assistant surgeon, scrub nurse, x-ray technologist, and patient. Prior to each phase, a mandatory 1-hour course on radiation safety techniques for use of intraoperative fluoroscopy was required for each participating surgeon. Phase 1 was the blinded arm of the study, during which participants were unable to see their radiation exposure. During phase 2, the badges were enabled to project real-time radiation exposure data to a screen connected to the C-arm image viewer. The radiation exposure of each badge for the duration of each operation was collected. Dosing levels were assessed and compared between the 2 phases of the study using the Student *t*-test and analysis of variance.

Results: Mean surgeon (MS; average of primary and assistant surgeon) radiation exposure including all fracture types was not different between the 2 phases of the study ($P = 0.06$). In phase 1, MS exposure was highest in femoral shaft fractures (mean 146.2 μSv, SD 163.4 μSv) and acetabular fractures (mean 158.1 μSv, SD 106.9 μSv). Mean non-surgeon personnel (MNSP; average of scrub nurse, x-ray technologist, and patient) exposure was highest in tibial shaft fractures (mean 19.8 μSv; SD 34.0 μSv). In these highest radiation cases, MS and MNSP exposure was significantly decreased in phase 2. MS radiation for femoral shaft fractures demonstrated a mean decrease of 107.2 μSv (95% confidence interval [CI] 38.2-176.2) and of 128.9 μSv (95% CI 69.1-188.6) for acetabular fractures. MNSP radiation exposure for tibial shaft fractures had a mean difference of 19.7 μSv (95% CI 11.4-27.9). Radiation dose (mGy) and duration of C-arm use (minutes) as recorded by the C-arm, and number of fluoroscopy shots were significantly decreased during acetabular fracture surgeries in the unblinded as compared to the blinded phase of the study ($P < 0.0001$; $P = 0.002$; $P = 0.004$ respectively).

Conclusion: Surgeon radiation exposure is highest during femoral shaft fracture and acetabular fracture repair. Our data demonstrate that real-time visualization of radiation exposure during orthopaedic trauma operations can significantly decrease radiation exposure, presumably through immediate feedback and motivation of use of dose-minimizing

See pages 99 - 147 for financial disclosure information.

techniques. Further research is necessary to establish the health effects of the exposure levels and to further understand how interventions, such as real-time radiation exposure data, can mitigate exposure.

• The FDA has not cleared this drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 600.