

Introduction

Intra-operative fluoroscopy has aided the orthopaedic surgeon but its advantages must be weighed against the threat that radiation poses to the surgeon's hands¹. Even without direct exposure, the surgeon and his or her hands are routinely exposed to radiation scatter²⁻⁹. Previous studies quantifying radiation exposure to the orthopaedist's hands during use of large C-arm fluoroscopy have lacked power and are contradictory³⁻⁹. Furthermore, limiting exposure with radiation-attenuating gloves can decrease the surgeon's tactile abilities, driving the surgeon to forgo their use¹⁰.

Objectives

The purpose of this study was to quantify radiation that the orthopaedic traumatologist's hands experience during routine clinical practice and to evaluate the ability of a novel radiation-attenuating product, only 0.2mm thick, to decrease this radiation.

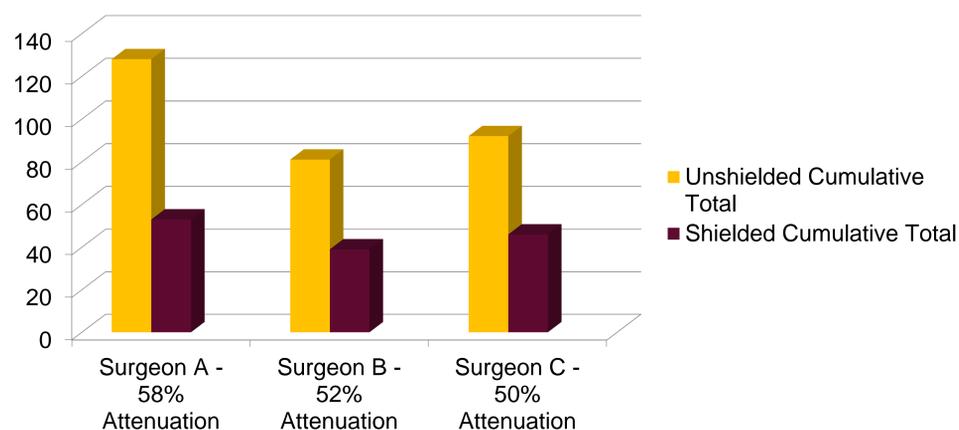
Methods

Three fellowship-trained orthopaedic trauma surgeons (A, B, C) at a Level I trauma center monitored radiation exposure to the dorsum of their dominant hand during 95 individual trauma cases (A-31, B-33, C-33) and 71 cumulative trauma cases (A-24, B-25, C-22) requiring the use of large C-arm fluoroscopy. Surgeons wore side-by-side dosimeters on the dorsum of their dominant hand for each case, one dosimeter shielded with a 0.2mm layer of the radiation-attenuating product and the other dosimeter unshielded. Both dosimeters, placed within a sterile package, were affixed to the surgeon's hand under his/her surgical gloves prior to each case. The dosimeters, controlled for environmental exposure, had a minimum radiation detection of 5mrem. All dosimeters were returned to the manufacturer to determine overall radiation exposure (unshielded) and attenuated radiation exposure (shielded). For the individual cases, the shielded dosimeters were initially covered only on their dorsal surface (34 cases – "H" dosimeters) and were subsequently covered on their dorsal and ventral surfaces (61 cases – "F" dosimeters). For the cumulative case series "F" dosimeters were used. Wilcoxon tests were utilized to assess for significant difference between radiation exposure to the unshielded dosimeters as compared to both the "H" shielded and "F" shielded dosimeters as well as radiation exposure during surgical cases involving particular body sites over others.

Results

During cumulative exposure, the surgeons' hand was exposed to an average of 100 mrem (range 81-128), with the novel radiation attenuation product demonstrating the ability to attenuate $\geq 50\%$ of this radiation exposure (Surgeon A - 58%, Surgeon B - 52%, Surgeon C - 50% [$p < 0.0001$]). Fig 1.

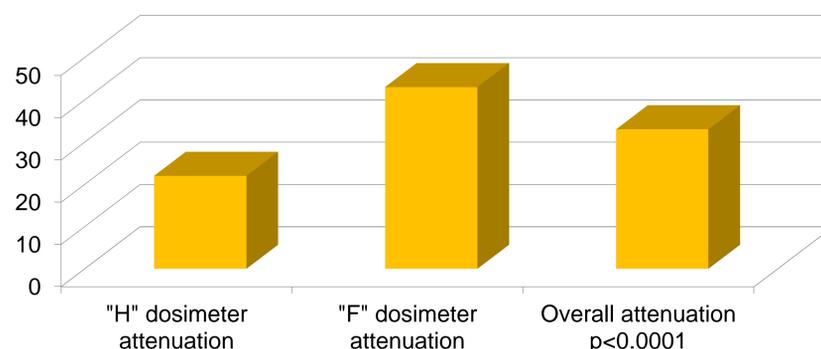
Fig 1: Attenuation of Radiation to the Hand during Cumulative Cases



Results continued

For individual cases, 77% of all dosimeters showed detectable levels of radiation ($\geq 5\text{mrem}$) to the hand, ranging from 5-69 mrem (average 16.8 mrem). "H" dosimeters attenuated 22% of all radiation. "F" dosimeters attenuated 43% of all radiation ($p < 0.0001$). Average attenuation amongst all individual cases was 33% ($p < 0.0001$). Fig 2

Fig 2. Attenuation of Radiation to the Hand during Individual Cases



Of the cases that registered undetectable amounts of radiation ($< 5\text{mrem}$) to the hand, $> 50\%$ consisted of ORIF ankle, syndesmosis and distal fibula. All other case types routinely registered detectable radiation to the hand. Exposure to the hand during ORIF/IMN cases of the proximal femur and femoral shaft, which averaged 25 mrem, was significantly greater ($p < 0.0001$) than during procedures involving other body sites.

Conclusion

The orthopaedic surgeon's hand is at risk to radiation exposure when utilizing C-arm fluoroscopy. Surgeons can reduce direct irradiation by keeping their hands out of the fluoroscopic field, but scatter radiation still poses a danger. As the maximal permissible annual dose to the skin or extremity (hand) is 50rem^1 , these data demonstrate that exposure to the hand during use of large C-arm fluoroscopy in the orthopaedic trauma setting exposes hands to levels below annual limits. Nevertheless, surgeons should take care to decrease exposure to levels as low a reasonably achievable. Hands are at greatest risk of radiation exposure during femoral ORIF and IMN procedures. The novel radiation-attenuating product, only 0.2mm thick, shows the ability to decrease the hand's exposure to scatter radiation by 33-58%.

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Disclosure

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