Eye Radiation Dose Comparison between Surgical Loupes, Lead-Lined Glasses, and Plastic Face Shields

Kyle Hardacker[1], Pierce Hardacker[2], Tucker Callanan, Alan H Daniels[3], Janine Molino, Rachel Schilkowsky, Michael Oumano[4], Eren O Kuris[5]

[1]Brown University Orthopedic Surgery, [2]Indiana University School of Medicine, [3]University Orthopedics, Inc., [4]Radiation Safety, [5]Warren Alpert Medical School of Brown University

INTRODUCTION: Fluoroscopy plays a crucial role in various medical procedures, especially in orthopaedic and spinal surgery. However, concerns have arisen regarding ocular radiation exposure given its association with posterior lens opacities and cataracts. Protective measures are essential to mitigate ocular radiation exposure. In spine surgery, loupes are frequently used but often lack lead lining. To our knowledge there is no data on radiation protection by surgical loupes. This study aims to assess the effect of surgical loupes on ocular radiation exposure versus lead glasses and plastic face shields.

METHODS: Dosimeters (Landauer VISION) were positioned anterior (unshielded) and posterior (shielded) to the lens of each type of eyewear: lead glasses (PROTECH, Plano 0.75 mm Pb), surgical loupes (DESIGN FOR VISIONS, Nike Micro 2.5 Scopes), and plastic face shields (HALYARD, Safeview). Eyewear/dosimeters was exposed directly to the horizontal beam of a C-arm (Phillips BV Endura, 50 kV, 1.06 mA, II size 23 cm, no collimation, on boost) for 2 minutes of continuous fluoroscopy. This was repeated 20 times for each type of eyewear (40 total/eyewear, 120 overall). Radiation doses were modeled utilizing generalized estimating equations with Gaussian distribution and identity link function. Separate models were employed for each outcome, including eyewear category (lead glasses, loupes, plastic shield) and dosimeter position (anterior/unshielded vs. posterior/shielded).

RESULTS: Radiation dose was significantly lower between shielded and unshielded dosimeters for lead glasses (0.00 v 1,689.80 mREM, $p<0.001$) and for loupes (20.27 v 1,705.95, $p<0.001$). No significant difference was observed for plastic shields (1,539.75 v 1,701.45 mREM, $p=0.06$). Lead glasses offered the most protection, followed by surgical loupes then plastic shields when comparing the shielded dosimeter readings (0.00 v 20.27 v 1,701.45 $p<0.001$ for all comparisons). There was no significant difference in radiation dose for dosimeters placed anterior to lead glasses, loupes, and plastic face shield (1,689.80 vs. 1,730.95 vs. 1,726.45 mREM, $p = 0.99$).

DISCUSSION AND CONCLUSION: Lead glasses were most effective (~100% reduction), surgical loupes (97%), whereas plastic face shields showed no statistically significant reduction in radiation dose. Surgical loupes can substantially reduce ocular radiation exposure.