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CLINICAL SUMMARY

RADIATION EXPOSURE TO THE HAND OF A SPINAL INTERVENTIONALIST DURING FLUOROSCOPICALLY GUIDED PROCEDURES

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BACKGROUND

The study authors review the effect of radiation of the hands of the spinal surgeon during guided spinal procedures. The surgeons are exposed to both direct and scattered ionizing radiation is during this time. Ionizing radiation is defined as any type of particle or electromagnetic wave that carries enough energy to ionize, or remove electrons from, an atom. When atoms in living cells become ionized, one of three things occurs:

1. Cell death
2. Cell repair
3. Cell mutation - becomes cancerous

Studies on long-term exposure to ionizing radiation shows a link to damage of tissue and to the DNA in genes.

Long term exposure to ionizing is linked to:

- Malignancies
- Genetic and hematological aberrations
- Dermatological lesions
- Cataracts

Exposure effects of ionizing radiation

Though orthopedic surgeons use a lead apron for protection during fluoroscopic procedures, their hands and fingers are prone to scattered radiation exposure due to the proximity to the field of procedure. And since zero exposure cannot be attainable, it becomes a matter of minimization using the ALARA principle, which dictates that levels should be "as low as reasonably achievable." The fundamentals of ALARA are as follows:

Time

- Minimize time near a radiation source

Distance

- Minimize distance from radiation source
- Greater distance equals lower exposure dose

Shielding

- Use lead or lead equivalent shielding for X-rays and gamma rays is an effective way to reduce radiation exposure
- Examples of shielding that contain lead and are used in the reduction of radiation exposure include: aprons, thyroid shields, mobile shields, glasses, gloves and other barriers

Regarding the radiation exposure experienced by spinal interventionalists during fluoroscopically guided operations, few studies are available.

OBJECTIVES AND METHODS

This prospective study evaluated the radiation exposure to the hands of spinal interventionalists. In addition, data was collected on the effects of whole-body dose of radiation during procedures, and the effectiveness of the lead apron in preventing this exposure. A three-month prospective study was conducted between August 1, 2012 and October 31, 2012. During fifty-two (52) consecutive fluoroscopic spine procedures, five radiation dosimeters monitored a single surgeon for radiation exposure. Real-time dosimeters secured at the dominant right forearm (unprotected), inside the lead apron over the left chest (protected), and outside the lead apron over the left chest (unprotected). The location of each radiophoto luminescence* glass dosimeters is: inside the lead apron over the left chest (protected) to measure the effective whole-body radiation dose and the ring glass dosimeter on the right thumb under the sterile surgical glove (unprotected).

Placement of dosimeters

Real-time dosimeter

- Dominant right forearm (Unprotected)
- Left chest, inside lead apron (Protected)
- Left chest - outside lead apron (Unprotected)

Glass dosimeter

- Left chest - Inside lead apron (Protected)
- Right thumb - Under sterile glove (Unprotected)

Ionizing radiation doses where measured in sieverts (Sv); the international unit for measuring radiation exposure.

RESULTS

The data extracted from the real-time dosimeters showed the average radiation exposure dose per procedure was 14.9 µSv inside the lead apron over the left chest (protected), 125.6 µSv outside the lead apron over the left chest (unprotected), and 200.1 µSv on the right forearm (unprotected). From these results, both unprotected areas, at the chest outside the lead apron and at the right forearm showed significantly higher radiation exposure than areas at the chest protected inside the lead apron (Figure 1).

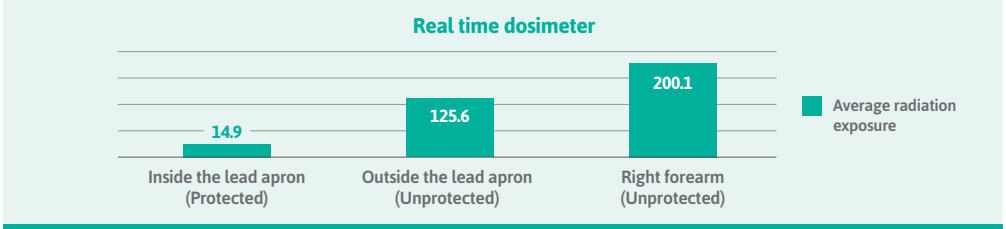

Figure 1: Radiation exposure data from real-time dosimeters

The data on the radiophoto-luminescence glass dosimeter secured over the left chest, inside the lead apron (protected), recorded less than the minimum reportable dose in all the 3 months of the study period. The radiophoto-luminescence glass ring dosimeter on the right thumb (unprotected) measured radiation doses of 122 mSv for August, 120 mSv for September, and 126 mSv for October (Figure 2).

Months	Chest, inside the apron (Protected)	Right thumb (Unprotected mSv)
August	X*	122
September	X*	120
October	X*	126

Figure 2: Radiation exposure data from radiophoto-luminescence glass dosimeters placed in front of the chest and on the thumb over 1 month

**X, indicates that the dosimeter recorded less than the minimum reportable dose*

Radiophotoluminescent glass dosimeter (RPLD) is a cumulative radiation dosimeter usually made of silver-activated phosphate glass. The silver atoms act as radiophotoluminescence (RPL) centres excited by ionizing radiation. The number of RPL centres excited is proportional to the absorbed dose

The permissible annual individual radiation dose for the skin and extremities is <500 mSv, according to the guidelines of the International Commission on Radiological Protection (ICRP). If one were to extrapolate the dose for the finger to reflect a 12-month period, that amount of radiation would be three times the allowable limit of 1,472 mSv.

CONCLUSION

The results of this study showed radiation doses at the protected chest fall within the annual allowable dose for occupational radiation exposure. However, radiation exposure to the upper extremities, in particular the fingers, was significantly greater. This is since interventionalists cannot avoid exposing their unprotected fingers and hands to the X-ray beam. The authors conclude that radiation exposure can be limited by following the fundamental rules of radiation protection:

Principles for radiation protection:

1. Maximize the distance from the radiation source
2. Use of shielding materials
3. Minimize exposure time

Furthermore, the authors recommend that spinal interventionalists note the position of their hands over the course of fluoroscopy so that they can perform necessary radiation-limiting adjustments. The lead apron showed to be particularly successful in diminishing exposure to radiation, according to the statistical analysis. With that in mind, it would prove beneficial to examine the concept as it pertains to limiting fluoroscopy-related exposure in the hands and fingers in future studies, namely in the form of radiation-attenuating gloves.

RECOMMENDED APPLICATION FOR PRACTICE

1. Be aware of all radiation exposure hazards in the occupational setting
2. Follow national and international professional guidelines and recommendations for radiation protection and shielding.
3. Use of radiation attenuation gloves – Lead free

Note: This clinical summary is written by clinicians at Ansell Healthcare Products, LLC. Please refer to the actual study for full text information.

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