Reducing staff exposure from fluoroscopy during ultrasound guided permanent prostate seed implantation

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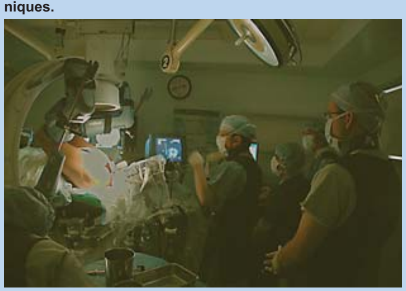
Introduction

Intraoperative use of fluoroscopy during permanent seed implantation, in addition to ultrasound, provides the physician with uninterrupted visualization of the seeds as they are placed in the gland. The physician can address commonly reported issues such as seed migration, "bunching", embolization, and needle "vacuum effect". As well, a final fluoroscopic image of the implanted volume permits the physicist to verify and record that the total number of seeds implanted matches the plan.

This raises a concern about staff radiation exposure during the procedure. Here, we evaluate the magnitude of this risk, and propose practical exposure reduction techniques.



Methods

Radiation exposure from a fluoroscopic C-arm was directed upon an anthropomorphic abdominal/pelvic phantom in a simulated clinical geometry was measured using an ion chamber, and verified by point measurements on equipment and staff during clinical procedures. Reduction techniques consisted of:

1. modifying beam management
2. use of additional shielding
   a) a leaded drape on the table
   b) a sterile shield on the patient

Unshielded | Lower Drape | Upper Sterile | Combined

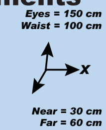
Shielding Materials

LOWER: Standard protective apron material 0.5 mm Pb

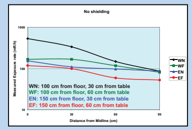
UPPER: Double-layer bismuth antimony material within a polymer sheet. Entire device** is sterile.

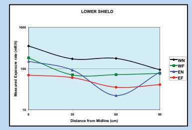
** RADPAD® - Worldwide Innovations and Technologies, Inc. Overland Park, KS

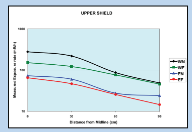
Phantom Measurements

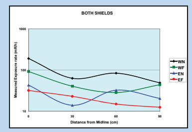


Phantom measurements were made at 100 and 150 cm from the floor at 30 and 60 cm from the edge of the table.



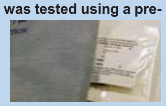






The attenuation of the pad for ^{125}I was tested using a pre-loaded cartridge.

Layers	Transmission
0	100 %
1	2 %
2	0.1 %



Use of the Fluoroscope

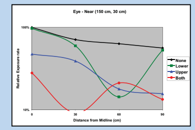
Optimizing beam management techniques, such as collimating the beam to the region of interest, resulted in an additional 20-40% reduction in scattered room exposures.

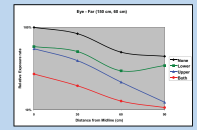
Clinical Measurements

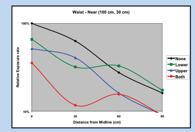
Confirming measurements were made in the operating room during several clinical procedures. Patients weights ranged from 70 – 94 kg. The C-arm fluoroscope was operated in its Automatic Dose Rate Control (ADRC) mode. Outputs were near or at maximum due to patient size and the projection. Fluoroscopic times were in the range 4 – 8 minutes. This did not correlate with either the number of needles or the number of seeds. Survey meter measurements were restricted to avoid interference with the clinical procedure. Nevertheless, we found that the phantom measurements were good predictors of relative exposure rate reductions in the operating room.

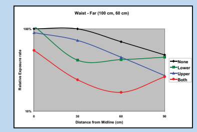
Discussion

The observed stray radiation field is affected by: Leakage from the X-ray tube, proximity of the beam to edge of the patient, metallic devices (ultrasound support, clamps, etc..), multiple scatter, and shielding. The effects of shielding from our phantom tests are shown. The data in each plot have been normalized to the midline (X=0) value for its locus. Measured values are shown to the left.



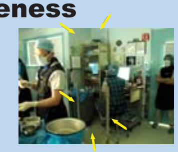






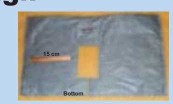
Radiation Awareness

The radiation awareness of both the medical and nursing staff was increased as a by-product of our measurements. For example, the shield was moved from a corner to the position shown.



Sterile Pad Design

The radiation pad design was modified to accommodate the template. This modification provides midline shielding from the template to the table-top.



Deployed Shields

The lower shield is deployed as soon as the patient is positioned. The sterile shield is deployed after the template is placed in position.

Conclusion

In accordance with the ALARA principle, simple beam management techniques and readily available supplemental shielding can be effectively utilized to reduce scattered room exposures without interfering with the clinical procedure.

If supplemental shielding is not used, measured exposure rates at eye level suggest that eye shielding (e.g. lead equivalent glasses) be evaluated for physicians performing a high volume of cases utilizing fluoroscopy..

Copies of this poster are available on request

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