ABSTRACT

Purpose: These studies measured the low energy X-ray shielding effectiveness of Xoft FlexiShield™ flexible tungsten-silicone sheets. The ability of the shielding material to lower the ambient radiation level in a treatment room was then evaluated during dose delivery to goats.

METHODS

X-ray attenuation readings were measured using a collimated beam from a Xoft Axxent™ X-ray Source operated at 30 to 50 kV. X-ray attenuation was calculated as the ratio of air kerma rate from the Source measured using an Exradin A600 Ionization Chamber with and without the shield in the beam path. To evaluate shielding effectiveness in a clinical setting, exposure rate was measured using a diode-attached APBR of four Nubian milk goats with balloon applicators inserted percutaneously into simulated lumpectomy cavities in their udders. A Victorian 4518 Ion Chamber Survey Meter was used to measure exposure rates at twelve locations with nominal distances of 1 meter from the udder being treated.

RESULTS

X-ray attenuation readings were measured during simulated APBR of four Nubian milk goats with balloon applicators inserted percutaneously into simulated lumpectomy cavities in their udders. A Victorian 4518 Ion Chamber Survey Meter was used to measure exposure rates at twelve locations with nominal distances of 1 meter from the udder being treated. X-ray attenuation was calculated as the ratio of air kerma rate from the Source measured using an Exradin A600 Ionization Chamber with and without the shield in the beam path. To evaluate shielding effectiveness in a clinical setting, exposure rate was measured using a diode-attached APBR of four Nubian milk goats with balloon applicators inserted percutaneously into simulated lumpectomy cavities in their udders. A Victorian 4518 Ion Chamber Survey Meter was used to measure exposure rates at twelve locations with nominal distances of 1 meter from the udder being treated.

CONCLUSION

Xoft FlexiShield™ flexible tungsten-silicone sheet is a conformable low energy X-ray shield that very effectively reduces the ambient exposure rate while performing APBR.

INTRODUCTION

• External beam radiotherapy following breast conserving therapy (BCT) lasts 6 to 7 weeks. Many women elect mastectomy or omit post-operative radiotherapy because they cannot commit the required time or resources.

• Accelerated Partial Breast Irradiation (APBI) using brachytherapy can significantly shorten treatment time but is labor intensive, requires a skilled operator, and can be uncomfortable for patients. Many radiation treatment centers cannot afford to maintain active isotopes or to build the shielded treatment room for HDR brachytherapy.

• X-ray has developed an electronic (non-isotopic) high dose rate brachytherapy device. The Xoft Axxent™ X-ray Source delivers tight, conformal doses of X-radiation to the inner surface of a body cavity such as an excised tumor bed.

• The initial application of the Xoft Axxent™ Electronic Brachytherapy System is to the conservative treatment of breast cancer utilizing balloon-based brachytherapy.

• The Xoft Axxent™ System has been evaluated in a Nubian milk goat animal model. Delivered doses from the Xoft Axxent™ System were well within the goal of 34 Gy (+20%), and there were no adverse tissue effects or adverse events. These results were reported at the ABS 2005 Annual Meeting.

• To reduce the ambient exposure rate while performing APBR, a conformable low energy X-ray shield, the Xoft FlexiShield™ was developed.

METHODS

Purpose

These studies measured the low energy X-ray shielding effectiveness of Xoft FlexiShield™ flexible tungsten-silicone sheets. The ability of the shielding material to lower the ambient radiation level in a treatment room was then evaluated during dose delivery to goats in the course of simulated accelerated partial breast irradiation (APBR).

Laboratory Evaluation

X-ray attenuation of 1 mm thick tungsten-silicone flexible sheeting was measured using a collimated beam from a Xoft Axxent™ X-ray Source operated at 30 to 50 kV. X-ray attenuation was calculated as the ratio of air kerma rate from the Source measured using an Exradin A600 ionization chamber with and without the shield in the beam path.

Clinical Evaluation

To evaluate shielding effectiveness in a clinical setting, exposure rates were measured during simulated APBR of four Nubian milk goats with balloon applicators inserted percutaneously into simulated lumpectomy cavities in their udders. FlexiShield™ were placed over the goat’s udders to reduce radiation levels in the treatment room during dose delivery. One or more shields were positioned on top of and along the side of the udders to attenuate radiation in directions where individuals would be observing the procedure. A Victorian 4518 Ion Chamber Survey Meter was used to measure exposure rates at twelve locations with nominal distances of 1 meter from the treated udder.

Exposure rates were measured during the delivery of fractions 3 and 7 to all four animals. To estimate the shielding effectiveness, exposure rates were measured without shields during the delivery of fractions 3 and 7 to one animal, which was chosen because the combination of a 3-4 cm applicator and 50 kV operation resulted in the shortest dose delivery time, about 4 minutes, thus minimizing exposure of personnel remaining in the treatment room.

LABORATORY RESULTS

50 kV Operation

• Measured radiation levels for the two animals treated with sources operating at 50 kV are presented in Figures 1 and 2. The maximum exposure rate with shields in place at any in-plane location was 43 mR/hr with the exception of one measurement near the right front leg. In this case the exposure rate was 194 mR/hr because the flexible shield was not pulled down completely. Readings behind the portable shield for the veterinary nurse were 0.04 to 50 mR/hr. This shield was at a distance of approximately 1.5 m high near the left front leg of the animals. All readings have been corrected to account for the survey meter’s energy-dependent response using data in the instrument manual.

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