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Osimetric analysis of lens shielding to reduce the risk of cataracts in patients undergoing electron radiation for ocular lymphomas

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Background: Radiation therapy with low energy electrons is particularly beneficial for treating ocular lymphomas involving the conjunctiva. The anterior lens, being a highly radiosensitive structure, has a dose tolerance range of 10 to 18 Gy. Lens shielding used in conjunction with electron beam therapy can reduce the risk of high-grade cataracts following treatment with prescriptive doses of 25 to 30 Gy. Bolus may be required in some clinical situations to ensure superficial tumour coverage. This work evaluates the effects of a suspended eye shield, placement of bolus, and varying electron energies. A cataract is a cloudy area in the lens of your eye. Cataracts are very common as you get older. In fact, more than half of all Americans age 80 or older either have cataracts or have had surgery to get rid of cataracts. At first, you may not notice that you have a cataract. But over time, cataracts can make your vision blurry, hazy, or less colourful. You may have trouble reading or doing other everyday activities. The good news is that surgery can get rid of cataracts. Cataract surgery is safe and corrects vision problems caused by cataracts.

Methods: GafChromic film dosimetry and relative output factors were measured for 6, 8, and 10 MeV electron energies. A customized 5-cm diameter circle electron orbital cutout was constructed with a suspended lens shield (8-mm diameter Cerrobend cylinder, 2.2-cm length). Point doses were measured using an electron diode in a solid water phantom at depths representative of the anterior and posterior lens. Depth dose profiles were compared for 0 mm, 3 mm, and 5 mm bolus thicknesses. A cataract is a vision-clouding area in the lens of the eye. About half of all people ages 65 to 74, and 70% of those ages 75 and over, develop cataracts, which are the leading cause of blindness worldwide. Fortunately, surgery is safe and effective; in places like the United States, where it's one of the most common operations performed, it leads to improved vision in about 90% of cases. Cataracts aren't made of calcium but rather of clumps of protein. Normally, the lens of the eye works like a camera lens to focus light on the retina at the back of the eye (see illustration) and to adjust the eye's focus, which allows us to see things clearly at varying distances. The cells of the lens are composed of water and protein arranged in a way that keeps the lens clear. For reasons that aren't fully understood, the protein molecules may clump together and start to cloud the lens. This is the beginning of a cataract. The effect has been likened to cooking an egg white.

Results: At 5 mm (approximate distance of the anterior lens from the surface of the cornea), the percent depth dose under the suspended lens shield was reduced to 15%, 15%, and 14% for electron energies 6, 8, and 10 MeV, respectively. Applying bolus reduced the benefit of lens shielding by increasing the estimated doses under the block to 27% for 3 mm and 44% for 5-mm bolus for a 6 MeV incident electron beam. This effect is decreased with 8 MeV electron beams. For orbital lymphomas treated with 6 MeV electrons, the lens block and 3-mm bolus combination reduces anterior lens dose, and incrementally less with higher electron energies.

Conclusion: Careful selection of electron energy, consideration of suspended lens shield effects, and bolus must be evaluated to ensure tumour coverage, while decreasing anterior lens dose to mitigate cataract formation.

Note: This work is partly presented at World Congress on Ophthalmology & Eye Surgery during August 16-17, 2018 Paris, France