

Ophthalmic Plaque Dosimetry: A Comparison of ^{125}I Source models MED3631-A/M and 6711

Robert E. Wallace, Ph.D.[#]

Abstract - Low-energy gamma emitting isotopes encapsulated for implant are routinely applied in brachytherapy. Various isotopes have been used in the treatment of ocular melanoma using episcleral plaques. In North America, the Collaborative Ocular Melanoma Study (COMS) had advocated the use of ^{125}I . Although ^{103}Pd , ^{198}Au , $^{106}\text{Ru/Rh}$, and ^{169}Yb may be used, the bulk of applicable clinical research in North America is for therapy employing ^{125}I . The most commonly used source in the COM Study was the Amersham model 6711 (OncoSeed™). In principle, any other model ^{125}I source could be used, providing equivalent plaque dosimetry is obtained. This note explores this dosimetry when using model MED3631-A/M (Prospera™) sources as COMS point sources in plaques. When compared to the model 6711, the larger dose-rate constant, Λ , for the MED3631-A/M leads to a lower required activity to achieve the same prescribed tumor dose. Point sources in COMS are assigned spherical symmetry, and anisotropy measures are unity. The MED3631-A/M source has a radial dose function, $g(r)$, that differs from that of the 6711 model source. This proves to have no real effect on plaque dosimetry. In plaque application, the difference is shown to be negligible and within the uncertainties that are associated with the prediction of dose. Thus, accounting only for difference in required activity, the two sources are interchangeable in episcleral plaque application.

Key words - brachytherapy, dosimetry, ocular melanoma

I. INTRODUCTION

Radioactive 125-iodine sources are routinely used in implant brachytherapy for ocular melanoma and are specified in the Collaborative Ocular Melanoma Study (COMS)¹. Appropriate measures to describe the dosimetric characteristics of ^{125}I sources are found the American Association of Physicists in Medicine Task Group #43 recommendations (TG43)². The plaque dosimetry of the COMS follows the TG43 point source formalism albeit for assumed isotropic point sources. In this note, the dose distributions of a selected episcleral plaque are compared for different ^{125}I source designs.

II. MATERIALS AND METHODS

Two dimensional dose distributions were calculated for a 14 mm plaque that might be designed for a specific patient's therapy. For this initial evaluation, the single plaque was taken to be representative of typical use. Distributions were calculated using a standard treatment planning system, Theraplan-Plus^a, using radiation source data^{2,3} following TG43 guidelines².

A. Radioactive sources:

Two source designs were evaluated, the OncoSeed™ model 6711^b, and the Prospera™ model MED3631-A/M^c. Each consists of a cylindrical titanium capsule containing the radioactive elements. These sources have nearly identical encapsulation dimensions, 4.5 mm (nominal) length and 0.8 mm diameter, with 0.05 mm wall thickness.

Source activity was calculated to maintain the TG43 reference dose-rate² by accounting for the difference in the dose-rate constants, $A_{\text{MED3631}} = A_{6711} * (\Lambda_{6711} / \Lambda_{\text{MED3631}})$. Dose-rate constants are found in the literature^{2,3,4} and are $\Lambda = 0.98$ for the 6711 source design and $\Lambda = 1.06$ for the MED3631-A/M source design.

B. Plaque design

A plaque, 14mm in diameter at the scleral surface, was designed according to the guidelines of the COMS¹. A plaque this size would be used to treat a small to intermediate basal dimension (8-10 mm) ocular melanoma. The cap shaped plaque is constructed of a thin gold backing, sufficient to shield adjacent tissue. Radioactive sources are placed in the

^a Theratronics International, Kanata, Ontario, Canada

^b Nycomed-Amersham, Arlington Heights, Illinois

^c North American Scientific, Inc., Chatsworth and North Hollywood, CA

cavity of the plaque, either by fixation to the gold backing inner surface using adhesive or by placement in source carrier insert to the plaque. With sources in place, the plaque cavity is filled with a water equivalent plastic shaped to conform to the outer scleral surface. The use of a water equivalent plastic ensures correct dosimetry.

C. Treatment planning system

Theraplan-Plus (V3) was used for the calculations of dose distributions. Dose is calculated for water equivalent tissue according to the COMS¹ and TG43² guidelines. The planning system does not account for shielding by the gold backing of the plaque. This was assumed to have negligible effect in the high dose regions of the dose distributions. All distances in the analysis are relative to the point where the central axis of the plaque intersects the inner scleral surface.

D. Dosimetric comparisons

The results of the calculations are dose calculated at points regularly sampling a three-dimensional volume enclosing the plaque and the sources. Two-dimensional distributions containing the central axis of the plaque were obtained to provide depth-dose-rate data

III. RESULTS AND DISCUSSION

The dose-rate distribution calculated for the plaque using Prospera™ (MED3631-A/M) sources is shown for reference in figure 1. In figure 2, the dose rate is plotted as a function of distance from the plane. The difference between the source designs is negligible. In figure 3, the difference in dose-rates with depth is plotted along the central, lateral, and plaque edge axes. In this figure, the dose rate provided by the plaque using the MED3631-A/M source is +/- 2.5% of that for the model 6711 source. In the therapy volume, the dose provided by the MED3631-A/M loaded plaque is at most 1.5% larger than that for the 6711 loaded plaque. This is well within the 8-10% uncertainty of this type of calculation². In figure 4, the absolute differences in dose-rate are plotted with depth relative to the back surface of the gold plaque (i.e.: offset from the sclera by 4 mm on the central axis). Absolute differences

of up to 4% are seen. The largest differences occur within the water equivalent plastic of the plaque, near the sources and are likely due to inadequate radial dose function information near the sources.

The COMS dosimetry sets the anisotropy constant to unity for the dose calculation. This study has not evaluated the use of non-unity anisotropy constants. However, the MED3631-A/M source is more isotropic than the 6711 source³ and dose calculated using it should therefore be closer to TG43 specifications².

IV. CONCLUSION

There is no significant dose distribution difference when using Prospera™ (MED3631-A/M) versus OncoSeed™ (6711) in a 14 mm episcleral plaque. It is reasonable to expect similar conclusions for other size plaques. In order to use the Prospera™ source in place of the OncoSeed™, one need only adjust source activity according to the formula in this note.

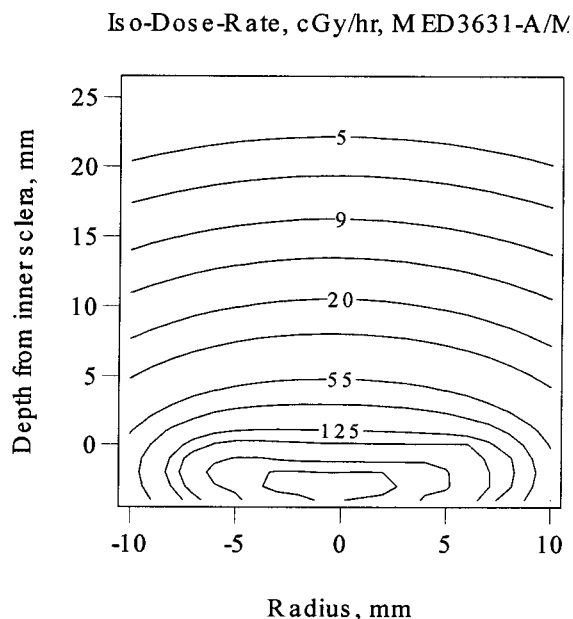


Figure 1.

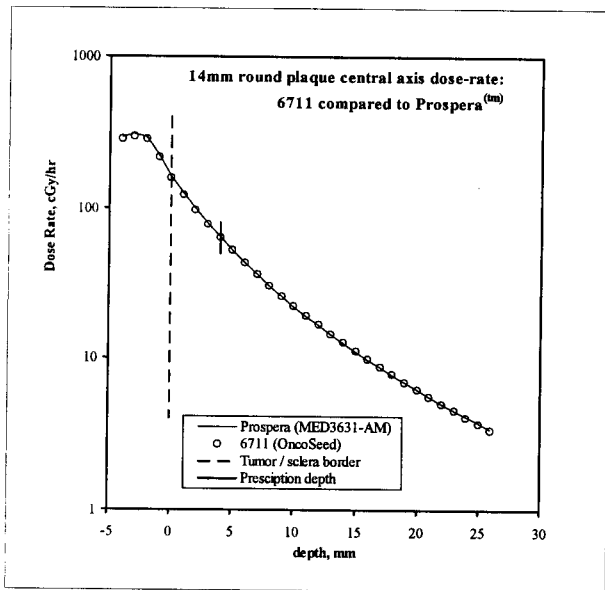


Figure 2.

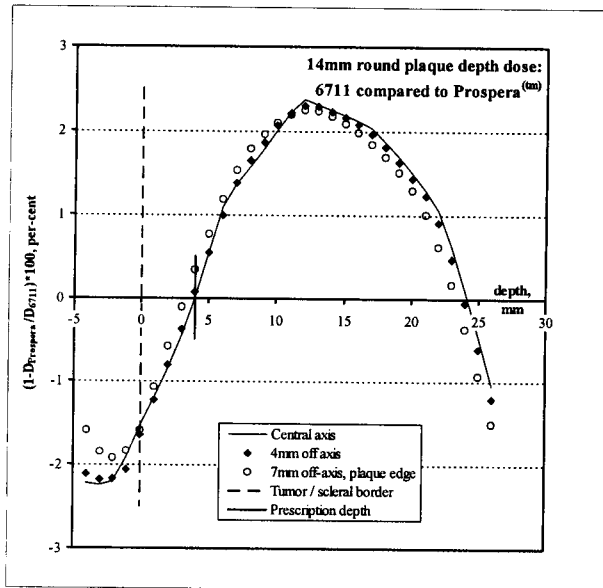


Figure 3.

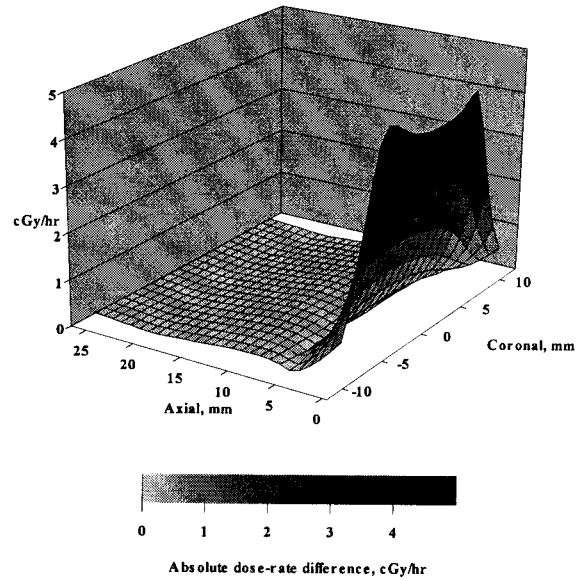


Figure 4.

- 1 COMS Manual of Procedures, section 12.2.5, Collaborative Ocular Melanoma Study, Wilmer Ophthalmological Institute, November, 1996.
- 2 R. Nath, L.L. Anderson, G. Luxton, K.A. Weaver, J.F. Williamson, and A.S. Meigooni, "Dosimetry of interstitial brachytherapy sources: Recommendations of the AAPM Radiation Therapy Committee Task Group No. 43," *Medical Physics* **22**, 209-234 (1995).
- 3 Wallace, R.R. and Fan, J.J., "Report on the dosimetry of a new design 125 Iodine brachytherapy source," *Med Phys* **26**, 1925-1931 (1999).
- 4 Williamson, J.F., Coursey, B.M., DeWerd, L.A., Hanson, W.F., Nath, R., and Ibbott, G., "Guidance to users of Nycomed Amersham and North American Scientific, Inc., I-125 Interstitial Sources: Dosimetry and calibration changes: Recommendations of the American Association of Physicists in Medicine Ad Hoc subcommittee on Low-Energy Seed Dosimetry," *Med Phys* **26**, 570-573 (1999).

Department of Radiation Oncology
 University of California, Los Angeles
 Los Angeles, California 90095-6951
 wallace@radonc.ucla.edu