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Evaluation of the visibility of a new thinner ^{125}I radioactive source for permanent prostate brachytherapy

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ABSTRACT

PURPOSE: The ^{125}I source currently used for prostate brachytherapy at St. James's Institute of Oncology is a standard size seed (≈4.5 mm in length and 0.8 mm in diameter). A new, thinner seed is under evaluation. This is designed to be implanted using narrower needles, potentially reducing edema and improving the dose distribution. This study investigated the visibility of the thinner source on multimodality images and compared it with that of standard size seeds.

METHODS AND MATERIALS: Images of dummy seeds of both thinner and standard size models were taken using ultrasound, fluoroscopy, computed tomography (CT), and magnetic resonance (MR) imaging. The ultrasound, fluoroscopy, and CT images were acquired with the seeds inserted into phantoms positioned in a water tank. The MR images were acquired using phantoms containing single seeds. The images were analyzed visually and quantitatively. The resolution of closely spaced seeds on CT images was investigated.

RESULTS: The visibility of both seeds was similar on ultrasound, fluoroscopy, and MR images. On CT images, the thinner seeds give reduced artifacts and better resolution.

CONCLUSIONS: The use of the thinner seed would have minimal effect on ultrasound and fluoroscopy imaging during treatment. However on CT images, the use of the thinner seeds may improve seed identification for post-treatment dosimetry. Further study is required into the suitability of MR images alone for post-treatment dosimetry.

Keywords: Prostate brachytherapy; ^{125}I; OncoSeed Model 9011; THIN Seed; Visibility

Background and purpose

Early stage prostate cancer may be treated with permanent brachytherapy using ^{125}I sources (1). The seed currently used at St. James' Institute of Oncology (SJIO) is the OncoSeed model 6711 (2) (Oncura Inc., Arlington Heights, IL). The seeds are supplied sutured into strands of 10 (RAPIDStrand; Oncura Inc.), which can be cut to size. OncoSeed model 6711 is used in many clinical reviews of treatment outcome currently available (3, 4). The OncoSeed model 6711 source consists of an active core of ^{125}I adsorbed onto the surface of a silver rod (length 2.8 mm, diameter 0.508 mm) contained within a titanium capsule (length 4.56 mm, diameter 0.774 mm) (5). The OncoSeed model 6711 seeds are implanted using 18-G needles, which have an outer diameter of 1.27 mm. A new, thinner seed model (OncoSeed model 9011—THIN Seed; Oncura Inc., Amersham, UK) has recently been developed and our center has obtained some non-radioactive dummy seeds for evaluation. The OncoSeed 9011 model seed is of a similar design to the 6711 and is manufactured in a similar way (6). The OncoSeed model 9011 seed will also be available in sutured strands (THIN Strand; Oncura Inc.). The main difference is the smaller diameter (source 0.30 mm, capsule 0.508 mm) (Fig. 1), which allows narrower 20-G needles (0.91 mm outer diameter) to be used during the implant process. This will potentially reduce the level of edema and trauma to the prostate and urethra (7).

The prostate volume may change during and after the implant process because of edema (8). Several studies have

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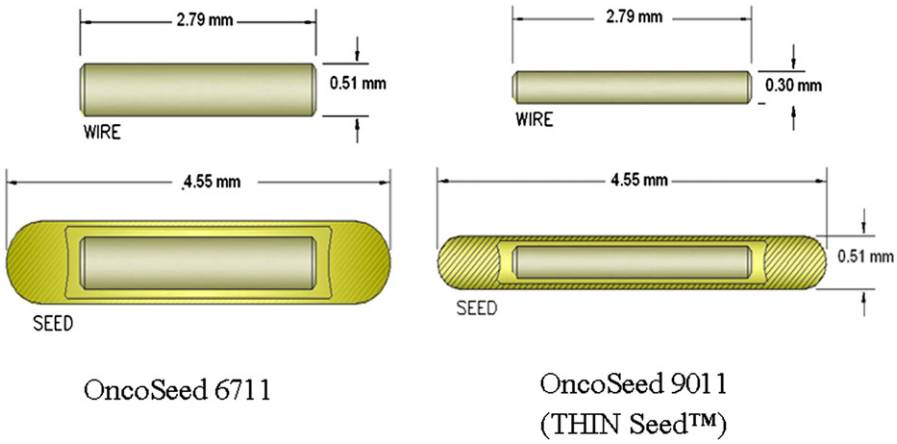

Fig. 1. Cross-sectional diagram showing the dimensions of the OncoSeed 6711 and OncoSeed 9011 (THIN Seed) (Image courtesy of Oncura Inc.).

shown that edema can affect the percentage of the prostate receiving the prescribed dose (V_{100}) by moving the seeds and increasing the volume (9–13). V_{100} and D_{90} (the dose received by 90% of the prostate) have been linked to patient outcome (3, 4, 14, 15). Assuming equivalent dosimetry, the new seed model could therefore potentially improve the dose coverage to the prostate by reducing the level of edema.

The study of Buskirk *et al.* (16) suggests that needle trauma is the main cause of short-term urinary symptoms. Several other studies (17–22) have found a statistically significant correlation ($p = 0.025$) (18) between needle trauma during implant (via the number of needles) and edema and urinary retention, which suggests that the new narrower needles could prove advantageous.

At the Seattle Prostate Institute, Seattle, WA, model 9011 OncoSeeds have been in clinical use since August 2008 (22). Initial results based on the first 100 patients treated have shown improved results for post-treatment dosimetry when compared with previous patients treated with model 6711 seeds, similar urinary retention rates, and lower levels of pain and bruising.

Several imaging modalities are used in the treatment and followup of ^{125}I prostate brachytherapy patients. Transrectal ultrasound (TRUS) is used for guiding needle insertion and in some centers for imaging seeds after implant (23). Fluoroscopy screening can be used at various stages during implant to check the positioning of the seeds. Computed tomography (CT) and magnetic resonance imaging (MRI) scans are used to identify seed positions for post-implant dosimetry. Before bringing a new source into clinical use, it is important to ensure that images obtained with the source are fit for purpose. This study aims to assess whether the introduction of model 9011 seeds and the associated 20-G narrow bore needle will have a clinically significant impact on the appearance and localization of the seeds using any of the above imaging techniques.

The importance of source visibility is mentioned by Heintz *et al.* (23) and Meigooni *et al.* (24) 2009, but only a small number of studies characterizing prostate brachytherapy sources take account of this aspect. Previous work at this center by Al-Qaisieh *et al.* (25) compared the visibility of five seeds implanted in a tissue equivalent phantom and imaged using ultrasound, CT, MRI, and fluoroscopy. Clinically significant differences in visibility were not found in this study. The present study is a continuation of the previous work by Al-Qaisieh *et al.* and was initiated as a result of the new THIN Seed source coming to market. The two studies jointly represent a comprehensive review of the visibility of ^{125}I sources from some of the more common manufacturers in Europe (Oncura Inc., Nucletron B.V, Veenendaal, Netherlands and Eckert & Ziegler BEBIG sa, Seneffe, Belgium). This is the first study looking at the differences in imaging between the 9011 and 6711 OncoSeed models.

Siebert *et al.* (26) designed a PMMA phantom for testing the localization of nine seed models on CT scans. All the seed types were identified using the VariSeed algorithm treatment planning system (Varian Medical Systems, Inc., Palo Alto, CA) for localizing seeds, but some were placed incorrectly and this varied with seed model. The algorithm had difficulty distinguishing between closely spaced seeds, which suggests that the smaller size of the 9011 seed could be advantageous for localization using CT images.

Methods and materials

We compared the visibility of the two seeds using ultrasound imaging, MRI, fluoroscopy, and CT. As our previous study had shown that there was no significant difference in the resolution (as given by the full width at half maximum [FWHM]) of seeds of similar sizes from different manufactures on any of these modalities, the 6711 OncoSeed was chosen as representative of all the seeds tested in the previous study. The exception to this was MR imaging, where the Intersource seed (Eckert & Ziegler BEBIG sa, no longer available) gave a larger signal void than the other seed types tested.