Prostate high dose-rate brachytherapy in men with bilateral hip prostheses.

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Abstract.

Bilateral hip prostheses challenge the acquisition of clinically useful treatment planning images for prostate HDR brachytherapy. Prostheses can introduce severe artifact into the principal modalities used for HDR prostate brachytherapy imaging – ultrasound, magnetic resonance imaging (MR) and computed tomography (CT). This study aimed to develop a protocol for clinically useful image acquisition that would ensure accurate and reliable implanted needle identification in all patients, including those with bilateral hip prostheses.

It was found that in conventional B-mode grey-scale ultrasound images used routinely for image guidance in brachytherapy procedures, artefact such as shadowing and reverberation were confounding factors for accurate HDR brachytherapy treatment planning and delivery. For MR imaging, spatial distortion due to local magnetic field disruption, local signal void within prostheses, and localised areas of high signal intensity near the prostheses all complicated image interpretation for treatment planning. On the other hand, CT images were generally free from distortion and were spatially accurate. The impact of volume averaging on the accuracy of needle tip identification was studied with models of steel implant needles, and CT level and window settings to ensure tip definition to within ±0.7 mm (ensuring dosimetric accuracy of better than 0.7%), were determined.

In a study of 91 patients with stainless steel needle implants and without hip prostheses, the mean caudal displacement before adjustment was 5.4 mm (SD 3.3 mm). Plastic needle implants in 14 patients with bilateral hip prostheses was examined, and the mean caudal displacement before adjustment was 1.6 mm (SD 3.1 mm). Nitinol marker wires developed for use in plastic needles implanted into prosthesis patients were found to be superior when compared with standard rigid obturators. The wires, with the same flex properties as an active Ir-192 source wire, assist accurate identification of needle tips and may also provide an improved match to the treatment geometry for treatment planning purposes.

The impact of stainless steel and plastic needle movement on treatment efficacy was studied via Tumour Control Probability (TCP) calculations using three different TCP models and simulated brachytherapy treatment plans. This study showed that it was feasible to maintain displacements less than 3 mm, and that if this limit were adopted, it would result in most patients having TCP close to or greater than 95% of the original.

Statement of originality and acknowledgement.

This work contains no material accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due acknowledgment is made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being made available for loan and photocopying.

David K Waterhouse
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