Evaluation of Magnetic Resonance Imaging for Treatment Planning for Brachytherapy for Cervical Cancer

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1.Introduction

- Brachytherapy is the treatment of cancerous tissues by the insertion of radioactive isotopes within the body near to the tumour site[1].
- Cervical cancer treatment is often planned using the Manchester Treatment System[2].
- Currently, brachytherapy treatment planning is carried out using plane-film X-Ray or CT images, but poor soft tissue delineation means that it is hard to distinguish between cancerous and healthy tissue[3].
- MRI images would clearly differentiate the tumour from surrounding tissue, but distortions and field inhomogeneities could mean that the positions of structures in the images are not accurate enough; due to the inverse-square law of radiation, these need to be known to within a millimetre to plan treatment doses.
- The aim of this work is to evaluate whether MRI is a viable imaging technique for treatment planning

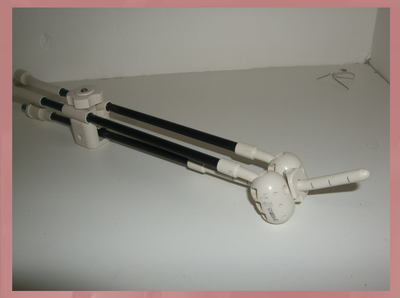
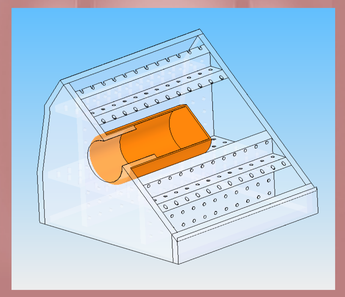
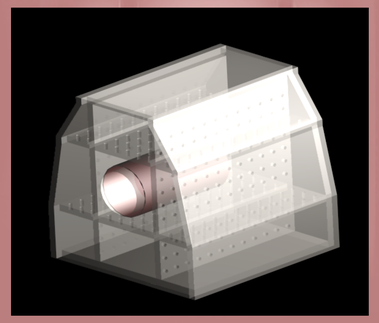


Figure 1: An MRI-safe version of the Manchester applicator

2. Phantom

- In order to simulate distortions that would appear on an image of a patient with applicator in-situ, a phantom was designed and built.
- The phantom was constructed out of Perspex and other plastic components and filled with a solution of a gadolinium based contrast enhancer.
- Within the phantom are grids of holes which were observed on the MRI images and used as reference points to plot distortions to the image.
- In order to hold the applicator, a rubber tube was included in the design in which the applicator would sit. When full, pressure from the surrounding water presses the rubber tight around the applicator, minimising the amount of air in the phantom.





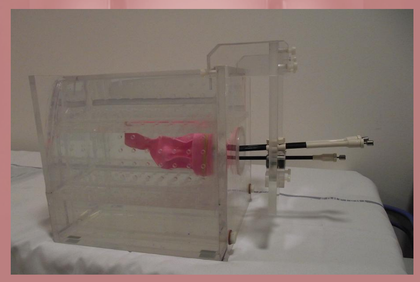


Figure 2: CAD renditions of the phantom during the design process, and a photo of the phantom when full and with applicator inserted.

3. Analysis Method & Results

- To quantify distortions present, the positions of the centre of the holes in the grids on the images were compared to an overlay of an undistorted grid at the same resolution.
- The magnitude of distortion was calculated from the number of pixels difference between the position of where the centre of the hole was compared to where it should be.

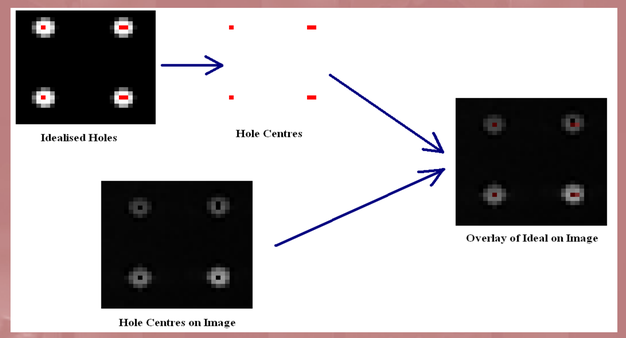


Figure 3: Illustration of hole comparison method. Holes shown have displacement (0,0), (-½, ½), (0,0) and (0, -½) when scanned left to right then top to bottom.

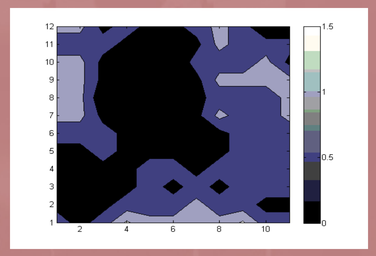


Figure 4: Example result from coronal grid of phantom showing distortions < 1.5 mm.

4. Conclusions

- By carrying out analyses on different field strength machines, it has been found that the average distortion in images with a field of view of 30 cm is approximately 1 mm.
- This corresponds to approximately a single pixel when using parameters as would be used in imaging a real patient.
- A further set of images were taken on CT and analysed in the same way, demonstrating a random distortion of 1 mm, proving that with these settings, MRI is comparable to CT in accuracy.

References & Acknowledgements:

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