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Assessment of immobilisation and imaging technologies to improve radiotherapy treatment accuracy

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Abstract

Recent developments in radiotherapy planning have enabled the radiotherapy dose to be sculpted closely to the target volume, to avoid adjacent organs. The accuracy of treatment delivery has thus become increasingly important. This work investigates improvements in accuracy for radiotherapy treatment of prostate and lung cancers.

For prostate cancer, the following possibilities for improvements were considered: external immobilisation to improve the position of the patient, diet and treatment scheduling to maintain rectal consistency, gold markers and ultrasound to localize the soft tissue of the prostate, and a novel rectal obturator to both maintain rectal consistency and localise the prostate. The importance of examining the whole process from using the immobilisation devices to setting the isocentre when determining reproducibility was shown. Gas was the major factor related to rectal distension and hence prostate motion. On-line verification protocols improved the set-up accuracy compared to off-line protocols, but the presence of intra fraction motion reduced the benefit. Ultrasound was not found to be clinically acceptable for soft tissue verification. The rectal obturator did not improve prostate reproducibility because the design was not optimal.

For lung cancer the possibilities investigated for improvement were: determining patient and tumour motion, using fluoroscopy for gating, and breath-hold techniques to reduce tumour motion. The limitation of generic margins was illustrated because motion was not entirely predictable. Any baseline shift of tumour position would need to be detected prior to using fluoroscopy for imaging. A

breath-hold technique was tolerable through radiotherapy course. Tumour changes during radiotherapy necessitated soft tissue verification, and a method to use cone beam with breath hold was developed.

Tumour and patient motion can be reduced but significant unpredictable motion remains. The use of soft tissue image guidance is essential and guidelines must be developed to enable efficient and effective use of these tools.