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Image Guided Focal Therapy for Magnetic Resonance Imaging Visible Prostate Cancer: Defining a 3-Dimensional Treatment Margin Based on Magnetic Resonance Imaging Histology Co-Registration Analysis.

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Abstract

PURPOSE: We compared prostate tumor boundaries on magnetic resonance imaging and radical prostatectomy histological assessment using detailed software assisted co-registration to define an optimal treatment margin for achieving complete tumor destruction during image guided focal ablation.

MATERIALS AND METHODS: Included in study were 33 patients who underwent 3 Tesla magnetic resonance imaging before radical prostatectomy. A radiologist traced lesion borders on magnetic resonance imaging and assigned a suspicion score of 2 to 5. Three-dimensional reconstructions were created from high resolution digitalized slides of radical prostatectomy specimens and co-registered to imaging using advanced software. Tumors were compared between histology and imaging by the Hausdorff distance and stratified by the magnetic resonance imaging suspicion score, Gleason score and lesion diameter. Cylindrical volume estimates of treatment effects were used to define the optimal treatment margin.

RESULTS: Three-dimensional software based registration with magnetic resonance imaging was done in 46 histologically confirmed cancers. Imaging underestimated tumor size with a maximal discrepancy between imaging and histological boundaries for a given tumor of an average \pm SD of 1.99 ± 3.1 mm, representing 18.5% of the diameter on imaging. Boundary underestimation was larger for lesions with an imaging suspicion score 4 or greater (mean 3.49 ± 2.1 mm, $p < 0.001$) and a Gleason score of 7 or greater (mean 2.48 ± 2.8 mm, $p = 0.035$). A simulated cylindrical treatment volume based on the imaging boundary missed an average 14.8% of tumor volume compared to that based on the histological boundary. A simulated treatment volume based on a 9 mm treatment margin achieved complete histological tumor destruction in 100% of patients.

CONCLUSIONS: Magnetic resonance imaging underestimates histologically determined tumor boundaries, especially for lesions with a high imaging suspicion score and a high Gleason score. A 9 mm treatment margin around a lesion visible on magnetic resonance imaging would consistently ensure treatment of the entire histological tumor volume during focal ablative therapy.

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KEYWORDS: computer-assisted; image processing; magnetic resonance imaging; pathology; **prostatic neoplasms**; risk

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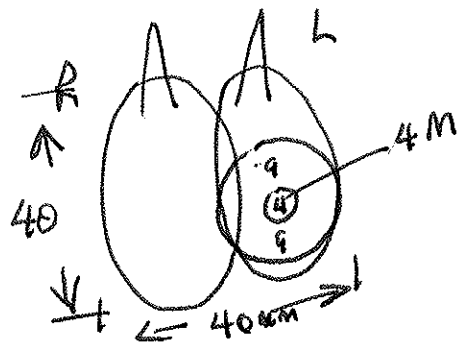
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22mm Diam
= hemi ablation!

$$Vol = \pi r^2 (or 3.8)$$

Prost vol 24 cc (40x40x30)

Rx vol ~~10 cc~~ (22x22x22)
5.3 cc