Significant changes in prostate shape and volume after endorectal coil introduction, as observed by 3T MR imaging

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Introduction

In 2007, with an estimated 218,890 expected new cases of prostate cancer in the United States alone, the prostate cancer disease burden is considerable [**1**]. Because of the ability to project functional MR imaging techniques on radiation therapy planning CT images, MR imaging is ever more widely used in radiation therapy of prostate cancer, particularly for intensity-modulated radiation therapy (IMRT) [**2**].

Imaging with an endorectal coil (ERC), which is similar in shape and profile to an endorectal balloon used during radiation therapy, provides higher resolution and the possibility of more accurate delineation of the prostate and related pelvic structures. However, the effect of introduction of the endorectal coil on the prostate shape and volume is unclear. These changes may have considerable implications for radiation therapy planning and on how to perform both MR imaging and CT scanning. Therefore, the purpose of our study is to determine the changes in prostate diameters and volume due to introduction of the endorectal coil by means of MR imaging at 3 tesla (T).

Materials and methods

Patients – In a prospective study, after obtaining written informed consent, from September 2004 to December 2005, 44 consecutive patients with biopsy-proven prostate cancer underwent MR imaging.

MR imaging – All imaging was performed on a 3T whole-body scanner (TRIO, Siemens Medical Solutions). First, an external body-array coil was placed around the patient's pelvic area. T2-weighted fast-spin echo images (TR/TE 3700/124 ms, hyperechoes [**3**], voxel size: 0.43 x 0.43 x 4.00 mm^3) in the sagittal, coronal, and axial plane were obtained. Second, an ERC (Medrad®) was inserted and inflated with 50 cc of fluid. Bowel movement was suppressed by intramuscular injection of 1 mg glucagon (Glucagen®, Novo Nordisk A/S). T2-weighted fast spin-echo images (TR/TE 5000/153 ms, voxel size: 0.26 x 0.26 x 2.50 mm^3, interslice gap: 0.5 mm) in the sagittal, coronal, and axial plane were obtained.

Prostate size determination – Two readers with more than 3 years of experience in prostate MR imaging independently determined the prostate diameters in the anteroposterior (AP), right-to-left (RL), and craniocaudal (CC) direction for the imaging series before and after ERC introduction.

Prostate volume determination – For each series, one reader outlined the entire prostate as well as the peripheral zone alone on every slice. From this, the number of pixels within the outlines was automatically determined. From the known in-plane resolution and slice thicknesses (including interslice gap), the entire prostate volume, peripheral zone volume and central gland volume were then calculated.

Statistical analysis – Wilcoxon's signed rank test was used to compare the mean diameters and volumes before and after ERC introduction. $P < .05$ was considered statistically significant.

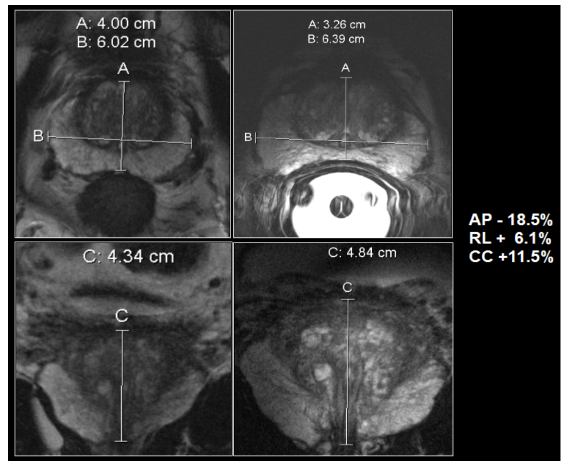

Fig.1: Example of the effect of the introduction of the endorectal coil on all prostate diameters, most particularly in the anteroposterior (AP) direction. Abbreviations: RL: right-to-left, CC: craniocaudal.

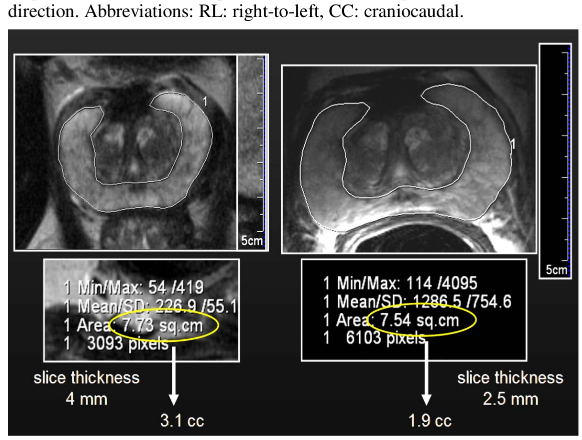

Fig.2: Example of the decreased peripheral zone volume before and after endorectal coil introduction in one image slice.

Results

Patients – Mean age was 61 years (range: 51-70), mean PSA level was 7.8 ng/ml (median: 6.1; range: 3.5-24.6), median Gleason biopsy score was 6 (range: 5-9).

Prostate diameter changes (see **Table**) – All prostate diameters changed significantly after ERC introduction (**Figure 1**). The mean AP prostate diameter decreased by 5.4 mm, a 15.7% reduction from the original diameter. Mean RL and CC diameters increased by 3.5 mm (8%) and 2.2 mm (6%), respectively.

Prostate volume changes (see **Table**) – The mean total prostate volume decreased significantly from 50.4 cc before to 42.2 cc after ERC introduction. The volume changes ranged between 0.3-23.9 cc. The mean peripheral zone volume decreased significantly from 21.9 cc to 17.0 cc (range: 0.3-11.2 cc) (**Figure 2**). The mean relative change in volume of the peripheral zone (21.6%) was significantly larger than that of the total prostate volume (17.9%) and central gland volume (14.2%).

Table: Prostate diameter and volume changes after endorectal coil introduction

	Mean Difference *	Mean relative Difference *
Diameter changes		
Anteroposterior	– 5.38 mm	– 15.7 %
Right-to-left	+ 3.49 mm	+ 7.69 %
Craniocaudal	+ 2.24 mm	+ 6.28 %
Volume changes		
Total gland	– 8.26 cc	– 17.9%
Peripheral zone	– 4.83 cc	– 21.6%
Central gland	– 3.43 cc	– 14.2%

Discussion and conclusions

Analyzed at 3T, all prostate diameters and volumes changed significantly after ERC introduction. The peripheral zone volume changed most prominently. These observations have implications for radiation therapy. Firstly, it is advised that radiation therapy planning and therapy CT scans and MR imaging are best performed in the same setting, with or without endorectal coil/balloon, so as to obtain maximal accuracy. Secondly, by using the ERC, the target volume for radiation therapy decreases, thereby reducing exposure of neighboring organs. Thirdly, the effect of prostate compression on vascular flow and thus a possible local hypoxia remains unclear and needs to be examined in future.

References

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