Fully Automated Prostate Segmentation on MRI: Comparison with Manual Segmentation Methods and Specimen Volumes

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OBJECTIVE: The objective of our study was to compare calculated prostate volumes derived from tridimensional MR measurements (ellipsoid formula), manual segmentation, and a fully automated segmentation system as validated by actual prostatectomy specimens.

MATERIALS AND METHODS: Ninety-eight consecutive patients (median age, 60.6 years; median prostate-specific antigen [PSA] value, 6.85 ng/mL) underwent triplane T2-weighted MRI on a 3-T magnet with an endorectal coil while undergoing diagnostic workup for prostate cancer. Prostate volume estimates were determined using the formula for ellipsoid volume based on tridimensional measurements, manual segmentation of triplane MRI, and automated segmentation based on normalized gradient fields cross-correlation and graph-search refinement. Estimates of prostate volume based on ellipsoid volume, manual segmentation, and automated segmentation were compared with prostatectomy specimen volumes. Prostate volume estimates were compared using the Pearson correlation coefficient and linear regression analysis. The Dice similarity coefficient was used to quantify spatial agreement between manual segmentation and automated segmentation.

RESULTS: The Pearson correlation coefficient revealed strong positive correlation between prostatectomy specimen volume and prostate volume estimates derived from manual segmentation (R = 0.89-0.91, p < 0.0001) and automated segmentation (R = 0.88-0.91, p < 0.0001). No difference was observed between manual segmentation and automated segmentation. Mean partial and full Dice similarity coefficients of 0.92 and 0.89, respectively, were achieved for axial automated segmentation.

CONCLUSION: Prostate volume estimates obtained with a fully automated 3D segmentation tool based on normalized gradient fields cross-correlation and graph-search refinement can yield highly accurate prostate volume estimates in a clinically relevant time of 10 seconds. This tool will assist in developing a broad range of applications including routine prostate volume estimations, image registration, biopsy guidance, and decision support systems.