Early DWI in Assessing Tumor Response in Locally Advanced Cervical Cancer: Is There a Role in 3D MRI Guided Brachytherapy?

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Target Audience: Radiologists and radiation oncologists with expertise in gynecological malignancy.

Introduction: MRI is used for treatment planning and assessment for patients with cervical cancer undergoing fractionated high dose-rate brachytherapy (HDR-BT) following placement of an intracavitary applicator. Diffusion-weighted imaging (DWI) coupled with conventional MRI has shown promise for residual tumor evaluation after external beam radiation therapy (EBRT). The purpose of our study was to assess the feasibility and impact of DWI in patients undergoing serial MRI-guided HDR-BT with ring and tandem applicator in situ.

Methods: 21 patients (mean age 47 years, range, 30-64) with locally advanced cervical cancer (squamous ca. 18/21; adenocarcinoma 3/21) treated between March 2011 to Sept 2012 underwent MRI-guided HDR-BT following standard chemoradiation with EBRT on a 1.5T GE HDx platform. 3D isotropic (CUBE) and 2D FRFSE T2-weighted imaging, together with single shot echo-planar DWI were performed in the axial plane with b value of 700s/mm2 (TR/TE 3800/71ms, slice thickness/gap 4/0.8mm, NEX 12, ASSET 2). MRI was obtained prior to EBRT (Pre-RT0 MRI), and during 5 sessions of MRI-guided HDR-BT with intracavitary ring and tandem applicator in situ (Post-RT1-5 MRI). Regions of interest around the tumor were drawn on ADC maps by an experienced radiologist with reference to the T2-weighted images, and the mean ADC (x 10^-3 mm^2/s) calculated. T2 intensity of tumor (T2-Tumor), psoas muscle (T2-Psoas), and T2-Tumor/T2-Psoas (T2-Ratio) were calculated for normalization. Patients were categorized as complete response (CR) versus partial response (PR) after completion of therapy. Paired student t-test was used to compare Pre-RT0 T2-Ratio, and ADC to the final Post-RT5 values, and to determine whether Pre-RT1, mid-treatment Post-RT3, and percentage change (Post-RT5 – Pre-RT0) differed between the CR and PR groups. Subgroup analysis was performed to determine whether the Pre-RT0 ADC varied by histology and tumor size.

Results: 2/21 patients were excluded, as no abnormal T2 signal was present after EBRT. 4/19 (21%) patients were classified as PR (3 adenocarcinoma, 1 squamous ca.), and 15/19 were classified as CR (15 squamous ca.) [Figs. 1, 2]. The mean Pre-RT0 ADC was 1.08 (range: 0.91-1.66) with significant difference between the mean Pre-RT0 ADC of CR and PR groups (1.03 vs. 1.22, p=0.046). Subgroup analysis showed that Pre-RT0 ADC did not vary based on tumor size (<5 vs. >5 cm), however, there was a difference in the ADC between squamous and adenocarcinoma histology (1.03 vs. 1.31, p=0.005). In comparing post-RT5 to Pre-RT0 parameters, both T2-Ratio and ADC demonstrated a significant change with treatment; (2.4 vs. 2.0, p=0.01, 15% change) and (1.07 vs. 1.58, p<0.001, 50% change) respectively, and no difference in T2-Psoas signal (286 vs. 256, p=0.25) was identified. Mid-treatment Post-RT1 ADC, mid-treatment Post-RT3 T2-Ratio, and percentage change from pre-therapy values for Post-RT1 ADC and T2-Ratio were not different between CR and PR groups and did not correlate with outcome (p=0.98, 0.32,0.21,0.72 respectively).

Conclusion: This study demonstrates the feasibility of DWI in treatment planning for patients undergoing HDR-BT with brachytherapy applicator in-situ. Both ADC and T2-Ratio reliably indicate treatment response, although ADC shows a wider dynamic range. Only pre-therapy ADC was statistically different between the CR and PR groups, with no outcome information provided by either ADC or T2-Ratio. Studies with large cohorts are needed to establish threshold values in defining residual disease at the time of brachytherapy and correlation with outcomes based on ADC.