MODALITY CAPSULE REVIEWS

Diffusion-weighted Imaging in Rectal Cancer

Introduction: Diffusion-weighted imaging (DWI-MRI) has moved from a research tool, to, in some scenarios, discussed below, a clinically relevant and applicable modality to apply to the imaging and management of rectal adenocarcinoma. This capsule will discuss its use from the standpoint of diagnosis, staging, restaging; primary tumor and nodal staging, and qualitative and quantitative assessment, drawing on the most current literature. Whole body DWI with background suppression for distant metastases will not be discussed. Intravoxel incoherent motion (IVIM) will nt be discussed.

Diagnosis: DWI-MRI is not used for the purpose of making a diagnosis of rectal cancer. The restricted diffusion seen with densely packed cells or complex fluid is nonspecific and could be used to confirm location of a known tumor for subsequent localization; however necrosis, edema, post-biopsy change and post radiation change may cause the same signal. Be sure to observe the apparent diffusion coefficient map (ADC) to avoid T2 shine through artifact. The recommended b-values are between 800 and 1000 for standard assessment.

Staging: Qualitative evaluation (i.e. visual inspection)
T-stage: The resolution of DWI-MRI is insufficient to serve as a method to assess depth of invasion. Again, it may confirm the presence of tumor which might otherwise be hard to see due to iso-intensity of tumor to surrounding rectal wall.
N-stage: Lymph nodes, as tightly packed cellular units, have restricted motion and therefore are well-visualized on DWI-MRI. The distinction between benign and malignant nodes is not possible on visual inspection of a given node at DWI-MRI. DWI-MRI could be used to "screen" for the presence of nodes given the high conspicuity of these images. Then, observation and evaluation of each node could proceed using T2WI after localization.

Restaging: Qualitative evaluation
T-stage: The presence of residual tumor has been shown to be more accurately predicted using DWI-MRI compared with T2WI alone, both in a large, recent meta-analysis (van de Paardt) and in a study of complete response assessment (Maas et al). Although these results should be validated, particularly in a prospective setting, they attest to the powerful tool that DWI-MRI has become in tumor assessment.

Once again, the depth of tumor invasion is not accurately assessed due to the low resolution. However, DWI has been found to increase accuracy in the detection of involvement of the CRM after therapy from 40%–69% to 89%–93% compared with T2WI alone, with high interobserver agreement.

COMPLETE RESPONSE ASSESSMENT: DWI assessment, which renders an image of protons immobilized by tightly packed tumor cell environments, has a high specificity and high negative-predictive value for the detection of complete response and is therefore considered particularly useful for highlighting the presence of residual tumor in incomplete responders. It thus has an emerging role in deselecting individuals otherwise chosen for nonoperative management on the basis of endoscopy. However, the limited positive-predictive value of DWI-MRI precludes confident identification of complete responders, which remains a major challenge. Post-CRT DWI volumetry has compared favorably with post- CRT T2 volumetry, proving a better predictor of complete response, with a higher specificity and an area under the curve of 0.93 vs 0.70, confirming the greater biospecificity of DWI signal compared with the non-specific T2 weighted signal in the tumor bed.

N-stage: Two investigations, one published and another in press indicate that, though rare, the absence of visualization of lymph nodes after neoadjuvant chemoradiotherapy, and prior to surgery, is highly predictive of a node negative specimen. Obviously the sensitivity of this finding is low, because one can still have and see LN by DWI which could still be benign.

Staging/Restaging: Quantitative evaluation (i.e. ADC values)

T-stage: Several investigators have reported a correlation between low ADC values (more restricted water motion) before the start of therapy and good response to therapy. This is usually attributed to the fact that tumors with high ADC values may contain areas of necrosis, causing reduced blood flow and inhibiting the delivery of CRT. Conversely, other authors have reported a correlation between low pretreatment ADC values and higher tumor aggressiveness or have been unable to reproduce the correlation between low pretreatment ADC values and good treatment response. These conflicting results may be attributed not only to variations in MRI technique but also to small sample sizes, variability in patient selection criteria, the use of regions of interest (the subjective placement of manually drawn circles encompassing a tumor), and interobserver variability, especially after neoadjuvant CRT.

N-stage: Research suggests that DWI may be effective in the estimation of N status. In one study, DWI yielded an accuracy of 84%, sensitivity of 97%, specificity of 81%, and negative predictive value of 99% in the detection of metastatic lymph nodes, although its PPV was low, at 52%.[70] However, there is

considerable overlap between the ADC values that have been identified for differentiating malignant and benign nodes and further studies are required to expand on these early results.

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