Musculoskeletal Sarcomas: Response Assessment Prior to Definitive Surgery
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Learning Objectives
• Appreciate specific rationale for, and challenges associated with, determination of therapy response in musculoskeletal tumors
• Summarize strengths and limitations of MRI in assessing response to therapy
• Understand potential of quantitative dynamic MRI and DWI for assessing response

Neoadjuvant (preoperative) chemotherapy for bone tumors frequently is given in an attempt to reduce tumor bulk, thereby facilitating subsequent surgical resection and limb salvage. Such therapy also decreases the incidence of local recurrence and distant metastasis, and enables prediction of response to adjuvant (postoperative) therapy. The histopathologic response to therapy in osteosarcoma (measured as the percent necrosis in the resection specimen, using the Huvos method) has been shown to correlate with patient prognosis. A response to chemotherapy is considered good only if more than 90% of the resected tumor specimen is found to be necrotic. However, the Huvos histopathologic method can be performed only once, after surgical resection of the tumor. Current radiologic methods, which typically focus on changes in one or two diameters of a tumor, often are misleading and inadequate for determining the actual histologic response of a bone tumor to neoadjuvant therapy. For example, the intraosseous component of a bone sarcoma typically does not decrease in size after successful therapy, even if 100% necrotic; and a persistent extraosseous component can be composed entirely of nonviable tissue (which represents an excellent therapeutic response). An adjustment to the percent necrosis observed at pathology has been proposed in order to account for change in tumor size after therapy; this adjustment awaits prospective validation.

Various radiologic findings have been reported as useful in the assessment of response of musculoskeletal tumors to therapy. Return of normal bone marrow at MRI, when it occurs, reliably excludes the presence of gross tumor in that region; however, this occurs infrequently in the setting of primary bone tumors. Increased ossification within an osteosarcoma after therapy does not necessarily indicate a good treatment response. Decreased perilesional edema after therapy facilitates the surgical procedure, but does not consistently reflect a good treatment response. Similarly,
changes in MRI signal are not reliable; MRI signal alone cannot distinguish viable tumor versus post-therapy change.

A marked decrease in size of a soft tissue mass is generally a favorable sign, but interval enlargement is not necessarily bad, because enlargement can be due to hemorrhage or edema within the mass. As with bone tumors, a persistent soft tissue mass can represent entirely necrotic tissue, entirely viable tumor, or a combination thereof.

Quantitative dynamic gadolinium-enhanced MRI is a promising technique for providing a noninvasive and repeatable assessment of the histologic response of a bone tumor to neoadjuvant therapy. Based on the principle that viable tumor enhances more rapidly than does necrotic tumor or post-therapy changes, this assessment can potentially allow early determination of poor response to a particular therapy, thereby allowing a change to be made in that therapy. Currently, however, the software needed for the data analysis is proprietary to each institution.

Diffusion-weighted MRI (DWI) also may provide information about the response of musculoskeletal tumors to treatment. In principle, the diffusion of water present within a tumor after successful treatment should increase, thereby resulting in a relative decrease in signal intensity of the lesion on post-treatment DWI together with an increase in the apparent diffusion coefficient (ADC). The utility of DWI for therapy response assessment is undergoing active investigation in many centers; standardization of the technique is one of several challenges to be overcome. Initial results from one center suggest that the relative change in ADC is significantly larger in tumors with at least 90% necrosis than in those with less than 90%.

Activity at FDG PET/CT has been reported to correlate with histopathologic response assessment in bone and soft tissue tumors, but is confounded in some cases by chemotherapy-induced inflammation. MRI currently remains the mainstay in radiologic assessment of response in malignant musculoskeletal tumors.

References


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