Neoadjuvant chemotherapy (NAC) is increasingly being used in the treatment of primary breast cancer, resulting in tumor down-staging with more women achieving breast conserving surgery (BCS) and complete pathological response (pCR) with concomitant improvements in survival. Imaging has an important role in the evaluation of effectiveness to NAC: determining response and the extent of residual disease. Both are important with regards to planning BCS for appropriate patients, and if pCR could be predicted then surgery could be avoided. Multiple imaging methods including mammography, ultrasound, MRI, PET-CT and others have been evaluated for their ability to assess the effectiveness of NAC. Mammographic and ultrasound findings have poor correlations with pathological results and increasingly, molecular imaging methods are being used to assess therapy effectiveness.

Dynamic contrast enhanced (DCE) MRI has been the most studied vascular imaging technique that can potentially distinguish residual invasive tumor and non-vascularised fibrosis at the end of therapy. When used early in the course of NAC, DCE-MRI can identify potential non-responders who might benefit from treatment changes. Because DCE-MRI evaluates vascularity not cell viability, its sensitivity following NAC may be limited. Diffusion weighted MRI (DW-MRI) directly evaluates cellularity and maybe better at addressing the extent of residual active disease, but spatial resolution is currently limiting.

PET-CT with the glucose analogue FDG has been shown to predict eventual pathologic response when done after 1 or 2 courses of NAC but is rarely used in practice. Indeed, seemingly paradoxical results with increased FDG uptake with anti-ER treatments can be a prelude to eventual treatment success. There is very little experience using other molecular PET tracers targeting HER-2 or ER because of their lack of availability. Molecular imaging shows potential for predicting and evaluating therapy effects of NAC that could effect subsequent treatments including BCS and adjuvant treatments. Mechanism based investigations with regards to breast cancer biologic sub-types, targeted therapy combinations and therapy timing are warranted.

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