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Editorial

Intraoperative Radiotherapy with Image Guidance: Mix and Match

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Partial breast irradiation (PBI) after conservative surgery for early breast cancer enables accelerated treatment delivery resulting in shorter overall treatment times and improvement in patient convenience.(1-4) A range of technologies and techniques are available for the delivery of PBI but consideration of patient convenience is particularly relevant in the case of intraoperative radiotherapy (IORT) which may be delivered to the primary tumour bed in a single fraction at the time of surgery.(5, 6)

Although early results of clinical trials evaluating PBI using IORT are promising, longer term outcomes are awaited as there have been concerns regarding increased local recurrence rates and cosmetic outcomes.(7) These concerns are reflected in two recent consensus statements which recommend that IORT should be used in the context of a prospective registry or clinical trial.(1, 8)

As key considerations underpinning the consensus statements are tumour control and treatment toxicity, verification of adequate target volume coverage is essential. This is where the value of image guidance lies. Image Guided Radiation Therapy (IGRT) has been a game changer in external beam RT with the potential to improve normal tissue sparing thereby decreasing treatment toxicity, and escalate radiation doses to the target volume thereby improving tumour control.(9-11)

To some extent, conventional breast IORT is an operator-dependent technique limited by the lack of image guidance. Thus, it is logical to apply intraoperative computed tomography (CT) imaging in patients undergoing PBI using high dose-rate brachytherapy for confirmation of applicator placement and treatment planning as reported by Hassinger *et al* in this issue of the Journal of Medical Imaging and Radiation Oncology (12) based on earlier work of the investigators.(13) The investigators showed that intraoperative CT imaging in 103 patients resulted in applicator adjustment in 26% of patients, and

dosimetry modifications in 79% of patients. Subject to validation of these findings, it is unusual for an intervention to improve the precision of treatment delivery in such a substantial proportion of patients.

Technical improvement in the precision of treatment delivery aside, mature clinical outcomes data and evidence-based patient selection criteria are key to informing the future of IORT in the management of patients with early breast cancer. If the longer term results of clinical trials examining IORT prove to be favourable, it would be important to address the more technical question of treatment delivery and image guidance modalities.

A range of IORT modalities are available including interstitial or balloon-based brachytherapy, intraoperative electron irradiation (14) and miniaturised low-energy X-ray sources.(15) In terms of image guidance, radiation dose is an important consideration in fractionated external beam RT (16) but less relevant in IORT. Intrafraction motion is usually not a significant problem in breast IORT as the applicators are secured and the patient is anesthetised during the procedure. Thus, continuous imaging during delivery of IORT is not required in distinction from external beam RT where intrafraction motion would need to be taken into account.(17)

IGRT using CT imaging as per the study of Hassinger *et al* may not be an option at many centres due to the requirement for a CT on rails system.(12) Other three-dimensional (3D) image guidance modalities such as 3D ultrasound which has been used in external beam PBI (18) may provide comparable improvements in applicator placement and dosimetry as CT imaging.

Finally, the clinical value of IGRT in IORT for breast cancer requires further examination. It is unclear if decreasing the margins of radiation target volume arising from the use of IGRT would compromise treatment efficacy.(19). Nonetheless, IGRT would provide confirmation of the actual volume treated in IORT, which is an important quality assurance measure in clinical trials and routine practice. It is likely that image guidance will become integral to the delivery of IORT in breast cancer. The work by by Hassinger *et al* has demonstrated the technical feasibility and impact of such an approach.(12)

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