A Scoping Review of Magnetic Resonance Imaging Guided Breast Radiotherapy

S. Elliott[1,2], A. Berlangieri[1], J. Wasiak[1], M.Chao[1] & F.Foroudi[1]

1. ONJCWC, Austin Health, Heidelberg
2. Peter MacCallum Cancer Centre, Melbourne

Background

The role of magnetic resonance imaging (MRI) in radiotherapy is increasing, as MRI simulators and the advanced technology of MR linacs are being introduced into the radiotherapy clinic.

MRI uses non ionizing radiation to obtain superior soft-tissue contrast. MRI can provide functional information through the use of different imaging sequences. MR linacs have the improved ability to provide real time image guidance throughout a patients' radiotherapy treatment. Higher precision target localization combined with dynamic target information, can lead to decreased planning target volume margins and new, sophisticated radiotherapy approaches.

The use of MRI guided radiotherapy for breast cancer is an area of active research. However, the significant health care resources associated with this new technology impact immediate widespread use and availability, and there is currently limited evidence to demonstrate the clinical effectiveness and inform decision making for radiotherapy to this treatment site.

Aims

The aim of this review is to provide a focused resource on the clinical and technical aspects of implementing MRI into radiotherapy for standard and new breast techniques during simulation, planning and treatment delivery.

Method

The scoping review is designed and will be conducted in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analysis extension for Scoping Reviews reporting guidelines[1]. The process will follow a series of steps[2,3] including:

(1) identifying the research question, (2) identifying relevant studies, (3) study selection, (4) charting the data, and (5) collating, summarising and reporting the results, and (6) consulting with relevant stakeholders and key informants.

Table 1: Search inclusion/exclusion criteria

Study characteristics	Inclusion criteria	Exclusion criteria
Design	Systematic review Randomised and non-randomised controlled studies Clinical Trials	Case report/study Descriptive report
Publication	Peer reviewed journal Published in English Abstract and full text available 2010 to present	Doctoral thesis Conference proceeding, abstract or poster
Population	Breast cancer only Adults ≥ 18 years Any tumour stage	Any cancer excluding breast Breast metastases, nodal spread
Intervention	MR Linac MR Simulator Any type of RT intervention eg. Brachytherapy, VMAT, IMRT, 3DCRT	Standard diagnostic MRI scans used in an RT setting

Results

Searches were performed in Ovid MEDLINE and EMBASE using terms describing the population and intervention (see Table 1). Additional screening was performed of the WHO International Clinical Trials Registry Platform, references, as well as key journals and conference papers.

Three reviewers independently screened title and abstracts of all potential citations against the inclusion and exclusion criteria. Any disagreement was resolved by a fourth reviewer and group discussion. The PRISMA flow diagram in Figure 1 outlines our search results.

A data extraction form has been developed using Microsoft Excel and pilot tested. The form is undergoing review to incorporate the diverse nature of the selected studies. Data to be extracted will include but not be limited to the information listed in Table 2.

Fig. 1: PRISMA flow chart

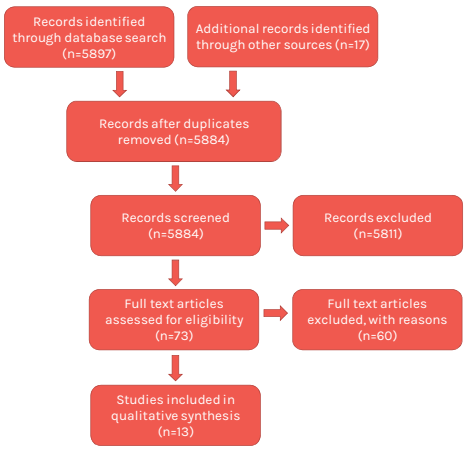

Table 2: Data extraction headings

Table heading	Key Results
Implementation 1: Imaging	Patient selection, MR acquisition sequences, parameters, image quality, quality assurance developments, image registration, patient setup, immobilisation equipment
Implementation 2: Planning	Structure delineation, technique, beam properties, dose calculation, dosimetry, corrections, interfractional & intrafractional adaptions, target volume margins, dose coverage of target, organ at risk doses, skin dose
Implementation 3: Treatment	Motion management, tumor localisation, delivered vs planned dose, workflow quality assurance & delivery issues, safety, patient outcomes, early assessment of treatment response such as local control, cosmetic results, treatment time
Challenges/ Knowledge gaps	Commissioning, planning, delivery, future research, clinical trials enabled by MRI in radiotherapy for breast cancer, limitations of technological development

Conclusion

Our thirteen included studies have indicated that accelerated partial breast irradiation treatments may benefit from the MR linac due to greater visibility of the tumor bed.

Margins in this cohort of patients can potentially be reduced enabling favorable cosmesis and shorter fractionation. Limitations include interactions between secondary electrons generated in the patient and the magnetic field, overall MR linac work flow, quality assurance and MR compatible equipment. This new technology appears to be a promising and feasible treatment option for APBI patients.

References

1. Liberati A, Altman DG, Tetzlaff J *et al.* The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. PLoS Med 2009;6: e1000100.

2. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol.* 2005; 8:19–32.

3. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. *Implement Sci* 2010; 5:69.