

## Multifunctional MRI to detect and localize multifocal and multicentric breast cancer

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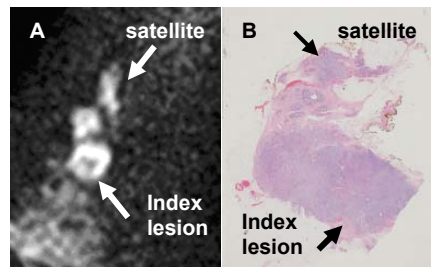
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**INTRODUCTION:** Pathological studies have demonstrated that up to 60% of apparently unifocal breast tumours identified on mammography and ultrasound are associated with microscopic multifocal and multicentric lesions ("satellite lesions")<sup>1</sup>. MR imaging has shown otherwise unsuspected sites of invasive/pre-invasive disease in the ipsilateral breasts of 27% women<sup>2</sup>. This pilot study therefore aims to determine the accuracy of dynamic contrast-enhanced (DCE)-MRI and diffusion-weighted (DW)-MRI alone, and in combination, in detecting and localising multifocal and multicentric disease in patients with breast cancer by correlating imaging with histopathology findings at mastectomy.

**METHODS:** Eligible patients with unifocal invasive ductal carcinoma on mammography, ultrasound and core biopsy underwent DCE-MRI and DW-MRI in the prone position <1 week before planned surgery on a 1.5T scanner using a dedicated breast coil. A single breast was imaged to maximise spatial resolution. 3D dynamic volume data sets following 0.1 mmol/kg of gadolinium chelate were acquired, and time to peak enhancement, maximum enhancement, wash-in and wash-out rates from the index lesion were obtained. DW images used a single shot echo-planar sequence (b-values 0, 200, 450 and 900 s/mm<sup>2</sup>) and were combined in an established model of diffusion to produce ADC maps. An experienced MR radiologist prospectively interpreted the data. The size of the target lesion was measured and the number, size and location of any satellite lesions (contrast-enhancing foci with rapid uptake and wash-out not in continuity with the index lesion) in relation to the index tumour were documented. An experienced histopathologist, blinded to the MR findings reported the number, location and size of satellite lesions. Photographs of each stained section were matched to the corresponding MR images. A satellite lesion on imaging was presumed to correlate with a satellite on histopathology if the 3-D co-ordinates were within ±0.5cm in each dimension. False positive and false negatives were recorded. To account for multiple lesions within each case with any combination of true and false positives and false negatives, each lesion was assigned a proportionate weight within each case: one true positive lesion, one false positive lesion and one false negative lesion, scored 0.33. A case with no lesions on either modality or several lesions all of which were true positives scored 1.

**RESULTS:** The study has recruited 6 patients so far (less than expected due to widespread use of neo-adjuvant systemic therapies). The index lesion measured between 15 and 22mm in longest dimension (median 18mm) on DCE-MRI. 7 satellite lesions were seen on pathology, 9 on DCE-MRI alone, 7 on DWI-MRI alone (Fig.1) and 11 on both DCE- and DWI-MRI (Table 1). Satellite lesions were between 3 and 22mm from the edge of the index lesion. The distance from the edge of the satellite lesion to the edge of the index tumour was comparable for MR and histopathology, mean difference 1.5 mm (p=0.16). Table 2 shows the concordance and discordance between MRI and pathology.

Case	(DCE-MRI)	DWI-MRI)	both DCE and DWI-MRI	Pathology
1	0	0	0	0
2	2	1	2	1
3	1	1*	2	1
4	1	1	1	1
5	2	2	2	1
6	3	2	3	3 <sup>†</sup>



**Fig. 1** Sagittal DW-MRI (b=900, A) with corresponding histopathology slice (B)

**Table 1** Number of satellite lesions seen with each technique.

\*=satellite lesions in DCE- and DWI-MRI for case 3 were in different locations

<sup>†</sup>= 2 satellite lesions on pathology were in geographically distinct locations to those seen on MRI

		Histology		False positive/ False negative
		Positive	Negative	
DCE-MRI	Positive	3.2	1.4	3.5
	Negative	0.4	1	
DWI-MRI	Positive	1.7	1.7	1.2
	Negative	1.4	1.2	
Combined-MRI	Positive	2.7	1.4	1.6
	Negative	0.9	1	

**Table 2:** Concordance and discordance between MRI and histology for identifying satellite lesions

**DISCUSSION & CONCLUSIONS:** DCE-MRI alone was most accurate in detecting satellite lesions with a sensitivity of 89% and compared favourably with previous work<sup>3,4</sup>. DW-MRI alone was least accurate (sensitivity 55%). Satellite lesions were found up to 22 mm from the edge of the index lesion in keeping with findings from a previous study of mastectomy specimens which found that in 90% of patients with satellite lesions, all lesions were encompassed within a 30 mm radius from the edge of the index tumour<sup>1</sup>. False positives may have arisen because spatial resolution of imaging was insufficient to visualize continuity of the "satellite" with the main lesion, therefore recording it as separate. Although patient numbers are currently low, a larger study with more precise histopathological mapping is underway. Accurate identification of satellite lesions with multifunctional MRI offers potential for monitoring the effects of local therapies on multifocal and multicentric disease, and in defining the target volume for partial breast irradiation.

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