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Influence of ROI placement: different ADC metrics on diagnostic accuracy of DWI in NME breast tumours

Poster No.: C-0525

Congress: ECR 2019

Type: Scientific Exhibit

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Keywords: Breast, Oncology, Anatomy, MR, MR-Diffusion/Perfusion, MR-Functional imaging, Imaging sequences, Contrast agent-intravenous, Biopsy, Cancer, Neoplasia

DOI: 10.26044/ecr2019/C-0525

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Aims and objectives

To investigate the influence of region-of-interest (ROI) placement and different ADC metrics on diagnostic accuracy of diffusion-weighted imaging (DWI) and to assess inter-reader and intra-reader agreement of ADC measurements with DWI in non-mass enhancing (NME) breast tumors with dynamic contrast-enhanced magnetic resonance imaging of the breast

Methods and materials

In this IRB-approved single-institution study and retrospective data analysis 95 patients, who underwent multiparametric MRI with DCE and DWI and were diagnosed with a suspicious NME breast lesion (BI-RADS 4/5) were included in this study.

Two readers independently assessed DWI and DCE in two separate randomized readings with a wash-out period of at least 3 weeks.

For DWI readers recorded ADC mean values using:

a) Whole tumor (Wtu) ROI, b) Darkest part (Dptu) tumor 10 mm ROI and c) point tumor (Ptu) 3 mm ROI.

NME lesions were classified as a benign (>1.3 $x10^{-3}$ mm^2/s) or malignant (1.3 x 10^{-3} mm^2/s). Histopathology was the standard of reference.

ROC curves were plotted and the area under the curve (AUC) was determined.

The concordance correlation coefficient (CCC) was performed to examine agreement on continuous measures (MRI features) obtained by the two independent readers

Images for this section:

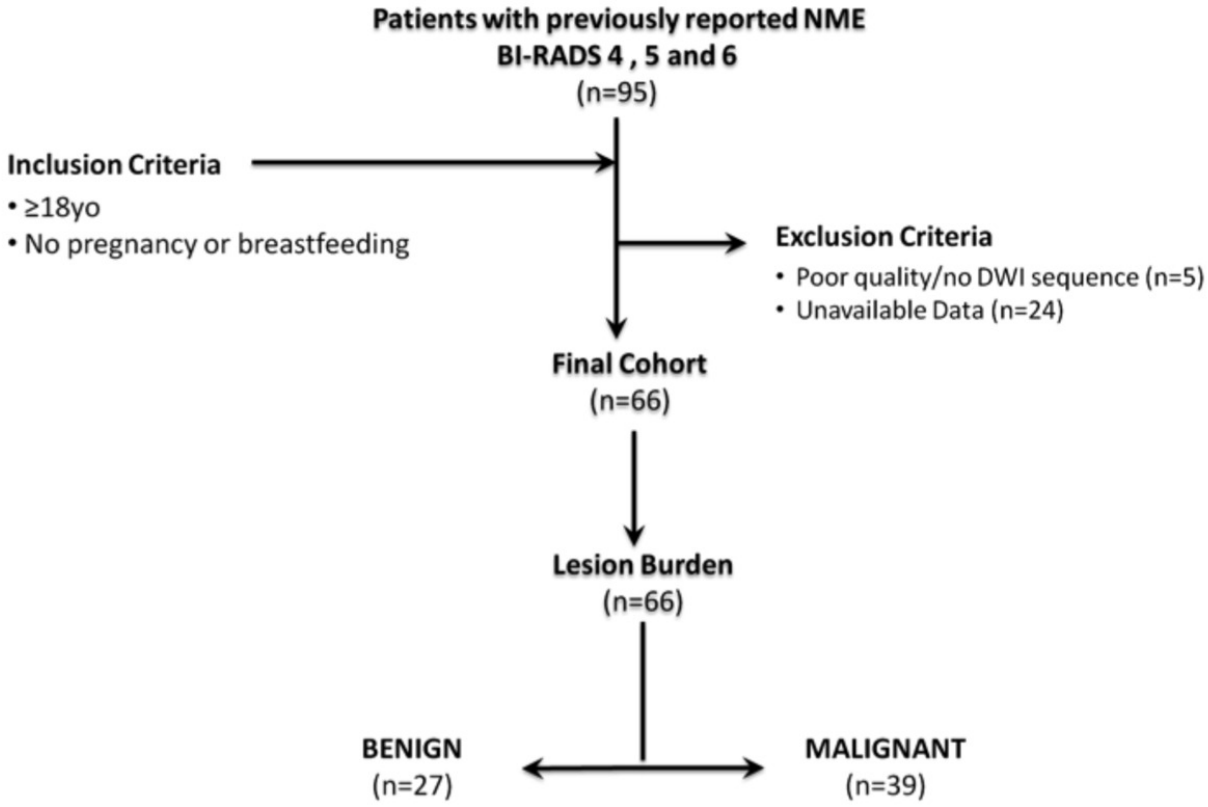

Fig. 1: The scheme summarizes the data selection criteria of our study inclusion and exclusion criteria

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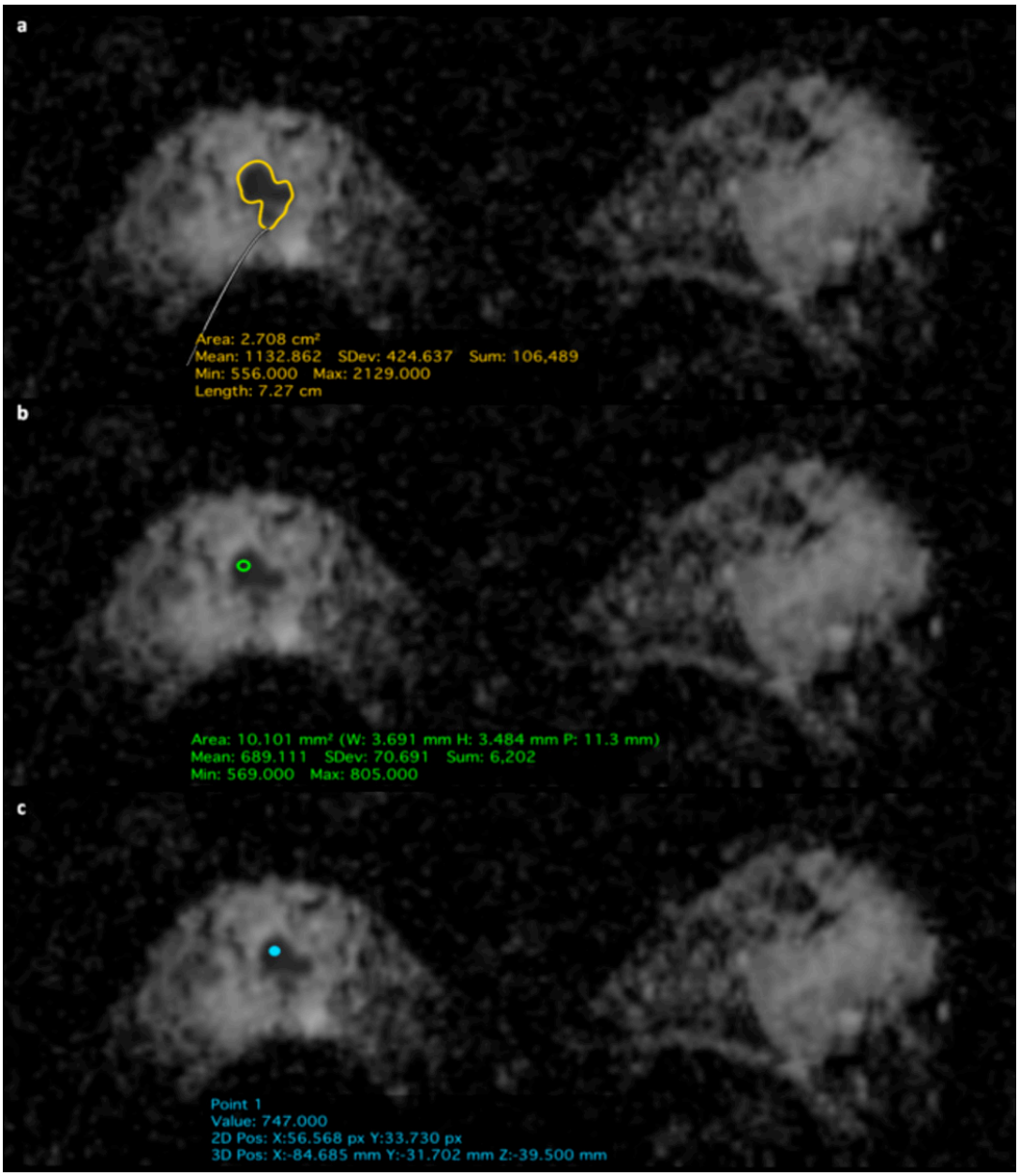

Fig. 2: Magnetic resonance of the breast with apparent diffusion coefficient map images axial view. Examples of the three methods used to measure the ADC values: a) whole tumor delineation, b) darkest part of the tumor and c) point tumor delineation. The three ROIs show low ADC values <1.3x10-3mm2/s indicating highly suspicious of malignancy. Final histopathological diagnosis yielded invasive ductal carcinoma, G3

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Results

66 patients (mean ages 51.8 ±10.8 yo, range 26-76 yo) were included for analysis with a mean size lesion of 40±25 mm, range 5 mm-98 mm): 39 (59%) malignant and 27 (42%) benign (see Fig. 3).

29 patients excluded; 5 insufficient quality DWI images (24 NME lesions not discernable on DWI alone (12 benign/12 malignant).

The best diagnostic performance for DWI for both readers and readings were achieved with Dptu mean with AUC range 0.512 and 0.709 (Fig 4).

CCC varied among the different ADC metrics was fair-to-moderate.

the best results for CCC were achived for Dptu max ADC (0.420) in second reading (fig 5).

Similar results were obtained for intra-reader agreement with the best CCC for Wtu mean, R1 0.435 and R20.412 (fig. 6)

Images for this section:

Histopathology	Mean size (mm)
Non-mass enhancement lesions	40
Malignant	48.4
Ductal carcinoma in situ	33.5
Invasive Ductal Carcinoma	48
Invasive Lobular Carcinoma	56.5
IDC+DCIS	30
IDC+LCIS	60
Benign	28
FA/FAH	21.5
Adenosis, Sclerosing Adenosis, Focal Fibrosis, Apocrine metaplasia, Breast parenchyma, Fibrocystic changes	23
Papilloma	45
High-Risk (CCC with atypia, papilloma with atypia)	42
Other (chronic abscess, gynecomastia, fat necrosis, scar tissue)	33.5

Fig. 3: Detailed histopathological diagnosis of all malignant and benign NME

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Parameters	TIME 1		TIME 2	
	R1	R2	R1	R2
Wtu max	0.699 (p=0.0021)	0.613 (p=0.994)	0.467 (p=0.652)	0.486 (p=0.852)
Wtu mean	0.549 (p=0.509)	0.530 (p=0.669)	0.596 (p=0.168)	0.669 (p=0.014)
Wtu min	0.500 (p=0.994)	0.599 (p=0.669)	0.508 (p=0.896)	0.646 (p=0.024)
Dptu max	0.538 (p=0.598)	0.667 (p=0.019)	0.628 (p=0.065)	0.657 (p=0.021)
Dptu mean	0.512 (p=0.844)	0.638 (p=0.050)	0.644 (p=0.034)	0.709 (p=0.001)
Dptu min	0.599 (p=0.166)	0.523 (p=0.753)	0.567 (p=0.357)	0.669 (p=0.014)
Ptu mean	0.542 (p=0.558)	0.592 (0.206)	0.595 (p=0.189)	0.736 (p=0.0002)

Fig. 4: Diagnostic accuracy: Influence of the ROI placements and ADC metrics Significant p value < 0.05

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Parameters	READER 1		READER 2	
	CCC	95% CI	CCC	95% CI
Wtu max	0.370	0.406-0.736	0.241	0.072-0.409
Wtu mean	0.435	0.258-0.612	0.412	0.209-0.615
Wtu min	0.212	-0.016-0.439	0.287	0.093-0.481
Dptu max	0.177	-0.057-0.411	0.326	0.111-0.540
Dptu mean	0.394	0.195-0.592	0.051	-0.013-0.116
Dptu min	0.222	-0.010-0.454	0.136	-0.129-0.187
Ptu mean	0.177	-0.057-0.411	0.021	-0.223-0.265

Fig. 5: Inter-reader agreement of ADC measurements. Fair to moderate

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Parameters	TIME 1		TIME 2	
	CCC	95% CI	CCC	95% CI
Wtu max	0.349	0.152-0.546	0.040	-0.011-0.091
Wtu mean	0.341	0.147- 0.535	0.040	0.324-0.688
Wtu min	0.297	0.100-0.494	0.087	-0.147-0.322
Dptu max	0.141	0.094-0.377	0.420	0.226-0.615
Dptu mean	0.111	-0.113-0.369	0.319	0.108-0.531
Dptu min	0.128	0.031-0.191	0.029	-0.129-0.187
Ptu mean	-0.014	-0.244-0.217	0.043	-0.092-0.178

Fig. 6: Intra-reader agreement of ADC measurements Fair to moderate. Best agreement for Dptu max

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Conclusion

Diagnostic accuracy of DWI with ADC mapping is limited in breast lesions presenting as Non- mass enhancement (NME).

Best results are achieved using 2D ROI measurements approach and ADC mean

Images for this section:

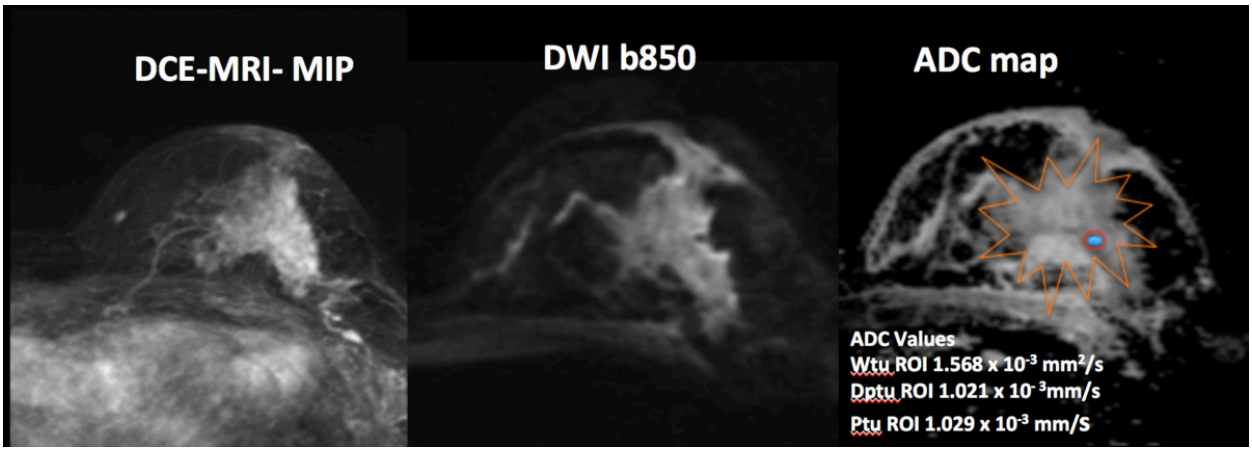

Fig. 7: Case. Axial T1 weighted post-contrast multi-projection reconstruction (MPR) of the left breast shows a segmental area of NME with correlate hyperintense DWI and heterogeneous on ADC map. Invasive lobular carcinoma as final histology.

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