Breast DWI standardization

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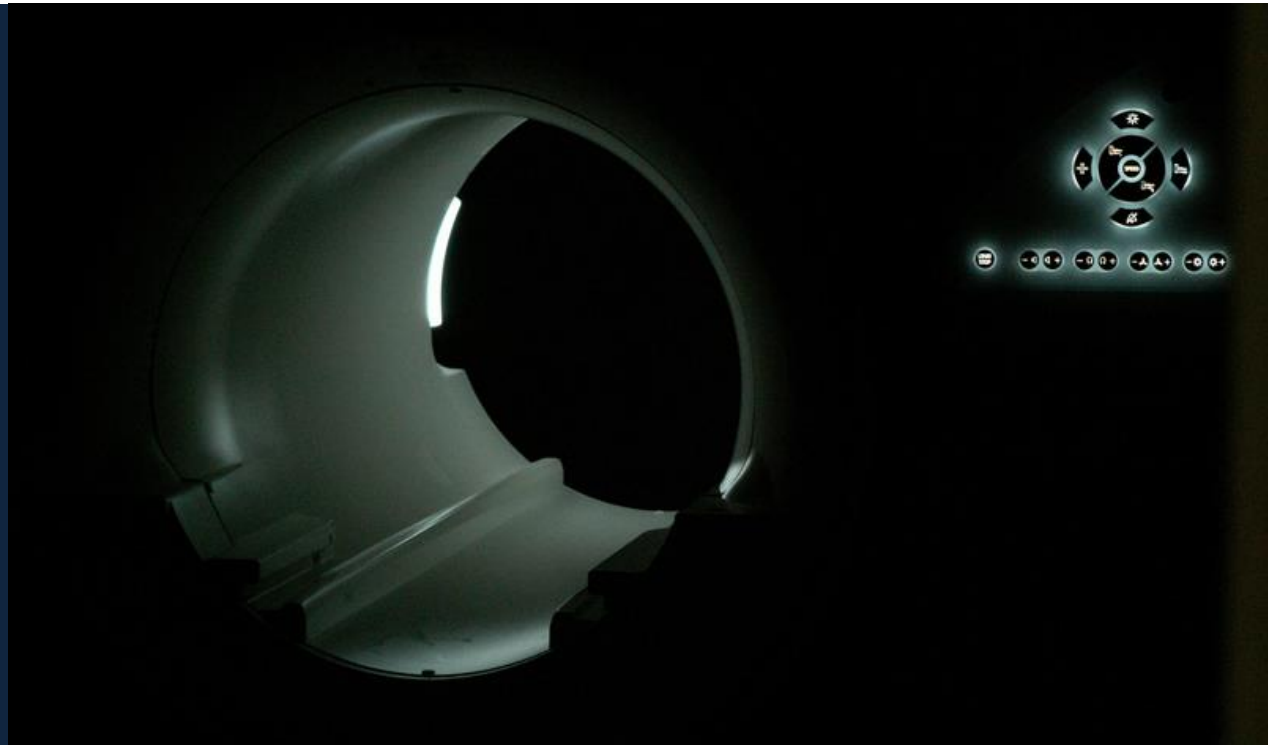
Breast DWI standardization

Disclosure

- Nothing to disclose

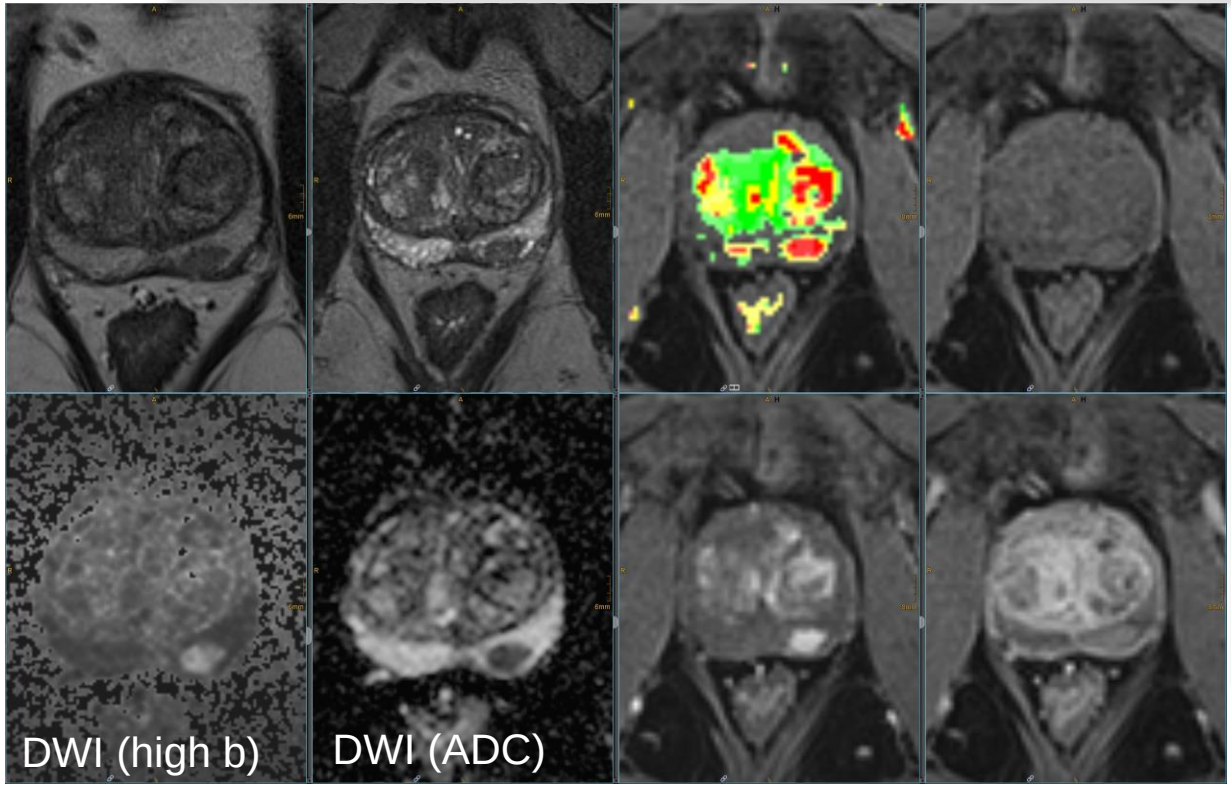
Breast DWI standardization

Background



Breast DWI standardization

Role of DWI



PI-RADS Assessment

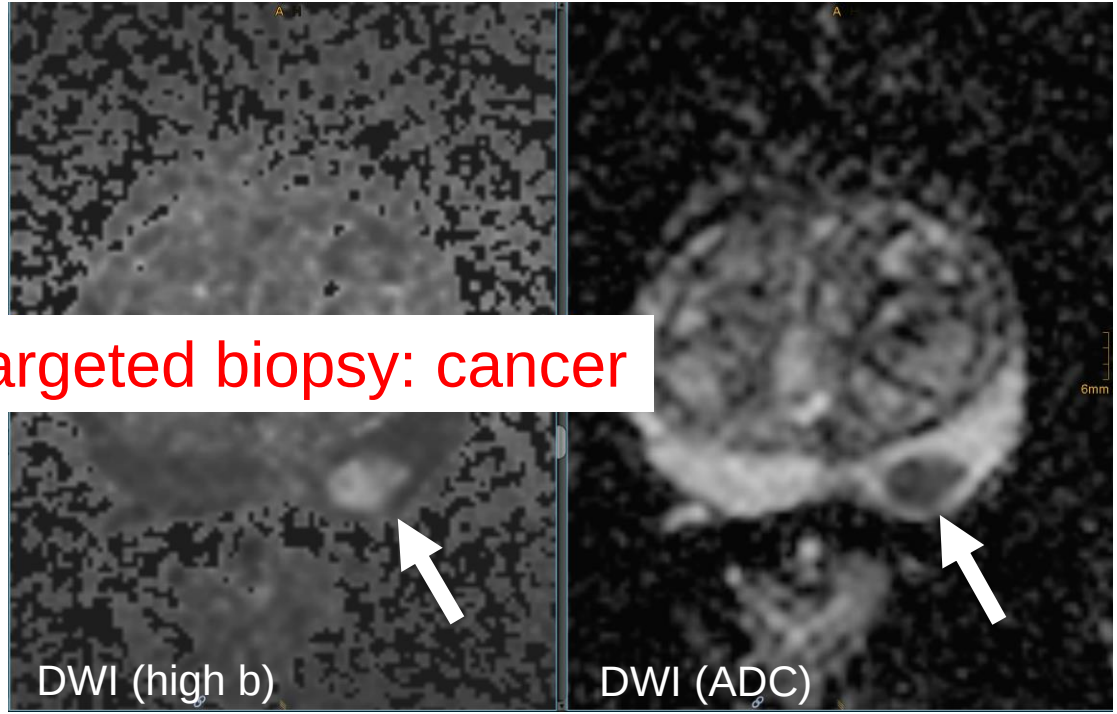
Peripheral Zone (PZ)

DWI	T2W	DCE	PI-RADS
1	Any*	Any	1
2	Any	Any	2
3	Any	–	3
		+	4
4	Any	Any	4
5	Any	Any	5

* "Any" indicates 1-5

Breast DWI standardization

Role of DWI



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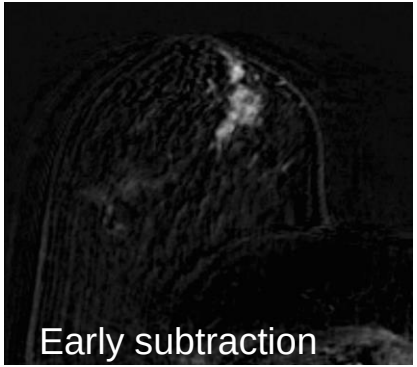
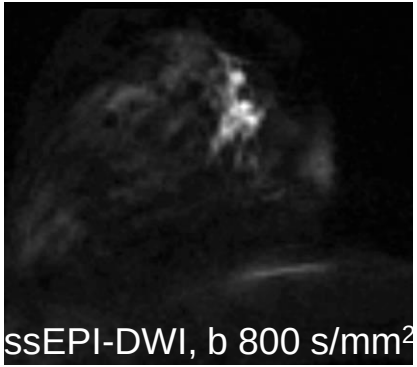
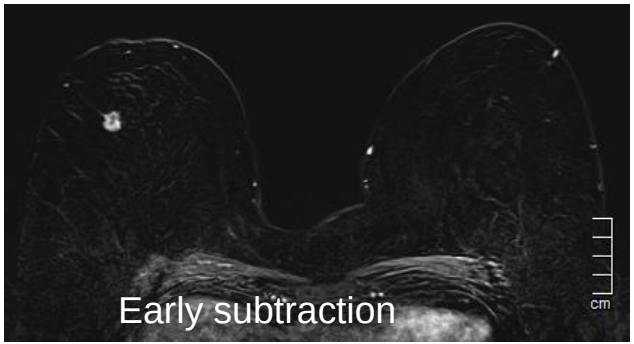
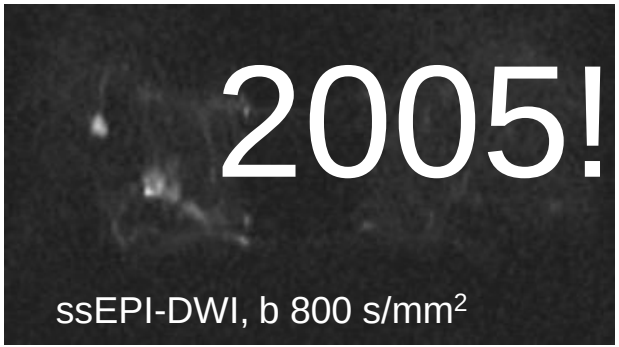
Breast DWI standardization

Background Diffusion Weighted Imaging: Lesion Visualization





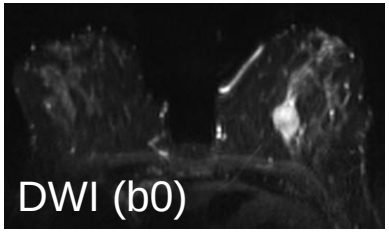


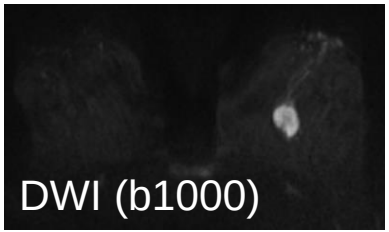


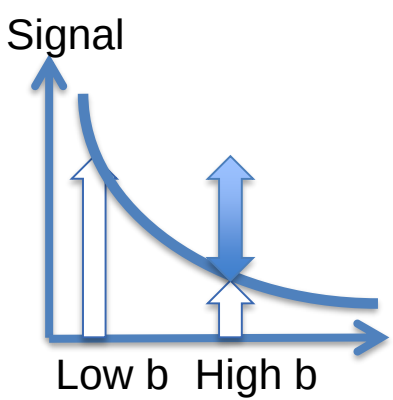
Breast DWI standardization

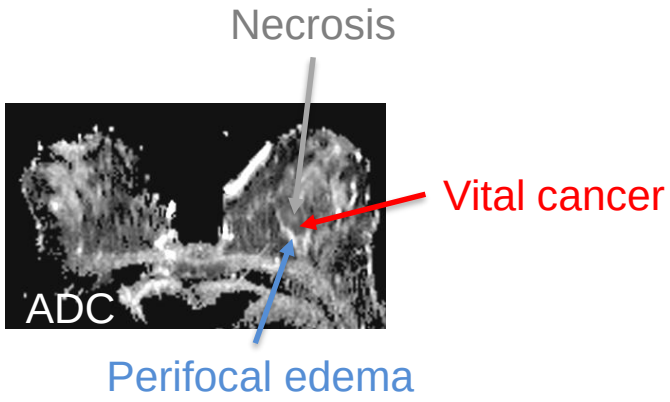
Background Diffusion Weighted Imaging

- Diffusion dependent signal loss $S=S_0*e^{-b*ADC}$





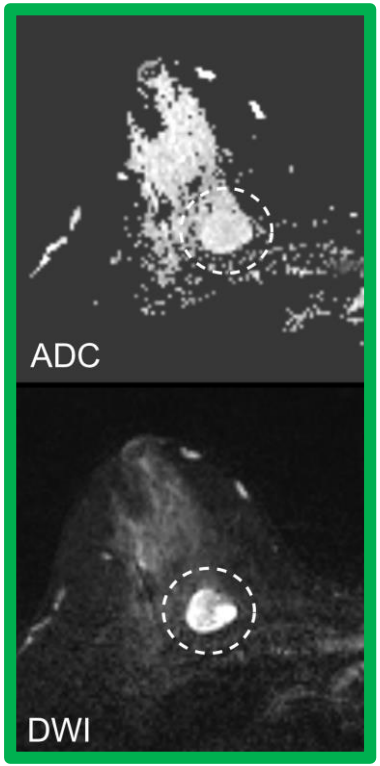


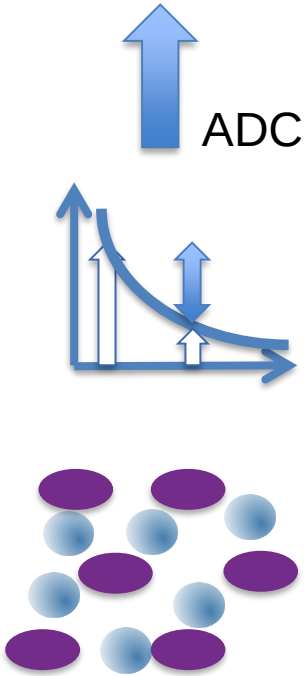


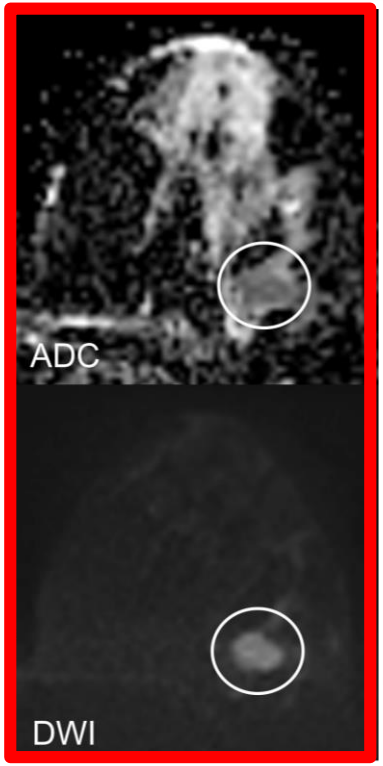
- Apparent Diffusion Coefficient (ADC) reflects tissue microstructure

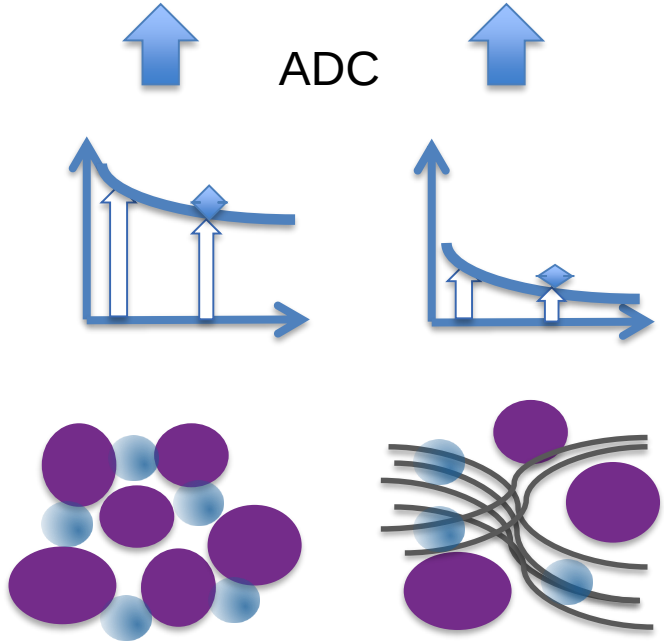
Breast DWI standardization

Clinical applications: quantitative lesion characterization



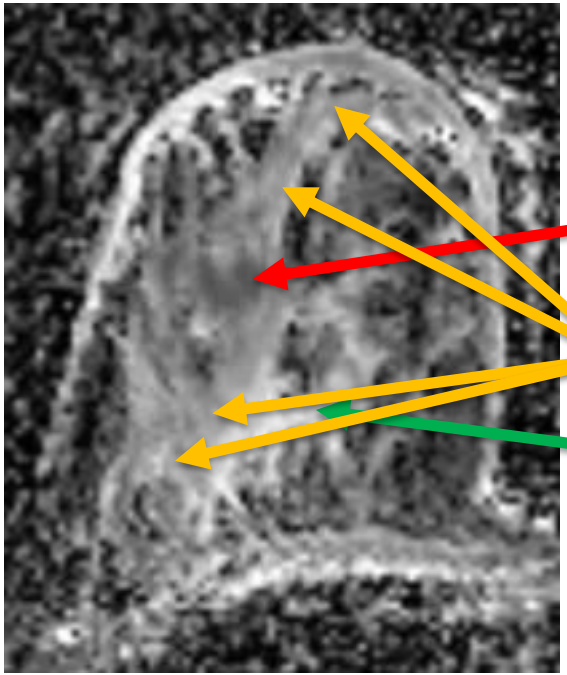


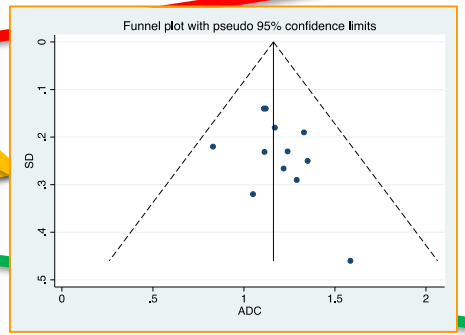




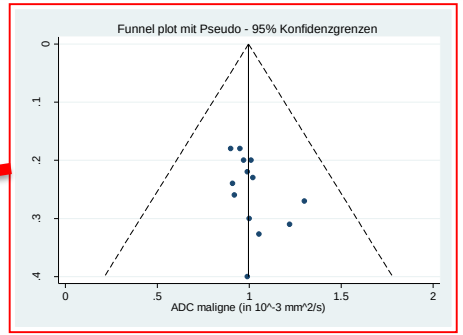
Breast DWI standardization

Clinical applications: quantitative lesion phenotyping

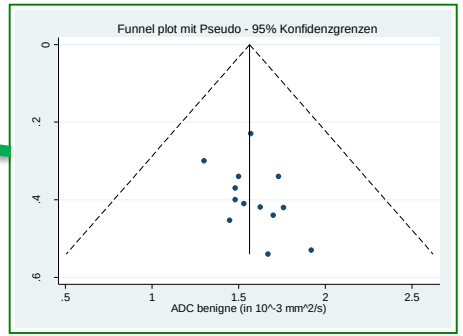




DCIS (intermediate ADC)



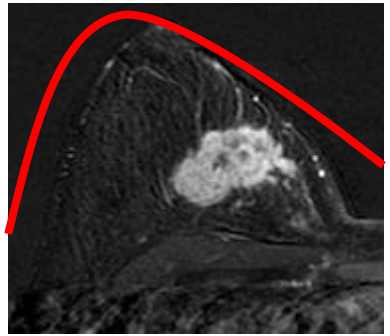
Invasive cancer (low ADC)



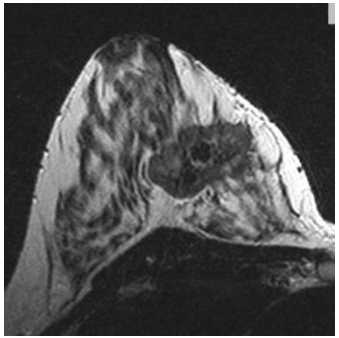
Benign (high ADC)

Breast DWI standardization

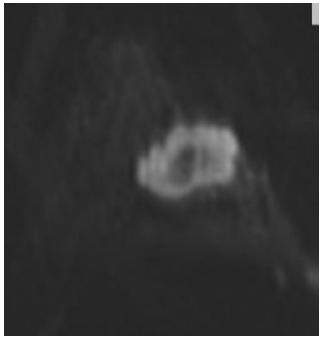
Clinical applications: response monitoring, unenhanced protocols



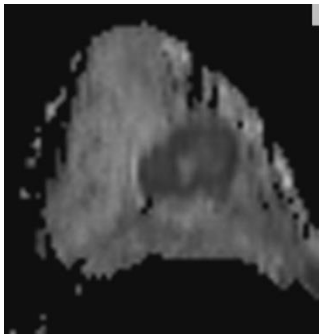
DCE



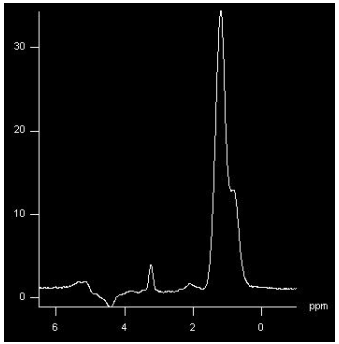
T2w



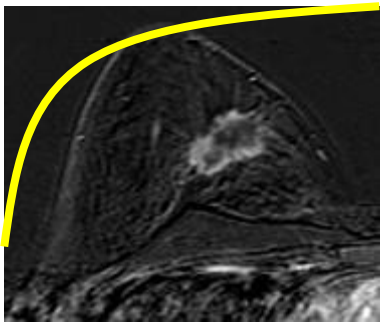
DWI

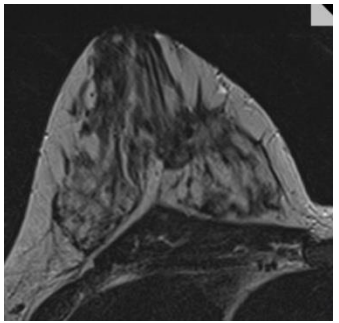


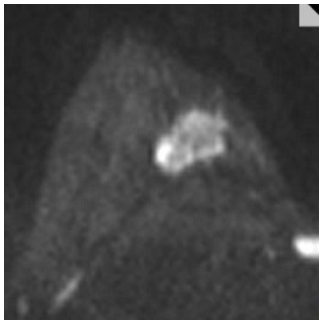
ADC

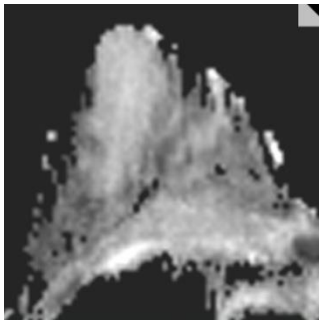


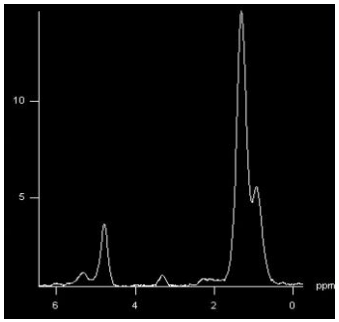
MRS





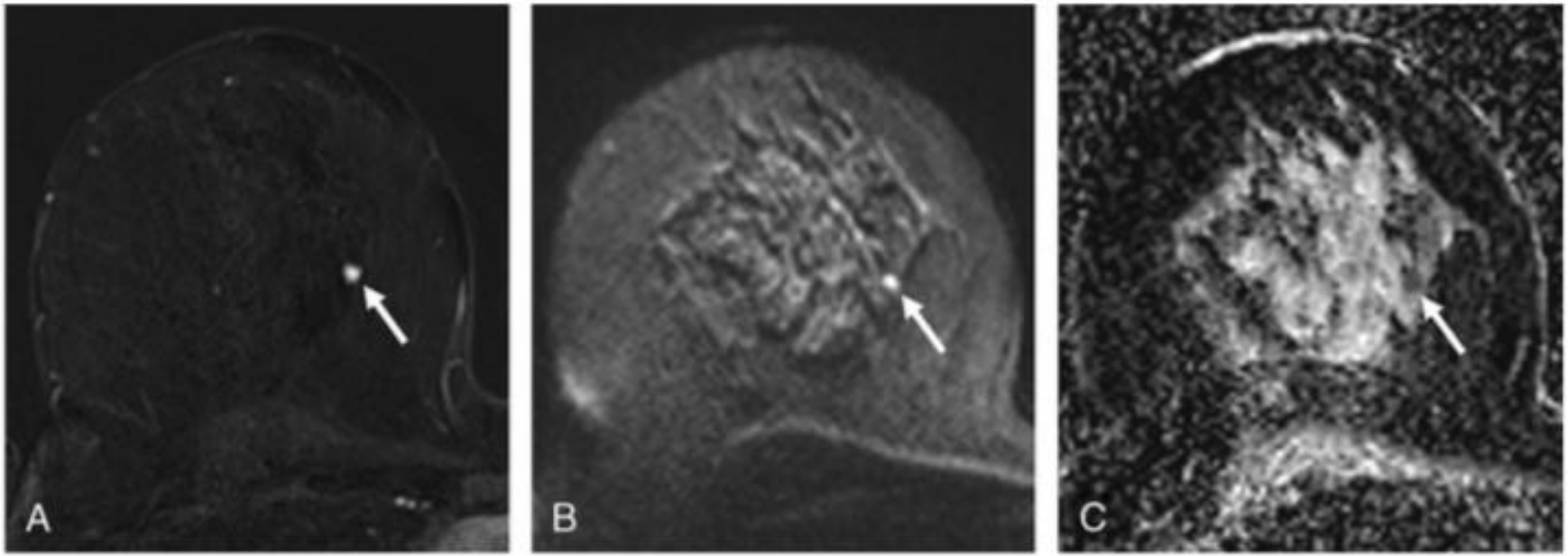






Breast DWI standardization

Clinical applications: what about small lesions?



Baltzer et al. 2018 Invest Radiol

Breast DWI standardization

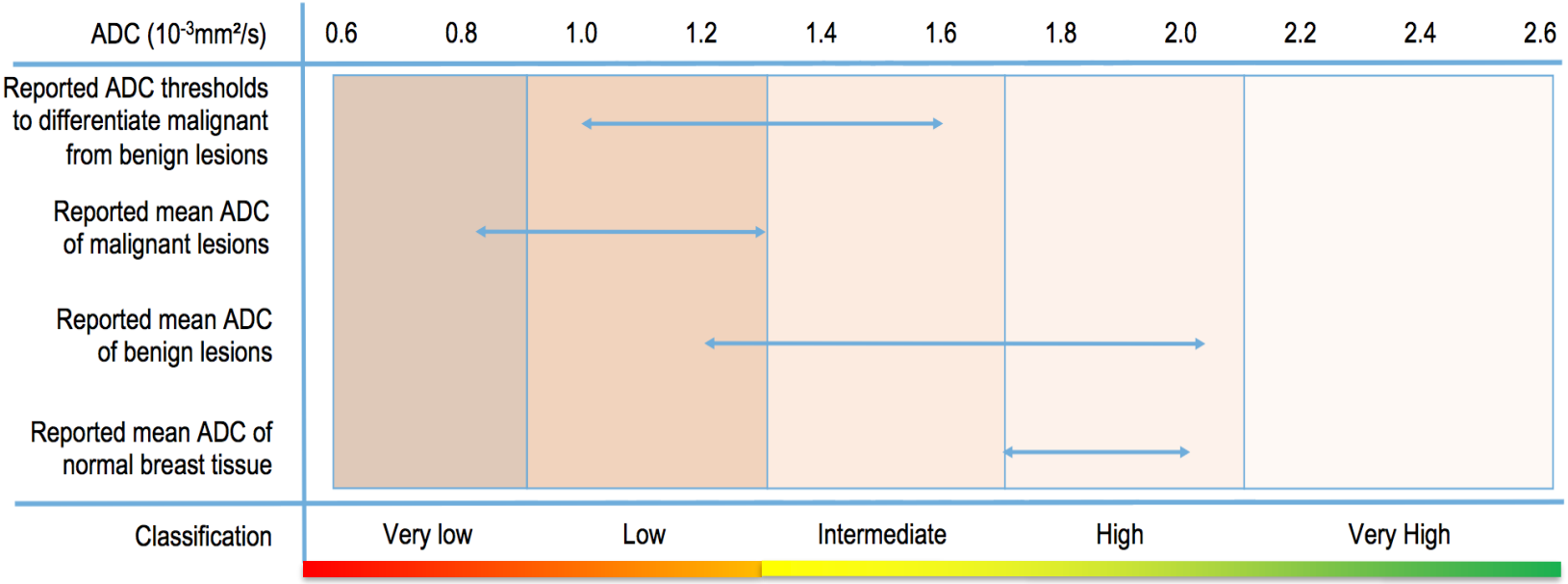
Breast: BI-RADS

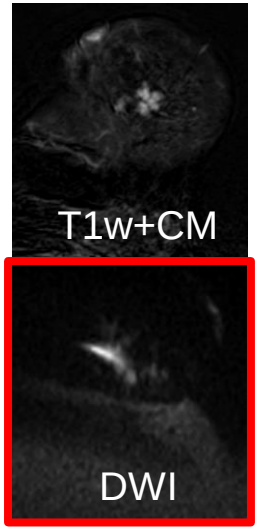
DWI?
Not considered!

Breast DWI standardization

Levels of Diffusion Restriction

- Issue: perceived heterogeneity of ADC ranges and thresholds





*: courtesy of Mami Iima 2018, International DWI working group, data taken from Shi et al. 2018

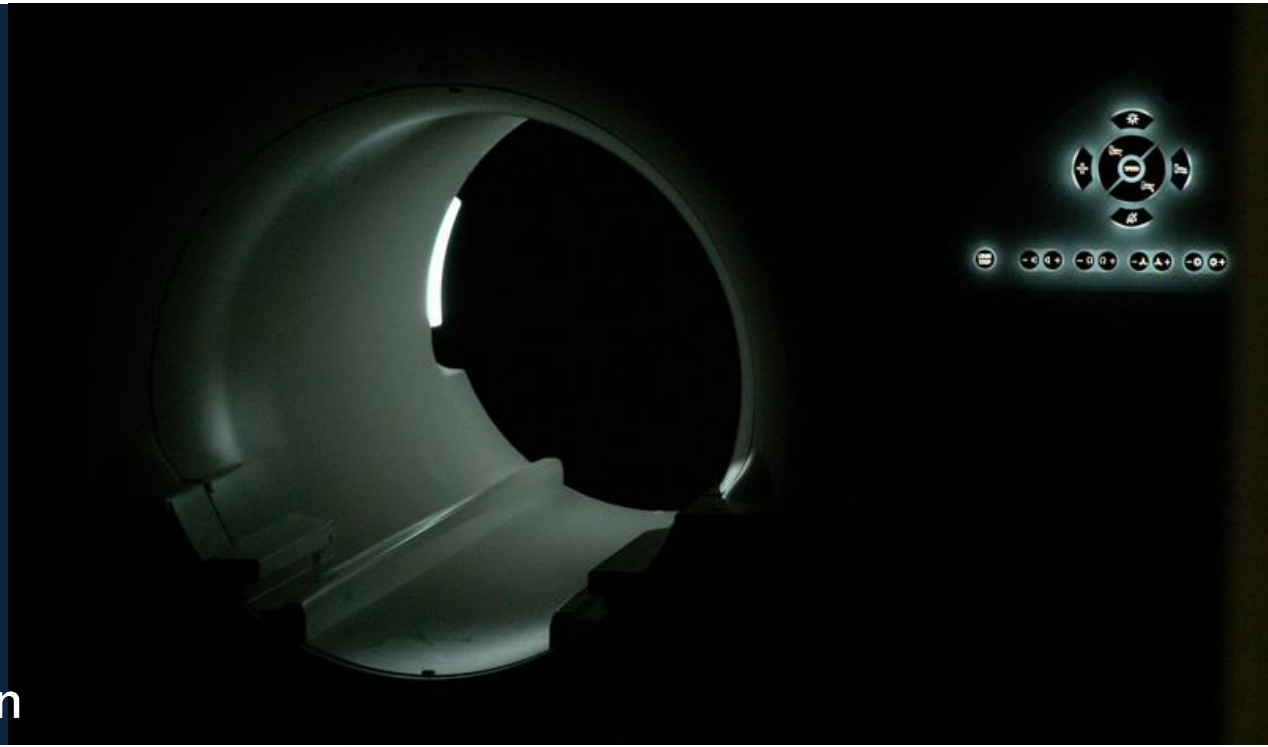
Breast DWI standardization

The EUSOBI international DWI working group „DWI club“

- Initiative by Julia Camps-Herrero and Denis LeBihan
- Aims: clinical implementation, standardization and development of DWI markers
- Current status: consensus/mission statement paper, subgroup formation

Diffusion-Weighted Imaging of the breast – A consensus and mission statement from the EUSOBI International Breast Diffusion-Weighted Imaging working group

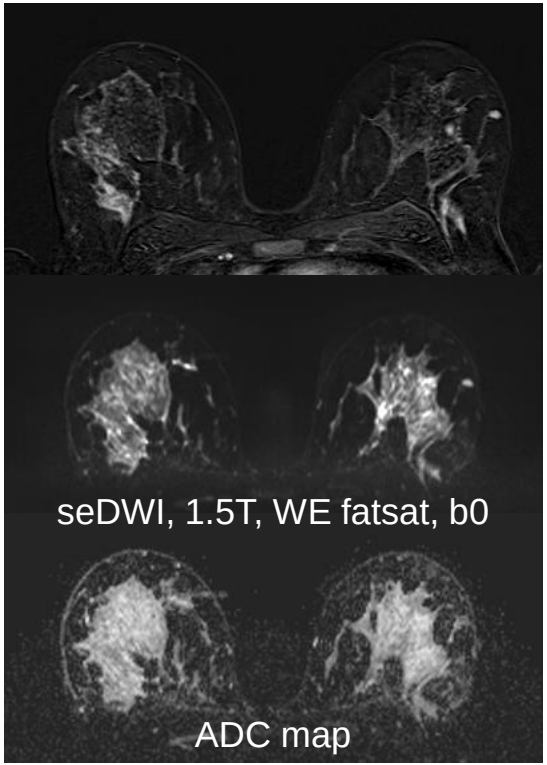
Breast DWI standardization

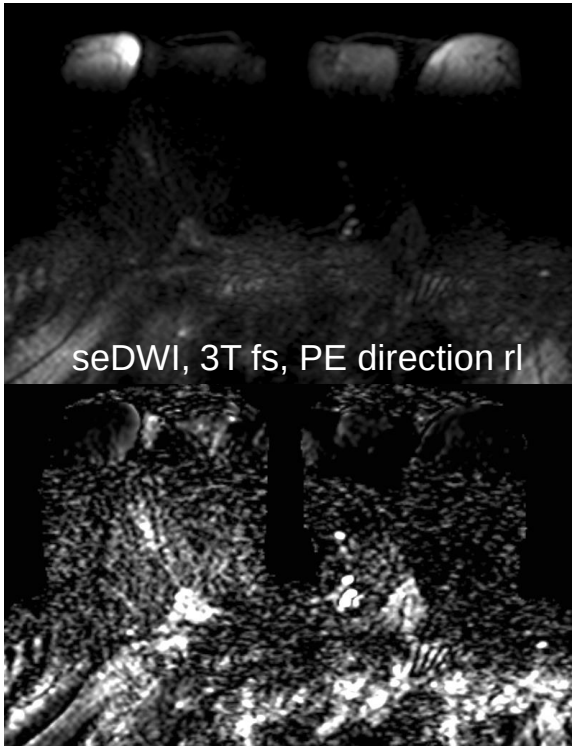


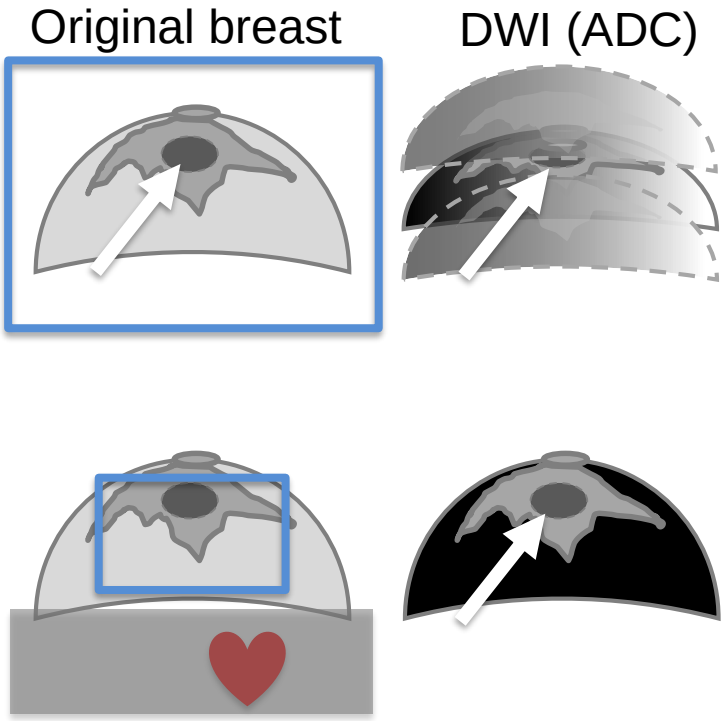
Issues in image acquisition

Breast DWI standardization

Image quality and artifacts



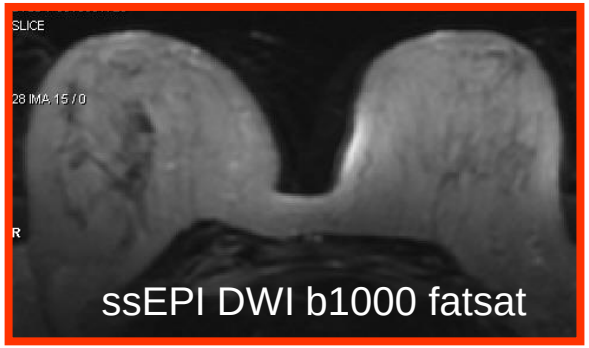


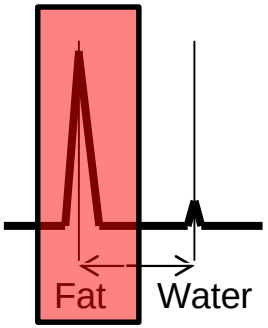


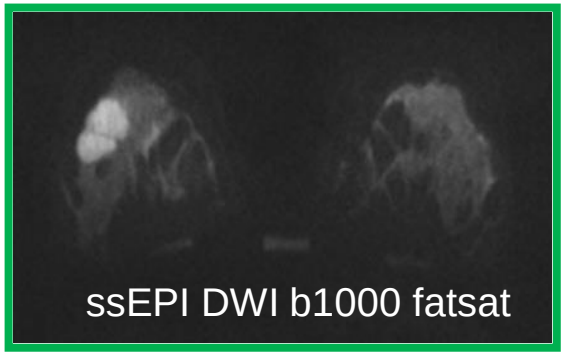
Breast DWI standardization

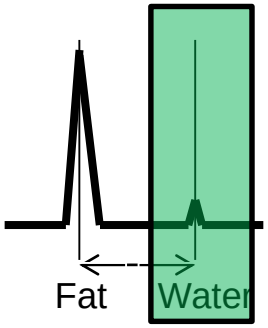
Fat suppression issues

- Insufficient fat saturation = non-diagnostic images
- Solution: manual water referencing



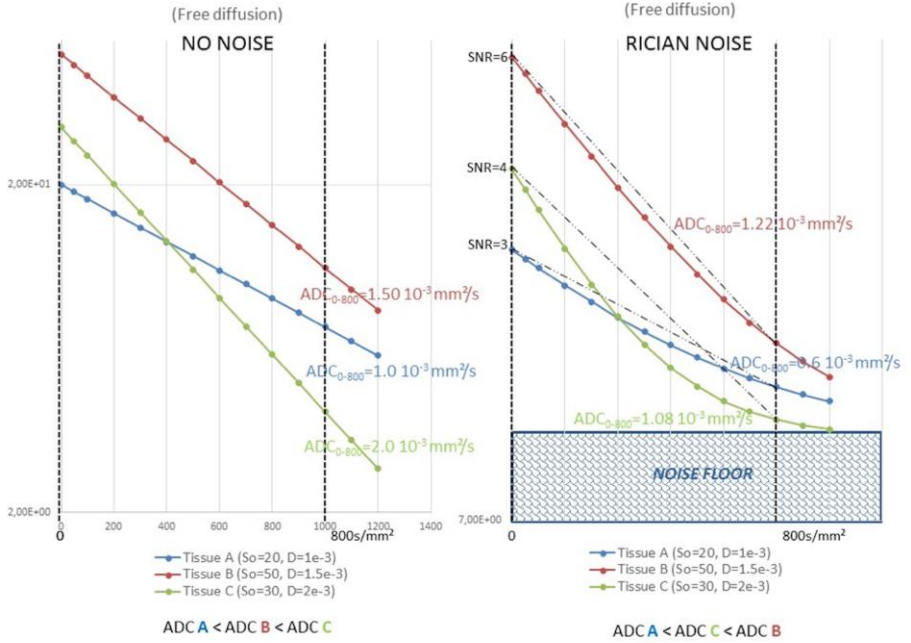


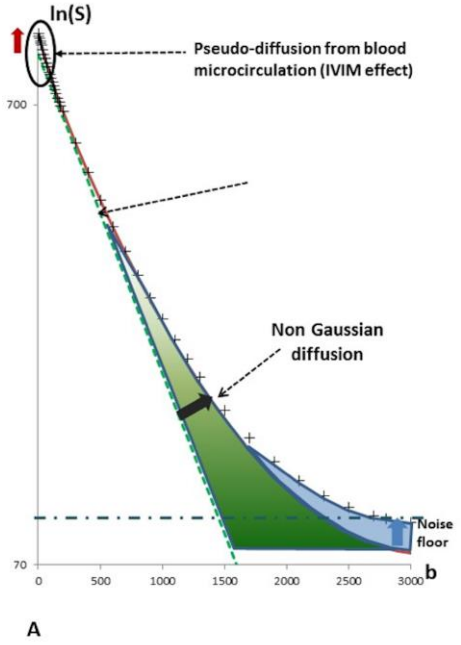


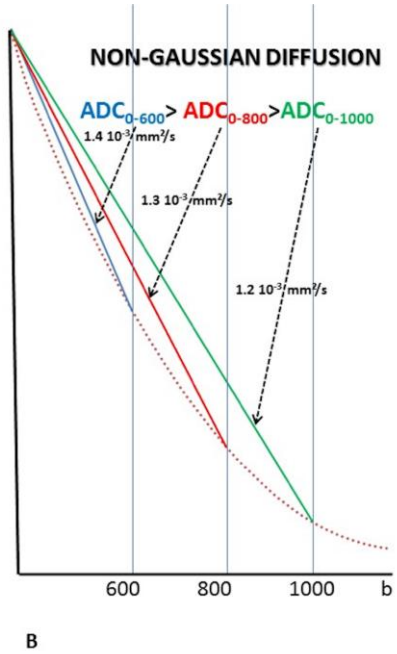


Breast DWI standardization

Choice of b-values



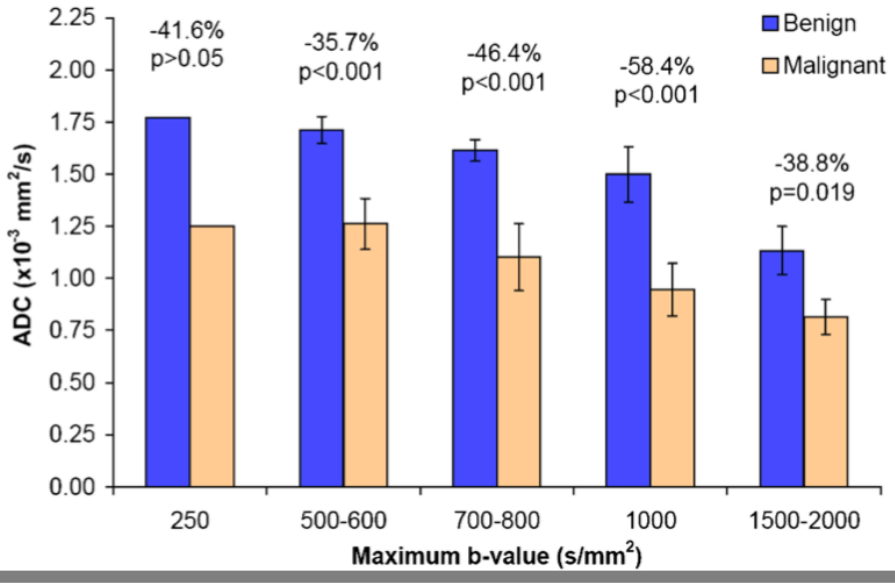


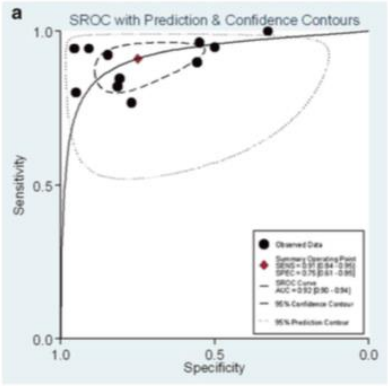


*: courtesy of Denis Le Bihan 2018, International DWI working group

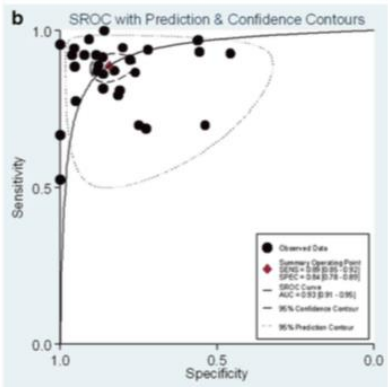
Breast DWI standardization

Choice of b-values





Highest b-value
≤ 600 s/mm



Highest b-value
> 600 s/mm

More relevant regarding standardization (thresholds!) than diagnostic performance!

Dorrius et al. 2014

Breast DWI standardization

Basic DWI protocol considerations

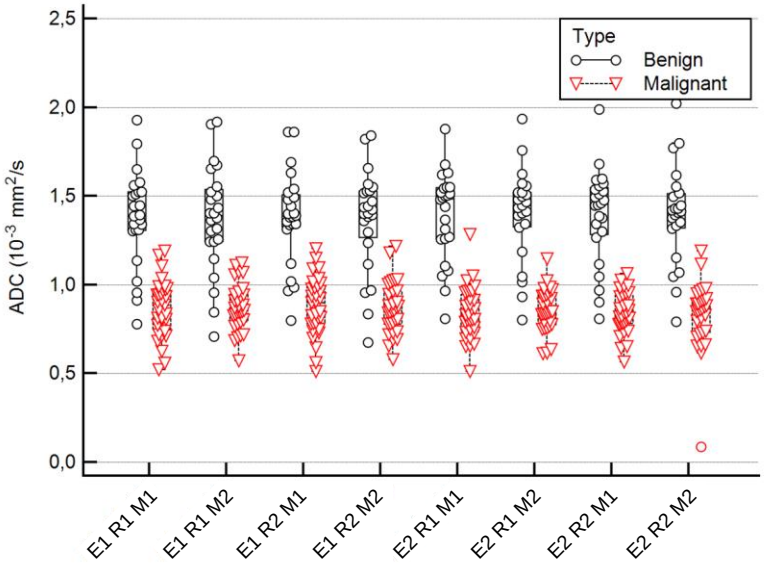
- *Choice of 2 b-values, one low (0 vs 50 s/mm^2), one high: 800 s/mm^2
- *Optional higher b-values ≥1200 s/mm^2 adapted to system SNR
- Choice of fat saturation critical (SNR & artifacts: WE > FS > SPAIR > STIR)
- *SPAIR preferred fat saturation
- Phase encoding direction a.-p., restrict FOV, +/- saturation pulses

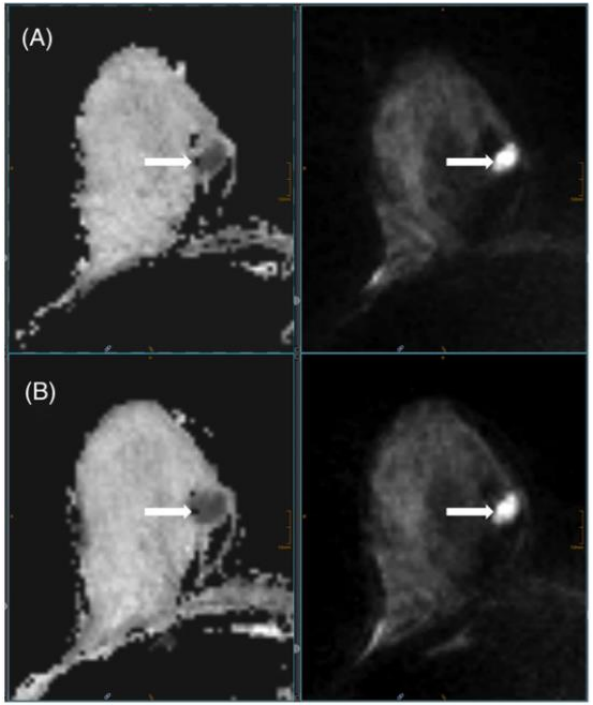
*: Preliminary consensus of the Berlin 2017 breast DWI club meeting

Breast DWI standardization

Reproducibility and repeatability

- Repeated measurements yield similar results!

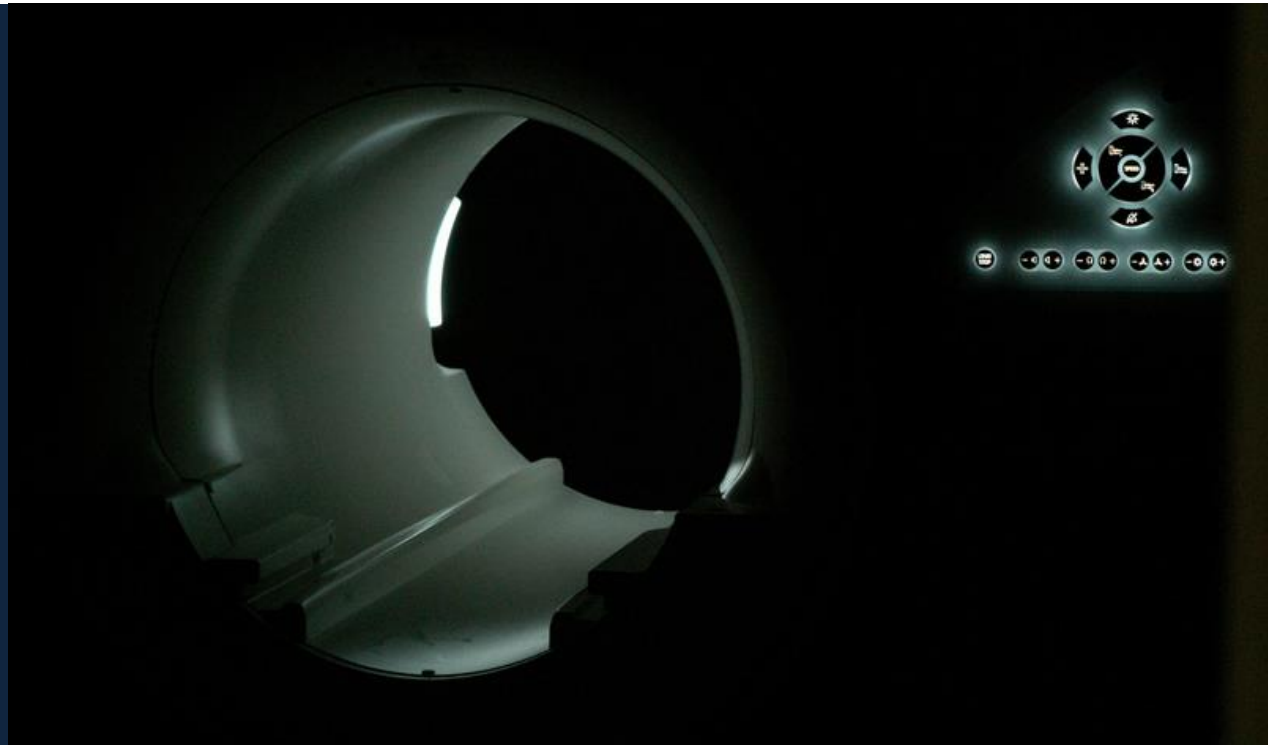




Spick et al. 2016 NMR Biomed

Breast DWI standardization

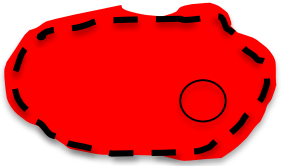
Issues in image analysis

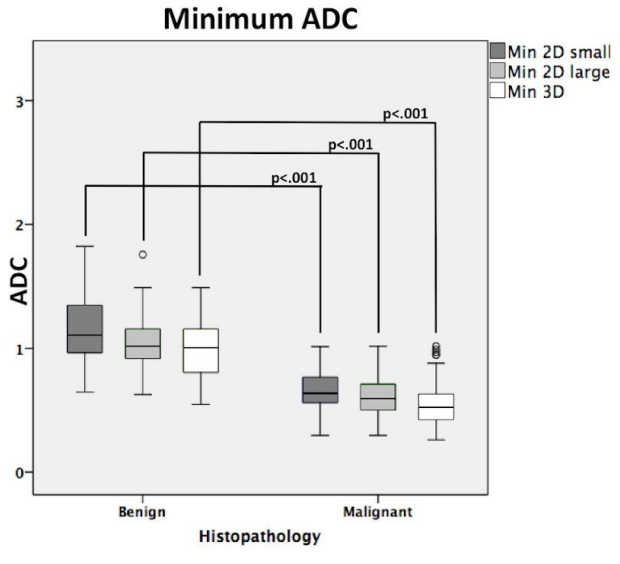


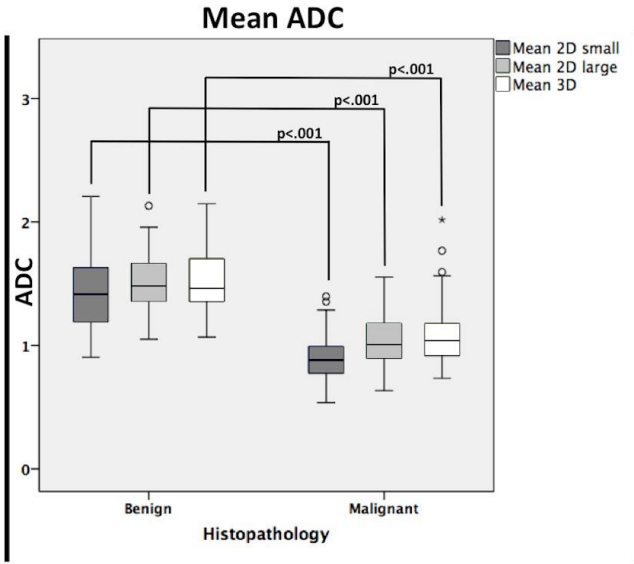
Breast DWI standardization

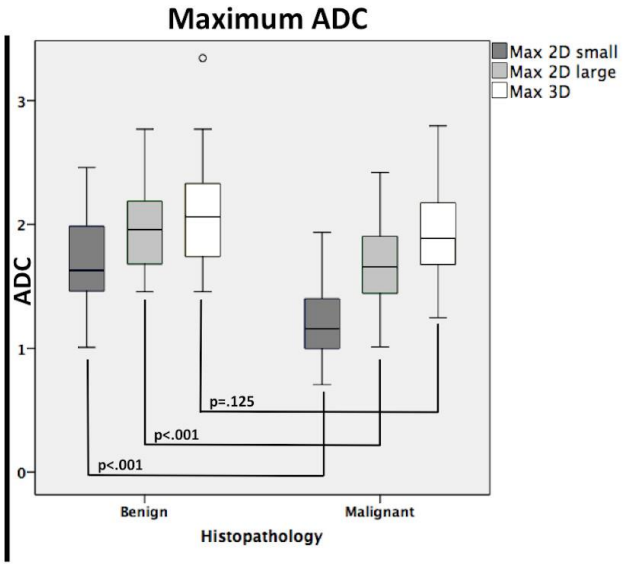
ROI placement and ADC readout

- Placement: whole lesion vs small ROI
- Target value: mean, minimum or maximum?







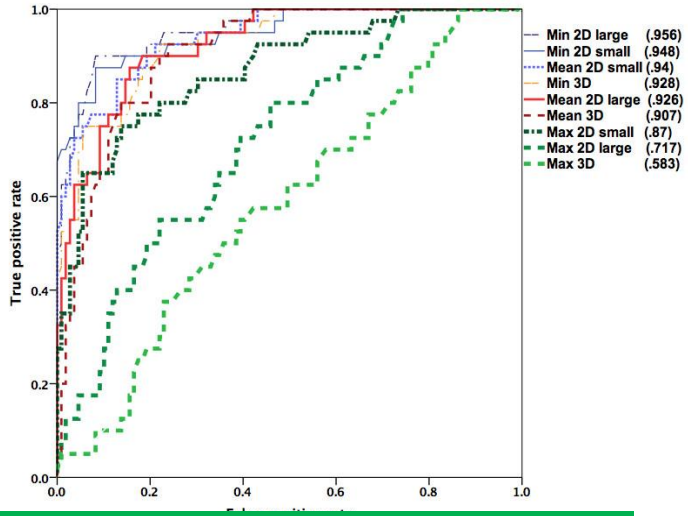


Bickel et al. Eur Radiol 2017

Breast DWI standardization

The influence of ROI placement and readout

- ROI placement has significant influence on measured ADC
- ADC mean&min preferable
- ROI types diagnostically similar
- Important: Thresholds differ!

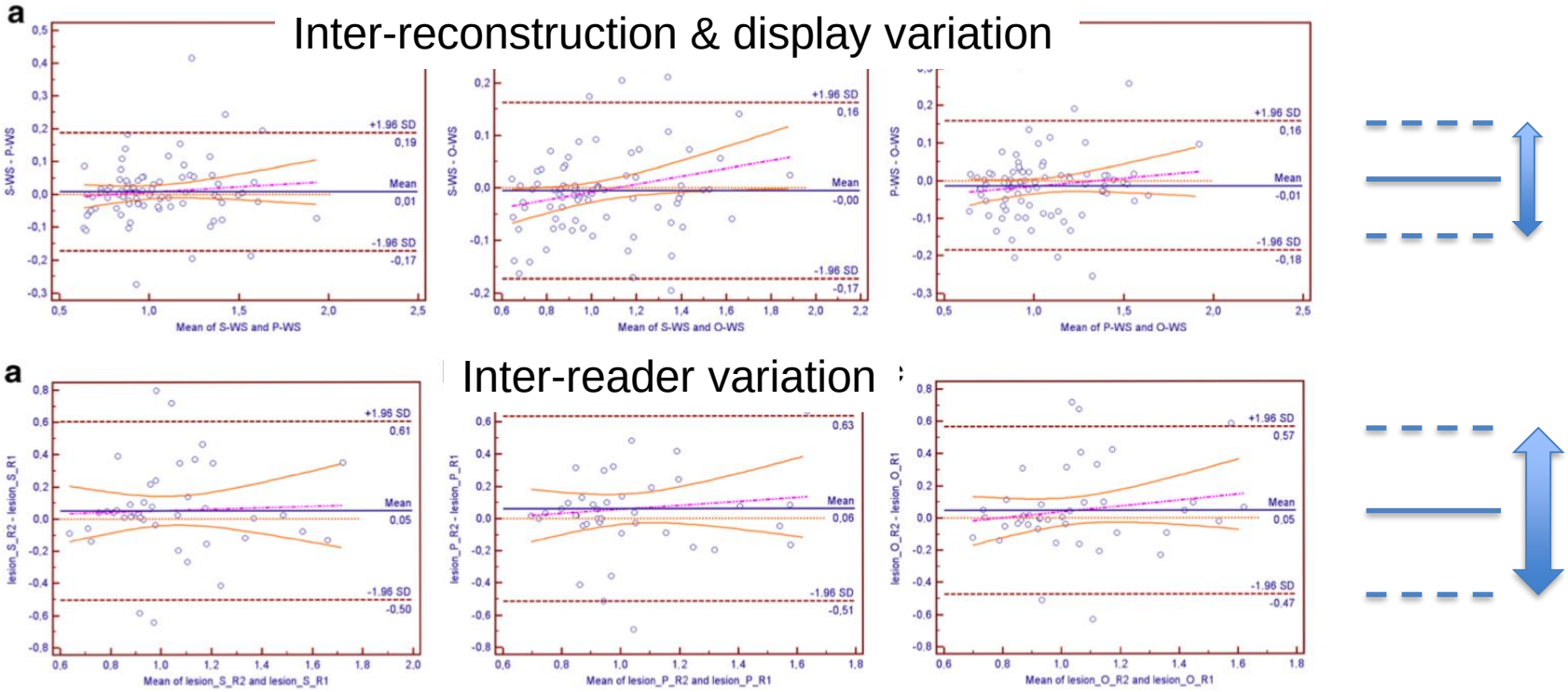


Current standard: mean ROI in the vital part of the tumor

Bickel et al. Eur Radiol 2017, Breast DWI WG consensus and mission statement 2019, under review

Breast DWI standardization

Influence of ADC reconstruction & display vs. Reader variation

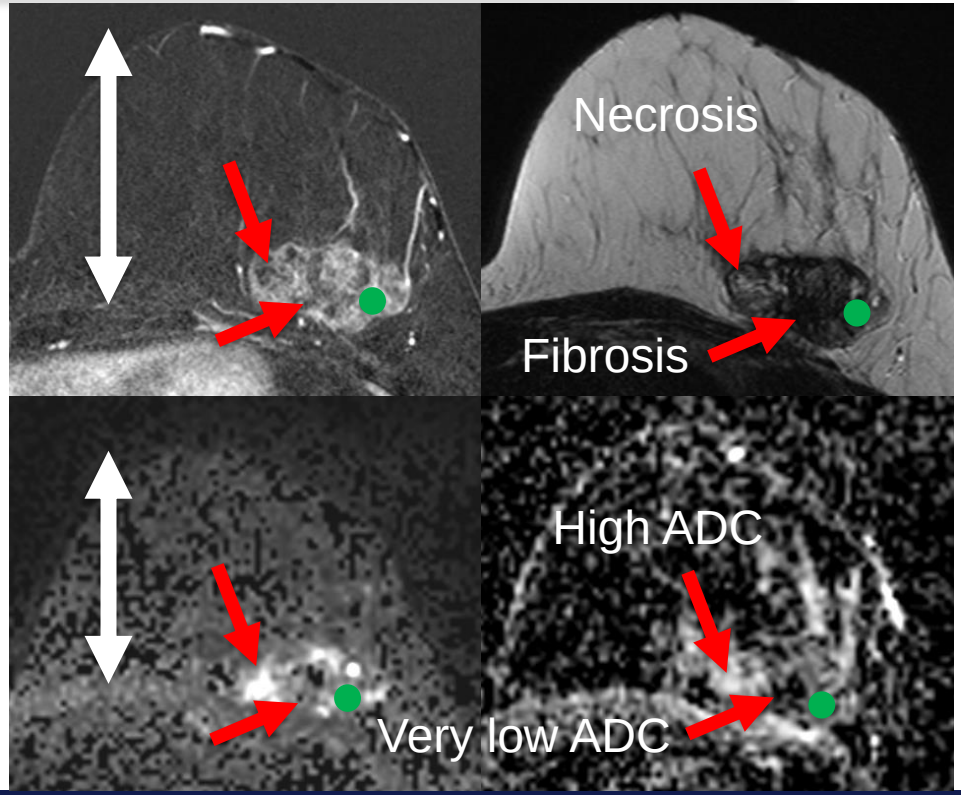


Clauser et al. Eur Radiol 2016

Breast DWI standardization

How I do it: ADC measurement

- Visual inspection
- Geometric distortion!
- Lesion heterogeneity
- ADC of vital tissue
- ROI analogue to DCE curve ROI



Breast DWI standardization

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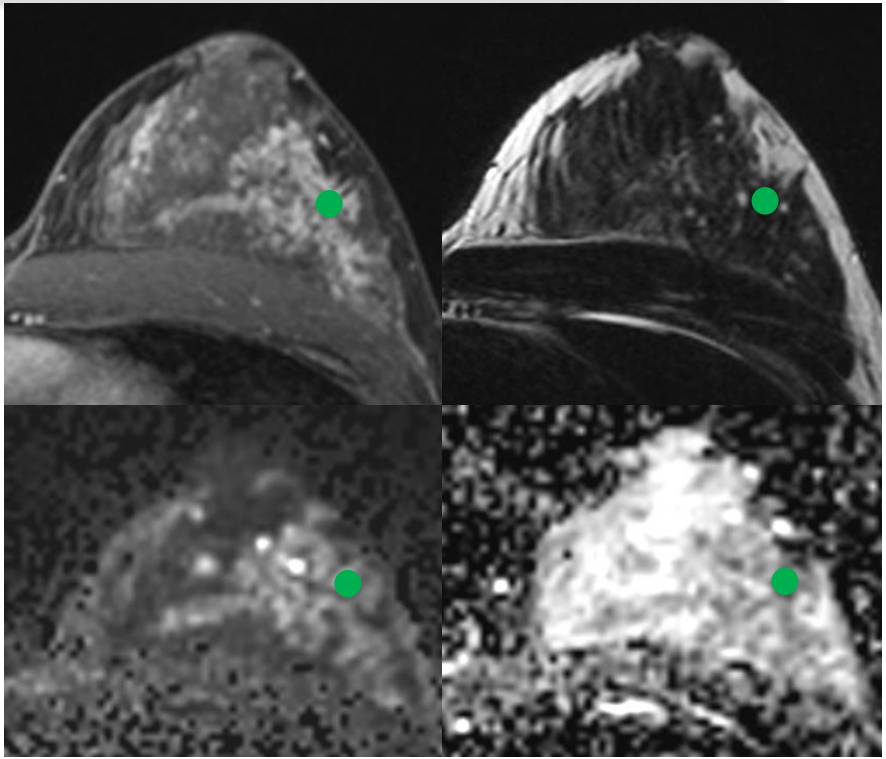
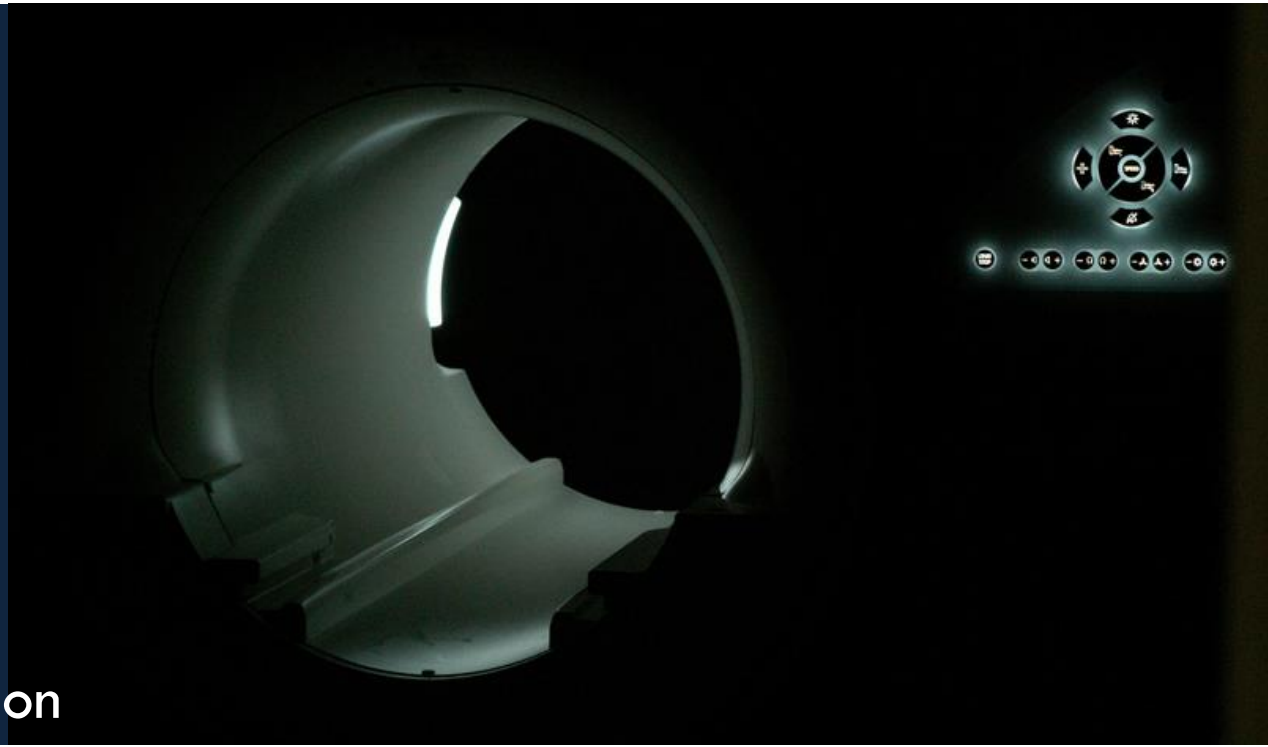


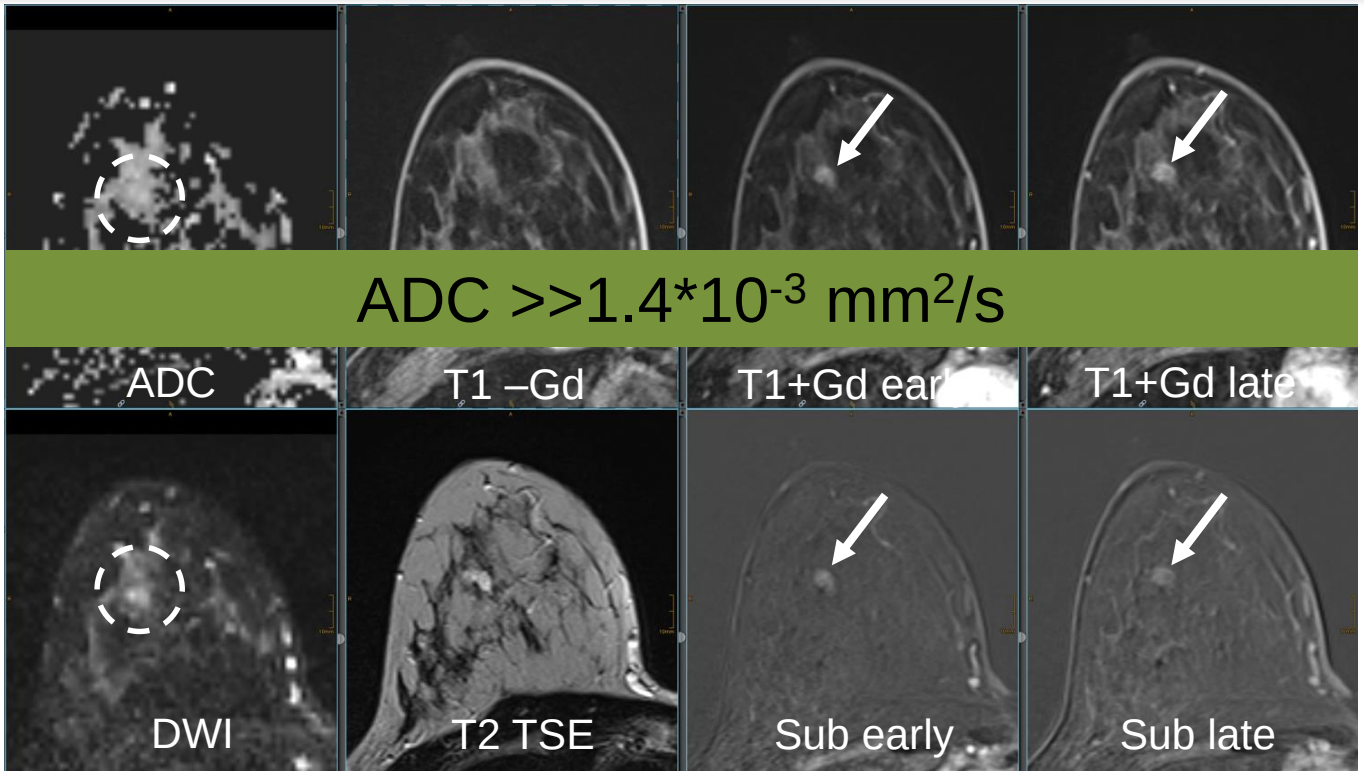
Breast DWI standardization



Issues in ADC interpretation

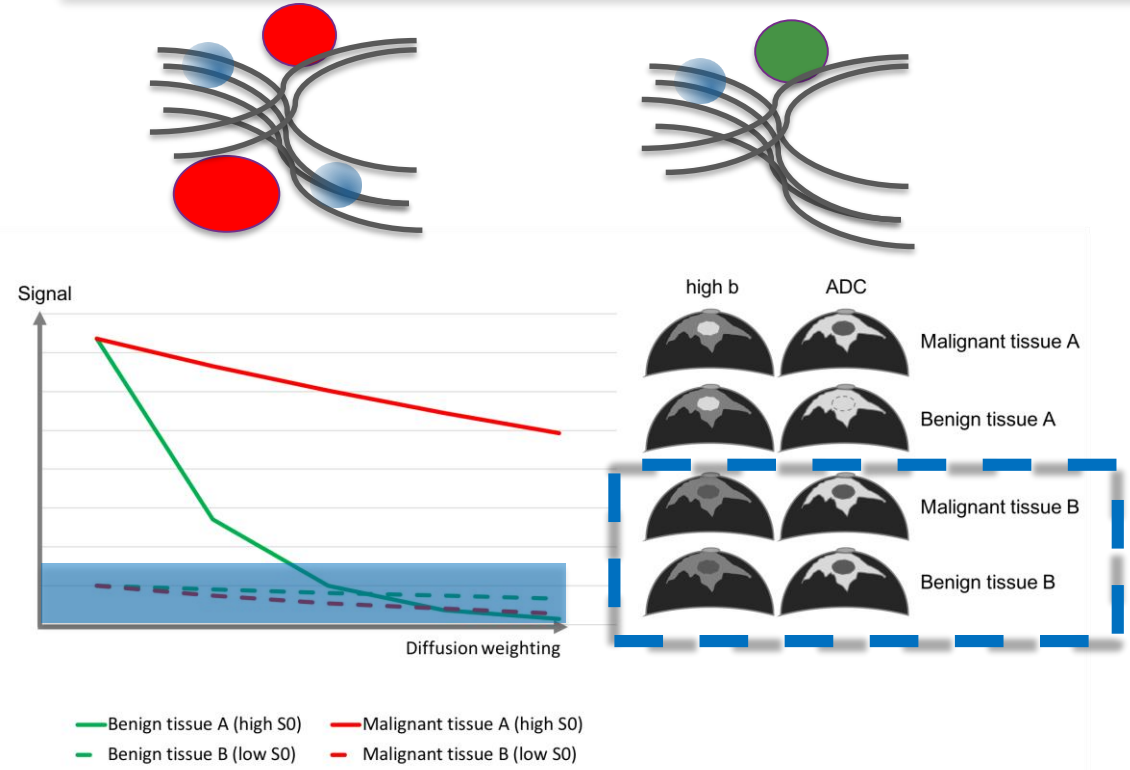
Breast DWI standardization

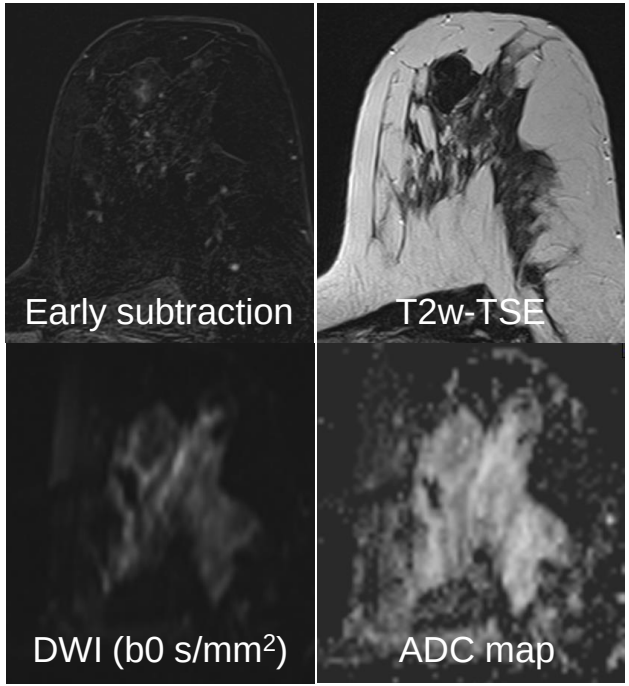
Clinical applications: downgrading BI-RADS 4 lesions using the ADC



Breast DWI standardization

Pitfall: low b0 signal conditions and T2-Blackout

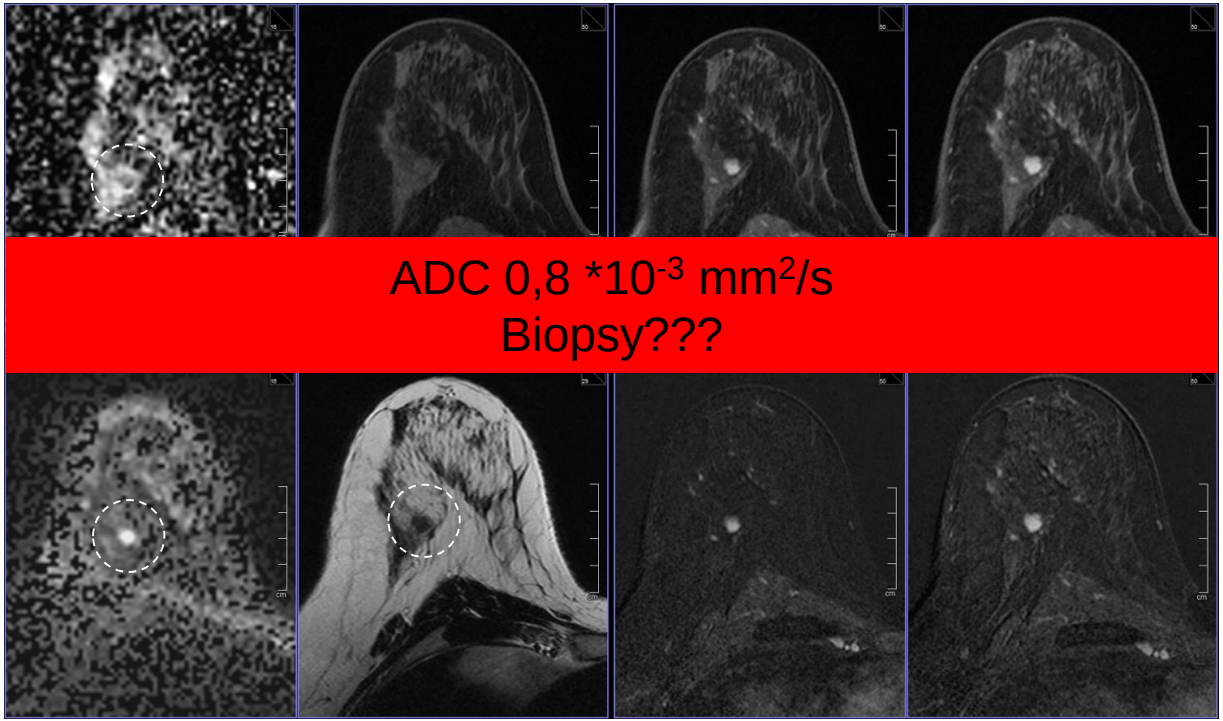


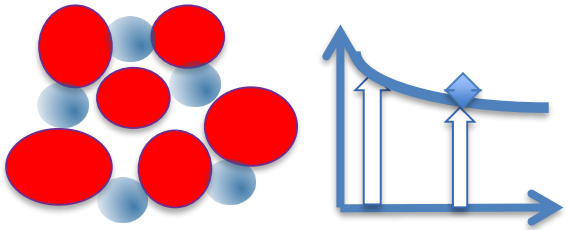


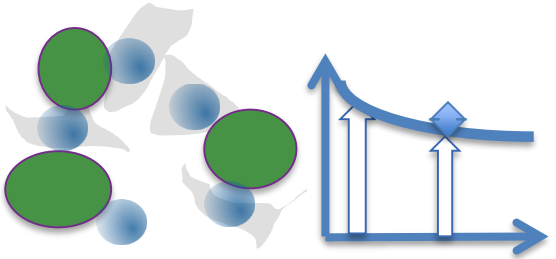
Breast DWI working group consensus and mission statement, Eur Radiol under review 2019

Breast DWI standardization

Pitfall: diffusion hindrance in benign lesions

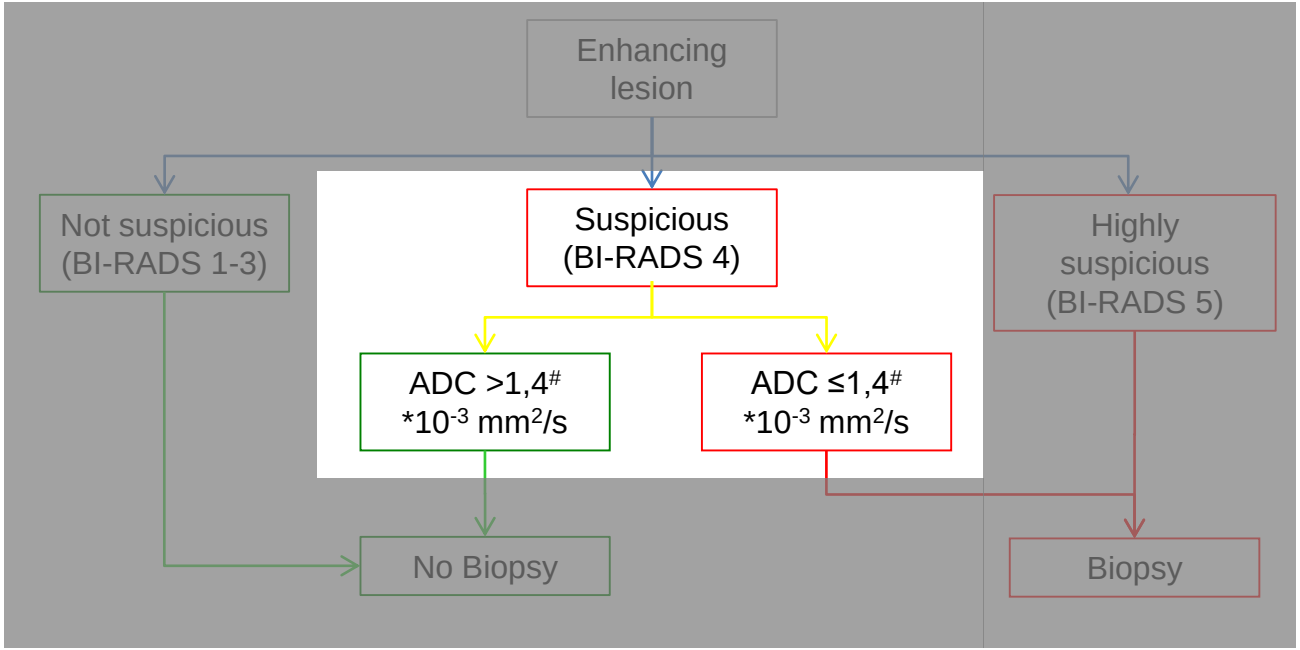






Breast DWI standardization

Clinical decision making using the ADC



- ≥10% increase in specificity without FN results

Baltzer et al., 2016, Pinker et al. 2013, Partridge et al. 2009, Woodhams et al. 2005

#: note that ADC thresholds may vary

Breast DWI standardization

Summary and conclusion

- DWI can identify and characterize breast lesions
- ADC is rather robust if acquisition conditions are kept constant
- ADC confounders influence thresholds (and less diagnostic accuracy)
- Lots of standardization issues: EUSOBI breast DWI working group
- **ADC is only one diagnostic marker – clinical decisions require thought**

Questions?

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