

BREAST MRI: BASES AND CASES



21 SETTEMBRE 2018
SEGRATE (MI)
HOTEL NH MILANO 2
via Fratelli Cervi
SEGRATE (MI)

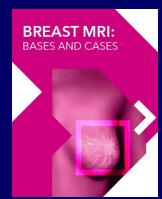
SEQUENZE E DIFFUSIONE



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Università Vita-Salute San Raffaele
IRCCS Ospedale San Raffaele, Milano*





Tecnica e Metodologia



Requisiti tecnici

Alto Campo Magnetico (1, 1.5 e 3 Tesla)

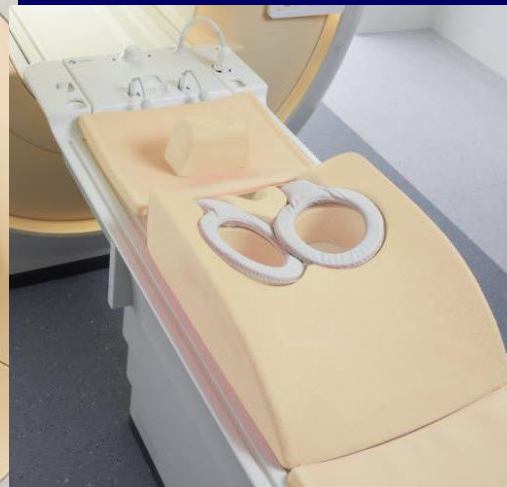
Gradienti performanti

Bobina multicanale dedicata

Mdc paramagnetici

Software dedicato

Esperienza (multidisciplinare?)

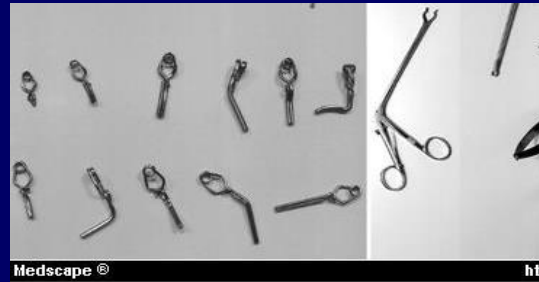
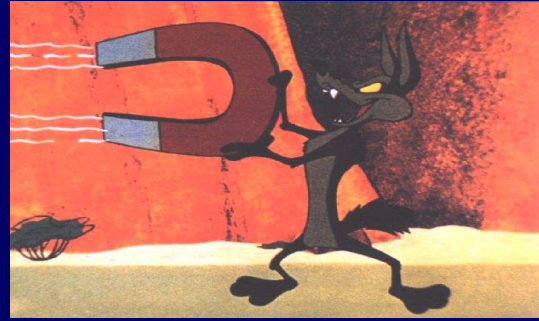


Controindicazioni

-ICD



-clips aneurismi intracranici



-Insufficienza renale grave (rischio Fibrosi Nefrogenica Sistemica)?

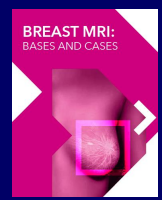
-NEW TOPIC: accumulo Gd nuclei della base (per esami ripetuti)



Controindicazioni



- Gravidanza (no studi controllati su mdc; RM fetale OK)*
- Espansore mammario (rischio di deposizionamento/surriscaldamento)*
- Claustrofobia/Ansia/Obesità severa*
- Pz non compliant (necessaria immobilità)*



Tecnica e Metodologia

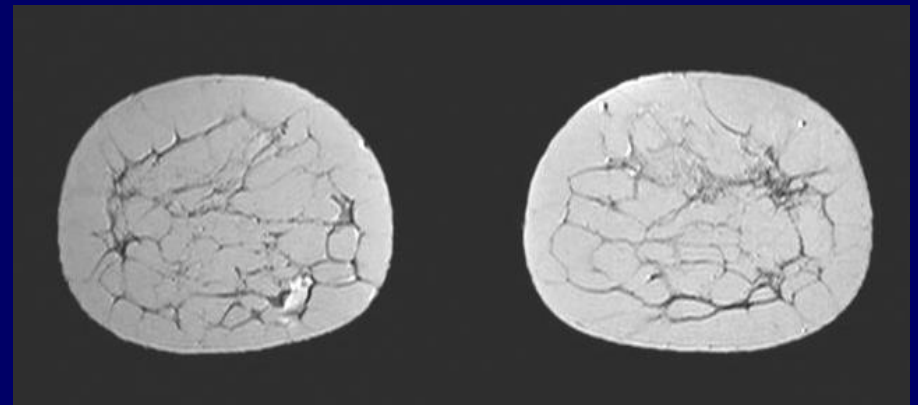
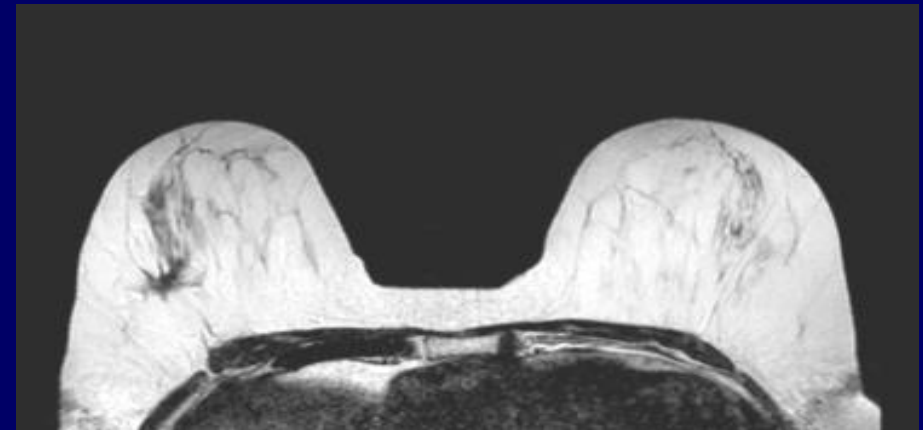


- Mettere la paziente a proprio agio
- Anamnesi ed esame ispettivo (stato ormonale, ev MX ed ECO)
- Spiegazione dell' esame e delle sue implicazioni (durata, immobilità, iniezione mdc, vantaggi e svantaggi)
- Buon accesso venoso (es: controlaterale se ascella operata)
- Corretto posizionamento sul lettino
- Ruolo di TSRM e infermiere



Sequenze

T2 Turbo Spin Echo pre-contrasto (differenziazione tissutale, dettaglio anatomico)



Il grasso è utile!

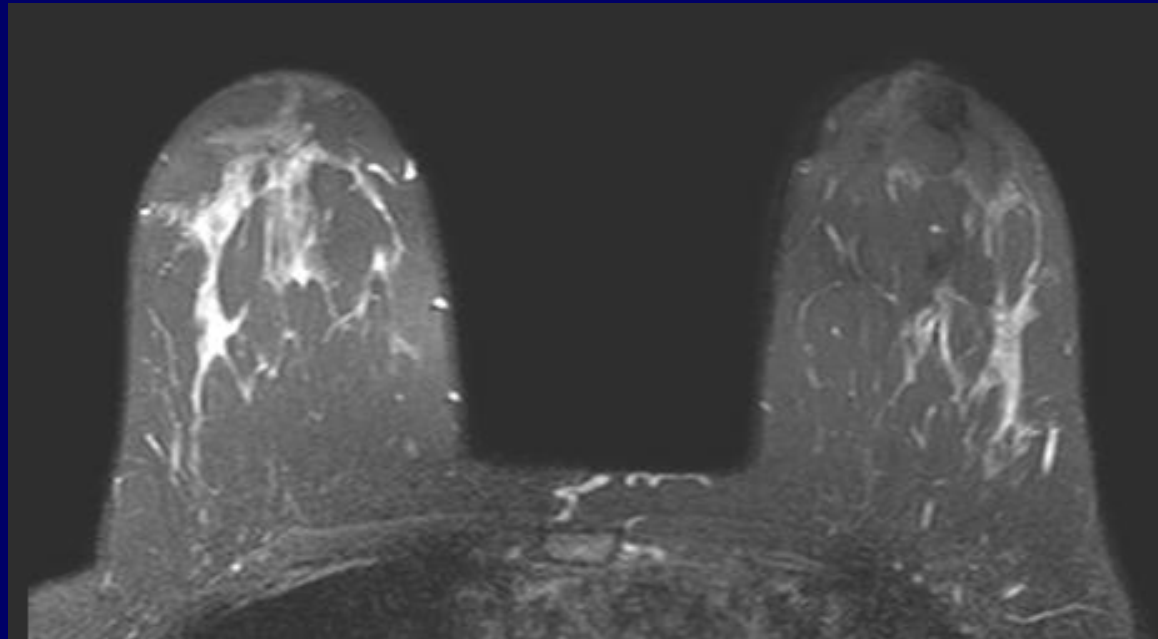


Tecnica e Metodologia



Sequenze

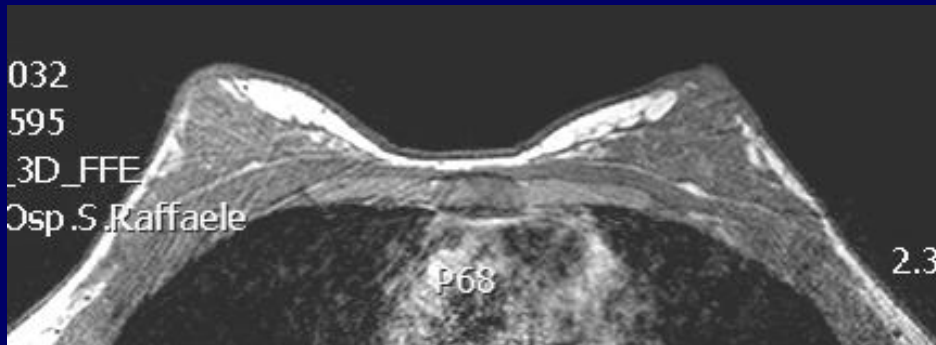
T2 con soppressione del grasso –STIR- (liquidi e lesioni)



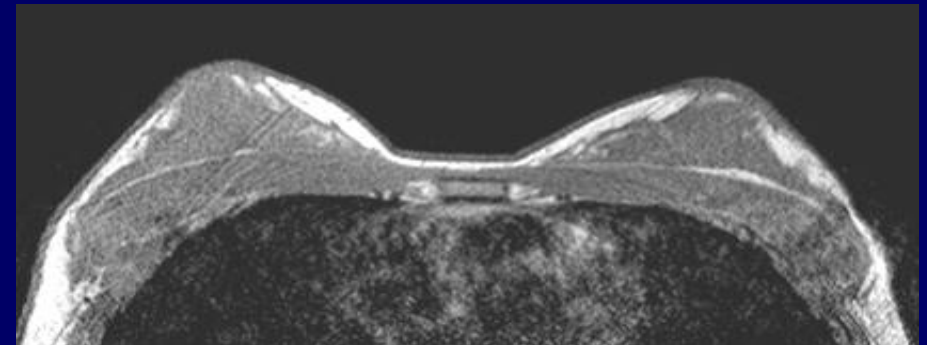
Sequenze: studio dinamico

T1-3D Gradient Echo pre e post-contrasto

(1 acquisizione basale e 5 post-contrasto)



2D

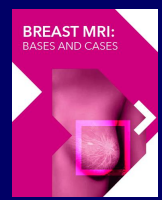


vs

3D

2D: > risoluzione di contrasto T1, < artefatti da movimento

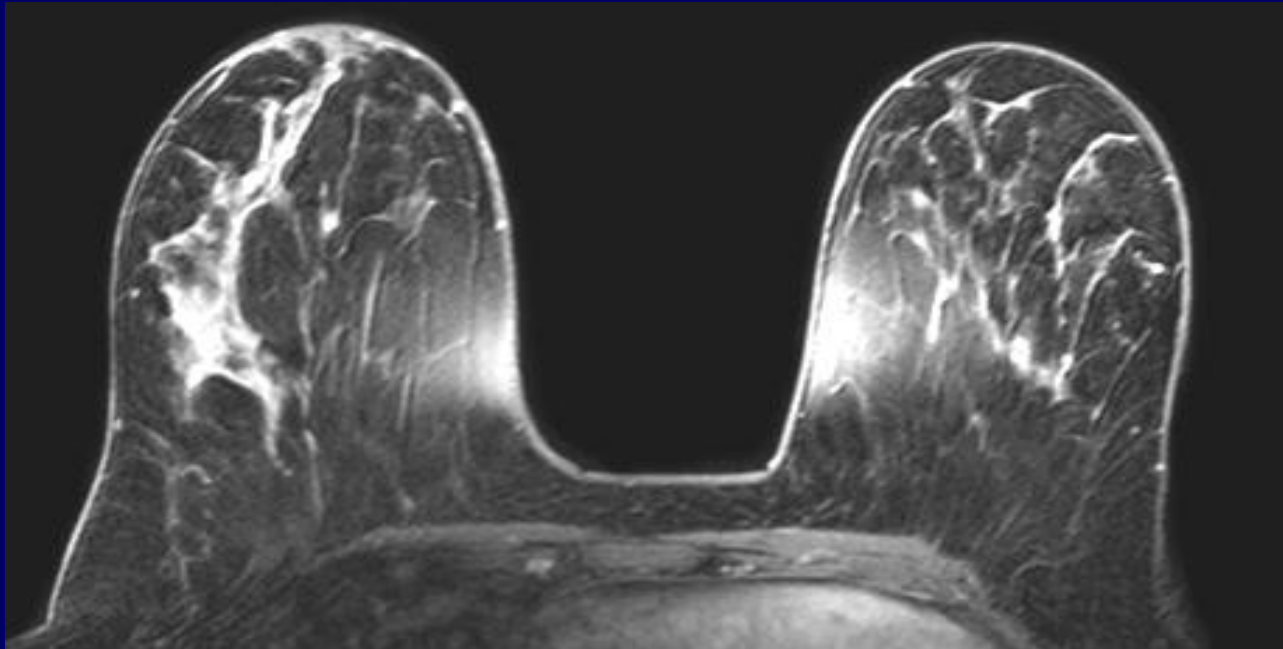
3D: possibilità di ricostruire su tutti i piani dello spazio (voxel isotropico)



Tecnica e Metodologia



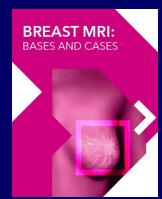
Sequenze: studio dinamico



T1 Fat Sat

Attenzione ad artefatti dovuti alla soppressione del grasso (inomogeneità, chemical shift) !!!

Possono “sporcare” le immagini in sottrazione



Importanza tecniche di soppressione del grasso

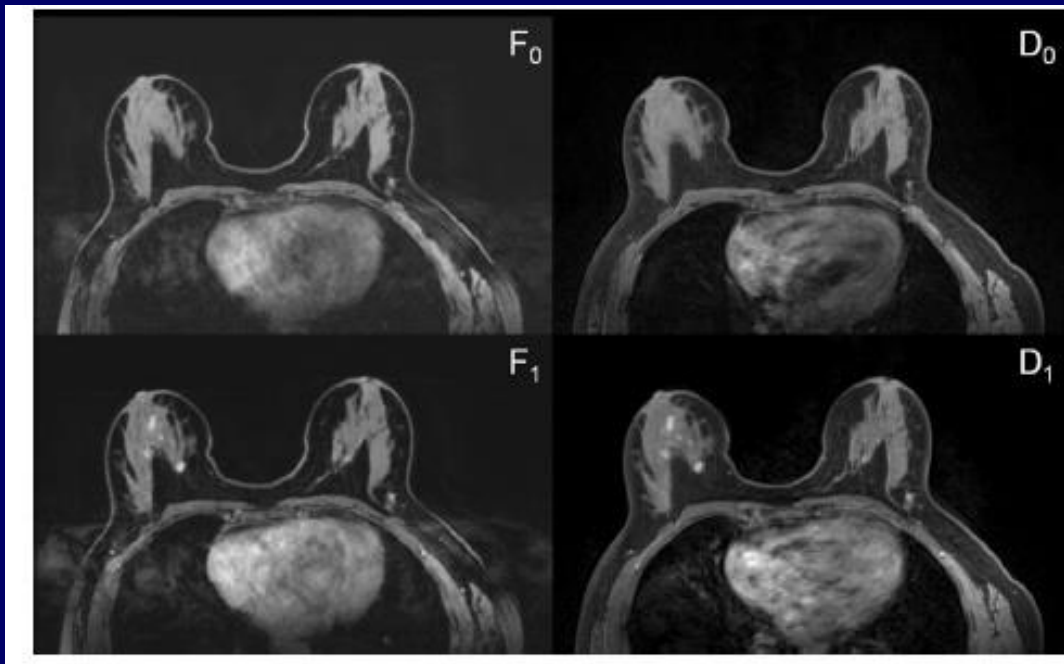


Eur Radiol (2014) 24:2213–2219
DOI 10.1007/s00330-014-3189-7

BREAST

Fat saturation in dynamic breast MRI at 3 Tesla: is the Dixon technique superior to spectral fat saturation? A visual grading characteristics study

P. Clauser • K. Pinker • T. H. Helbich • P. Kapetas •
M. Bernathova • P. A. T. Baltzer



< artefatti su asse codifica di fase

> Qualità di immagine

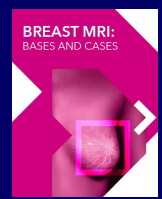


Tabella I - Sequenze per il sospetto di patologia oncologica (Esempio di sequenze con apparecchiatura Philips)				
sequenze (Philips)	TSE T2-W	3D TFE T1-W studio dinamico con soppressione del tessuto adiposo (Dixon)	3D FFE T1-W studio dinamico	DWIBS EPI-IR
FOV				
RL (mm)	339	330	300	356
AP(mm)	280	330	320	320
Dimensione voxel (acquisizione)				
RL (mm)	0.9	0.83	0.81	3
AP (mm)	1	0.83	0.81	3
FH (mm)	2.2	2.2	2.2	3
voxel di ricostruzione				
RL (mm)	0.64	0.49	0.62	1.48
AP (mm)	0.64	0.49	0.62	1.48
FH (mm)	2.2	2.2	2.2	3
spessore di strato (mm)	2.2	2.2	2.2	3
matrice di ricostruzione	528	672	512	240
sense				
P reduction (mm)	4	3.3	2.6	4
S reduction (mm)	/	2	/	/
B value	/	/	/	0-900
EPI factor	/	/	/	37
TFE factor	/	46	/	/
TSE factor	23	/	/	/
TR (ms)	3847	10	9	2224
TE (ms)	120	2.2/4.2	4.6	77
flip angle (°)	90	15	15	
Compensazione del respiro	libero	libero	libero	libero
numero di medie	2	1	1	b 0 → 3 b 900 → 9
numero di dinamiche	/	6	6	/
piano di acquisizione	assiale codifica RL	assiale codifica RL	assiale codifica RL	assiale codifica RL
tempo singola dinamica	/	1' 24"	1' 23"	/
tempo di acquisizione	3' 35"	8' 32"	8' 22"	3' 33"



Protocollo OSR



Protocollo standard OSR

T2 Turbo Spin Echo (non fat-sat)

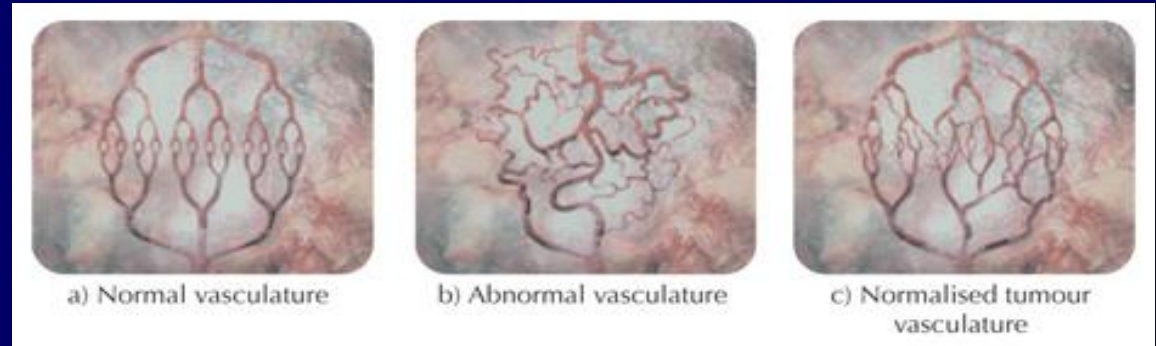
DWI ($b=0, 900$), DWIBS (seni voluminosi o adiposi)

Studio dinamico (3D Fast Field Echo con saturazione del grasso DIXON, 1 pre e 5 post mdc)

Durata totale 15-20' + post-processing

Razionale dello studio dinamico

Neoangiogenesi tumorale

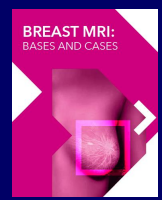


Generazione di nuovi vasi malformati

>Densità vascolare

>Permeabilità endotelio

>Stravasato di mdc

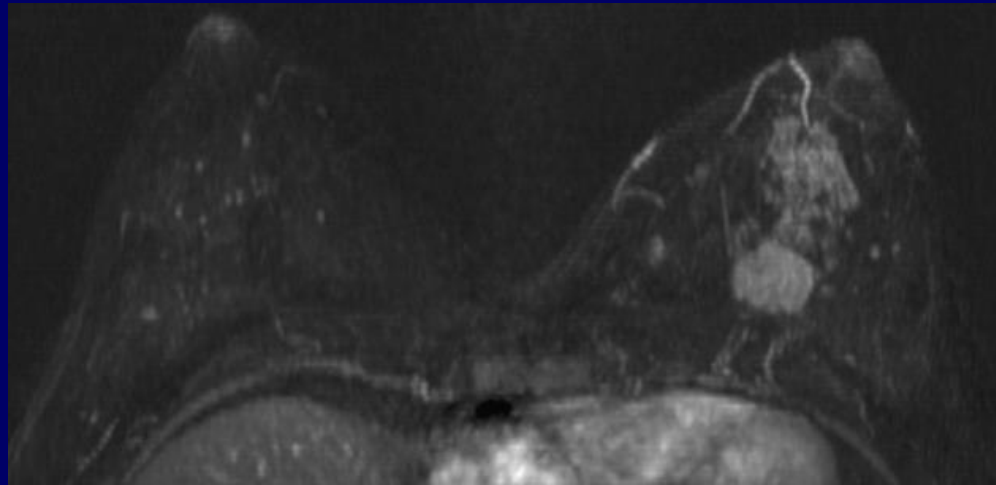


Tecnica e Metodologia

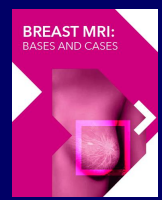


Razionale dello studio dinamico

Visualizzazione carcinoma



- Rapida impregnazione lesione con mdc paramagnetico
 - $< T1$
- Iperintensità di segnale (enhancement o potenziamento)



Tecnica e Metodologia



MEZZO DI CONTRASTO E.V



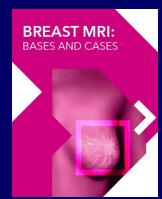
ANGIOGENESI

DIFFERENTI MODALITA' DI IMPREGNAZIONE

DIFFERENTI MODALITA' DI ENHANCEMENT RM



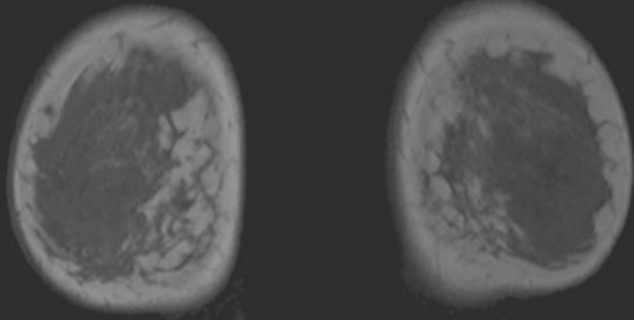
CARATTERIZZAZIONE LESIONE



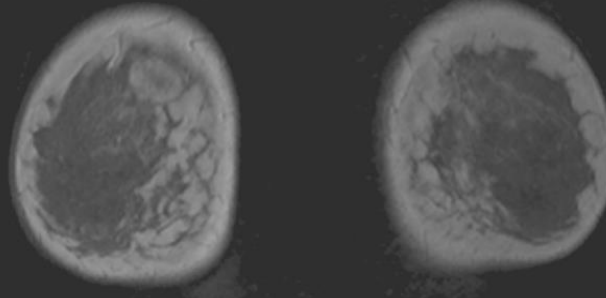
Tecnica e Metodologia



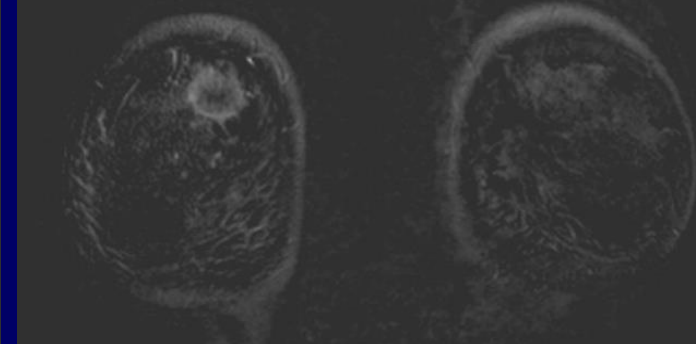
Sottrazione



T1 pre-contrasto



T1 post-contrasto



sottrazione

FONDAMENTALI le prime 2 serie sottratte dopo mdc

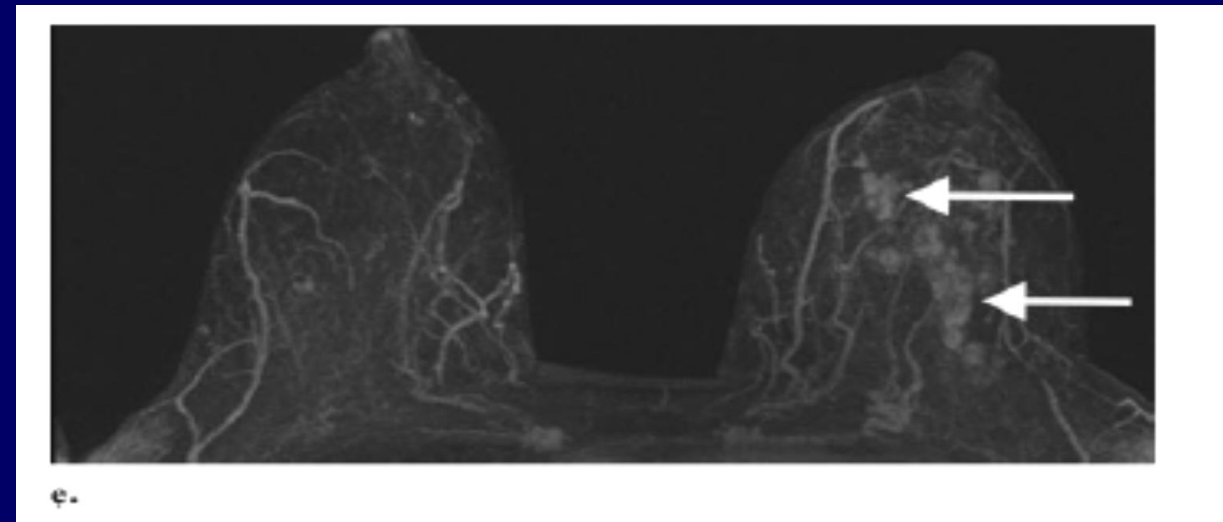
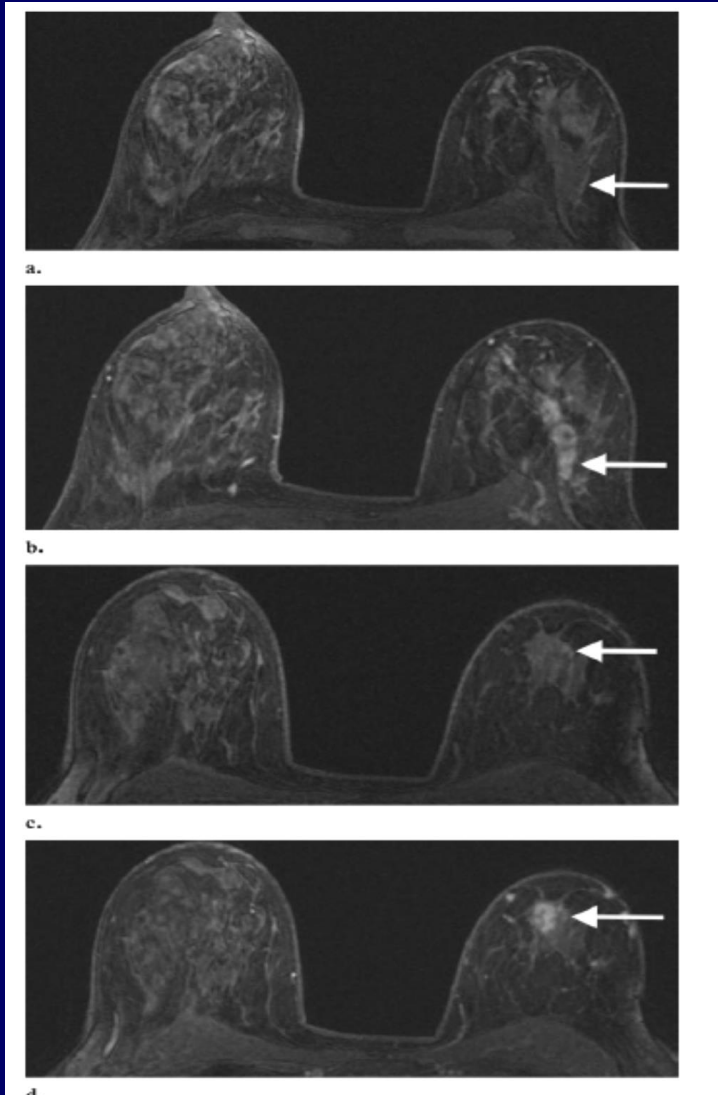
90% carcinomi si vedono entro i primi 3 minuti

Valutare sempre sottrazioni tardive



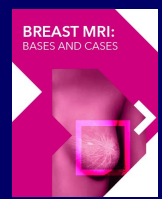
Ca lobulare infiltrante e CDIS possono avere enhancement lento e progressivo

MIP



Rausch et al, Radiographics 2006

- Miglior rappresentazione del tumore nei tre piani
- Localizzazione spaziale (chirurgo)
- Mappe vascolari

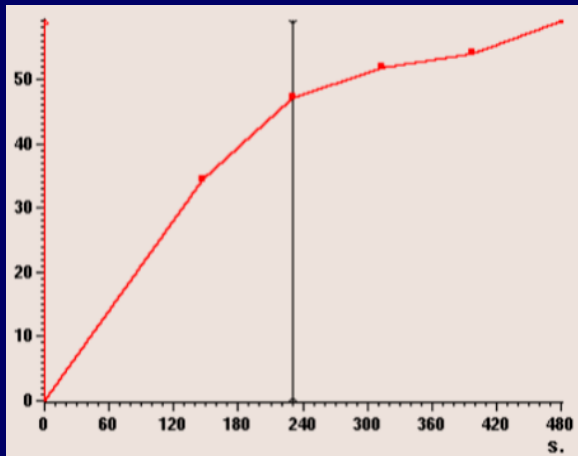


Tecnica e Metodologia

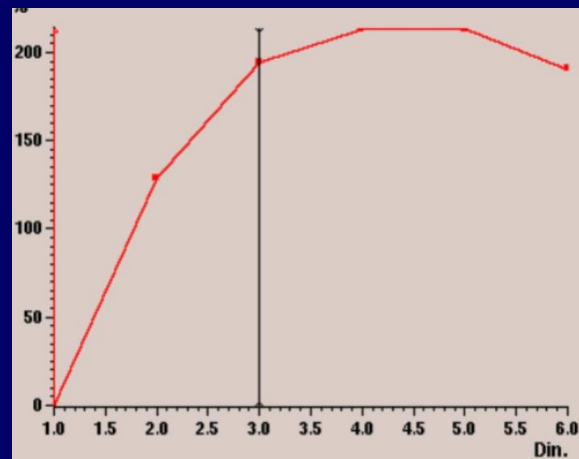


CURVA DI ENHANCEMENT (intensità di segnale/tempo)

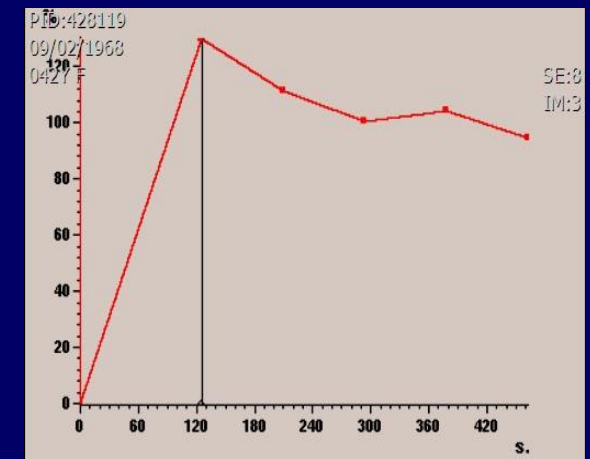
**CURVA DI TIPO I
BENIGNO (persistent)**



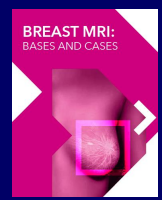
**CURVA DI TIPO II
INDETERMINATO (plateau)**



**CURVA DI TIPO III
MALIGNO (washout)**



- Tracciare una ROI di almeno 9 pixel nella zona più vascolarizzata del tumore
- Scegliere la curva più patologica



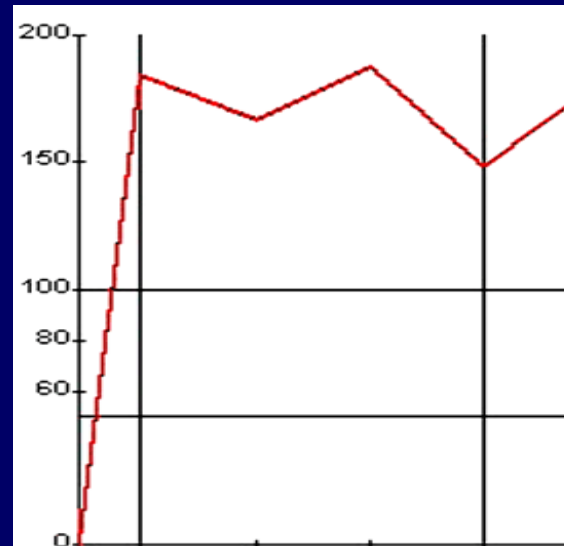
Tecnica e Metodologia

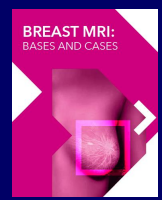


CURVA DI ENHANCEMENT

Attenzione ad artefatti da movimento (misregistration)

- Rendono la curva non informativa
- Più probabili se lesione molto piccola (NO ROI SU FOCUS!!!)



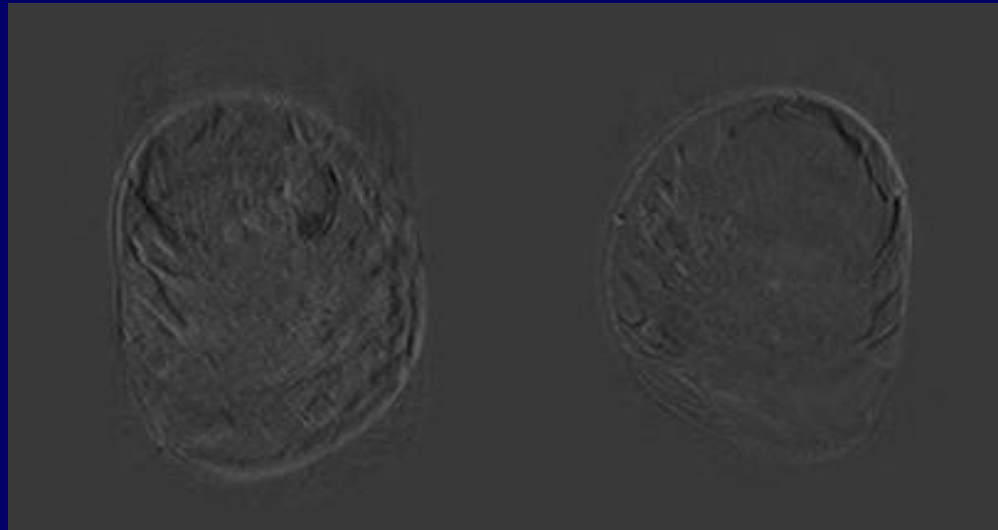


Tecnica e Metodologia

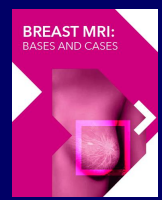


PROBLEMI: MANCATO ENHANCEMENT

Problemi accesso venoso, iniettore, circolo lento



Guardare se mdc presente nelle camere cardiache (durante 1^a acq post-contrasto)

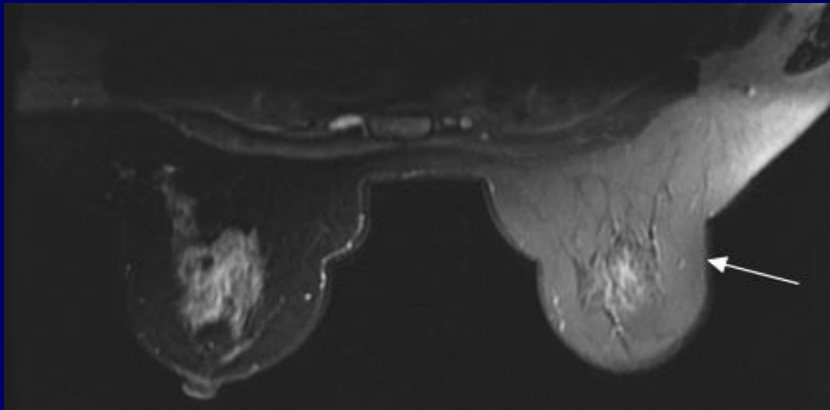


Tecnica e Metodologia

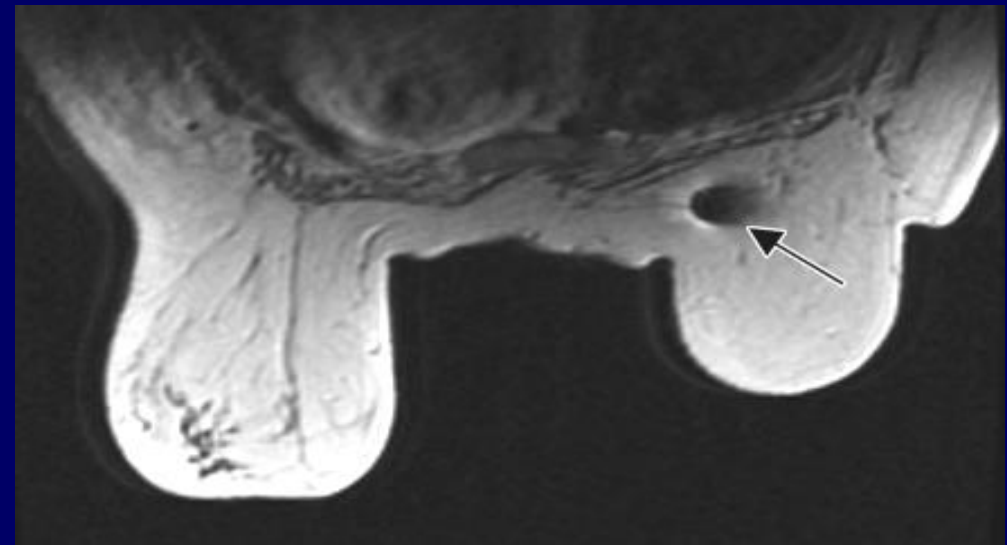


ALTRI ARTEFATTI

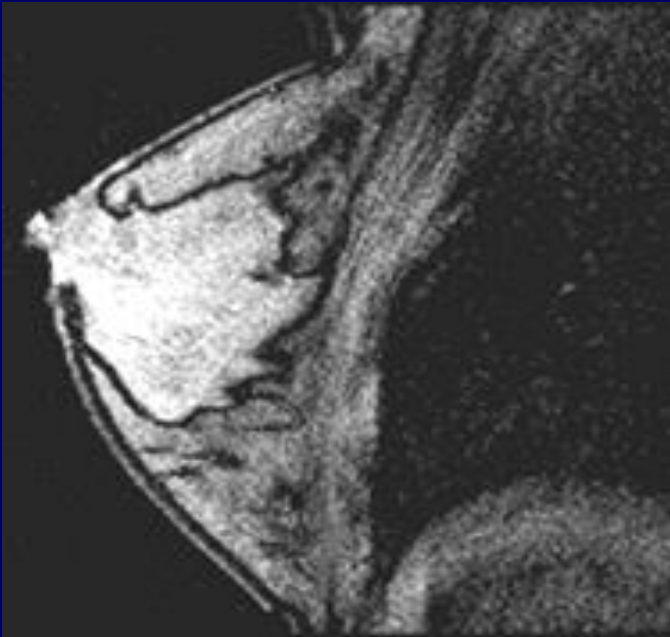
disomogenea soppressione del grasso



Suscettività magnetica



ALTRI ARTEFATTI



Harvey JA et al, Radiographics 2007

Chemical shift

Contatto cute-bobina in
mammella voluminosa





Mezzi di contrasto paramagnetici

- Gadopentetato Dimegluminico (Magnevist[®], Bayer-Schering)

0.2 mmol/kg

- Gadobenato Dimegluminico (Multihance[®], Bracco),

0.1 mmol/kg

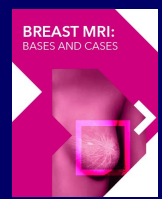
*Studio DETECT

- Gadobutrolo (Gadovist[®], Bayer-Schering), 0.1 mmol/kg

(< rischio di NSF)

*Studio GEMMA

Velocità di iniezione: 2 ml/sec



Tecnica e Metodologia



CAD

PID: 428119
09/02/1968
042Y F

Location: P. UL 12 o'clock middle

Cor: Ax-CF, Sag-ML

R Lat Med

Distance (cm) edge to:
 Nipple 7.5 (radial 2.8)
 Skin 2.9
 Chest 3.0

Size
 Diameters: 2.9 x 2.5 x 2.4 cm
 Angio Volume: 6.6 cc

Encapsulating Ellipsoid (10 mm margin)
 Diameters: 5.3 x 4.9 x 5.2 cm
 Angio Volume: 70.6 cc
 Involvement: ~ 4%

Kinetics
 Curve Peak: 215 % (Rapid, Washout)

Morphology
 Lobular shaped mass; Smooth margin; Rim enhancement

Assessment
 3 - Probably benign finding
 Recommendation: ultrasound-guided FNAB

SE: 5000
IM: 2

Series: SUB Post 1 - Index: 38
 Ax: 521.8mm
 12-23-10
 SUB Post 1
 38 / 75

Series: Post 1 - Index: 38
 Ax: 521.8mm
 12-23-10
 Post 1
 38 / 75

Series: SUB Post 4 - Index: 38
 Ax: 521.8mm
 12-23-10
 SUB Post 4
 38 / 75

Series: MIP 3 piani - Index: 8
 Ax: 521.8mm
 12-23-10
 MIP 3 piani
 8 / 45

TR:
 TE:
 CAD~ Snapshots
 HSR Osp.S.Raffaele

thk/

PID: 428119
09/02/1968
042Y F

Series: SUB Post 1 - Index: 37
 Ax: 519.8mm
 12-23-10
 SUB Post 1
 37 / 75

Series: SUB Post 4 - Index: 37
 Ax: 519.8mm
 12-23-10
 SUB Post 4
 37 / 75

Series: diff b=0 (0) - Index: 22
 Ax: 520mm
 12-23-10
 diff b=0 (0)
 22 / 40

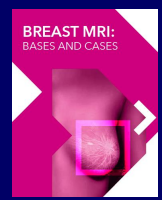
Series: diff b=900 (900) - Index: 22
 Ax: 520mm
 12-23-10
 diff b=900 (900)
 22 / 40

Series: ADC Map 0-900 (0 900) - Index: 22
 Ax: 520mm
 12-23-10
 ADC Map 0-900 (0 900)
 22 / 40

SE: 5000
IM: 3

TR:
 TE:
 CAD~ Snapshots
 HSR Osp.S.Raffaele

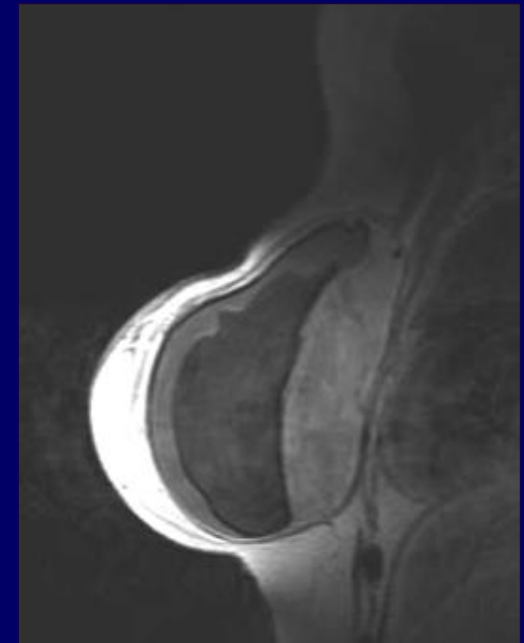
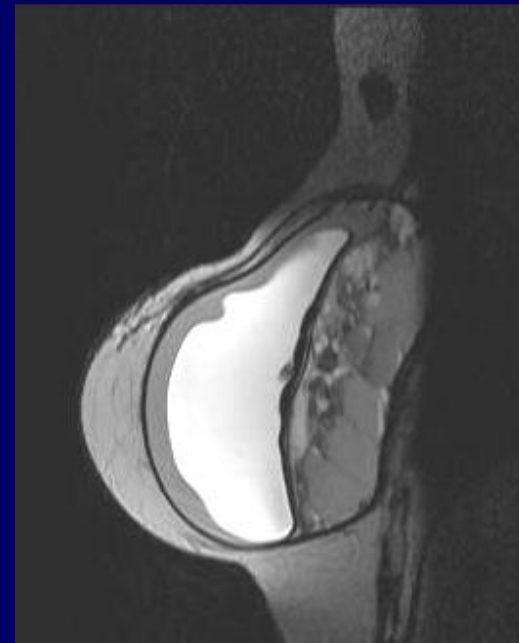
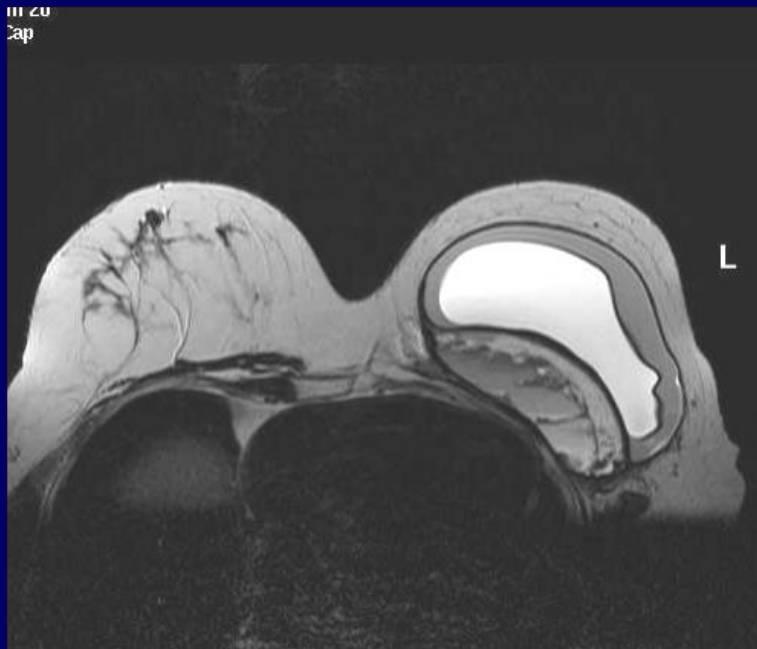
thk/



Tecnica e Metodologia



STUDIO PROTESI



Sequenze T2 e T1 pesate, possibilmente assiali e sagittali (morfologia, liquidi, struttura protesi)

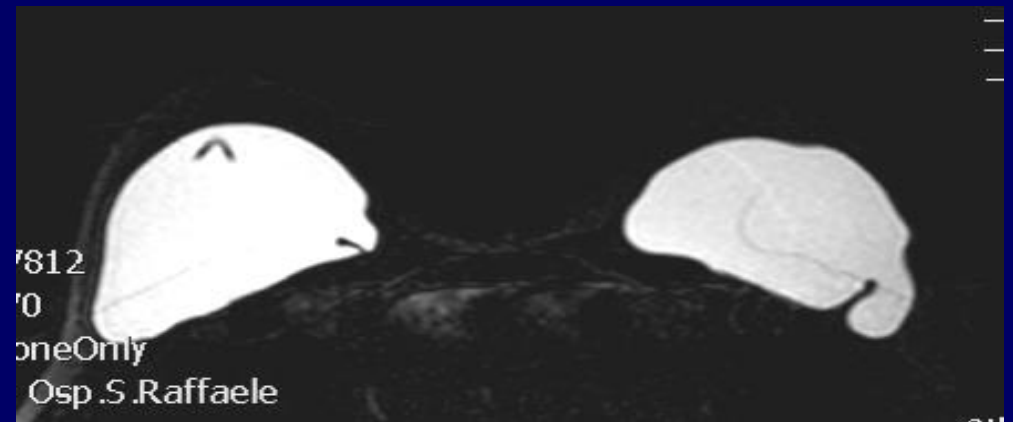


Tecnica e Metodologia

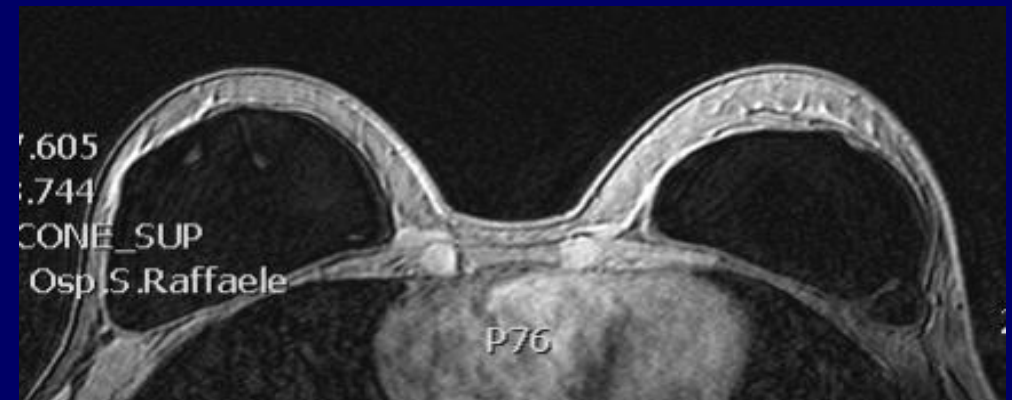


STUDIO PROTESI

Sequenze sensibili al segnale del silicone (Silicon Only)



Sequenze con soppressione del segnale del silicone (Silicon Suppression)



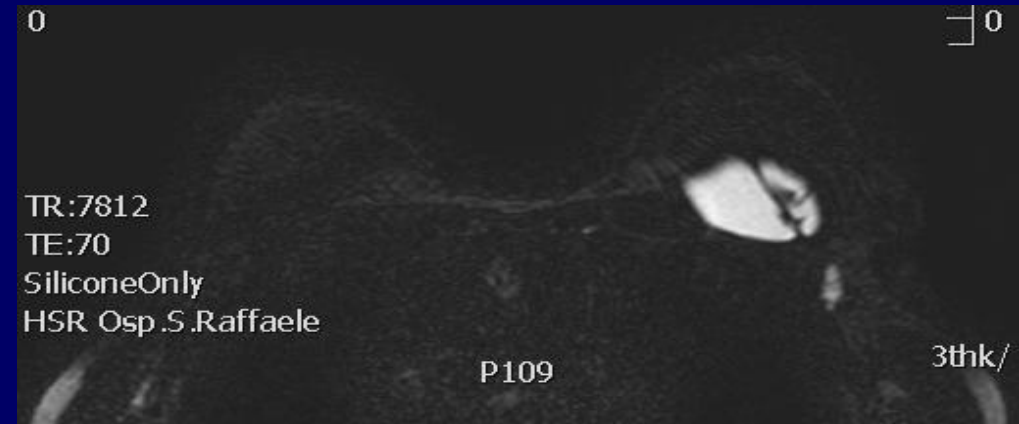


Tecnica e Metodologia

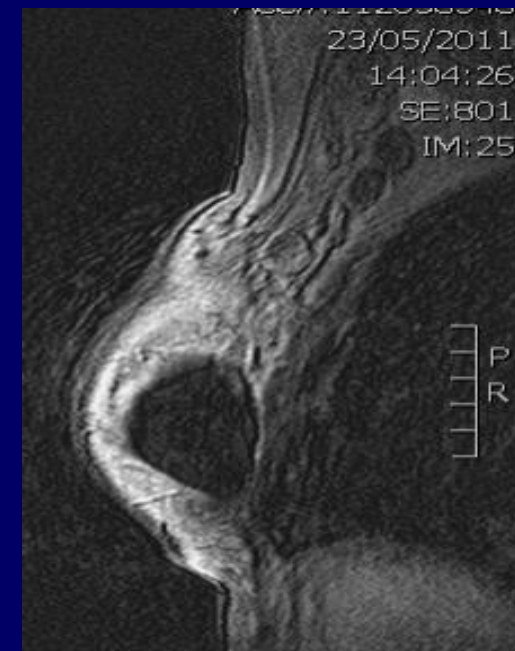
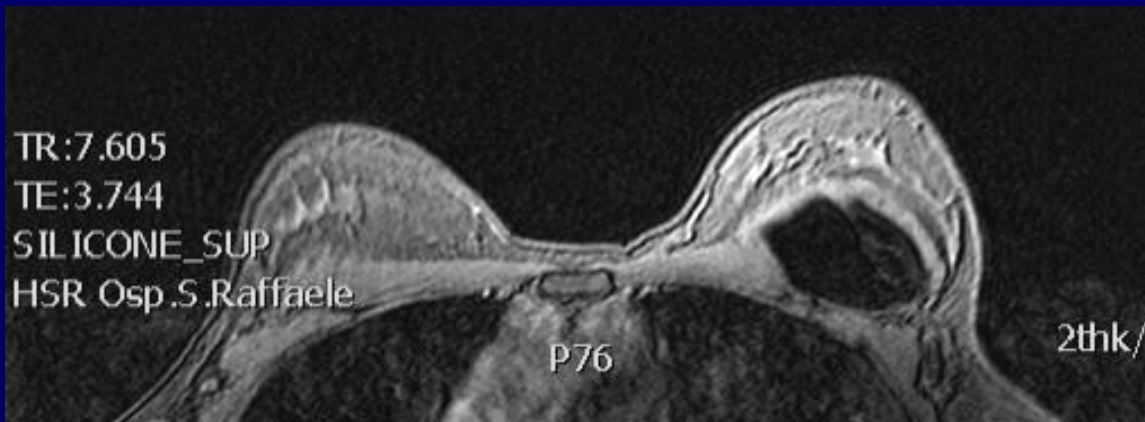


STUDIO PROTESI

Sequenze sensibili al segnale del silicone (Silicon Only)

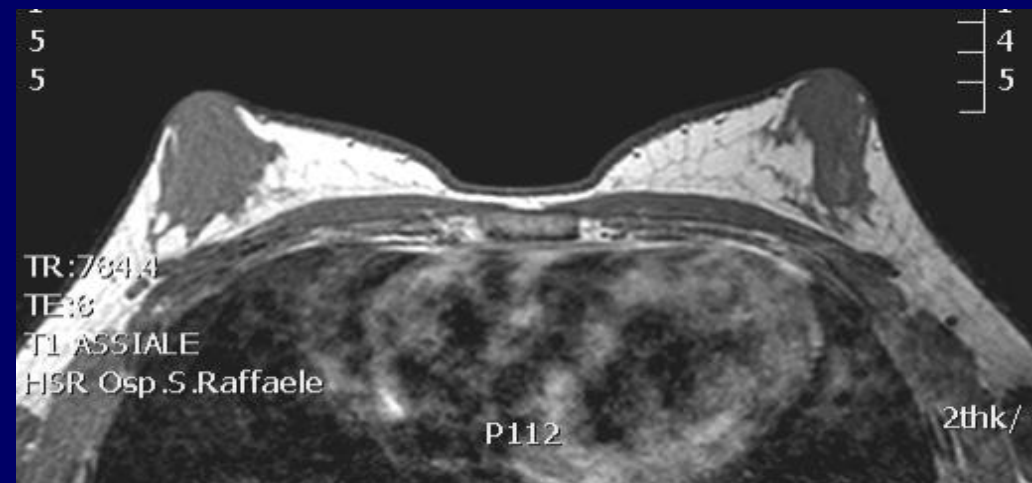
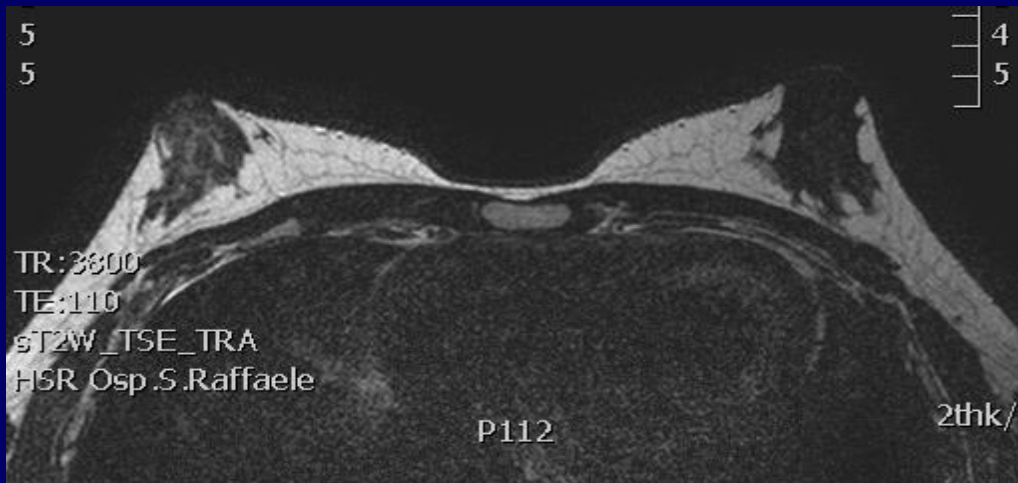


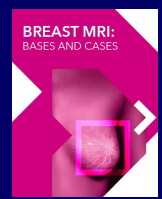
Sequenze con soppressione del segnale del silicone (Silicon Suppression)



Studio ginecomastia (mammella maschile)

T2 e T1 assiali, no mdc, eventualmente DWI





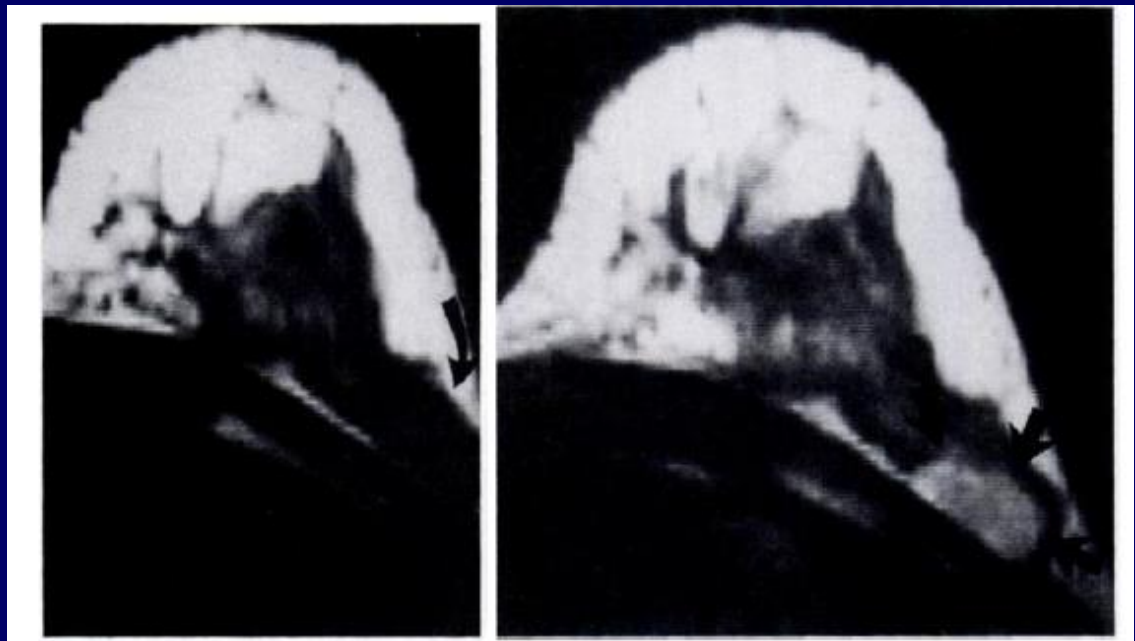
Le origini...



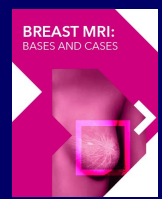
Sylvia H. Heywang, MD • Anton Wolf, MD • Elke Pruss, MD • Thomas Hilbertz, MD • Wolfgang Eiermann, MD • Willibald Permanetter, MD

MR Imaging of the Breast with Gd-DTPA: Use and Limitations¹

Radiology 1989; 171:95-103



0.35-1 Tesla
T1 spin echo
Bobina di superficie



Le origini...



Breast Imaging

Werner A. Kaiser, MD • Eberhard Zeitler, MD

MR Imaging of the Breast: Fast Imaging Sequences with and without Gd-DTPA

Preliminary Observations¹

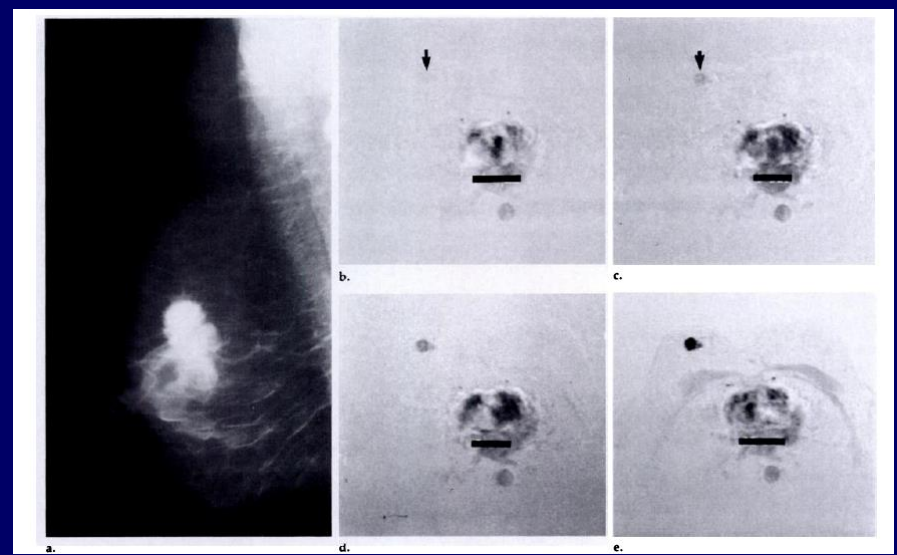
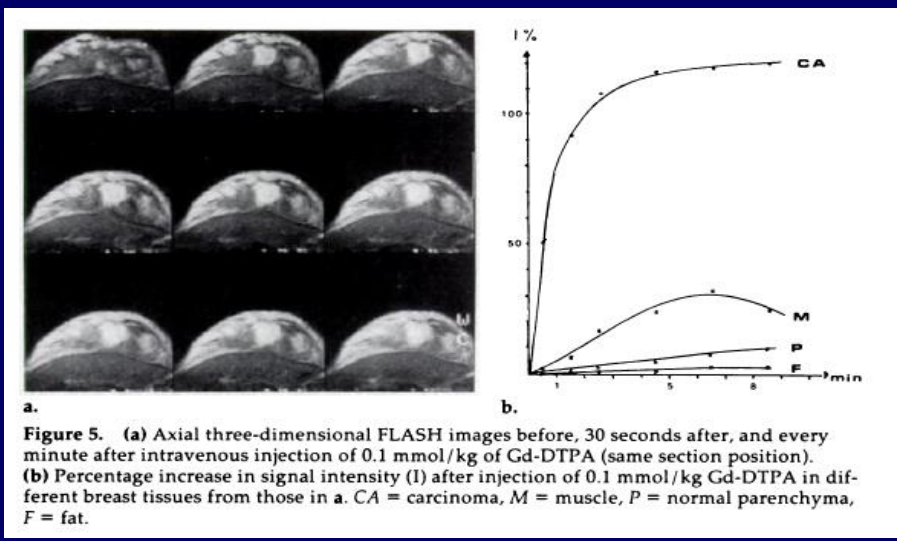
Radiology 1989; 170:681-686

Breast Imaging

Carla Boetes, MD • Jelle O. Barentsz, MD • Roel D. Mus, MD • Rigtje F. van der Sluis, MD
Leon J. T. O. van Erning, PhD • Jan H. C. L. Hendriks, MD • Roland Holland, MD
Sjef H. J. Ruys, MD

Radiology 1994; 193:777-781

MR Characterization of Suspicious Breast Lesions with a Gadolinium-enhanced TurboFLASH Subtraction Technique¹



1 Tesla
T1 gradient echo
(T2 in casi selezionati)
Studio dinamico

Sottrazione
di immagine



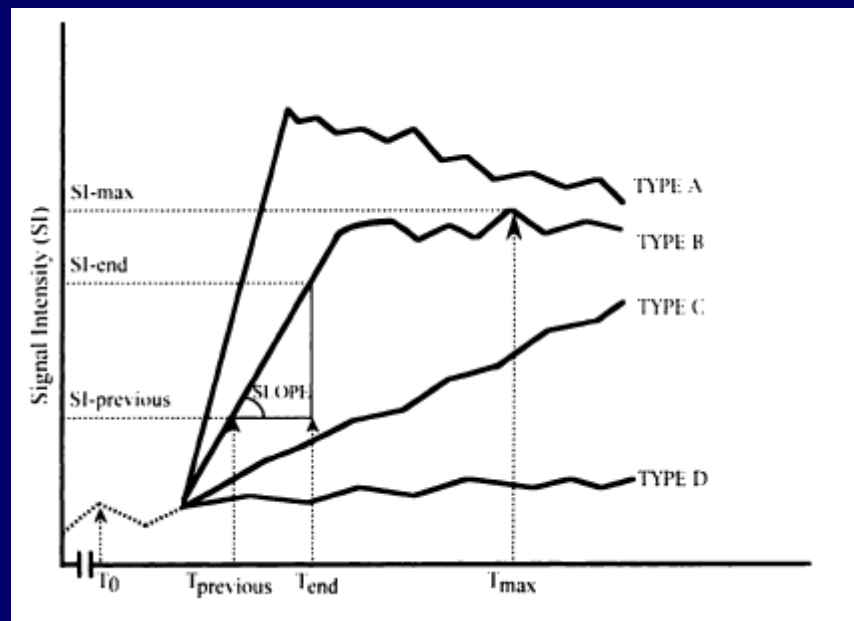
Le origini...



Lawrence D. Buadu, MB, ChB • Junji Murakami, MD • Sadayuki Murayama, MD
Norihsa Hashiguchi, MD • Shuji Sakai, MD • Kouji Masuda, MD
Satoshi Toyoshima, MD • Syoji Kuroki, MD • Shinji Ohno, MD

Breast Lesions: Correlation of Contrast Medium Enhancement Patterns on MR Images with Histopathologic Findings and Tumor Angiogenesis¹

Radiology
September 1996



Curve IS/T

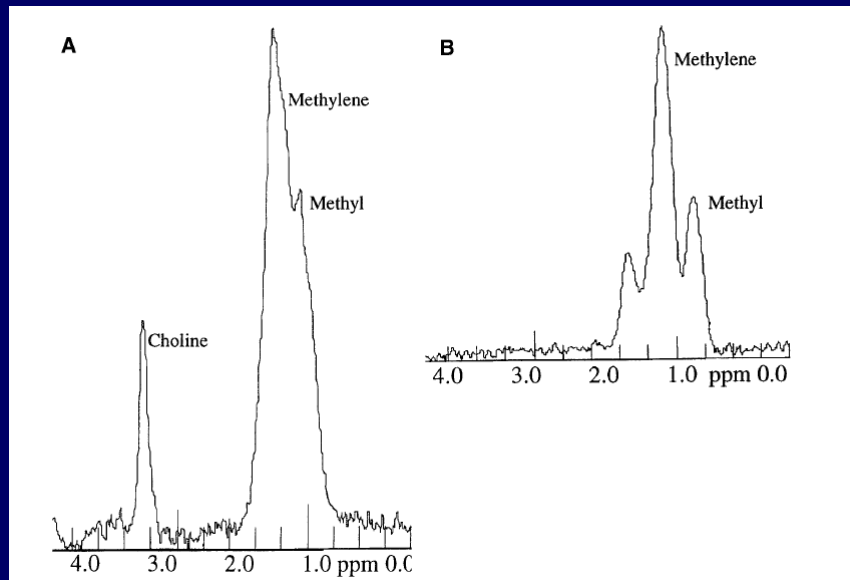


JOURNAL OF MAGNETIC RESONANCE IMAGING 10:159-164 (1999)

Original Research

Characterization of Neoplastic and Normal Human Breast Tissues With In Vivo ^1H MR Spectroscopy

Kjell A. Kvistad, MD,^{1*} Inger J. Bakken, PhD,² Ingrid S. Gribbestad, MS,² Benny Ehrnholm, RT,¹ Steinar Lundgren, MD, PhD,³ Hans E. Fjøsne, MD, PhD,⁴ and Olav Haraldseth, MD, PhD,⁵



Identificazione Picco Colina

DD K vs B



2006-2007



JOURNAL OF MAGNETIC RESONANCE IMAGING 24:319-324 (2006)

Original Research

Quantitative Diffusion Imaging in Breast Cancer: A Clinical Prospective Study

Erika Rubesova, MD,^{1*} Anne-Sophie Grell, PhD,² Viviane De Maertelaer, PhD,³
Thierry Metens, PhD,⁴ Shih-Li Chao, RT,² and Marc Lemort, MD²

DWI: Valutazione diffusività dell' acqua nei tessuti
Possibilità di caratterizzazione (qualitativa e quantitativa)

Eur Radiol (2007) 17: 2646-2655
DOI 10.1007/s00330-007-0621-2

BREAST

C. Marini
C. Iacconi
M. Giannelli
A. Cilotti
M. Moretti
C. Bartolozzi

**Quantitative diffusion-weighted MR imaging
in the differential diagnosis of breast lesion**



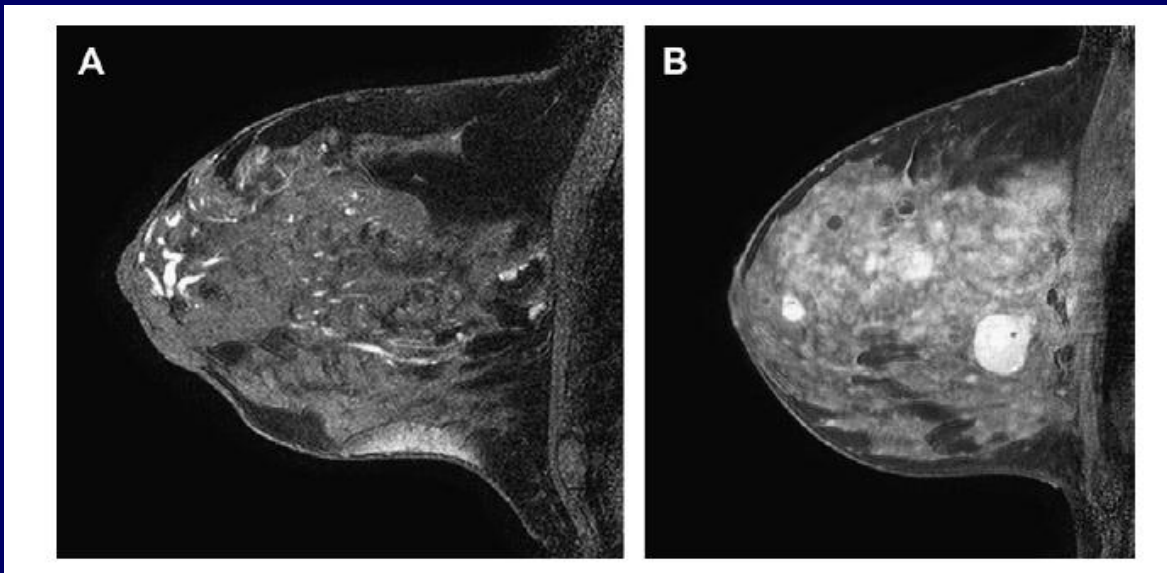
Ultimo decennio



 **MAGNETIC RESONANCE IMAGING CLINICS**
Magn Reson Imaging Clin N Am 15 (2007) 315-320

Breast MR Imaging at 3T

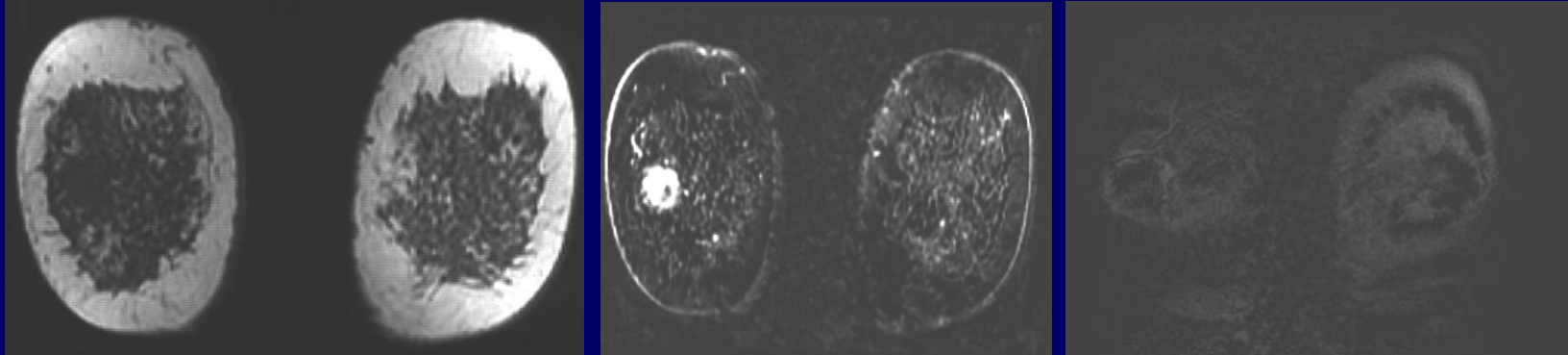
Christiane K. Kuhl, MD



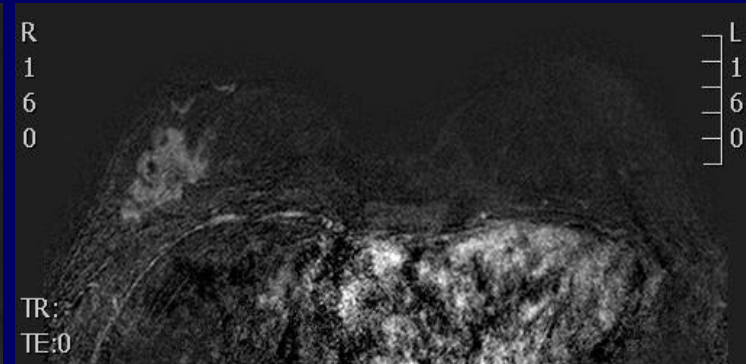
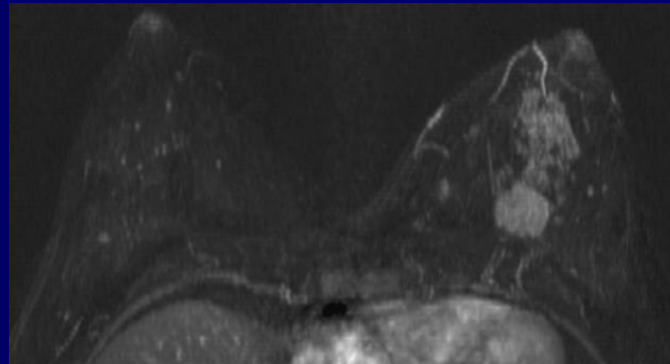
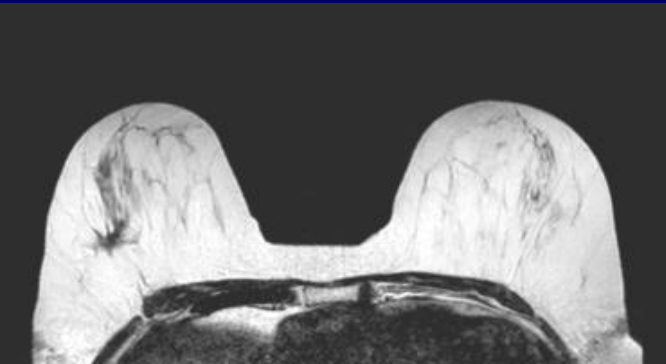
- > SNR
- > risoluzione temporale e spaziale

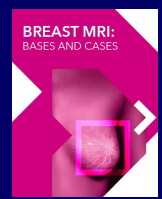
Nostra esperienza

2003

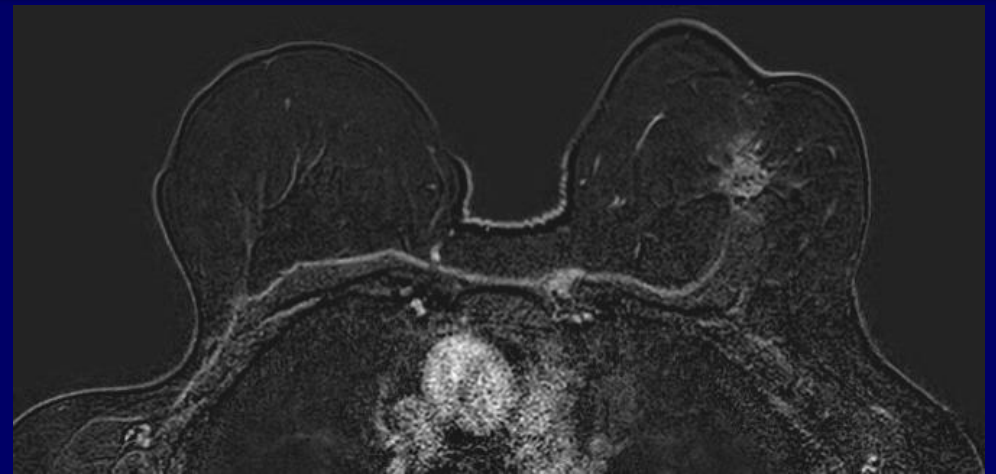
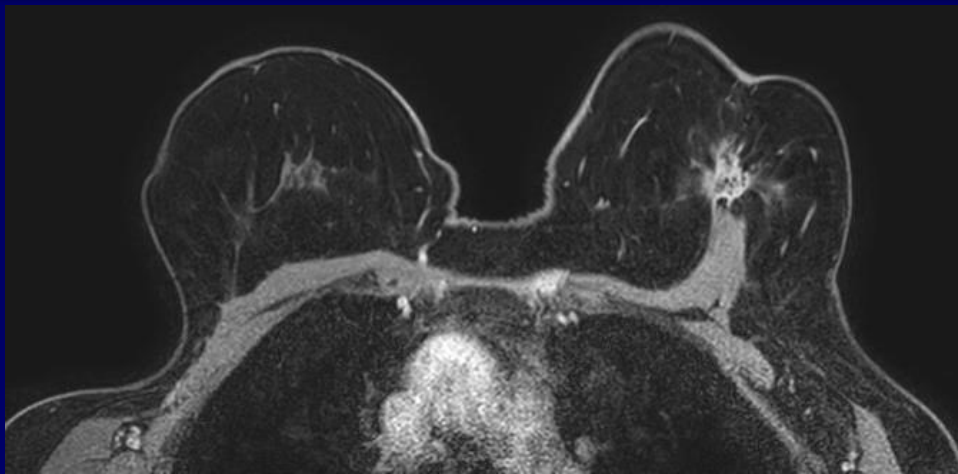


2009

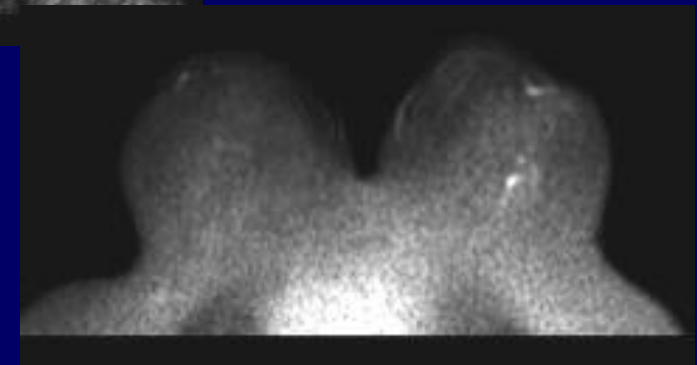
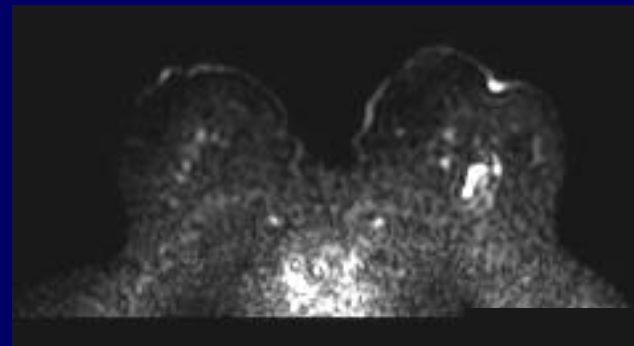




Nostra esperienza



OGGI





RISONANZA MAGNETICA MAMMARIA:

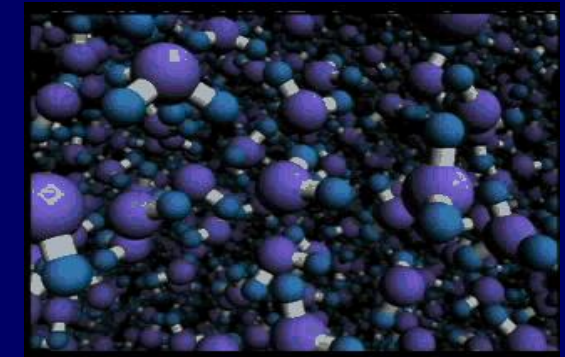
L' IMAGING IN DIFFUSIONE



Diffusion-Weighted Imaging (DWI)

Sfrutta un fenomeno naturale:

Moto Browniano: movimento casuale delle molecole d'acqua (agitazione termica), influenzato a livello biologico dalle componenti strutturali dei tessuti



Diffusività H₂O nei tumori solidi è ridotta a causa di:

- 1) Elevata densità cellulare
- 2) Minor permeabilità delle membrane cellulari

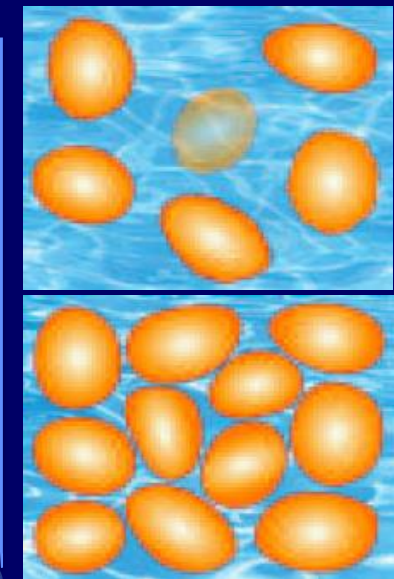


**NUOVA FINESTRA DI OSSERVAZIONE BIOLOGICA
NELL' AMBITO DELL' IMAGING RM**

RM dinamica:
Neoangiogenesi tumorale

DWI:
Microambiente tumorale

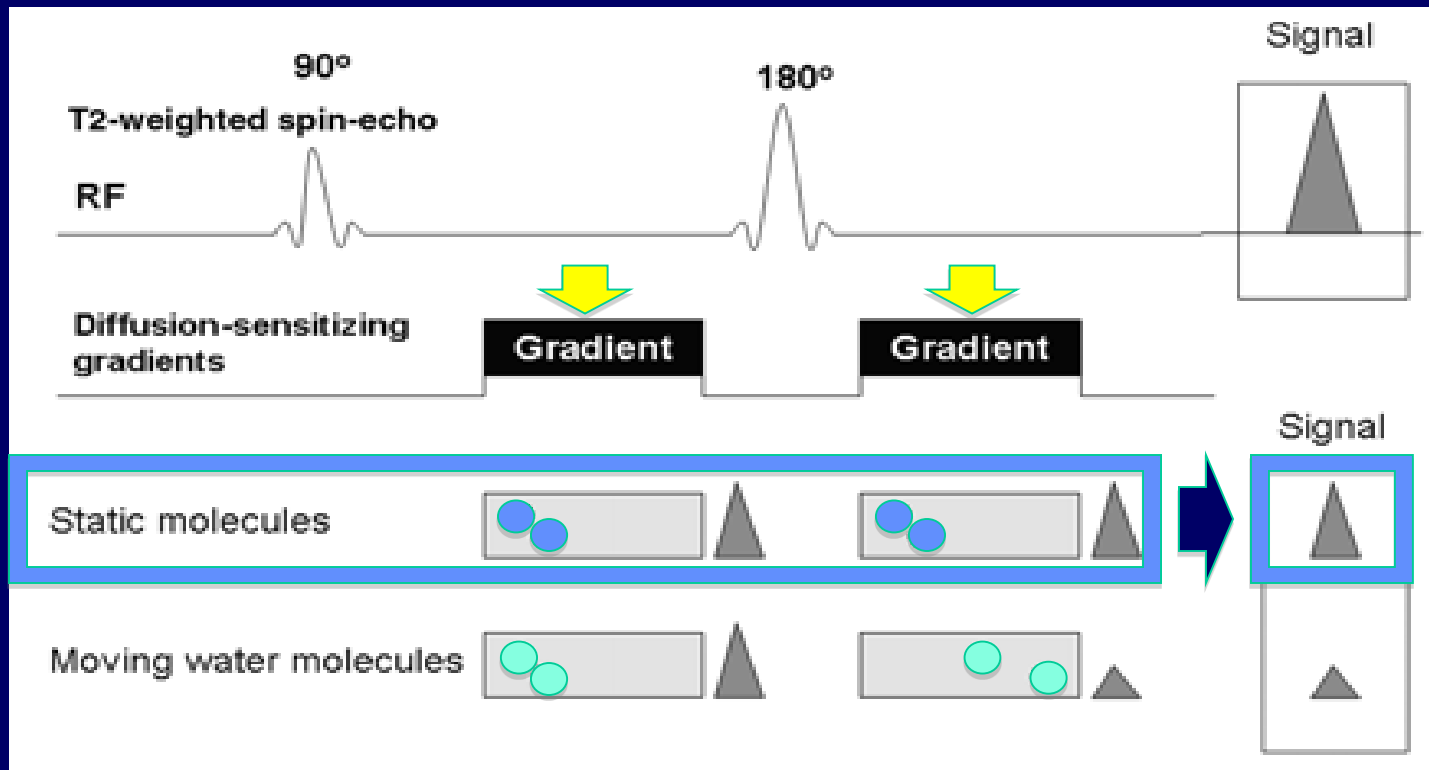
DIFFUSIVITÀ



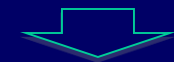
CELLULARITÀ

Diffusion-Weighted Imaging (DWI)

Sequenza sensibile alla diffusione:

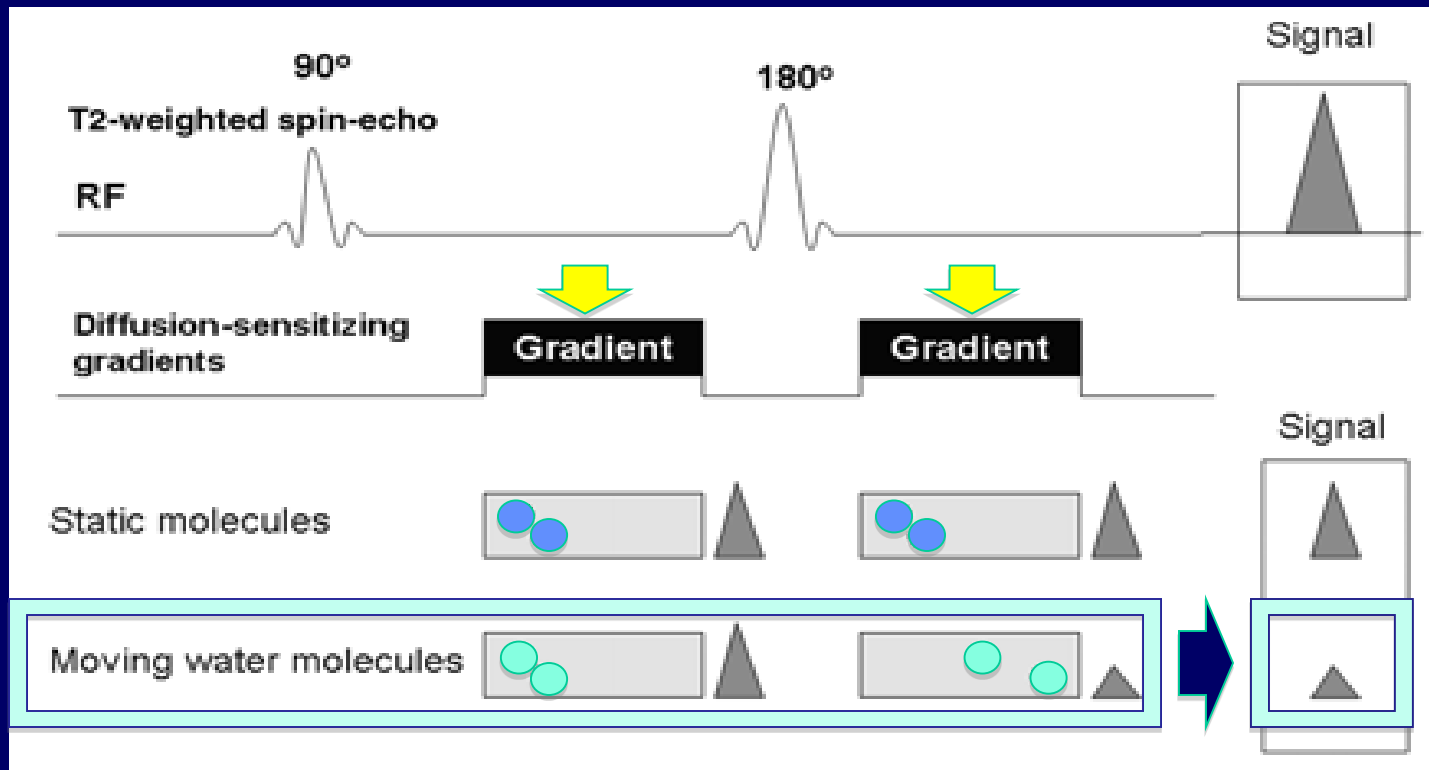


Molecole H₂O
"statiche"

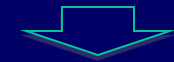


Diffusion-Weighted Imaging (DWI)

Sequenza sensibile alla diffusione:



Molecole H₂O
“statiche”



Molecole H₂O in
movimento



Perdita segnale

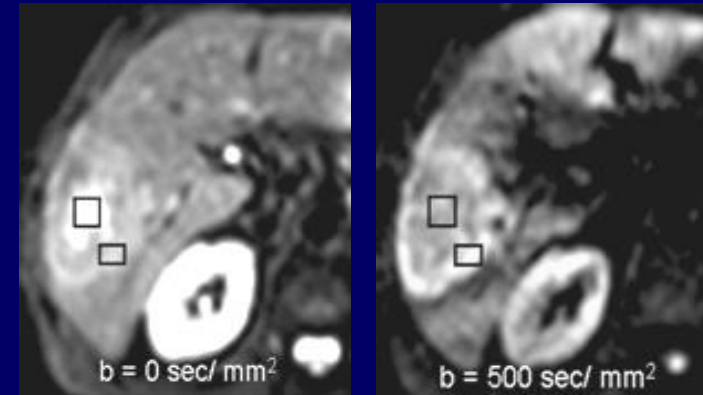
Diffusion-Weighted Imaging (DWI)

• Sequenze Single Shot Eco Planari (EPI)

ANALISI QUALITATIVA: confronto tra immagini pesate in diffusione (coefficiente di pesatura $b > 0$) e immagini di riferimento a pesatura in diffusione “nulla” ($b = 0$)

Diffusività ristretta = **IPERINTENSITA’ RELATIVA**

Diffusività aumentata = **IPOINTENSITA’ RELATIVA**



Problemi:

- 1) Per bassi valori di b le immagini pesate in DWI subiscono contributo della perfusione capillare (T2 “shine through” effect) = USARE b elevati ($> 500 \text{ s/mm}^2$)
- 2) Necessità di quantificare numericamente la diffusività dell’ acqua

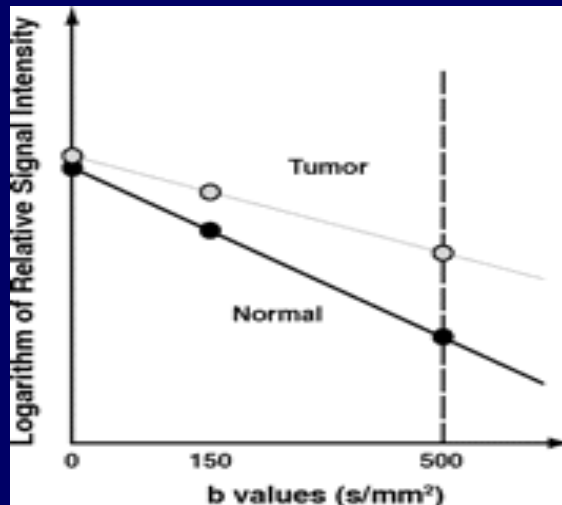


Diffusion-Weighted Imaging (DWI)

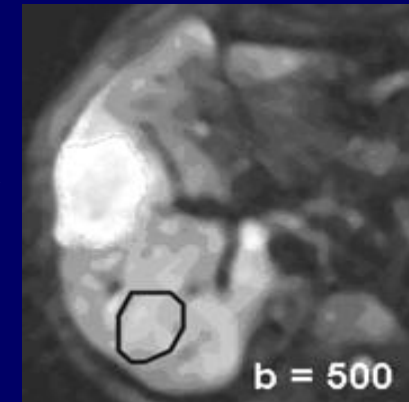
•Post processing

ANALISI QUANTITATIVA, attraverso il calcolo dei coefficienti di diffusione apparente (ADC), misurabili sulle mappe ADC:

$$S = S_0 \cdot \exp(-b \cdot \text{ADC})$$



ADC map



- Tracciare una ROI perilesionale sulla mappa ADC, evitando le zone necrotiche, liquide o emorragiche (ADC è problematica se tumore eterogeneo)

Breast DWI

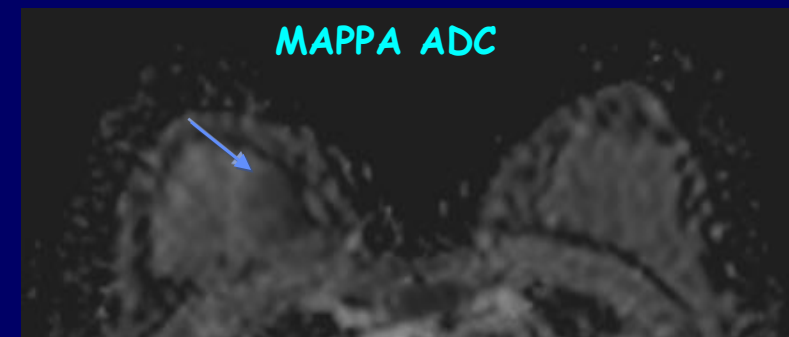
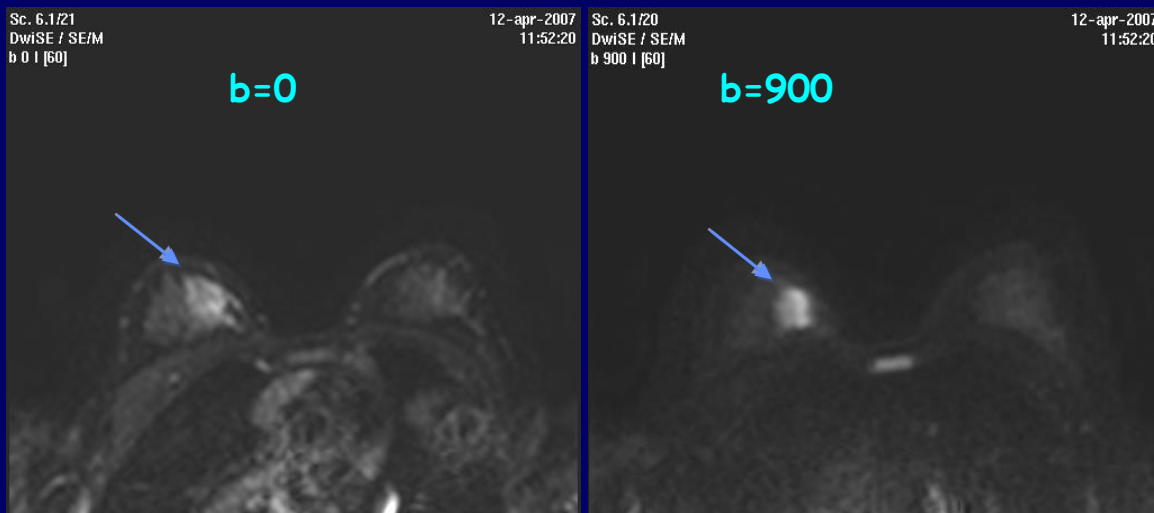
• Post processing
analisi

QUALITATIVA

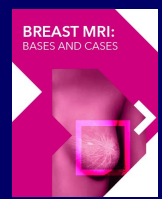
QUANTITATIVA

Identificazione lesioni maligne:
Iperintensità di segnale

Caratterizzazione lesione:
coefficiente di diffusione apparente (ADC)



espressione numerica della
diffusività dell'acqua



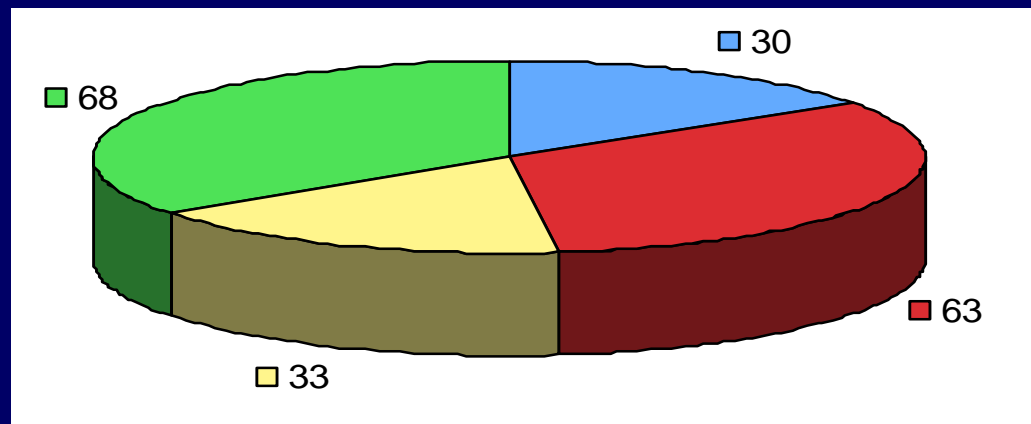
POPOLAZIONE STUDIATA



194 donne (età media 49 aa; range 25-78) sottoposte a RM dinamica con le seguenti indicazioni:

follow-up in pazienti operate per Ca mammario

screening in donne ad alto rischio genetico-familiare



stadiazione locale del tumore mammario

caratterizzazione di lesioni mammarie dubbie alla diagnostica senologica tradizionale (eco e Mx)



1. DETECTION RATE DWI



Lo studio RM dinamico ha rilevato un totale di 138 lesioni / 194 pazienti
(dm = 12 mm; range 4-80 mm)



Di queste, il DWI ha rilevato 85 lesioni



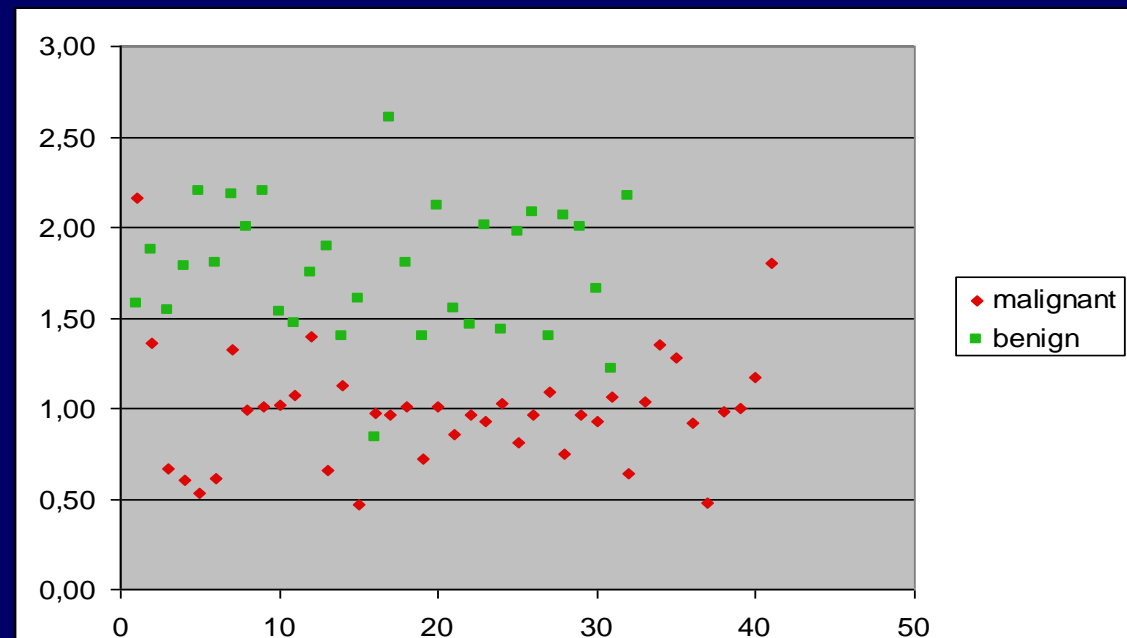
	Studio RM dinamico	DWI	detection DWI
benigne	47	32	66.7%
maligne	50	41	83.6%
indeterminate	41	12	29.2%
totali	138	85	61.6%



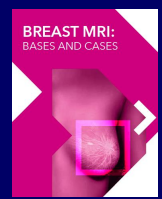
2. ADC LESIONI MALIGNNE vs BENIGNE



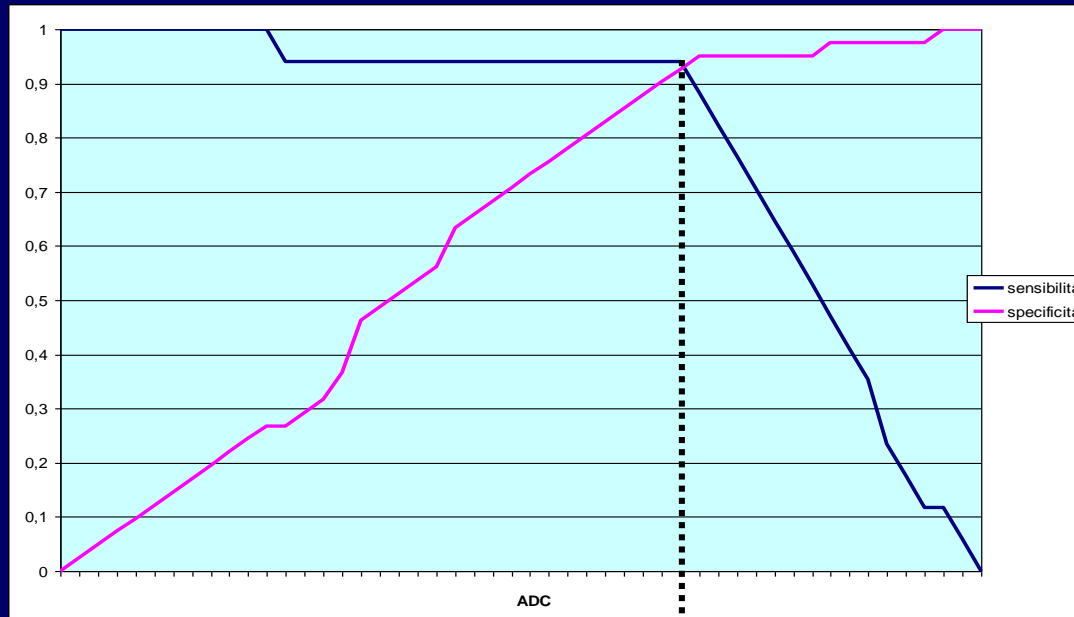
	ADC
MALIGNNE	0.98 ± 0.28
BENIGNE	1.76 ± 0.29
INDETERMINATE	1.27 ± 0.23



ADC significativamente \leftarrow nelle lesioni maligne rispetto alle benigne ($p < 0.001$)



3. VALORE SOGLIA DI ADC (analisi curve ROC)



$1.38 \times 10^{-3} \text{ mm}^2/\text{s}$

Il livello di cut-off del valore di ADC è $1.38 \times 10^{-3} \text{ mm}^2/\text{s}$

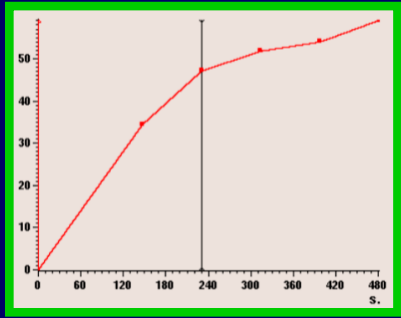
SENSIBILITA': 94%

SPECIFICITA': 92.7%

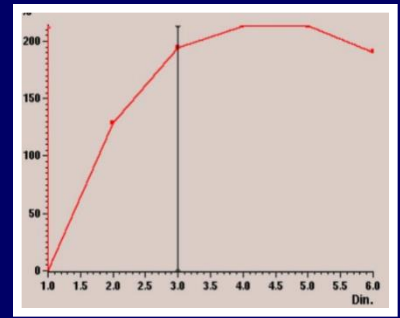


4. ADC vs CURVE DI ENHANCEMENT

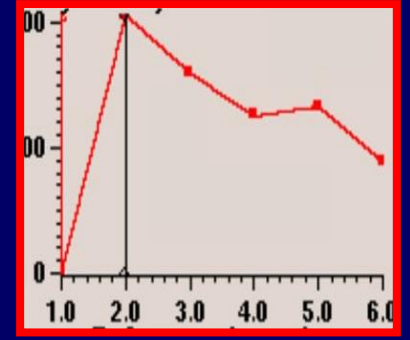
**CURVA DI TIPO I
BENIGNO**



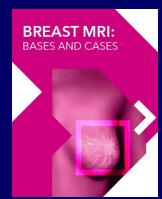
**CURVA DI TIPO II
INDETERMINATO**



**CURVA DI TIPO III
MALIGNO**

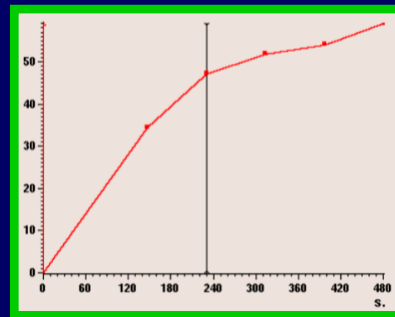


Tipo di curva	CURVA TIPO I	CURVA TIPO II	CURVA TIPO III
LESIONI MALIGNI	10%	27.5%	62.5%
LESIONI BENIGNE	62.1%	31%	6.9%

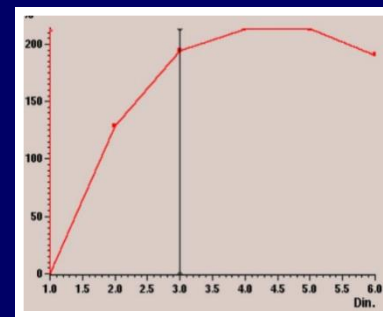


4. ADC vs CURVE DI ENHANCEMENT

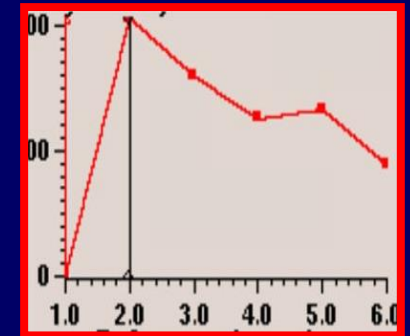
CURVA DI TIPO I
BENIGNO



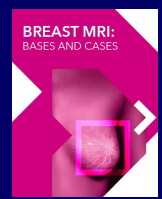
CURVA DI TIPO II
INDETERMINATO



CURVA DI TIPO III
MALIGNO



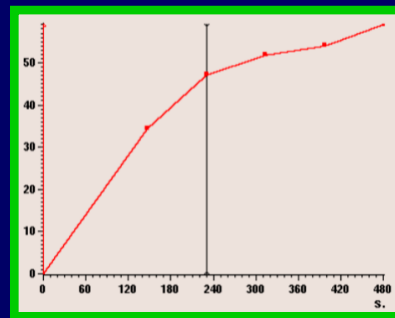
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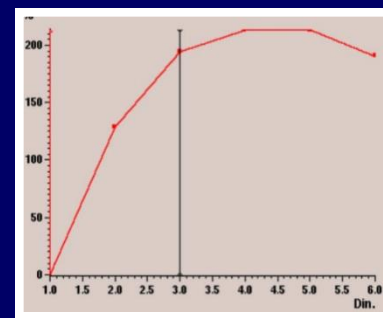
4. ADC vs CURVE DI ENHANCEMENT



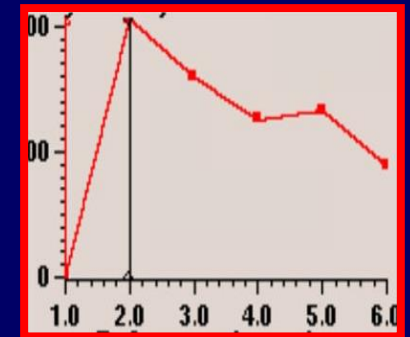
CURVA DI TIPO I
BENIGNO



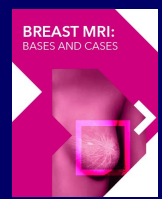
CURVA DI TIPO II
INDETERMINATO



CURVA DI TIPO III
MALIGNO



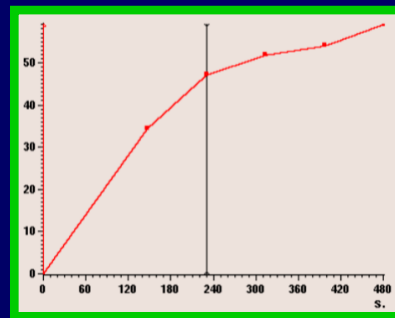
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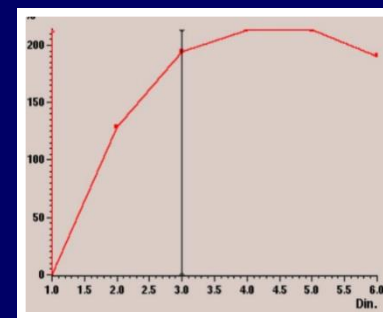
4. ADC vs CURVE DI ENHANCEMENT



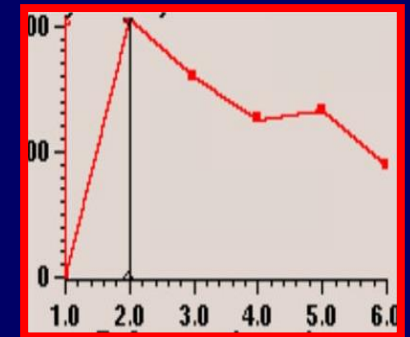
CURVA DI TIPO I
BENIGNO



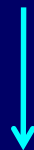
CURVA DI TIPO II
INDETERMINATO



CURVA DI TIPO III
MALIGNO



Tipo di curva	CURVA TIPO I	CURVA TIPO II	CURVA TIPO III
LESIONI MALIGNE	(10%)	(27.5%)	(62.5%)
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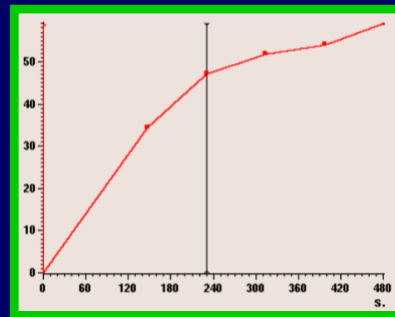


**ADC maligno nel 100%
dei casi!**

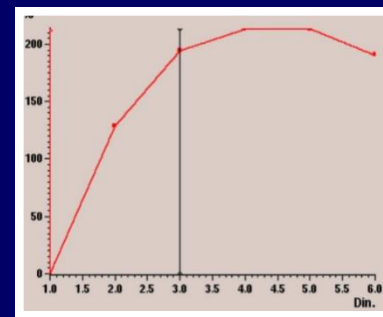


4. ADC vs CURVE DI ENHANCEMENT

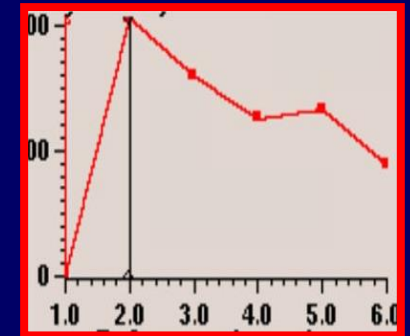
CURVA DI TIPO I
BENIGNO



CURVA DI TIPO II
INDETERMINATO



CURVA DI TIPO III
MALIGNO



Tipo di curva	CURVA TIPO I	CURVA TIPO II	CURVA TIPO III
LESIONI MALIGNE	(10%)	(27.5%)	(62.5%)
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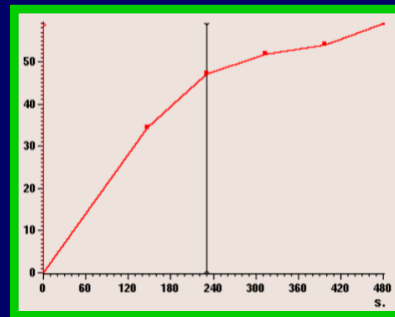


**ADC maligno nel 90.9%
dei casi!**

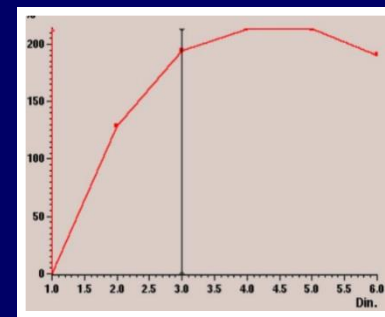


4. ADC vs CURVE DI ENHANCEMENT

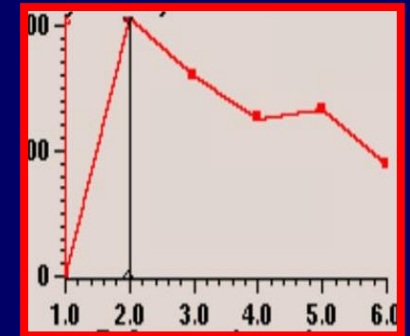
CURVA DI TIPO I
BENIGNO



CURVA DI TIPO II
INDETERMINATO

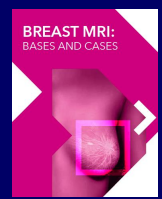


CURVA DI TIPO III
MALIGNO



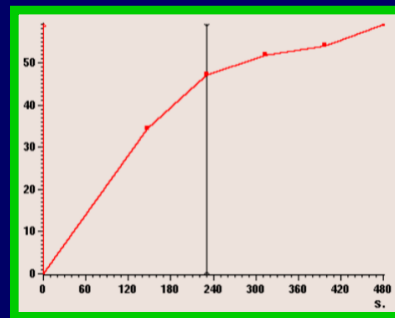
Tipo di curva	CURVA TIPO I	CURVA TIPO II	CURVA TIPO III
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ADC benigno nel 100% dei casi!

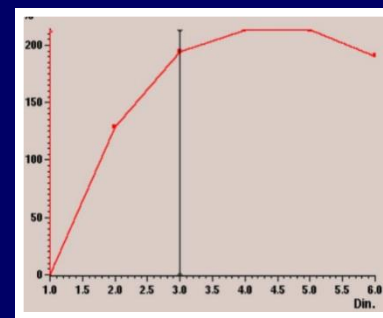


4. ADC vs CURVE DI ENHANCEMENT

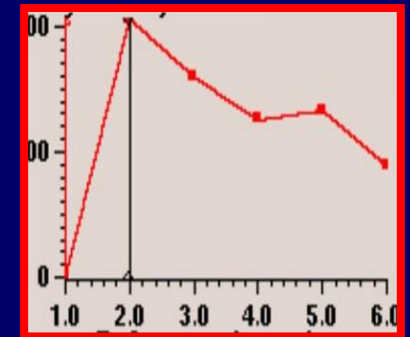
CURVA DI TIPO I
BENIGNO



CURVA DI TIPO II
INDETERMINATO



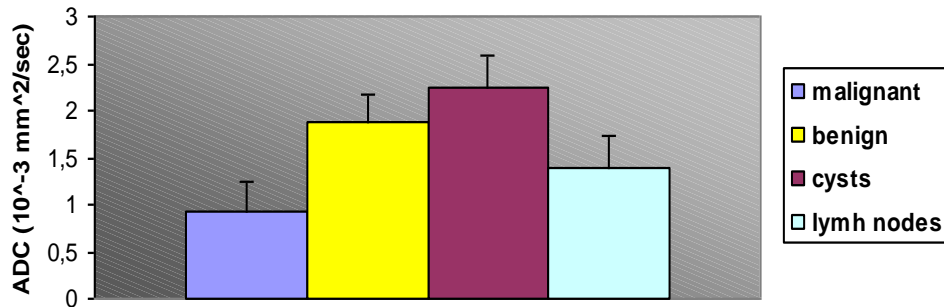
CURVA DI TIPO III
MALIGNO



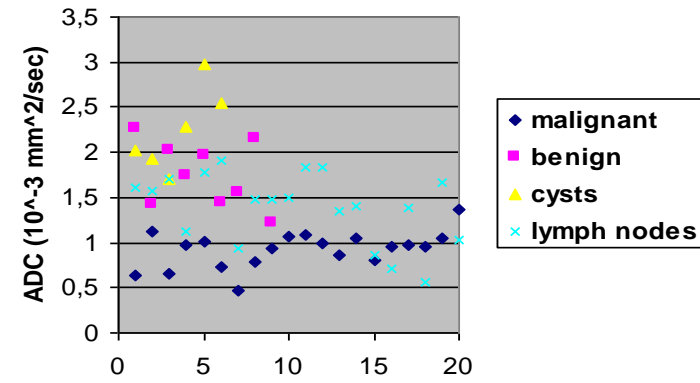
Tipo di curva	CURVA TIPO I	CURVA TIPO II	CURVA TIPO III
LESIONI MALIGNE	(10%)	(27.5%)	(62.5%)
LESIONI BENIGNE	(62.1%)	(31%)	(6.9%)

ADC benigno nel 50% dei casi!

Distribution of ADC values in different lesions (mean and standard deviation)

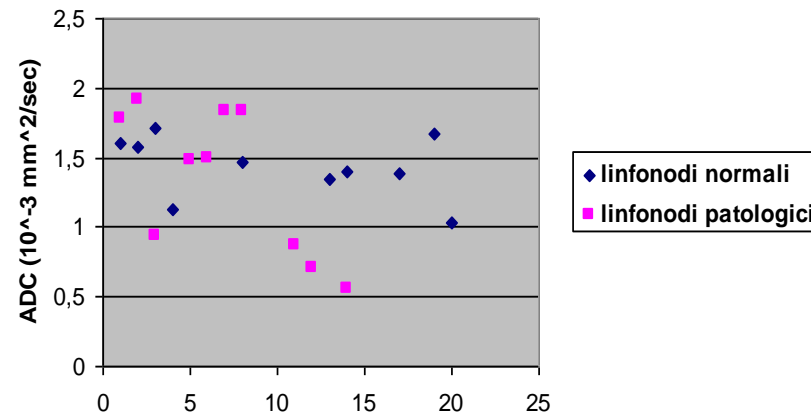


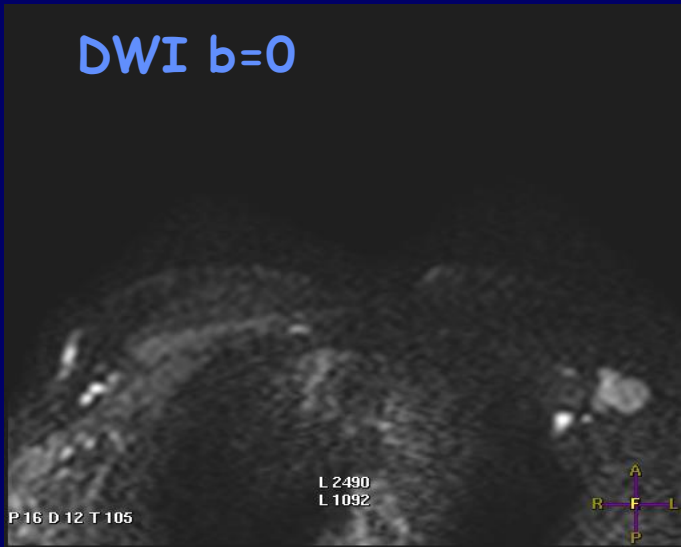
Distribution of different lesions according to ADC value



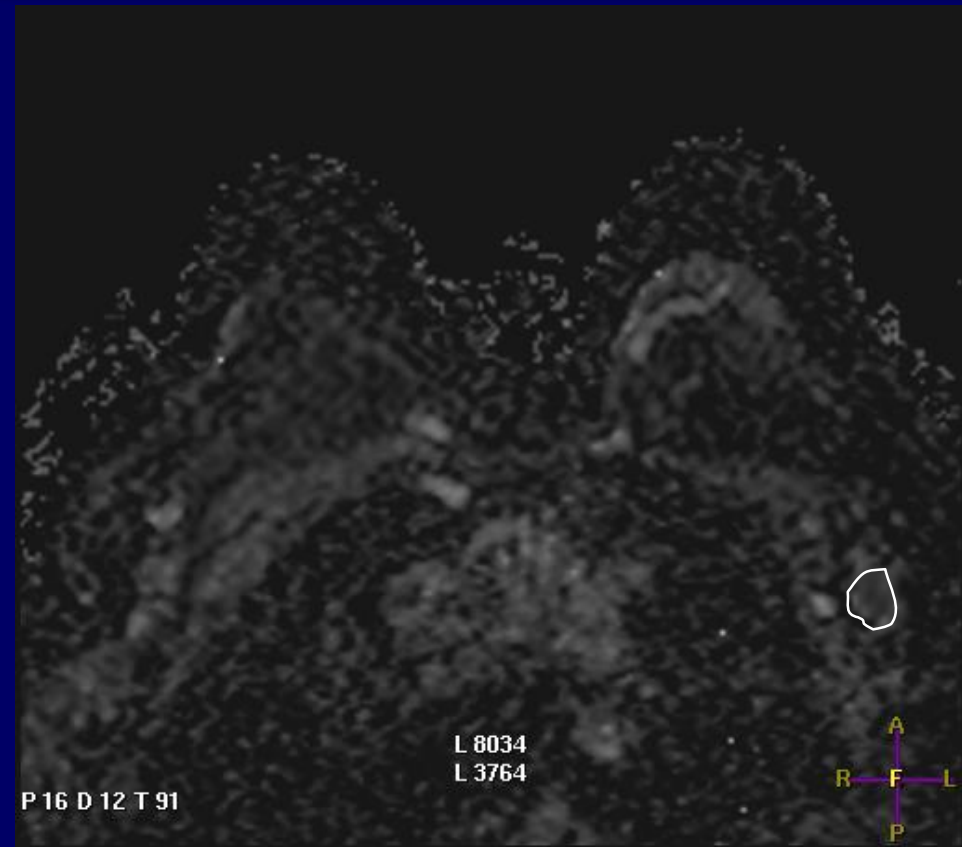
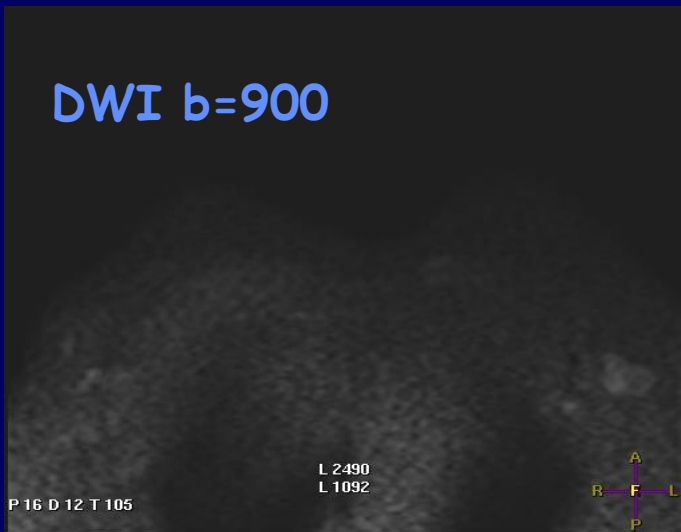
Losio, Panizza et al. RSNA 2008, ECR 2009

Distribuzione linfonodi in relazione all' ADC





LNF
AX



ADC Inf=0.86



DWI



- Tecnica relativamente semplice, basso costo (tempo), eseguibile routinariamente
- Utile complemento a studio dinamico (migliora specificità RM)
- Possibile uso senza mdc (screening RM?)
- Attenzione ad artefatti e bassa risoluzione spaziale !
- Necessaria > uniformità di sequenze tra le diverse macchine RM



BI-RADS?



HHS Public Access

Author manuscript

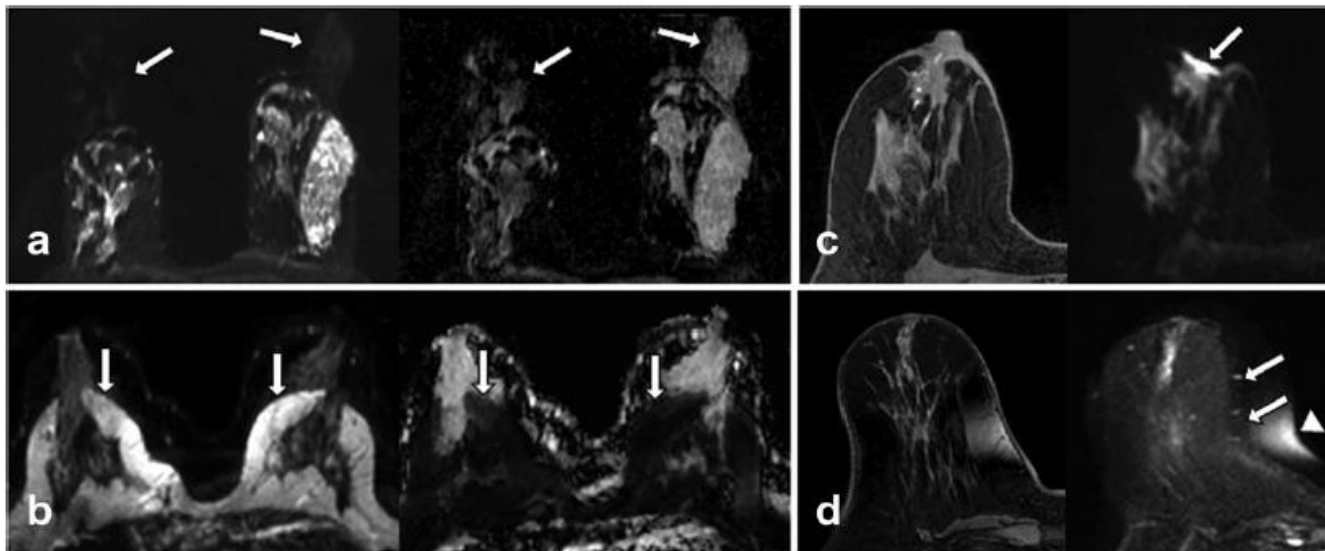
J Magn Reson Imaging. Author manuscript; available in PMC 2018 February 01.

Published in final edited form as:

J Magn Reson Imaging. 2017 February ; 45(2): 337–355. doi:10.1002/jmri.25479.

Diffusion-weighted Breast MRI: Clinical Applications and Emerging Techniques

Savannah C. Partridge, PhD^{1,2}, Noam Nissan, MD, PhD³, Habib Rahbar, MD^{1,2}, Averi E. Kitsch, BS^{1,2}, and Eric E. Sigmund, PhD⁴





frontiers
in Oncology

MINI REVIEW
published: 28 October 2016
doi: 10.3389/fonc.2016.00217

Check for updates

Clinical Breast MR Using MRS or DWI: Who Is the Winner?

Francesco Sardanelli^{1,2}, Luca Alessandro Carbonaro¹, Stefania Montemezz³, Carlo Cavedon⁴ and Rubina Manuela Trimboli¹*

	pooled sensitivity	pooled specificity
1H-MRS	71-74%	78-88%
DWI	84-91%	75-84%



Protocolli abbreviati



Esigenza pratica:

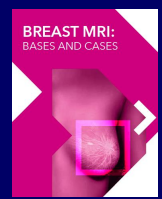
> cost-effectiveness della RM mammaria

> disponibilità e la fruibilità

Trasformare la RM da esame “di nicchia” in un potenziale strumento di screening

Razionale:

- 1) Il 90% dei carcinomi invasivi presenta picco di enhancement entro i primi 3 minuti
- 2) Acquisizione pre e singola post-contrasto
- 3) Refertazione “tutto o niente” (1 sottrazione e/o MIP)



Protocolli abbreviati



VOLUME 32 · NUMBER 22 · AUGUST 1 2014

JOURNAL OF CLINICAL ONCOLOGY

ORIGINAL REPORT

Abbreviated Breast Magnetic Resonance Imaging (MRI): First Postcontrast Subtracted Images and Maximum-Intensity Projection—A Novel Approach to Breast Cancer Screening With MRI

Christiane K. Kuhl, Simone Schradang, Kevin Strobel, Hans H. Schild, Ralf-Dieter Hilgers, and Heribert B. Bieling

Purpose

We investigated whether an abbreviated protocol (AP), consisting of only one pre- and one postcontrast acquisition and their derived images (first postcontrast subtracted [FAST] and maximum-intensity projection [MIP] images), was suitable for breast magnetic resonance imaging (MRI) screening.

Methods

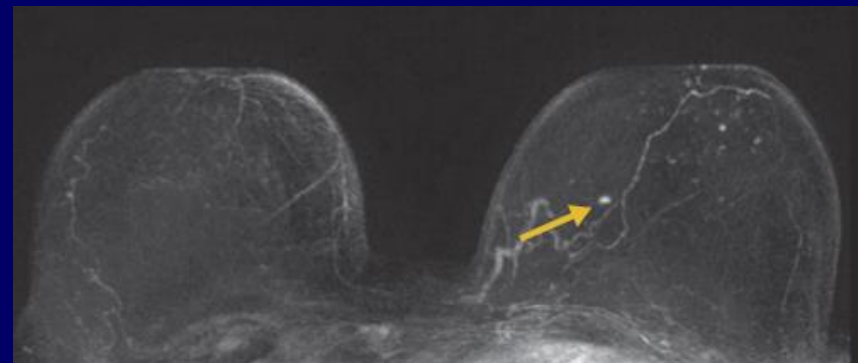
We conducted a prospective observational reader study in 443 women at mildly to moderately increased risk who underwent 606 screening MRIs. Eligible women had normal or benign digital mammograms and, for those with heterogeneously dense or extremely dense breasts ($n = 427$), normal or benign ultrasounds. Expert radiologists reviewed the MIP image first to search for significant enhancement and then reviewed the complete AP (consisting of MIP and FAST images and optionally their nonsubtracted source images) to characterize enhancement and establish a diagnosis. Only thereafter was the regular full diagnostic protocol (FDP) analyzed.

Results

MRI acquisition time for FDP was 17 minutes, versus 3 minutes for the AP. Average time to read the single MIP and complete AP was 2.8 and 28 seconds, respectively. Eleven breast cancers (four ductal carcinomas in situ and seven invasive cancers; all T1N0 intermediate or high grade) were diagnosed, for an additional cancer yield of 18.2 per 1,000. MIP readings were positive in 10 (90.9%) of 11 cancers and allowed establishment of the absence of breast cancer, with a negative predictive value (NPV) of 99.8% (418 of 419). Interpretation of the complete AP, as with the FDP, allowed diagnosis of all cancers (11 [100%] of 11). Specificity and positive predictive value (PPV) of AP versus FDP were equivalent (94.3% v 93.9% and 24.4% v 23.4%, respectively).

Conclusion

An MRI acquisition time of 3 minutes and an expert radiologist MIP image reading time of 3 seconds are sufficient to establish the absence of breast cancer, with an NPV of 99.8%. With a reading time < 30 seconds for the complete AP, diagnostic accuracy was equivalent to that of the FDP and resulted in an additional cancer yield of 18.2 per 1,000.





Protocolli abbreviati



Breast Cancer Res Treat
DOI 10.1007/s10549-017-4264-y



CLINICAL TRIAL

Abbreviated breast dynamic contrast-enhanced MR imaging for lesion detection and characterization: the experience of an Italian oncologic center

Antonella Petrillo¹ · Roberta Fusco¹ · Mario Sansone² · Marilena Cerbone² · Salvatore Filice¹ · Annamaria Porto¹ · Maria Rosaria Rubulotta¹ · Massimiliano D'Aiuto³ · Franca Avino³ · Maurizio Di Bonito⁴ · Gerardo Botti⁴

Clinical Breast Cancer

Volume 16, Issue 3, June 2016, Pages 207–211



Original Study

Abbreviated Combined MR Protocol: A New Faster Strategy for Characterizing Breast Lesions

Marco Moschetta · Michele Telegrafo, Leonarda Rella, Amato Antonio Stabile Ianora, Giuseppe Angelelli

accuratezza Fast comparabile a protocollo intero

Journal of the American College of Radiology

Volume 13, Issue 4, April 2016, Pages 374–380

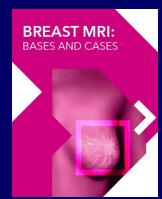


Original article

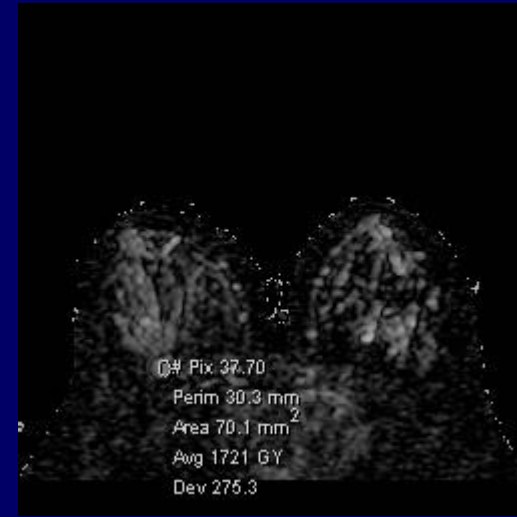
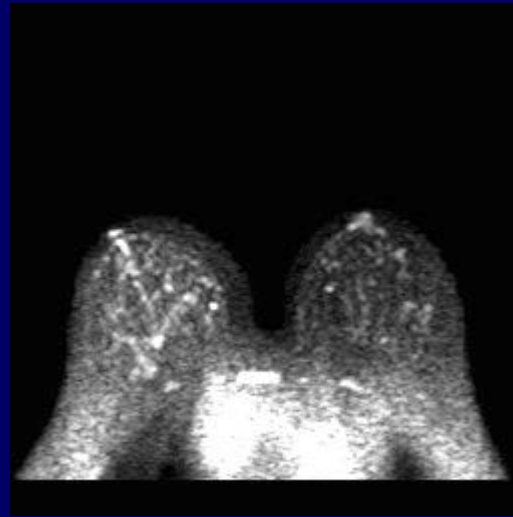
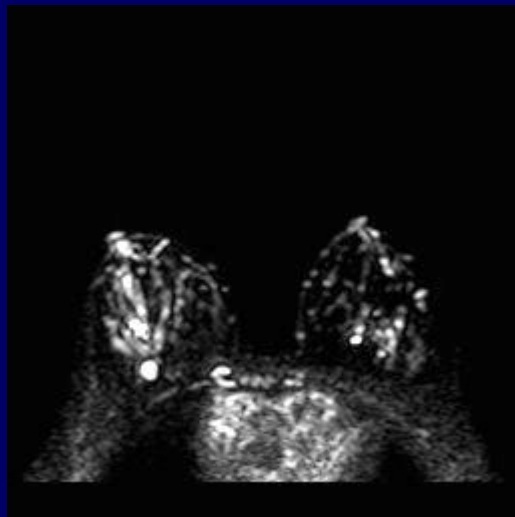
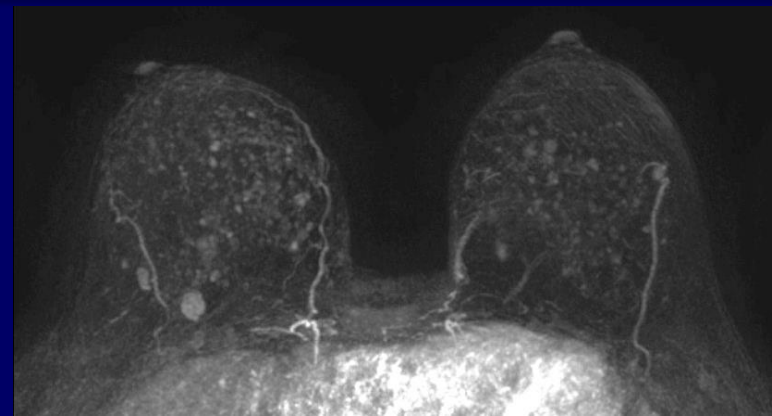
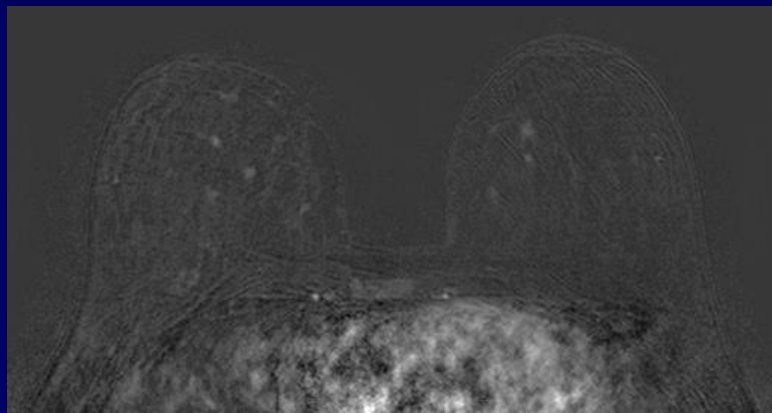
An Abbreviated Protocol for High-Risk Screening Breast MRI Saves Time and Resources

Susan C. Harvey, MD^a · Phillip A. Di Carlo, MD^a, Bonmyong Lee, MD^a, Eniola Obadina, MD^a, Dorothy Sippo, MD^b, Lisa Mullen, MD^a

Solo il 2 % di richiami

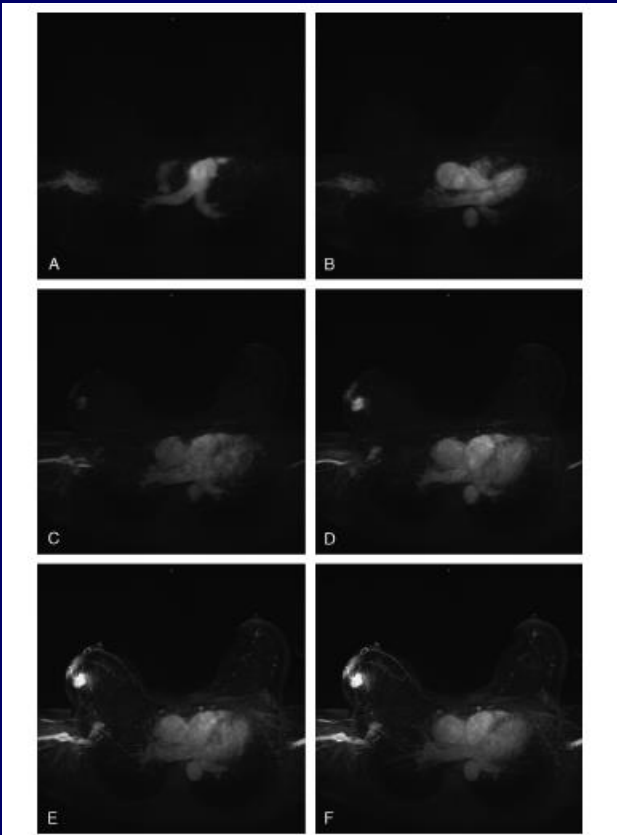


Protocolli abbreviati



Positivo o negativo?

E' possibile coniugare una buona qualità di immagine con elevata risoluzione temporale ?

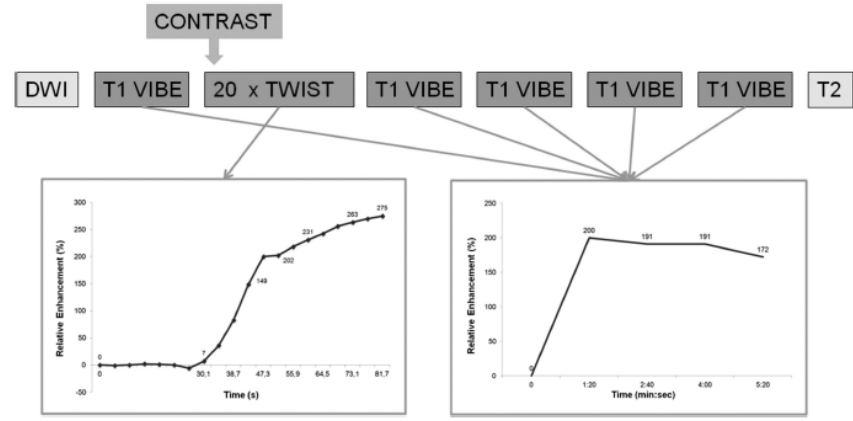


ORIGINAL ARTICLE

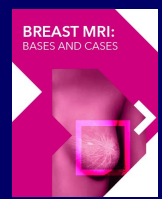
Investigative Radiology • Volume 49, Number 9, September 2014

A Novel Approach to Contrast-Enhanced Breast Magnetic Resonance Imaging for Screening High-Resolution Ultrafast Dynamic Imaging

Ritse M. Mann, MD, PhD,* Roel D. Mus, MD,* Jan van Zelst, MD,* Christian Geppert, PhD,† Nico Karssemeijer, PhD,*‡ and Bram Platel, PhD*



- *Tutti i tumori visibili sia nelle sequenze TWIST che nello studio dinamico standard*
- *Criterio quantitativo TWIST (pendenza curva uptake mdc) + accurato rispetto a classiche curve IS/T*



RM unenhanced



Breast Cancer Detection Using Double Reading of Unenhanced MRI Including T1-Weighted, T2-Weighted STIR, and Diffusion-Weighted Imaging: A Proof of Concept Study

AJR:203, September 2014

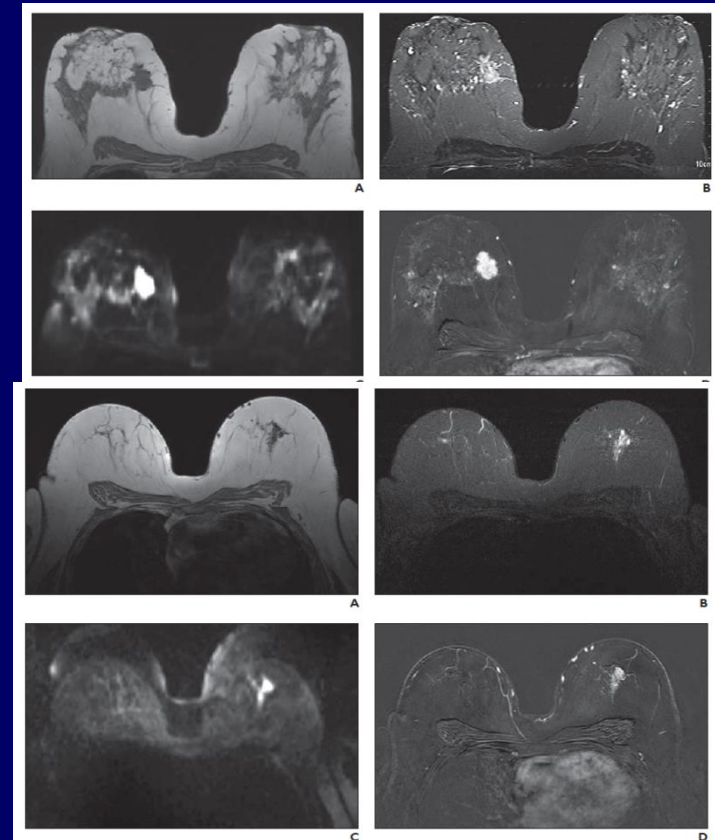
Rubina M. Trimboli¹
Nicola Verardi¹
Francesco Cartia²
Luca A. Carbonaro¹
Francesco Sardanelli^{1,3}

OBJECTIVE. The purpose of this study was to investigate the diagnostic performance of unenhanced MRI in detecting breast cancer and to assess the impact of double reading.

MATERIALS AND METHODS. A total of 116 breasts of 67 women who were 36–89 years old were studied at 1.5 T using an unenhanced protocol including axial T1-weighted gradient-echo, T2-weighted STIR, and echo-planar diffusion-weighted imaging (DWI). Two blinded readers (R1 and R2) independently evaluated unenhanced images using the BI-RADS scale. A combination of pathology and negative follow-up served as the reference standard. McNemar and kappa statistics were used.

RESULTS. Per-breast cancer prevalence was 37 of 116 (32%): 30 of 37 (81%) invasive ductal carcinoma, five of 37 (13%) ductal carcinoma in situ, and two of 37 (6%) invasive lobular carcinoma. Per-breast sensitivity of unenhanced MRI was 29 of 37 (78%) for R1, 28 of 37 (76%) for R2, and 29 of 37 (78%) for double reading. Specificity was 71 of 79 (90%) for both R1 and R2 and 69 of 79 (87%) for double reading. Double reading did not provide a significant increase in sensitivity. Interobserver agreement was almost perfect (Cohen $\kappa = 0.873$).

CONCLUSION. An unenhanced breast MRI protocol composed of T1-weighted gradient echo, T2-weighted STIR, and echo-planar DWI enabled breast cancer detection with sensitivity of 76–78% and specificity of 90% without a gain in sensitivity from double reading.





RM unenhanced



European Journal of Radiology 81S1 (2012) S121–S123



Contents lists available at SciVerse ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

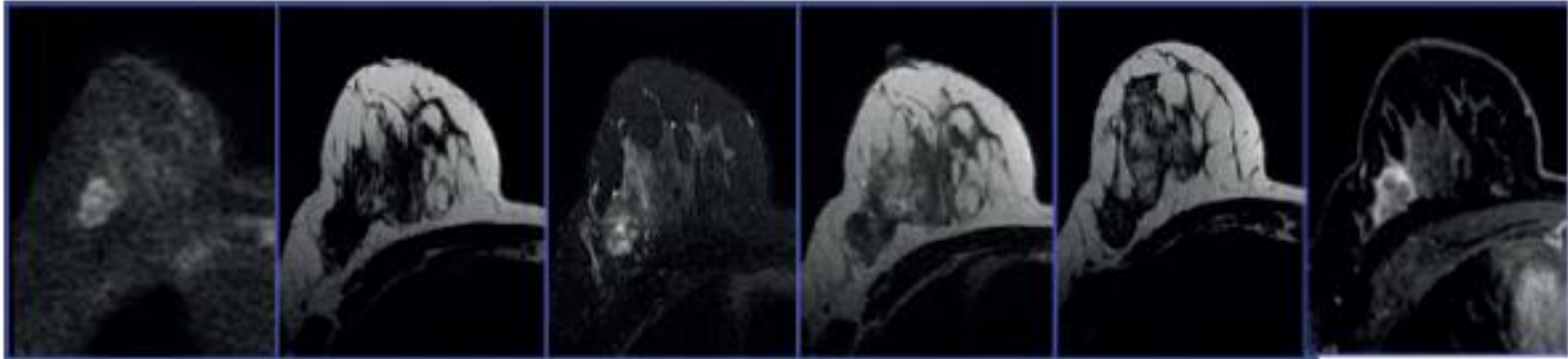


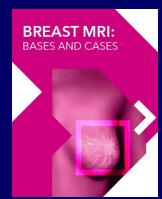
3T

Unenhanced MRI at 3T in neo-adjuvant chemotherapy

Federica Pediconi*, Federica Vasselli, Antonella Roselli, Fulvio Zaccagna, Luisa Di Mare, Carlo Catalano

Department of Radiological, Oncological and Pathological Sciences, Sapienza, University of Rome, Rome, Italy





Imaging Ibrido



Acquisizione PET prona



Clinical Imaging xxx (2015) xxx-xxx

Contents lists available at ScienceDirect

Clinical Imaging

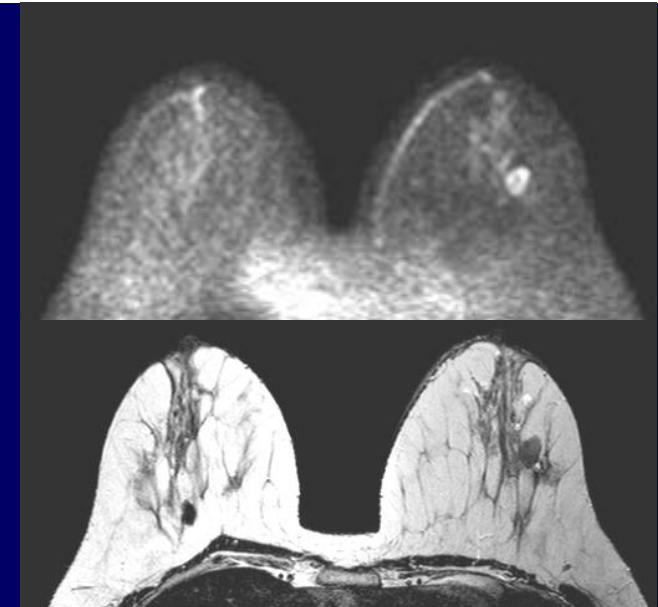
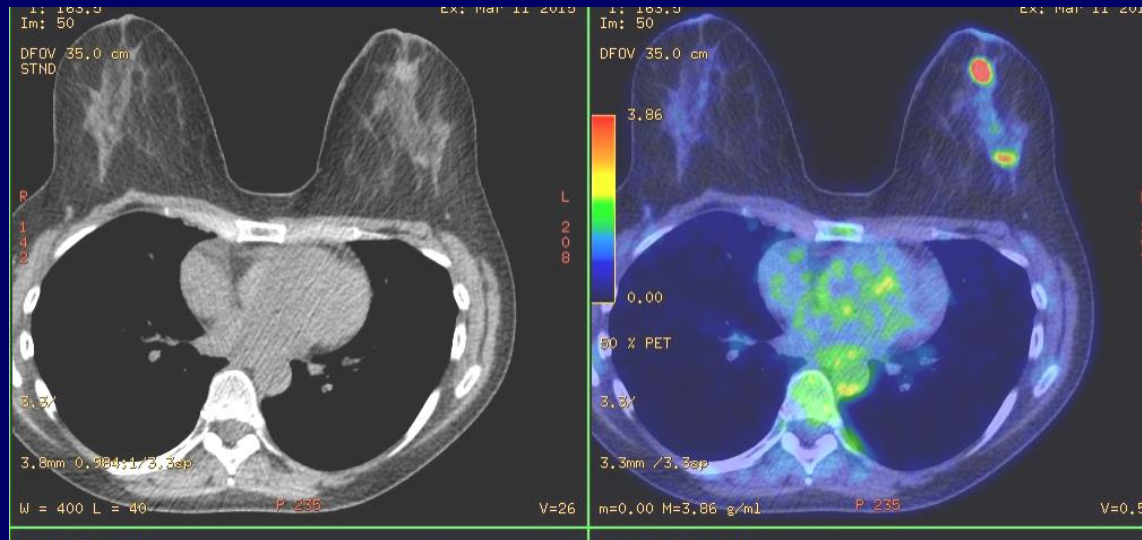
journal homepage: <http://www.clinicalimaging.org>

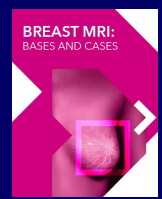
Case report

Prone 18F-FDG PET/CT changes diagnostic and surgical intervention in a breast cancer patient: some considerations about PET/CT imaging acquisition protocol

Carla Canevari ^a, Francesca Gallivanone ^b, Veronica Zuber ^c, Alberto Marassi ^c, Claudio Losio ^d, Luigi Gianolli ^a, Maria Carla Gilardi ^b, Isabella Castiglioni ^{b,*}

^a Division of Nuclear Medicine, IRCCS San Raffaele Scientific Institute, via Olgettina 60, 20132 Milan, Italy
^b Institute of Molecular Biomedicine and Physiology, National Research Council (IBFM-CNR), via Fratelli Cervi 93, 20090 Segrate (MI), Italy
^c Division of Breast Surgery, IRCCS San Raffaele Scientific Institute, via Olgettina 60, 20132 Milan, Italy
^d Division of Radiology, IRCCS San Raffaele Scientific Institute, via Olgettina 60, 20132 Milan, Italy





Imaging Ibrido



Magn Reson Mater Phy
DOI 10.1007/s10334-017-0610-7

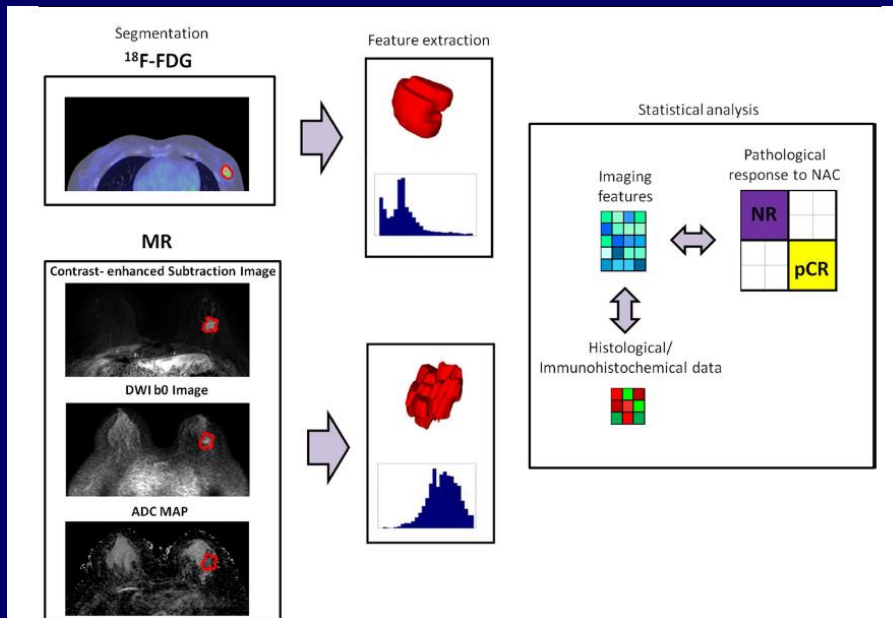
RESEARCH ARTICLE

Biomarkers from in vivo molecular imaging of breast cancer: pretreatment ¹⁸F-FDG PET predicts patient prognosis, and pretreatment DWI-MR predicts response to neoadjuvant chemotherapy

Francesca Gallivanone¹ · Marta Maria Panzeri² · Carla Canevari³ · Claudio Losio² · Luigi Gianolli³ · Francesco De Cobelli^{2,4} · Isabella Castiglioni¹

Estrazione caratteristiche di Texture dalla lesione

Correlazione con fattori biologici e prognostici



MTV [cc]	p << 0,001	V ADC [cc]	1
SUV max [g/cc]	p < 0,05	ADC min [mm ² /sec]	0.8
PVC-SUV [g/cc]		ADC mean [mm ² /sec]	0.6
TLG [g]	p << 0,001	TLD [cm ⁵ /sec]	0.4
Energy [(g/cc) ²]		Energy [(mm ² /sec) ²]	0.2
Entropy	p = 0,05	Entropy	0
Kurtosis		Kurtosis	
Maximum [g/cc]		Maximum [mm ² /sec]	
Mean [g/cc]		Mean [mm ² /sec]	
Mean Absolute Deviation [g/cc]		Mean Absolute Deviation [mm ² /sec]	
Median [g/cc]		Median [mm ² /sec]	
Minimum [g/cc]		Minimum [mm ² /sec]	
Range [g/cc]		Range [mm ² /sec]	
Root Mean Square (RMS) [g/cc]		Root Mean Square (RMS) [mm ² /sec]	
Skewness		Skewness	
Standard Deviation [g/cc]		Standard Deviation [mm ² /sec]	
Uniformity	p < 0,05	Uniformity	
Variance [(g/cc) ²]		Variance [(mm ² /sec) ²]	
Surface area [cm ²]	p << 0,001	Surface area [cm ²]	
Spherical disproportion	p < 0,01	Spherical disproportion	
Sphericity	p < 0,01	Sphericity	
Surface to volume ratio [cm ⁻¹]	p << 0,001	Surface to volume ratio [cm ⁻¹]	



Breast PET/MR Imaging



Amy Melsaether, MD^{a,*}, Linda Moy, MD^b

KEYWORDS

- PET/MR imaging • Breast MR imaging • Breast PET • Breast PET/MR imaging • Multiparametric
- Breast cancer • Whole-body PET/MR imaging

Radiol Clin N Am 55 (2017) 579–589

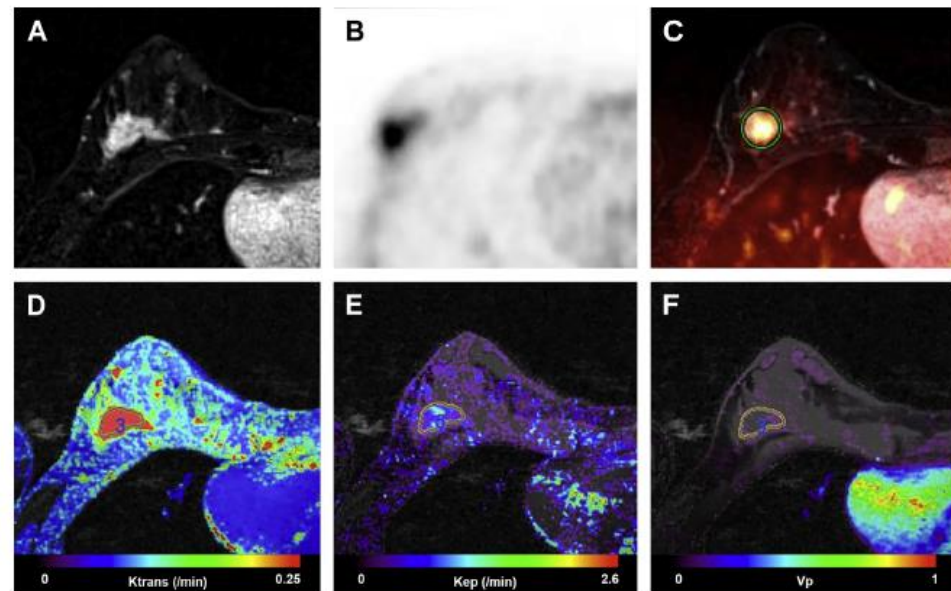
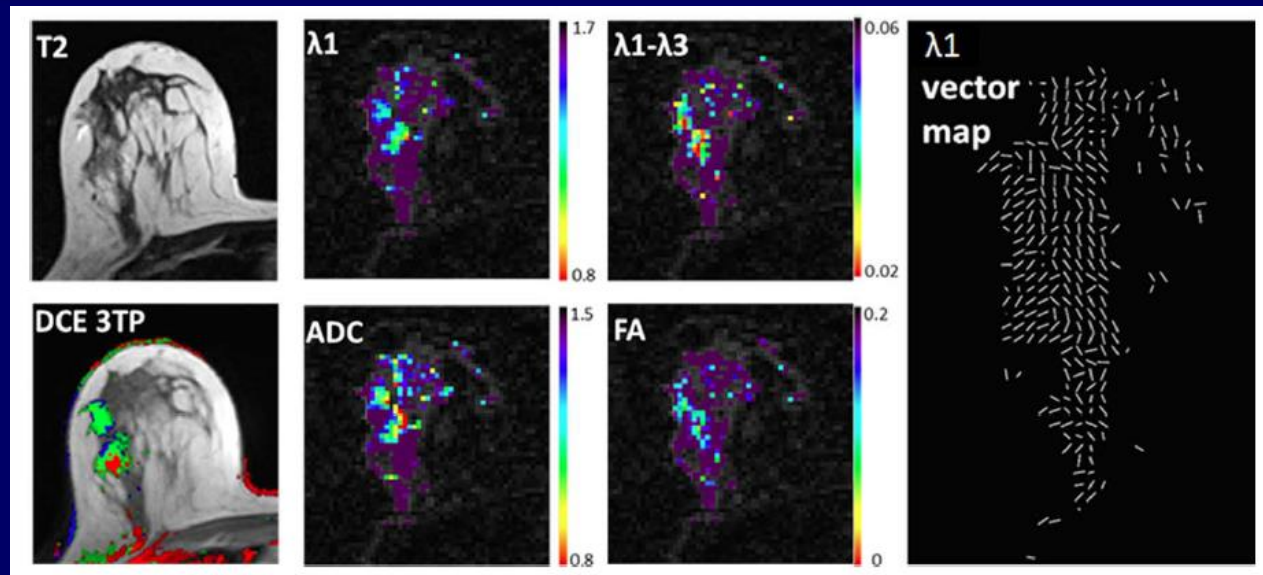


Table 1
Suggested MR imaging sequences by station for whole-body PET/MR imaging in the setting of breast cancer

Station	T1-Weighted Sequences	T2-Weighted Sequences
All	Coronal 3D gradient echo for creation of DIXON-based μ -map	Coronal high-speed turbo spin echo T2
Bone/pelvis	Radial 3D gradient echo, noncontrast preferred, or T1 DIXON (fat-containing lesions)	Axial high-speed turbo spin echo, or Axial 3 b-value DWI
Liver/abdomen	Radial 3D fat-suppressed gradient echo with or without contrast	Axial high-speed turbo spin echo, axial 3 B-value DWI, possible axial fat-saturated T2 (fat-containing lesions)
Lung/thorax	Radial 3D fat-suppressed gradient echo with or without contrast	
Brain/head	Postcontrast magnetization prepared rapid gradient echo Precontrast 3D gradient echo useful for hemorrhage	T2 postcontrast FLAIR (leptomeningeal disease)

Tecniche DWI avanzate

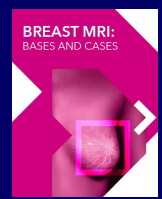


DTI, Diffusion Tensor Imaging

La diffusività dell' H₂O non è omogenea, ma anisotropica

Dotti galattofori consentono una diffusività preferenziale in senso a-p

Presenza di K altera questa architettura



7 Tesla



Special issue review article

NMR IN BIOMEDICINE

Received: 2 October 2014, Revised: 20 January 2015, Accepted: 22 January 2015, Published online in Wiley Online Library: 12 March 2015

(wileyonlinelibrary.com) DOI: 10.1002/nbm.3272

Clinical applications at ultrahigh field (7 T). Where does it make the difference?

Siegfried Trattnig^{a,b*}, Wolfgang Bogner^a, Stephan Gruber^a, Pavol Szomolanyi^{a,c}, Vladimír Juras^{a,c}, Simon Robinson^a, Štefan Zbýň^a and Stefan Haneder^d

Menezes et al. *SpringerPlus* (2016) 5:13
DOI 10.1186/s40064-015-1654-7

SpringerPlus
a SpringerOpen Journal

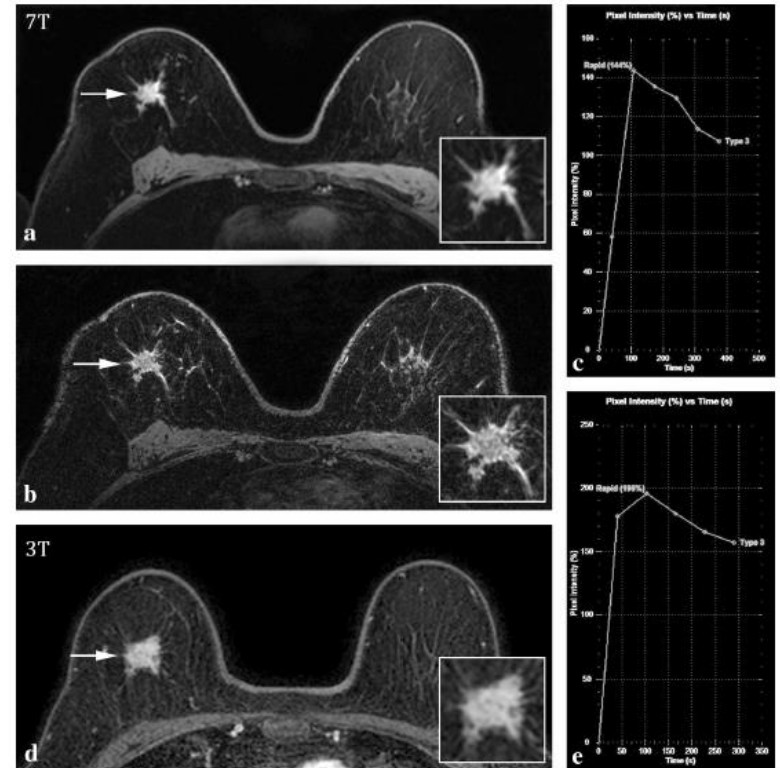
RESEARCH

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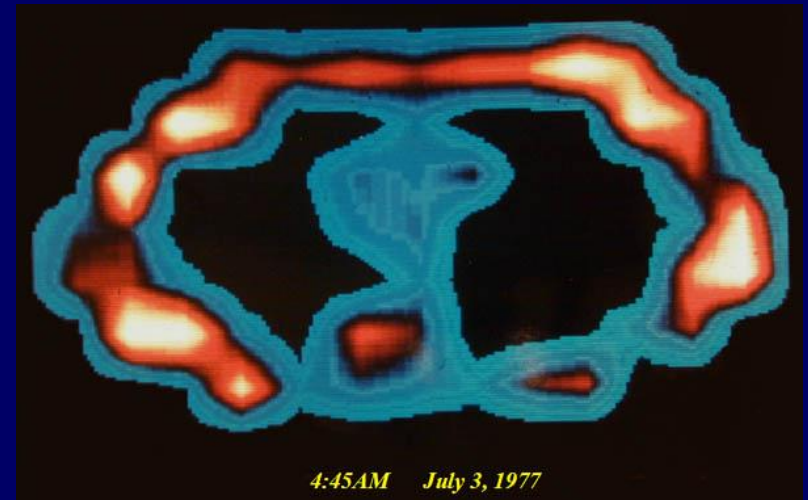


Dynamic contrast-enhanced breast MRI at 7T and 3T: an intra-individual comparison study

Gisela L. G. Menezes^{*}, Bertine L. Stehouwer, Dennis W. J. Klomp, Tijn A. van der Velden, Maurice A. A. J. van den Bosch, Floortje M. Knuttel, Vincent O. Boer, Wybe J. M. van der Kemp, Peter R. Luijten and Wouter B. Veldhuis



Conclusioni





Grazie per la vostra attenzione!

losio.claudio@hsr.it