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INVASIVE CANCER



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SAPIENZA
UNIVERSITÀ DI ROMA



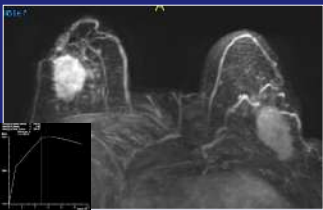
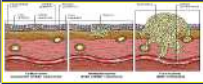

CANCER AND ANGIOGENESIS

- Tumor growth and metastasis depend on angiogenesis
- Angiogenesis is the process by which new blood vessels are formed


CANCER AND ANGIOGENESIS

Dynamic contrast-enhanced breast MRI allows to study the type of enhancement of a lesion

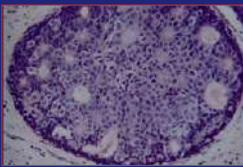
TYPES OF INVASIVE CANCER

- Invasive Ductal Carcinoma not otherwise specified (NOS)** 79%
- Mucinous Carcinoma 2%
- Tubular Carcinoma 2%
- Medullary Carcinoma 5%
- Papillary Carcinoma 1-2%
- Invasive Lobular Carcinoma** 10%




INVASIVE DUCTAL CARCINOMA: IDC

- "invasive ductal carcinoma" refers to cancer that began in the milk ducts, has broken through the wall and begun to invade the tissues of the breast.
- IDC presents different histological features and morphologies
- different histological types can appear in the same lesion




DIFFERENT PROGNOSIS

IDC HAS THE WORST PROGNOSIS THAN THE OTHER BREAST CANCER



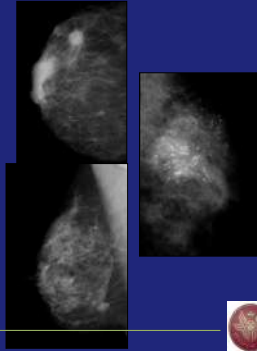
INVASIVE DUCTAL CARCINOMA: IDC

- Irregular shape lesion
- Multifocal in 25-50%
- Multicentric in 15-20%
- Bilateral in 5-8%
- Contralateral (especially if there are LCIS foci)
- Invasion of Cooper's ligaments with skin retraction



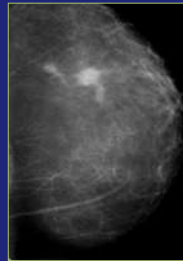
IDC: MAMMOGRAPHIC FINDINGS

- ✓ Ill-defined mass with spiculated margins
- ✓ Amorphous calcifications
- ✓ Architectural distortion



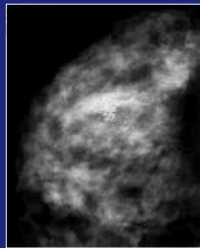
IDC: MAMMOGRAPHIC FINDINGS

- ✓ Spiculated/ill-defined borders
- ✓ Some cases regular borders: but with small irregular, lobulated area or indentation



IDC: MICROCALCIFICATIONS

- 50% of IDC has microcalcification usually for DCIS component of the lesion
- High grade: vermicular (linear), irregular
- Low grade: granular, punctate

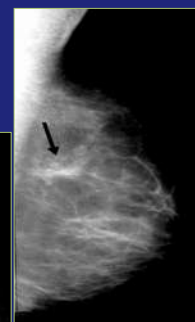


The extension of microcalcification is correlated with the extension of disease in the cases of high grade cancer



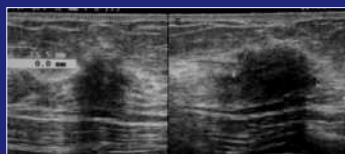
IDC: ARCHITECTURAL DISTORSION

In some cases there is an architectural parenchymal distortion or asymmetry



IDC: ULTRASOUND

- Hypoechoic mass with irregular margins
- Inhomogeneous internal echoes
- Ratio of length to anteroposterior diameter lesser than 1.4
- Variable acoustic shadowing



IDC: ULTRASOUND



- ✓ High grade lesions have often large size and necrotic central area
- ✓ high vascularization with Color-Power-Doppler



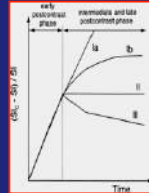
ATTENTION: must be careful to evaluate multifocality, multicentricity and axillary lymph nodes



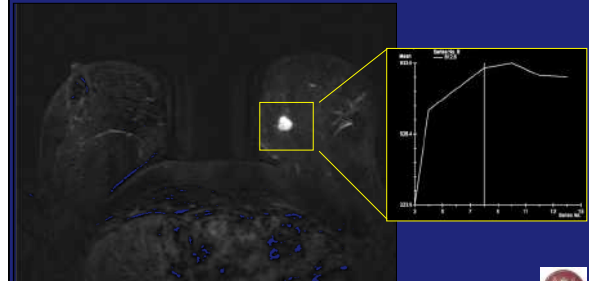
IDC: MRI FINDINGS

Magnetic resonance imaging is highly sensitive in the detection of invasive ductal carcinoma of the breast

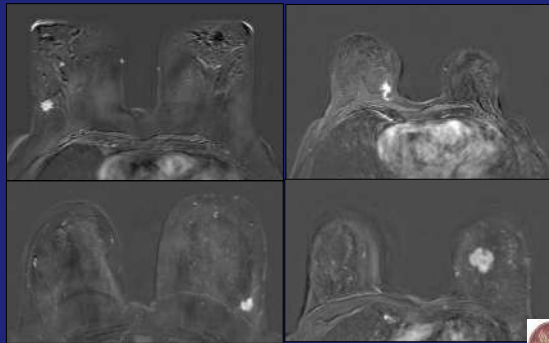
- ✓ irregular or spiculated mass
- ✓ peripheral or rim enhancement
- ✓ irregular enhancement within the mass
- ✓ type II or III of enhancement kinetics



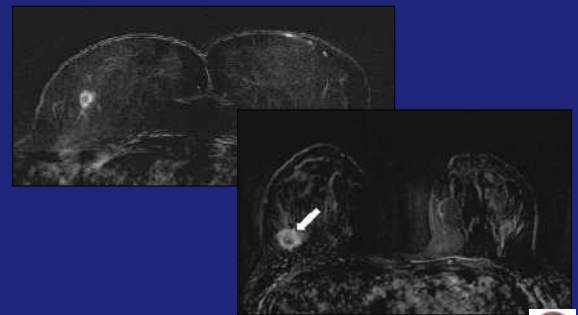
IDC: MRI FINDINGS



IDC: MRI FINDINGS "SHAPE"



IDC: MRI FINDINGS "RIM ENHANCEMENT"



RIM ENHANCEMENT

Original Article

Rim Enhancement of Breast Cancers on Contrast-Enhanced MR Imaging: Relationship with Prognostic Factors

Hiroyuki Inoue^{1,2}, Yoko Kato^{1,2}, Ryoko Kato^{1,2}, Hiroyuki Fukaya^{1,2}, Yoko Sugita^{1,2}, Takuya Takahashi^{1,2}, Atsuhiko Aoki^{1,2}, Yoko Ito^{1,2}, Yoko Kato^{1,2}, Yoko Kato^{1,2}, and Hiroyuki Inoue^{1,2}

¹Department of Radiology, Kagoshima University Graduate School of Medical and Dental Sciences, ²Department of Radiology, Kagoshima University Graduate School of Medical and Dental Sciences, Japan



- ✓ Rim enhancement in breast cancer is associated often with metastatic lymph nodes, vascular infiltration, histological type, size of tumor and prognostic factors.

- ✓ Breast MRI allows to evaluate locoregional staging and biological activity of the cancer



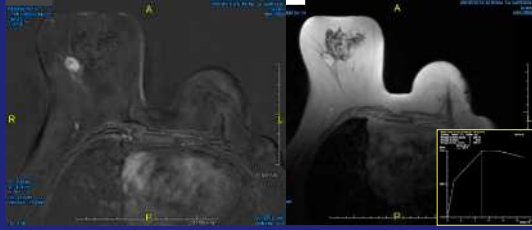
RIM ENHANCEMENT

65yo female with nipple retraction and palpable bilateral masses



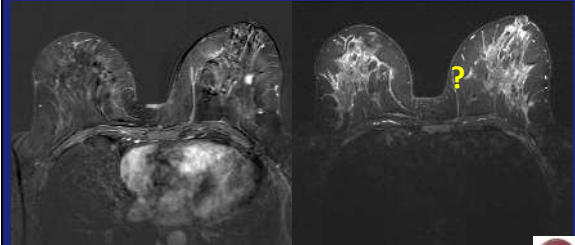
INHOMOGENOUS ENHANCEMENT

42yo female with left mastectomy and spiculated right mass



MRI FINDINGS T2w SEQUENCES

Breast cancer often don't show any alteration on T2w sequences



SUBTYPES OF IDC

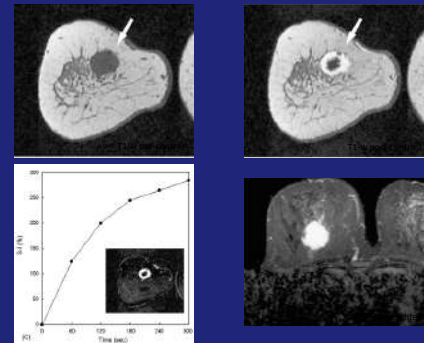
MUCINOUS CARCINOMA

T2-weighted sequences are necessary:

- ✓ High intensity
- ✓ Greater of fatty tissue



MR imaging features of pure mucinous carcinoma of the breast
Takashi Okafuji^a, Hidetake Yabuuchi^{a,*}, Shuji Sakai^b, Hiroyasu Soeda^a,
Yoshio Matsuo^a, Takahiro Inoue^c, Masamitsu Hatakenaka^d, Naoki Takahashi^a,
Syoji Kuroki^e, Enko Tokunaga^f, Hiroshi Honda^g



Okafuji et al, EJR 2006



SUBTYPES OF IDC

TUBULAR CARCINOMA

- ✓ 40-50yo patients
- ✓ Small size, metastasis are rare (well-differentiated variant, good prognosis).
- ✓ Spiculated lesion with delayed rim enhancement
- ✓ MRI is not helpful to differentiate spiculated lesion from other type of tumor or radial scar lesions (frequently associated)

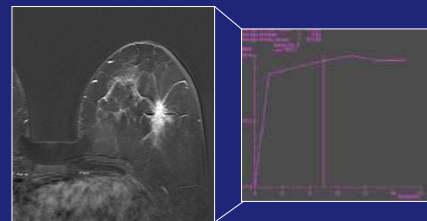
K. Kitagawa et al, AJR 2004



SUBTYPES OF IDC

TUBULAR CARCINOMA

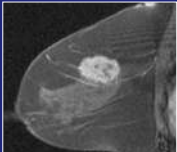
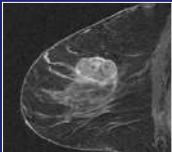
60 yo female with right breast suspicious lesion
Contrast kinetics: Fast enhancement and plateau



SUBTYPES OF IDC

MEDULLARY CARCINOMA

- ✓ lobulated mass with regular borders
- ✓ omogenous or inhomogenous enhancement
- ✓ rim enhancement
- ✓ Kinectics curve type: II/III

J. Tominaga et al, EJR 2008

SUBTYPES OF IDC


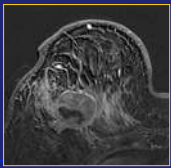
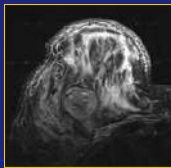
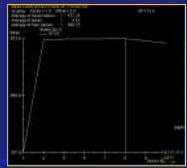
PAPILLARY CARCINOMA

- ✓ It's located in a cyst or in a milk duct with ductal ectasia and corpuscolated/hematic intraductal material
- ✓ When there is a cyst it is defined as "intracystic papillary cancer", low growht and no invasivity
- ✓ No hight enhancement
- ✓ Irregular margin and internal hypointense septation

Nunes LW et al, Radiology 2001

BI-RADS 5


- ✓ Round mass
- ✓ Irregular margins
- ✓ Low T2 signal
- ✓ Fast and heterogeneous enhancement
- ✓ Wash out







INVASIVE LOBULAR CARCINOMA: ILC


Patients with ILC often present with locally advanced disease because it can be difficult to detect it on physical examination or imaging

Histologically, tumor cells infiltrate the stroma in a single file arrangement without formation of a mass or development of associated fibrosis






No mass



Normal clinical examination




Mammography often normal

INVASIVE LOBULAR CARCINOMA: ILC

- ✓ Hight incidence of bilateral, multifocal/multicentric disease
- ✓ Better prognosis than IDC
- ✓ Metastases reach throught circulation bowel, peritoneum, retroperitoneum, pelvis and meninges

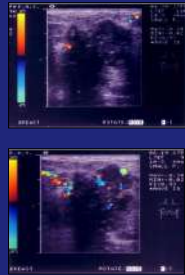
ILC: MAMMOGRAPHICS FINDINGS

- ✓ Asymmetric density or architectural distorsion
- ✓ Mass with stellate margins
- ✓ Microcalcifications only in 1-28% of cases, and frequently represent unrelated histological lesions (IDC, DCIS...)



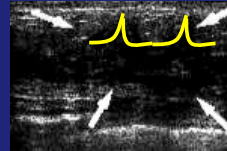
ILC: US FINDINGS

- ✓ Hypoechoic mass with irregular margins
- ✓ Inhomogeneous internal echoes and variable acoustic shadowing
- ✓ high vascularization with Color-Power-Doppler



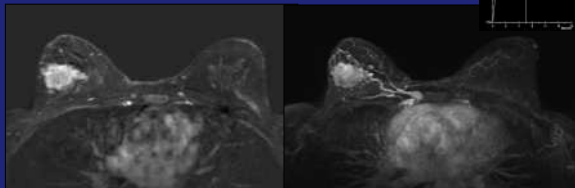
ILC: US FINDINGS

- ✓ ill-defined area of partial acoustic shadowing is the result of diffusely infiltrating ILC
- ✓ When two or three adjacent Cooper's ligament are involved the hypoechoic or shadowing area can assume a shape similar to the profile of a suspension bridge (*Golden Gate Sign*).



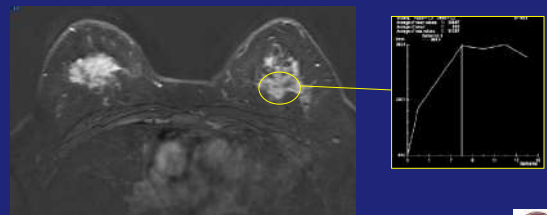
ILC and MRI

- ✓ large enhancing mass with irregular morphology and inhomogeneous enhancement



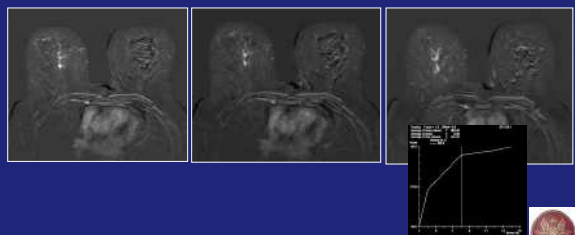
ILC and MRI

- ✓ In about 10%-20% of the cases, the tumor grows diffusely, without forming an actual nodule or mass, and it may present as diffuse, nonmass-related enhancement



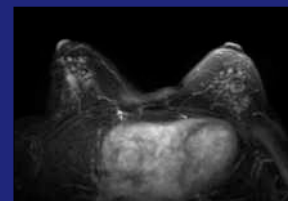
ILC and MRI

- ✓ These types of lobular cancers are not associated with significant angiogenic activity, such that enhancement may be only intermediate, and (rarely) even only low



ILC and MRI

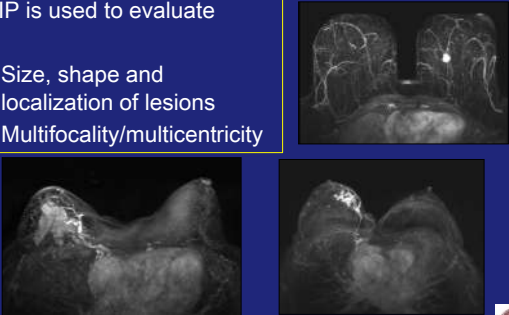

- ✓ in some cases there are foci of enhancement similar to normal parenchymal enhancement



INVASIVE CANCER AND MIP

MIP is used to evaluate

- ✓ Size, shape and localization of lesions
- ✓ Multifocality/multicentricity

INVASIVE CANCER AND MIP


Gadobenate Dimeglumine-enhanced MR Imaging Breast Vascular Maps: Association between Invasive Cancer and Ipsilateral Increased Vascularity!

Analysis of Coronal and Transverse MIP

A score ranging from 0 (absent or very low breast vascularity) to 3 (high breast vascularity) assigned to each pair of images on the basis of the number of vessels seen and the length and conspicuity of the vessels

Sensitivity 88% **VASCULAR ASIMMETRY**


Specificity 82% **MRI INDEX OF INVASIVITY**



INVASIVE CANCER: MRI FINDINGS


Secondary signs of invasivity

- Chest wall/pectoralis infiltration
- Nipple and skin



⚠ Skin and nipple have a normal enhancement

SEE CONTRALATERAL BREAST!!



MRI: LYMPH NODE



AXILLARY NODES AND INTERNAL MAMMARY NODES

BREAST MRI IS NOT THE BEST TECHNIQUE TO EVALUATE PATOLOGICAL LYMPH NODES

Lymph nodes have an high normal vascularization

What to evaluate?

- shape round
- absence of fatty hilum
- asymmetry

ADC-DWI VERSUS PROGNOSTIC BIOMARKERS


Preoperative MRI in 190 pts.

Weak but significant correlation of ADC with ER+ cells % ($r = -0.168$, $P = 0.020$)

Median ADC $\times 10^3 \text{ mm}^2/\text{s}$

ER-	1.110	$P = 0.015$
ER+	1.050	
HER2+	1.190	$P = 0.004$
Luminal A	1.025	
Luminal B/HER2-	1.060	$P = 0.008$
Luminal B/HER2+	1.020	
		$P = 0.183$

Martinić et al, Eur Radiol 2012



PROGNOSIS BY VESSEL ANALYSIS

Retrospective analysis of **249 BC patients**

Ipsilateral Increased Whole Breast Vascularity associated with all histopath. predictors ($p < 0.018$)

Spiculated margins → ER- (OR = 0.42) and PR- (OR = 0.23)

Rim enhancement → ER- (OR = 3.28) and PR- (OR = 3.01)

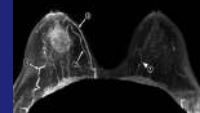

Kinetic curve type III → Higher histological grade (OR = 1.75)

Ipsilateral Increased Breast Vascularity

- Larger tumor size (OR = 2.15)
- LN metastasis (OR = 1.47)
- Distant metastasis (OR = 2.61)
- Higher nuclear grade (OR = 1.49)
- Higher histological grade (OR = 1.46)

AVS → rim enhancement (OR = 10.22)

IIWBV → rim enhancement (OR = 4.23)

MRI AND INVASIVE CANCER

Preoperative staging

- Contribute to complete tumor removal
 - Negative margins, avoid local recurrence
- Detect contralateral breast cancer
 - lobular cancer: 10% within 2 years
 - ductal cancer: 9% within 5 years
- Detect metastases
 - Avoid unnecessary surgery

Staging

MRI BEFORE TREATMENT

- Early detection and diagnosis of breast cancer with histological proof
- Tumor extension prior to treatment
- Pre-operative localization of non palpable masses
 - US guidance for masses
 - Stereotactic guidance for microcalcification



HOW TO DEAL WITH MRI-ONLY LESIONS?

- The lesion will change a lumpectomy into a mastectomy
 - Search the MR lesion at “second look” US and/or magnification views
 - biopsy/US or stereotactic guidance
- The lesion is not seen at 2nd look US or mammo
 - biopsy or localize / MRI or CT guidance

Staging



ROLE OF MRI AFTER TREATMENT

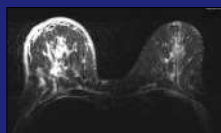
- After neoadjuvant chemotherapy
 - Tumor extension before breast conservation
- After surgery with positive margins
 - Assess residual tumor
- After breast conservation
 - Early recurrence / post-treatment changes
- After mastectomy
 - Control skin and chest wall



RESIDUAL DISEASE

Residual carcinoma is suspected when the initial attempt at surgical resection is incomplete.

Even with accurate preoperative needle localization, the positive margin rate is high because there is often incomplete knowledge of the true extent of the tumor before the operation.

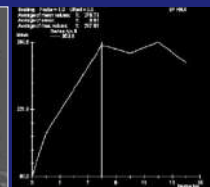
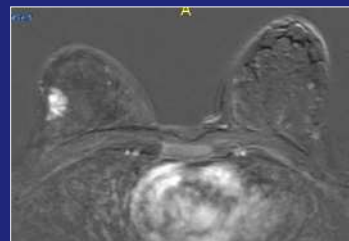


The role of MRI is in the assessment of bulky residual disease at the margin of resection that can direct the surgeon to a particular margin and the assessment of residual disease distant from the lumpectomy site



RESIDUAL DISEASE

45 yo patient with residual invasive ductal carcinoma in same quadrant as lumpectomy site



ROLE OF MRI AFTER TREATMENT

- After neoadjuvant chemotherapy
 - Tumor extension before breast conservation
- After surgery with positive margins
 - Assess residual tumor
- **After breast conservation**
(early recurrence / post-treatment changes)
 - Early recurrence / post-treatment changes
- After mastectomy
 - Control skin and chest wall



FOLLOW-UP AFTER TREATMENT

- ✓ Early post surgical imaging for breast cancer : to detect microcalcification
- ✓ Routine follow-up starts 6 months after end of radiation therapy*
 - yearly mammography up to 10 years
 - ultrasound and clinical examination on chest wall if mastectomy
- ✓ Recurrence rate over 20 years**
 - mastectomy 4-6%, breast conservation 12%

*De Brock GH, J Clin Oncol 2004; 22: 4010. **Veronesi, N Eng J Med 2002;



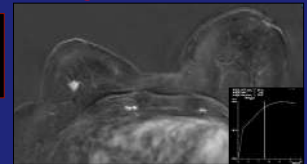
RECURRENCE

- Recurrence occurs in a treated breast following lumpectomy (with negative margins) and usually chemotherapy and radiation therapy (12-36% at 15 y follow-up).
- It is thought to be either due to undetected tumor that was not adequately treated at the time of detection of the index tumor or due to de novo development of cancer.

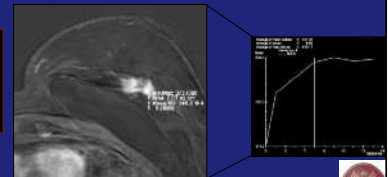


RECURRENCE

65 yo patient with a spiculated mass on mammography, 10 years after breast-conserving therapy for IDC



Four year following quadrantectomy left and mastectomy right for bilateral lobular invasive carcinoma



CONCLUSION

- The use of CE-MRI is to add information about **detection, diagnosis, prognosis, pre-operative and post treatment management** of breast invasive cancer
- Breast MRI is increasingly used and investigated

