Evaluation of tumor size in breast cancer patients using MRI navigated Ultrasound (US)

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Introduction

- *Accurate measurement of tumor size and localization of their extent → essential for surgery*
- *MRI to be most accurate modality**
  - *However, MRI assessments fail to improve postoperative margin status and subsequent local recurrence, even compared with conventional imaging modalities***
- *US : real-time direct information of tumor extent*

** Hata T et al. (2004), Berg WA(2004)*
*** Morrow M (2006)*

Introduction

- *Real time MR navigated US (MRnav US)*
  - *Position tracking system is coordinated with a magnetic sensor*
  - *Synchronize US and MR image*
  - *Provide size information through MRI and tumor location through real-timeUS*

  → *beneficial in tumor extent measurement*

Purpose

- *To evaluate the accuracy of MRnav US for tumor size measurement*
- *To investigate factors influencing the accuracy of MRnav US in comparison with US without MRI navigation*

Materials and Methods

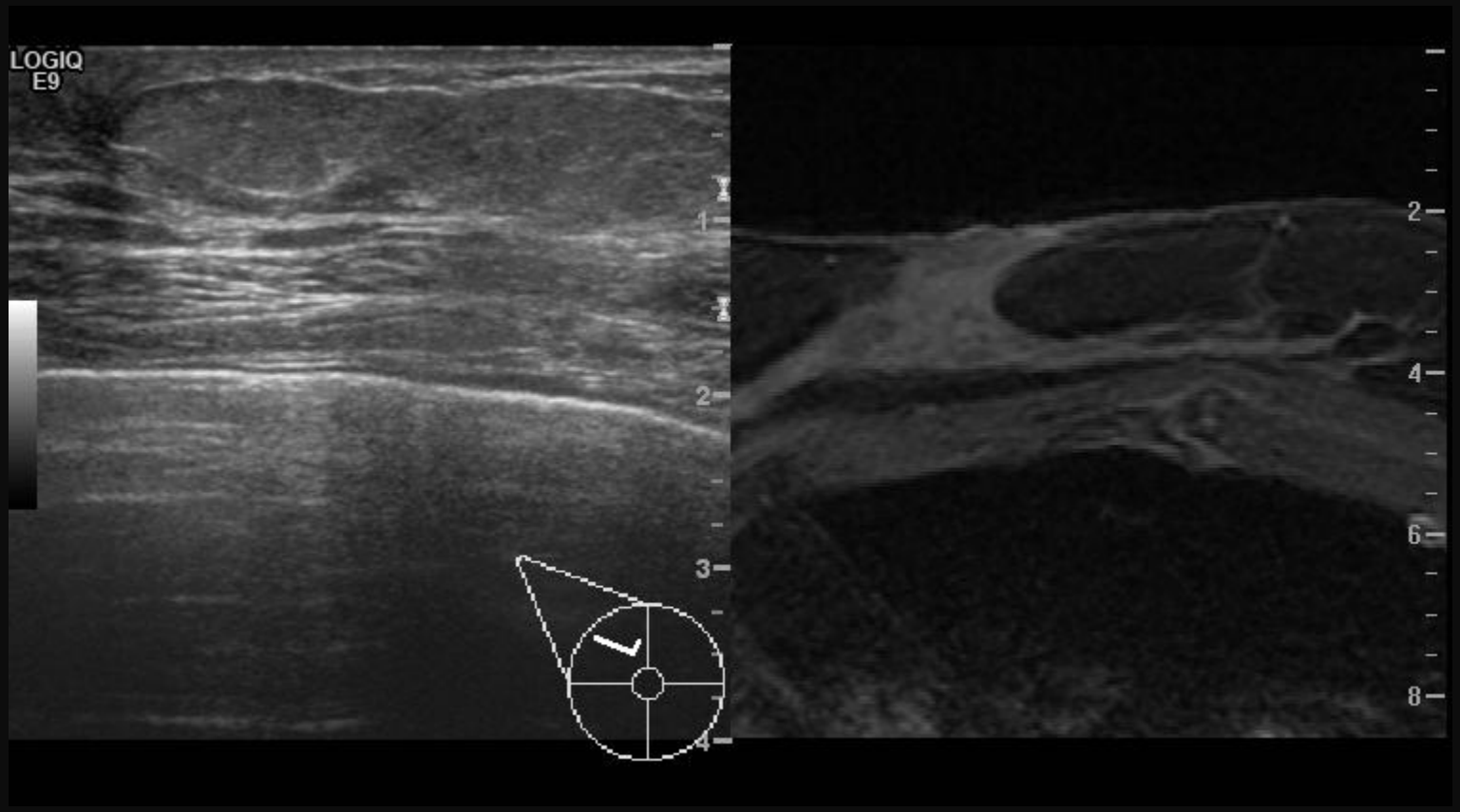
- *Study Participants*
  - *2010.10-2010.12*
  - *53 patients with 60 breast cancers*
  - *Asx (n=18), palpable mass (n=35)*
  - *MG*
    - *Gr 1 (n=5), Gr 2 (n=9), Gr 3 (n=34), Gr 4 (n=5)*
  - *Neoadjuvant systemic chemotherapy (n=17)*
  - *MRM (n = 19), BCS (n = 41)*

Materials and Methods

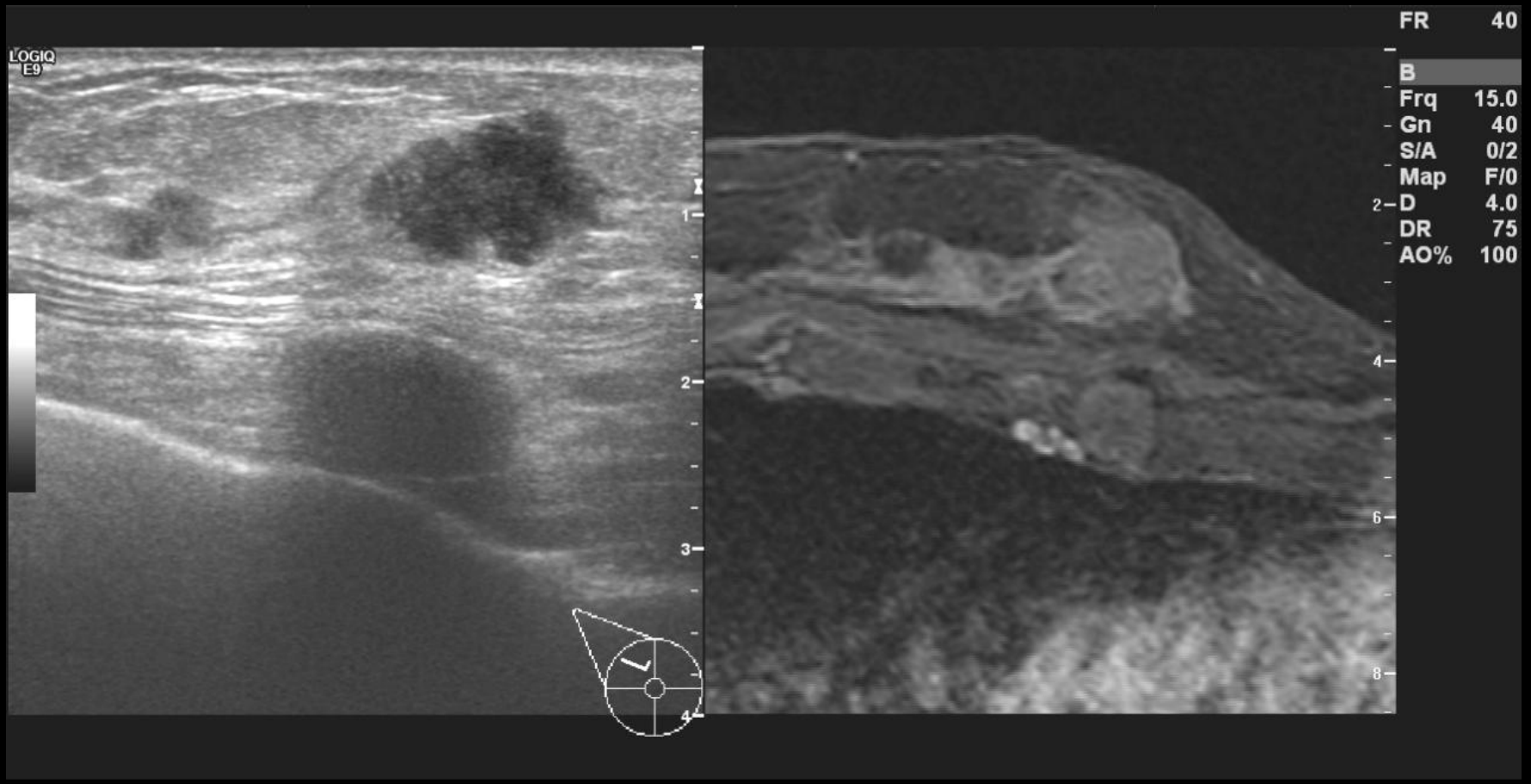
- *Image studies*
  - *MRI : 1.5 T (Signa; GE Medical Systems, Milwaukee, Wis), breast coil, in prone position*
  - *US : 15-6 MHz linear transducer (LOGIQ E9, GE, Milwaukee, USA)*
  - *MRnav US : uploaded volumetric MRI data (DICOM format) in the fusion mode of the US*

Materials and Methods

- *Image evaluation*
  - *Lesion type on MR: mass type vs. non-mass type*
  - *Tumor size on MRI, US, MRnav US*
    - *Tumor size on MRnav US*
      - *suspicious MR-enhancing lesion and corresponding subtle or suspicious changes on MRnav US → included those areas in the tumor extent*
      - *no definite MRI lesion, suspicious lesion on MRnav US → included those areas in the tumor extent*



VNav with supine MR


LOGIQ
E9
FR 40
B
Frq 15.0
Gn 40
S/A 0/2
Map F/0
D 4.0
DR 75
AO% 100

Materials and Methods

- *Pathologic evalution*
  - *Histopathologic, immunohistochemistry results*
  - *Tumor size, marginal status*
  - *ER, PR, HER2 status*

Materials and Methods

- *Accuracy of the tumor extent measurement*
  - *Tumor size on US only, MRnav US correlated with pathology (Pearson's correlation)*
  - *Accurate group vs. inaccurate groups (MRnav US)*
    - *Discrepancy of size (1cm) btw image vs.pathology*
    - *Differences in clinicopathologic variables of the patients*
      - *$\chi 2$ test, Fisher's exact test, and Student's t-test. Logistic regression analysis*

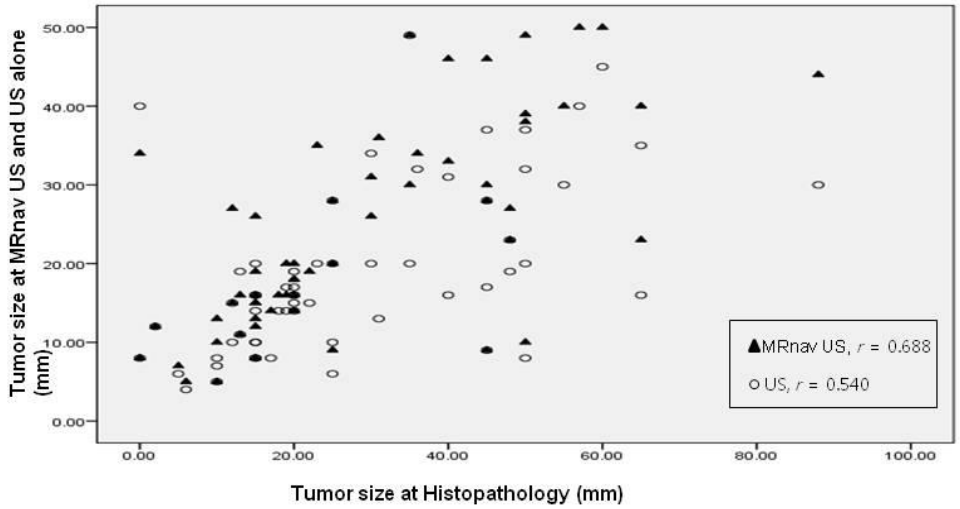
Materials and Methods

- *Factors benefitted from MRnav US than US alone*
  - D_m = | US size-pathology size | - | MRnav US size-pathology size |
  - *Large D_m means MRnav US much closer to pathologic size*
  - *Mean Dm in different groups of clinicopathologic profiles were tested*
    - *Wilcoxon rank sum test, the Kruskal-Willis test, and multiple linear regression analysis with the stepwise selection method*

RESULTS

Results

- *IDC (n= 53), DCIS (n=5), ILC (n=1), metaplastic carcinoma (n=1)*
- *The mean size 2.8 cm (range 0 -8.8 cm)*
- *Margin positive (n=2)*
- *Correlation btw image and pathology*
  - *MRnav US (r = 0.6*
  - *Mean size MRnav*



Results

Percentage of accurate and inaccurate measurements of tumor size with MRnav US and US alone.

Modality	Accurate*	Inaccurate†	
		Underestimation	Overestimation
MRnav US	43 (71.7%)	13 (16.7%)	4 (6.7%)
US alone	38 (63.3%)	20 (33.3%)	2 (3.3%)

** Accurate : difference between the imaging and the histopathologic size of the lesion was less than 1 cm*
† Inaccurate : difference between the imaging and histopathology of the lesion was more than 1 cm, included both underestimation and overestimation

Analysis of clinicopathologic variables of both accurate and inaccurate groups with MRnav US

- *Accurate measurement by MRnav US*

Variable	***Accurate***	***Inaccurate***	***P value***
MR findings			*0.035*
Mass type (n=47)	*37*	*10*	
Non mass type (n=13)	*6*	*7*	
Molecular subtype			*0.025*
LumA (n=35)	*26*	*9*	
LumB (n=10)	*8*	*2*	
HER2 (n=9)	*3*	*6*	
TN (n=6)	*6*	*0*	

Lesion type correlate with molecular subtype

HER2- : mass type vs. HER2+ : non-mass type

Logistic regression analysis: MR finding is only significant factor affecting accuracy

Mean D_m values (difference between US-pathology discrepancy and MRnav US-pathology discrepancy) in tumors of different clinicopathologic variables

Univariate Analysis

Variables	US-pathology discrepancy	MRnavUS-pathology discrepancy	P value
Neoadjuvant chemotherapy			0.0330*
No (n=43)	12.07 ± 13.76	9.72 ± 11.67	
Yes (n=17)	14.12 ± 10.97 →	7.94 ± 9.15	
MR findings			0.0666*
Mass type (n=47)	9.49 ± 10.43	7.06 ± 9.18	
Non mass type (n=13)	24.08 ± 15.17 →	17.00 ± 13.57	

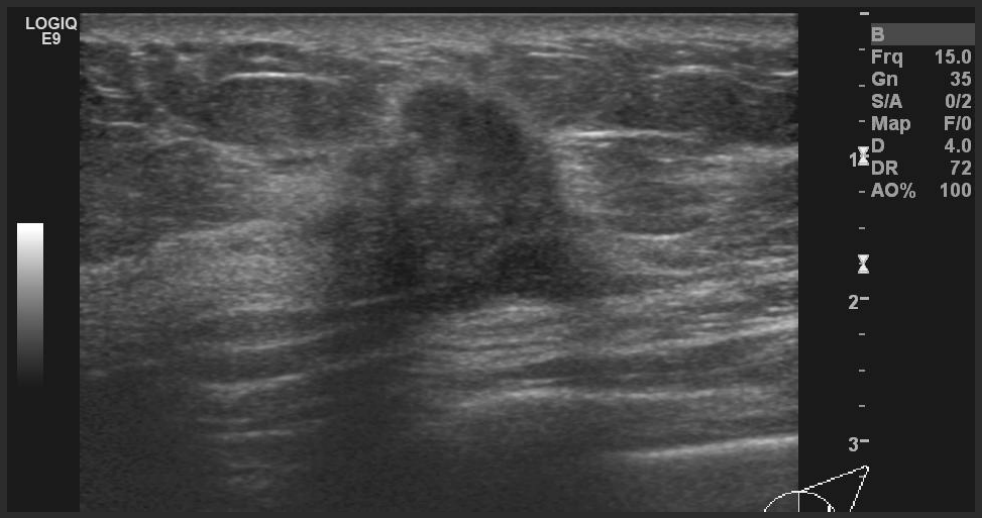
Mean D_m values (difference between US-pathology discrepancy and MRnav US-pathology discrepancy) in tumors of different clinicopathologic variables

Multiple linear regression

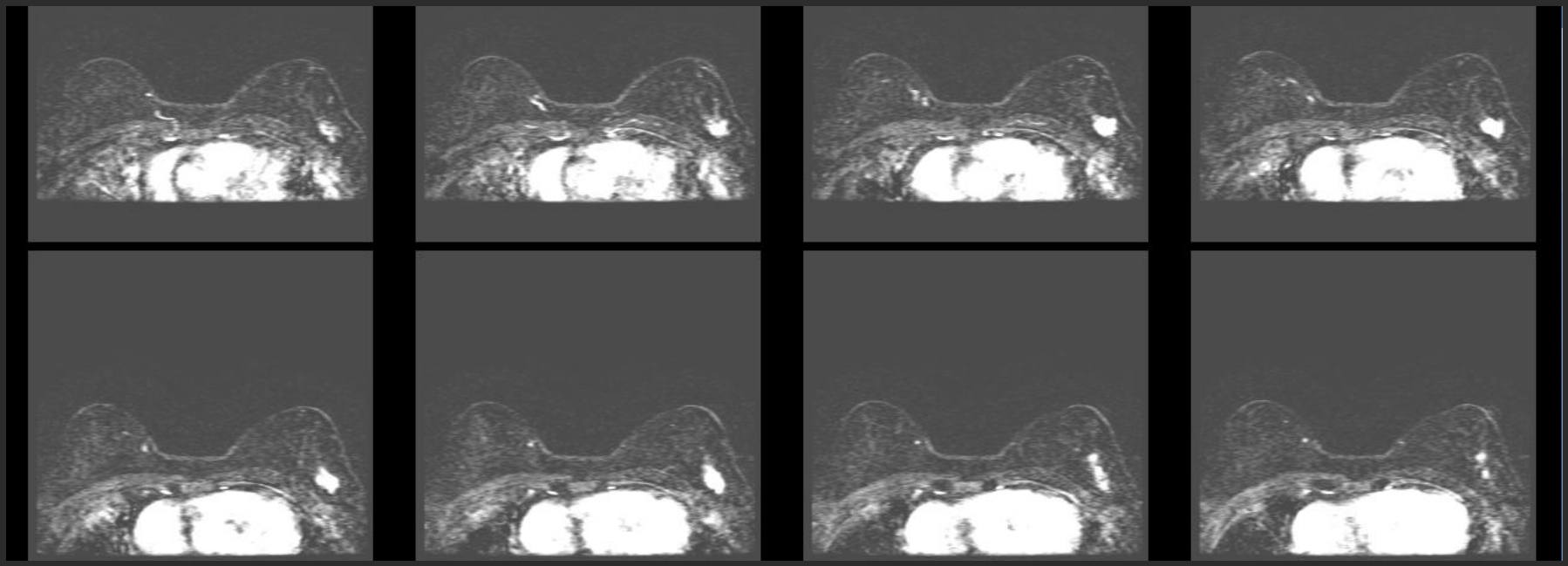
Variables	Parameter Estimate	P value
Neoadjuvant chemotherapy (not performed vs. performed)	5.05	0.011
MR findings (mass vs non-mass)	4.39	0.012

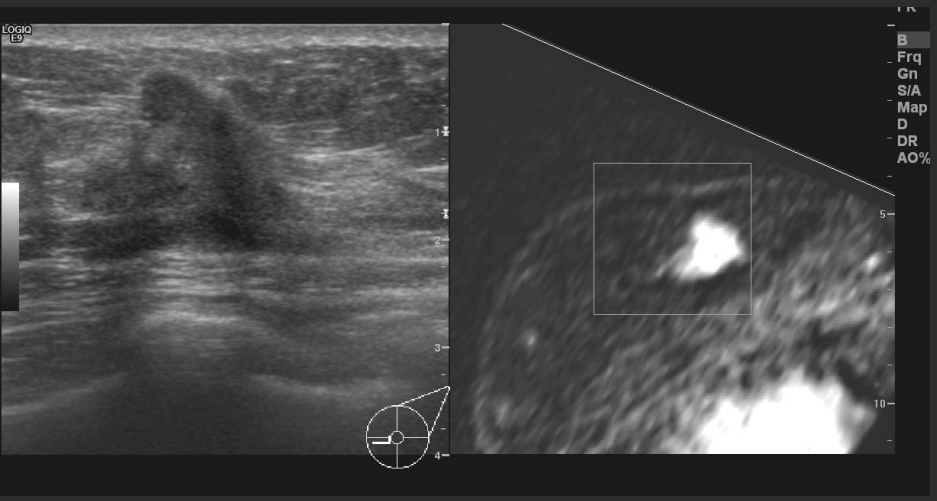
- Non mass type lesion : indistinct margin, hard to identify on US
- Residual tumor after neoadjuvant chemotherapy: US measurement inaccurate

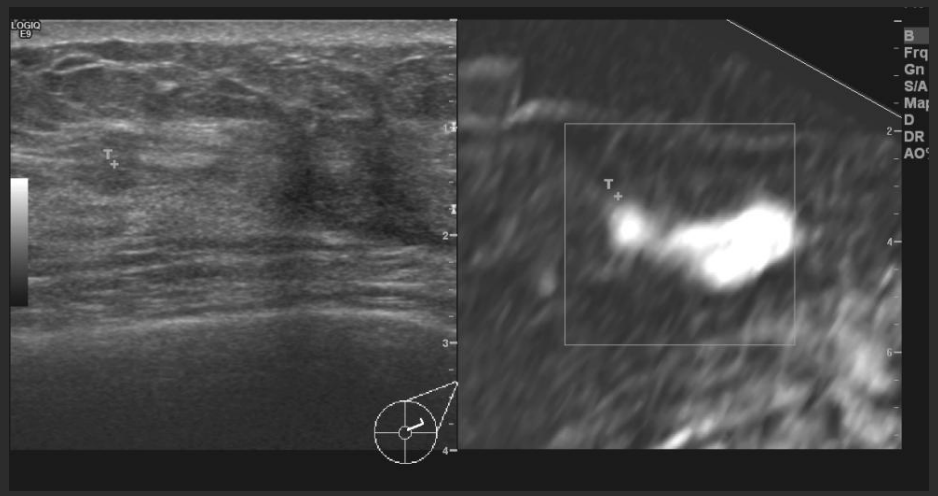
F/51

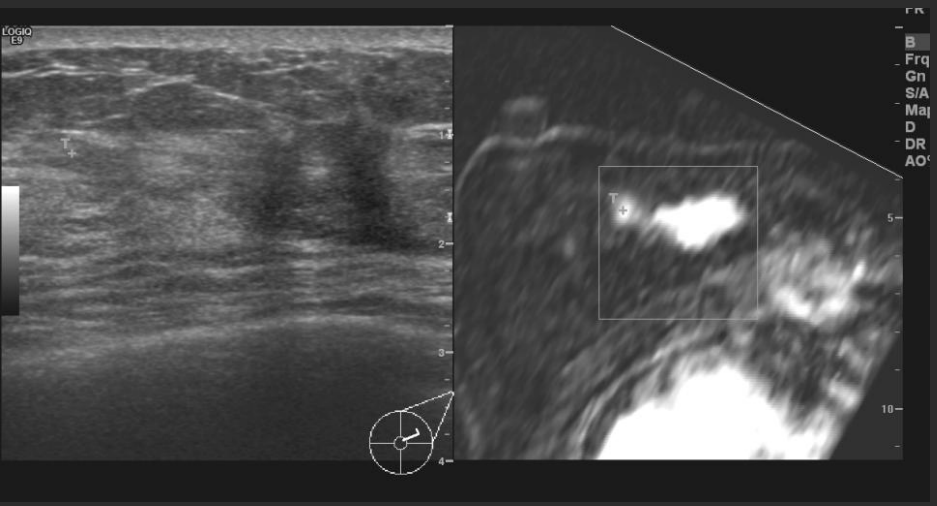


Initial US size: 2x1.8cm









Multiplanar demonstration

Initial US size: 2.0x1.8cm
Revised US size: 3.3x1.6cm
MR size: 3.1x1.8x1.9cm

Path:2.4x1.1x4cm invasive cancer,
DCIS 2.8x1.2x5cm

Conclusion

- *MRnav US predicted tumor extent more accurately than US alone*
- *Lesion type on MRI and molecular subtype were correlated with the accuracy of the tumor size measurements*
- *The accurate measurement of tumor extent by MRnav US may be especially useful for patients who have non-mass type lesions on MRI and who have undergone neoadjuvant systemic chemotherapy*

Thank You for your attention