Breast cancer staging: correlation of automated breast volume scanner (ABVS) and breast magnetic resonance imaging (MRI) findings.

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Learning objectives

This exhibit reviews imaging findings of breast cancer on ABVS and their correlation with MR findings, based on our experience on a large number of histologically proven lesions (including IDC, ILC, invasive mucinous carcinoma and invasive papillary carcinoma) evaluated on both imaging modalities.
Background

Breast cancer remains the most common malignancy in women population in all countries [1]. There is a decline in mortality in several European countries over the last decades. However, an increasing incidence of more aggressive breast lesions with higher stage and worse prognosis in a relatively young women has been reported [2, 3]. Mammography is still the first level imaging examination in association with handheld ultrasound (HHUS) and its still present inherent deficits. The second level gold-standard examination is breast MR imaging [4]. The idea of automated whole breast ultrasound emerged in the late 1970s in order to overcome the limits of the HHUS [5], but only the remarkable technology progress of the last years has lead to significant interest in potential use of ABVS in clinical and also screening setting. Recent studies [6, 7, 8, 9] have shown that this promising method has several advantages over HHUS like less operator dependence, higher reproducibility, multiplanar reconstructions, large field of view, high-resolution volume data but one of its major limitations is the presence of false positive findings.

It was demonstrated that ABVS could have an important role in dense breast screening [10, 11, 12] and also in pre-operative setting [9]. Because of high sensibility of breast MRI [10] and its well established use in pre-operative planning we compare findings in both techniques in order to learn how to evaluate malignant lesions and to avoid false positive cases.
Findings and procedure details

ABVS acquisition details

The ABVS integrated system (ACUSON S2000, ABVS Ultrasound System, Siemens) is equipped with a flat rectangular transducer (5-14 MHz bandwidth), that is situated on a flexible arm with touch screen monitor. The acquisition is done in axial plane. In one sweep it acquires 15.4 cm x 16.8 cm x 6 cm (maximum) volume data sets and slice thickness is 1 mm. For better image optimization the selection of breast cup (A-D) is needed before the acquisition in order to let ABVS to adjust automatically various settings (gain, frequency, depth, e. c.). The patient lies in a supine position and the transducer is applied with a tender compression on the breast in three main views: anterior-posterior, lateral and medial. If needed, for example in case of large breasts, an additional views can be acquired: superior and inferior view or as well special views targeted on the single quadrant with a suspicious finding. All views have to contain nipple as a reference point. Technically well executed exam provides consistent, reproducible, operator-independent ultrasound imaging of the entire breast [13]. The images are evaluated on a 3D working station connected to ABVS where multiplanar reconstructions are available: coronal and sagittal views. Whole exam of both breasts (standard 3 projection per breast) lasts about 15 minutes and the evaluation of a negative bilateral exam takes about 3-4 minutes by experienced reader.

Breast MRI protocol

MR imaging was performed using a 1.5 T MR scanner (Magnetom, Avanto Siemens Medical System, Erlagen, Germany) with a dedicated, bilateral, 7-channels surface breast coil and the patient in the prone position. In case of pre-menopausal patients MR was performed regardless of the phase of menstrual cycle in order not to delay surgery. T1-weighted (T1w) images were acquired on the axial plane using a 3D fast low-angle shot pulse sequence (FLASH); T2-weighted (T2w) images were acquired on the axial plane using a fast spin-echo short-time inversion recovery sequence (STIR). Imaging acquisition parameters are reported in Table 1.

Gadobenate Dimeglumine (Gd-BOPTA - Multihance, Bracco, Milan, Italy) was administered IV as an automated bolus injection at a dose of 0.2 mL/kg body weight at a flow rate of 2 mL/s, followed by flushing of 20 mL of saline. Serial dynamic images were acquired once before injection of contrast agent and five times after the start of injection. After the examination, images underwent post-processing: subtraction of the pre-contrast images from the post-contrast images, multi-planar reconstruction (MPR) and maximum intensity projection (MIP). Curves of the variations time/signal intensity were constructed placing a region of interest (ROI) on detected foci.
Findings - diagnostic approach

Malignant breast lesions seen on pre-operative MR imaging were evaluated through BI-RADS®RM criteria [14] (Table 2). The same lesions were identified also on the following ABVS examination and evaluated through BI-RADS®US criteria [14] (Table 3).

Findings - clinical cases

First case presents an invasive ductal carcinoma in a 44 years old woman between inferior quadrants in periareolar zone of the left breast. MRI (Figure 1) shows mass-like oval lesion with intense and inhomogeneous enhancement, followed by rapid wash-out (RM4) that correlates on ABVS (Figure 2) to a hypoechoic nodule with vertical growth and irregular margins (U5).

Second case shows an invasive lobular carcinoma in a 48 years old woman localized between outer quadrants of the right breast. MRI (Figure 3) presents mass-like irregular ill-defined inhomogeneous and intense lesion (RM4) that is compatible on ABVS (Figure 4) with a large hypoechoic area with indistinct margins and multiple posterior shadowing artifacts (U5).

Case three is a 70 years old woman with palpable nodule characterized as invasive mucinous carcinoma between outer left quadrants. MRI (Figure 5) shows a mass-like lobulated lesion with intense "rim" enhancement and rapid wash-out (RM5) associated with hyperintensity in STIR T2w sequences that confirms mucinous intralesion content. ABVS images (Figure 6) demonstrate an iso-hypoechoic lobulated suspicious lesion (U4) that is not perfectly distinguished from surrounded breast tissue.

Fourth case is an example of invasive papillary carcinoma in 58 years old woman situated in outer-upper quadrant of right breast. Breast MRI shows (Figure 7) small irregular mass-like intense and inhomogeneous lesion (RM4) that is compatible with a tiny hypoechoic irregular lesion (U4) showed by ABVS (Figure 8).
Fig. 1: IDC MRI

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Fig. 2: IDC ABVS

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Fig. 3: ILC MRI

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Fig. 4: ILC ABVS

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Fig. 5: Invasive mucinous carcinoma MRI

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Fig. 6: Invasive mucinous carcinoma ABVS

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Fig. 7: Invasive papillary carcinoma MRI

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Fig. 8: Invasive papillary carcinoma ABVS

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<th>MR Imaging Acquisition Parameters</th>
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**Table 1: MR Imaging Acquisition Parameters**

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**Table 2: ACR BI-RADS®RM criteria [14]**

### Table 3: ACR BI-RADS®US criteria

Conclusion

ABVS and MRI findings correlate closely. ABVS shows peculiar that can be interpreted in the light of MRI appearance, thus avoiding false negative and false positive cases. ABVS has the potential to represent the ideal second-look tool after pre-operative MRI.
References


3. Thangjam S, Laishram RS, Debnath K. Breast carcinoma in young females below the age of 40 years: a histopathological perspective. South Asian J Cancer 2014;2:97-100


