



# 3D Automated Breast Ultrasound (ABUS): The dense breast screening tool and its potential role for preoperative staging

## Introduction

Breast cancer is by far the most common cancer amongst women across Europe, with an estimated 494,000 new cases per year.<sup>1</sup> Since the implementation of routine screening mammography, there has been a 30 percent reduction in breast cancer mortality.<sup>2</sup>

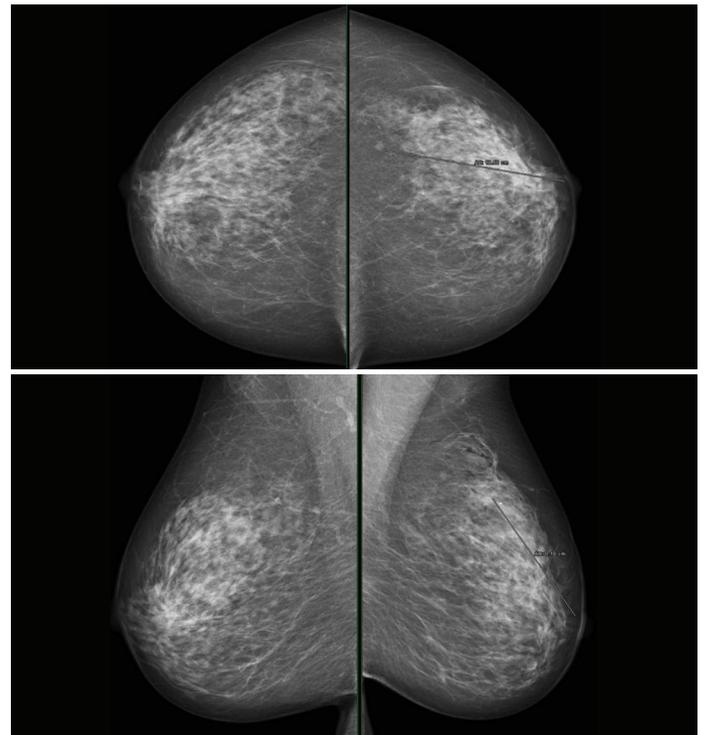
In various screening studies, three-dimensional automated breast ultrasound (3D ABUS) has shown similar cancer detection rates as handheld ultrasound when used as an adjunct to mammography, especially for cancers masked by dense breast tissue.

However, beyond its advantages for breast cancer screening, there is an additional potential role for 3D ABUS for use in preoperative staging for determining tumor extent, multifocality and occult contralateral breast cancer. Accurate preoperative staging could improve breast cancer outcomes by establishing a precise surgical plan.

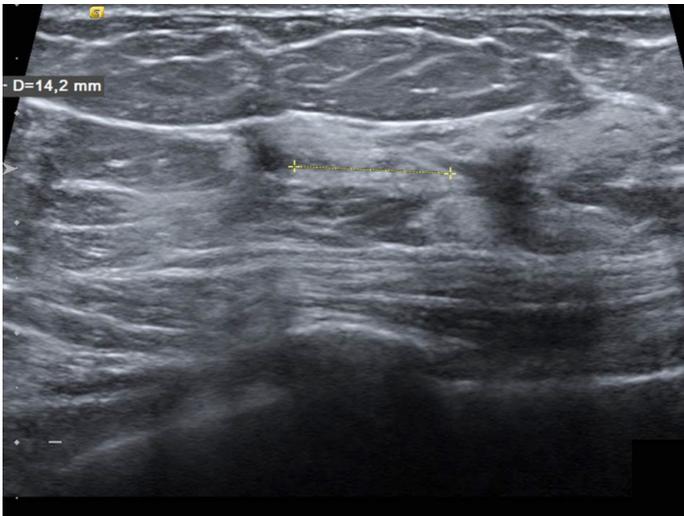
## Case 1

### Presentation

67 year old woman was referred after a screening mammogram for further assessment. The mammogram demonstrated two lesions within 1.5 cm in the left upper outer quadrant. Handheld ultrasound identified two corresponding lesions.

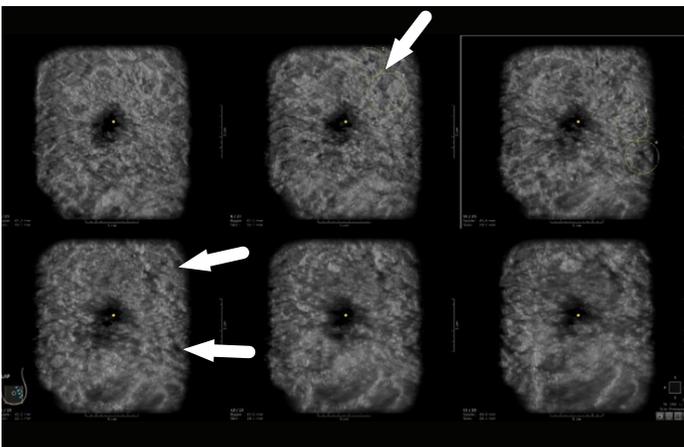


## Case 1 (continued)

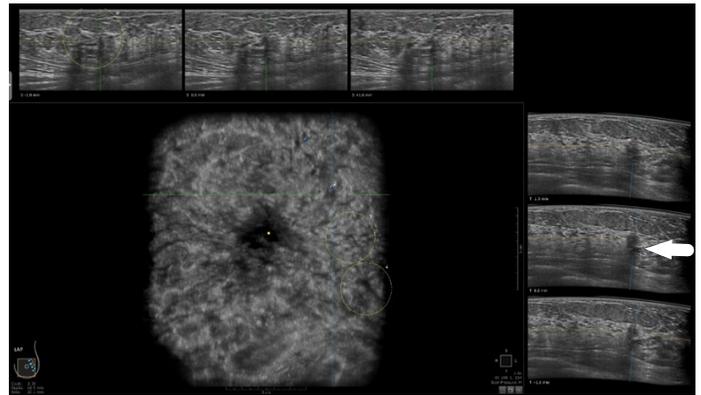


Handheld ultrasound reported and documented two lesions and no architectural distortion

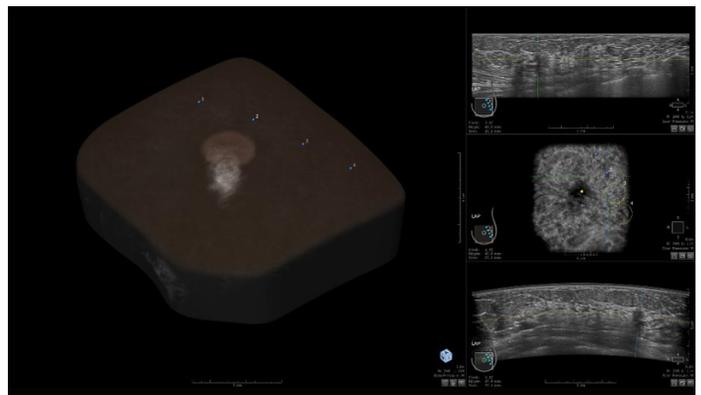
3D ABUS demonstrated the same lesions visualized with handheld ultrasound, plus one additional lesion. The ABUS finding excellently correlated to the preoperative staging MRI. The coronal plane precisely showed the different lesions and the full extension of this multifocal breast cancer with its architectural distortions. Excellent visualization was shown in the coronal plane, but with the multi-planar visualization, these views also provided a detailed description of the different findings and their spatial orientation in relation to the nipple and surrounding breast tissue.



The coronal multi-slice view demonstrates clearly the multifocal breast cancer and relation to the nipple and surrounding tissue



The ROI view confirmed the malignant appearance of the described lesions. Especially in the transversal plane, the typical ultrasound signs for malignancy were apparent with irregular shape, spiculated margin, hypoechoic echo pattern and posterior shadowing



The large volumetric display is very helpful for surgeons to see the overall extension of the multifocal breast cancer in relation to the nipple and the skin for accurate surgical planning

## Final diagnosis with histopathological confirmation

Invasive lobular multifocal breast cancer in the upper outer quadrant of the left breast. The histopathology confirmed the 13 × 8 × 4 cm resection containing 3 tight nodes with 1 × 1.2 cm, 1 × 0.9 cm and 1 × 0.6 cm size. Upper outer quadrant with manifestation of a multifocal, maximum 1.2 cm invasive lobular breast cancer.

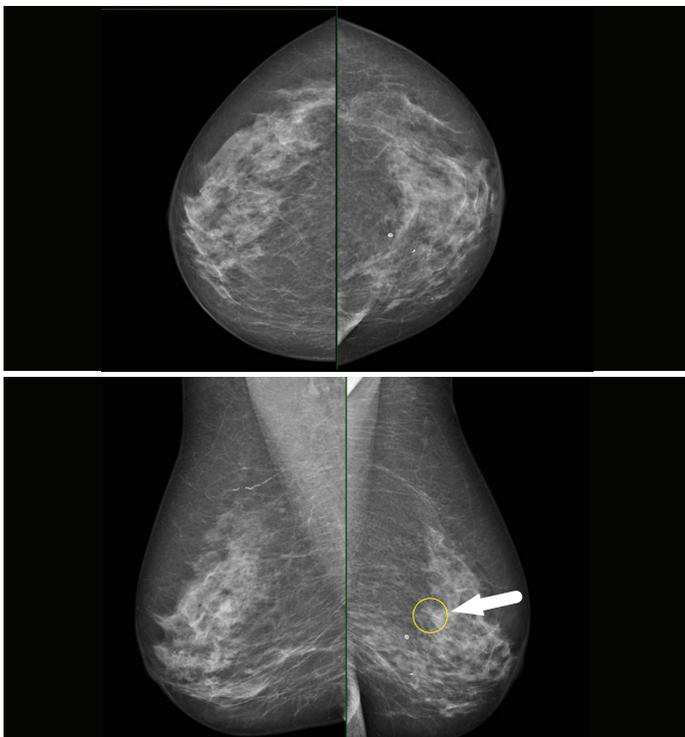
## Treatment and conclusion

The precise diagnosis of the invasive lobular multifocal breast cancer with 3D ABUS and the correlation with the MRI findings changed the surgical plan for the patient, leading into an accurate treatment plan. This accurate staging of this surgery may also decrease the likelihood of contingent recurrence.

## Case 2

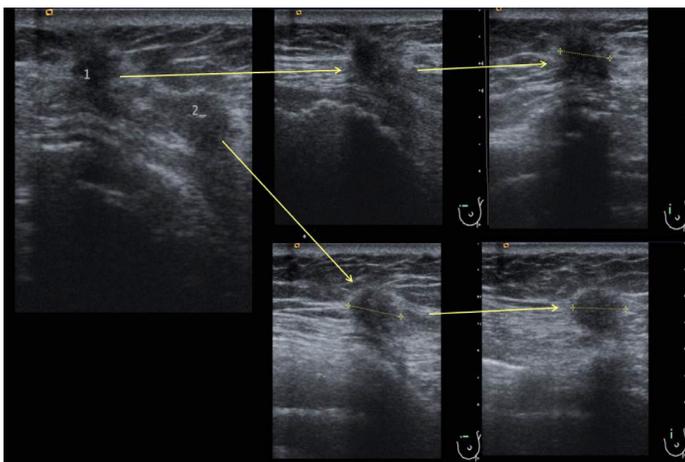
### Presentation

80 year old women, who detected a skin retraction and palpable, small and diffuse nodules during her self-exam. The patient's first imaging exam was a diagnostic 2D FFDM.

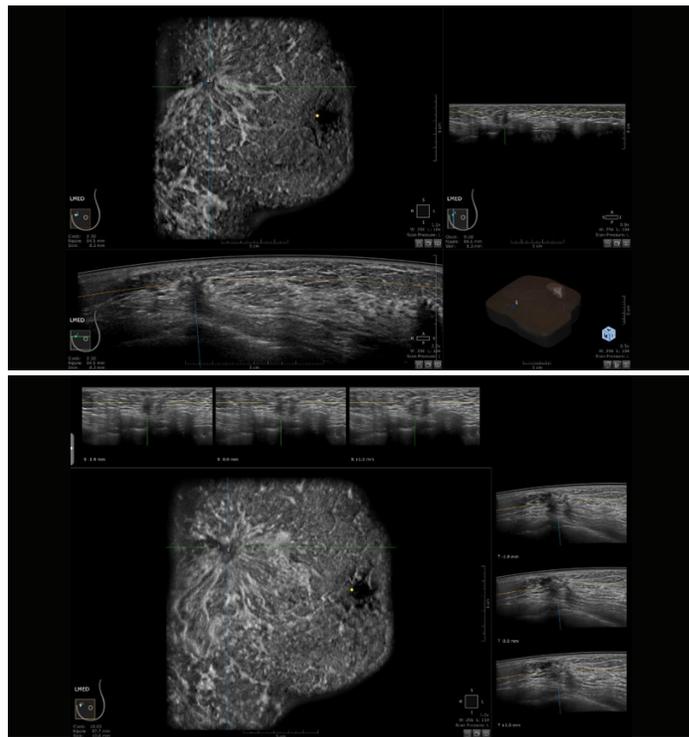


2D FFDM showed one 1 x 7 mm suspicious area with amorphous calcification, but without any architectural distortion in the left breast

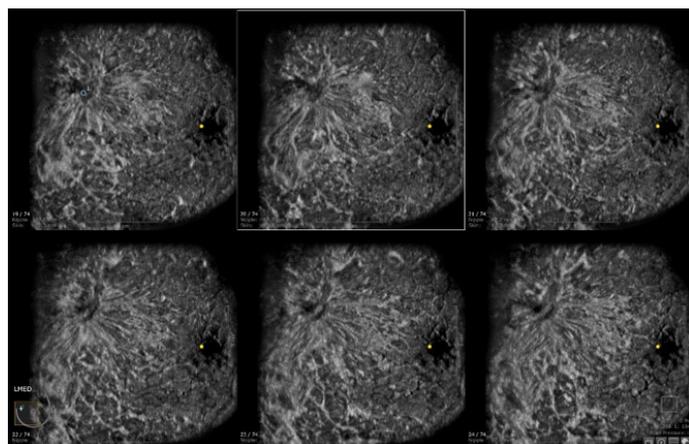
Handheld ultrasound reported two hypoechoic irregular lesions with a maximum size of 12 mm.



In contrast to handheld ultrasound, 3D ABUS reported only one coherent lesion with strong associated architectural distortions. The multiplanar review clearly confirmed no signs of bifocality. The size of the whole tumor was described in greater dimension compared to the two other imaging modalities (FFDM and handheld ultrasound), with a 30 x 13 mm size.



3D ABUS multiplanar and ROI review demonstrated the irregular shape of the lesion, the architectural distortion and the spiculated margin, but confirmed that it was only one lesion without bifocality



The 3D ABUS coronal plane in the multi-slice layout demonstrated clearly the architectural distortion of the lesion as well as the full extension of the tumor

### Final diagnosis and histopathological confirmation

3.5 cm invasive breast cancer on left with 2 extensions. The histopathological report highlighted that the extensions might be misinterpreted by the imaging modalities as bifocality.

### Treatment and diagnosis

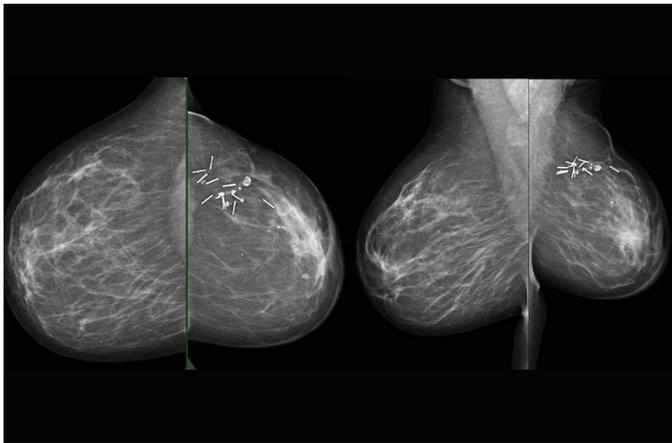
3D ABUS showed superiority versus the other imaging modalities for correct tumor staging in regards to the reported, and the histologically confirmed tumor size under consideration of the full extension, which was correctly displayed in the coronal plane. Additionally, the singularity of the invasive breast cancer was obvious and confirmed with 3D ABUS.

## Case 3

### Presentation

37 year old woman was diagnosed 10 years ago (06/2007) with a pregnancy associated invasive breast cancer. The woman presented in our breast center because of symptomatic signs, with pain in the left breast and a retracted nipple.

2D FFDM showed, after breast-preserving surgery, no other signs of malignancy in comparison to previous examinations. However, the retraction of the nipple was clearly described. The handheld ultrasound exam showed a 20 x 17 mm suspicious lesion in the left breast retro-mamillary area.

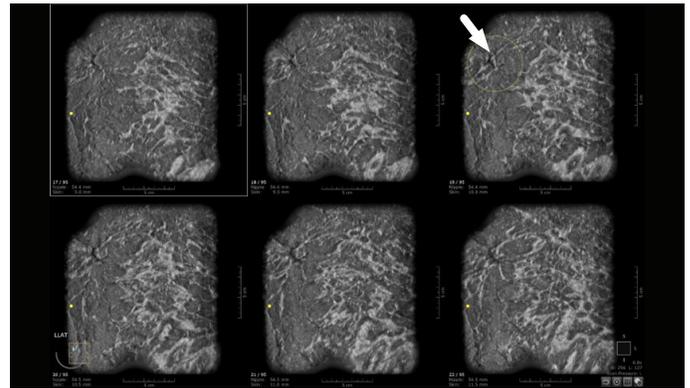


Handheld ultrasound clearly showed a 20 x 17 mm suspicious lesion retro-mamillary

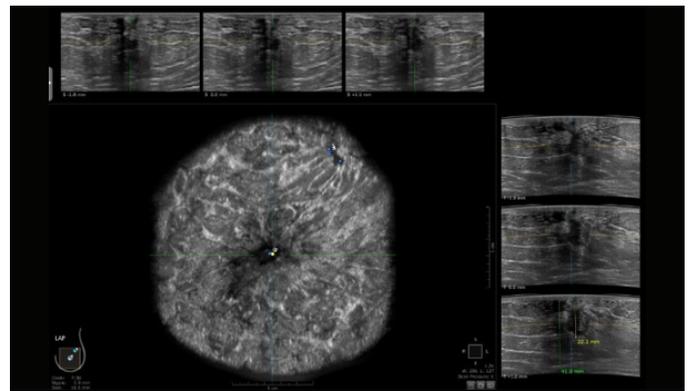
3D ABUS confirmed the finding from the retro-mamillary handheld ultrasound, but reported another finding in the left breast between 1 and 2 o'clock on the LAP (left anterior-posterior) volume. Additionally, ABUS reported shadowing artifacts due to calcifications on the left side and due to fibrosis on the right side. These additional findings were prominent and easily detected in the 3D ABUS coronal plane due to its global view of all the breast tissue.

## Summary

3D ABUS is an established technology that provides valuable clinical information on multifocal breast cancer disease, which may not be easily detected with other imaging modalities. These additional findings with 3D ABUS in the staging phase have the potential to change the treatment plan, providing improved clinical outcomes and a more precise planning strategy for the multidisciplinary teams. Additionally, 3D ABUS offers a



The coronal plane with multi-slice review precisely showed the suspicious lesion between 1-2 o'clock in the lateral volume



The ROI-view demonstrated an additional finding at 1-2 o'clock next to the retro-mamillary lesion

### Final diagnosis and histopathological confirmation

Relapse triple negative breast cancer left retro-mamillary. The mastectomy preparation showed a minimal differentiated invasive breast cancer close to the nipple. Additionally, one ductal cancer in situ was confirmed.

### Treatment and conclusion

A left side nipple-sparing mastectomy was performed. 3D ABUS confirmed the relapse triple negative cancer retro-mamillary which was described with handheld ultrasound, but had not been reported from the 2D FFDM. The additional finding on the left side was correlated to macrocalcifications and scars on mammography.

better survey for the surgeons by depicting the tumor and its surrounding tissue with reference to the nipple in all three planes: transverse, coronal and sagittal. Importantly, the coronal plane visualizes the extent of architectural distortion better than the other planes, and as well as handheld ultrasound, therefore supplements the tumor extent within its tissue landscape. The precise and reproducible definition of the tumor location and automatic calculation of distance to the nipple contributes to preoperative quality assurance.

## About the authors

The Breast Centre Osnabrueck is one of the largest certified breast centers in Germany. It is accredited by the German Cancer Society and as well by the German Senology Society. The multi-disciplinary teams work on diagnosis, therapy and follow-up using the latest standards. The Breast Centre Osnabrueck was also mentioned in the FOCUS list to be one of the best dedicated medical centers, especially for patient satisfaction.

Special thanks to all employees of the Breast Centre Osnabrueck under the lead of Dr. A. von der Assen and the screening practice Suedwest, MD's Drewes and Partners for the great cooperation and providing the mammograms.

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## Imagination at work

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