# E10. New frontiers in breast ultrasound technology

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## Introduction

The progress in two-dimensional high frequency ultrasound (US) transducer technology in combination with compound imaging and speckle reduction leads to new frontiers of high quality three-dimensional volume US. Highlighting the actual status in three-dimensional (3D) and four-dimensional (4D) breast US technology includes tomographic ultrasound imaging (TUI), 3D rendered image information, volume contrast imaging (VCI), inversion mode rendering, virtual computer-aided lesion analysis (VoCal) and extended view (XTD View) documentation. In addition, the three-dimensional vascular assessment helps to differentiate between benign and malignant breast lesions.

## Tomographic ultrasound imaging (TUI)

TUI presents the diagnostic information of a static 3D dataset comparable with CT or MR scans. A topogram shows the spatial position of the slices obtained from the 3D data set and the customised distance between the different slices. [1,2]. TUI is the basis to offer comprehensive diagnostic information of the three-dimensional extent and shape of a lesion.

## Static volume contrast imaging

Static volume contrast imaging deals with a static three-dimensional dataset with preselected slice thickness (1–10 mm). In all three planes, different render algorithms can be applied. [1–3] The contrast between lesion and background structures will be improved in order to obtain accurate measurements.

## Dynamic volume contrast imaging

Dynamic volume contrast imaging is a real-time 4D ultrasound technique which offers thick-slice rendering (6–10 mm slice thickness) or thin-slice rendering (2–4 mm slice thickness). [1,2,4] The render algorithm is a combination of surface- and transparency mode. The Voluson technology (GE Medical Systems Kretz-Ultrasound) offers VCI in the typical 2D ultrasound accessible planes as well as in the coronal plane. VCI-C is the preferred technique to study a lesion and the surrounding tissue under 4D. VCI-C is able to differentiate between a spiculation of the breast mass and a US artefact using sonopalpation. Sonopalpation means to compress and decompress the breast tissue to monitor the movements between the different tissue layers with VCI-C and to study the tissue elasticity.

## Inversion mode rendering

The inversion render mode shows an echo poor lesion in a 50% mixed surface smooth and 50% gradient light algorithm. The result is a coloured 3D model. The inversion mode is a tool which offers quick access to the three-dimensional morphology of the investigated breast lesion. [1,2]

## Virtual computer-aided lesion analysis (VoCal)

The basic principle of volume calculation (VoCal) is to combine geometric surface information with the volume dataset of a lesion. [1–3,5–7] On the condition that the lesion is circumscribed with clear contours, the VoCal software enables automated or manual volume calculation. The surface geometry is defined by rotation of an image plane around a fixed axis. The surface geometry can be visualised as a coloured surface, a wire mesh model or a rendered greyscale surface. Well-defined lesions including fibroadenomas, papillomas or rare, well-defined breast cancers such as medullary or mucous carcinomas can be evaluated by VoCal.

## Extended view (XTD View) documentation

Extended view (XTD View) documentation is a 2D technique that estimates the probe movement through analysis of subsequent images. Based on the computed movement, all images of a sequence can be mapped into a common reference system, thus generating a compound panorama image.[8,9] This technique is used for a precise documentation of a lesion in the breast with one image.

## Vascularisation

The vascularisation of a breast lesion can be investigated using 2D and 3D technique with power-Doppler (amplitude-based colour-Doppler sonography) and frequency-based colour-Doppler sonography, which presents coded colours related to the median frequency-shift combined with the option of spectral-Doppler analysis. Breast cancer has the tendency to produce angiogenetic factors which influence the vessel growth into the tumour. As a consequence of this, neovascularisation inside the tumour and in the peritumoural tissue can be found. The vascular assessment on the one hand has the target to help differentiate between benign and malignant breast tumours. Additionally, it gives information about the degree of neovascularisation, which correlates with the biologic behaviour of the tumour. The analysis of the three-dimensional vascular architecture is an approach for 3D HD-Flow, 3D power-Doppler and 3D colour Doppler studies.[10] 3D power-Doppler imaging provides the analysis of blood flow and three-dimensional vascularisation patterns of the entire tumourous lesion without the limitation of scanning only two-dimensional planes, including the potential problem that the most representative slice might not be scanned. 3D HD-Flow additionally shows the blood flow direction in the three-dimensional vascular architecture. Glass body rendering is a special transparency mode, which makes the grayscale data transparent and displays the colour data of 3D high definition flow (HD-Flow), 3D Power-Doppler and 3D colour Doppler in a surface mode. This mode offers the basis for a detailed study of the three-dimensional vascular supply of the lesion and of the surrounding breast tissue structures.[1,2] In combination with glass body rendering, the vascular architecture in relationship to the tumour extent and the surrounding breast tissue can be investigated. By suppressing the grey scale parameters a three-dimensional angiogram will be obtained.

According to the above mentioned topics, new 2D, 3D and 4D ultrasound technologies are helpful diagnostic tools. Not to be overrun by these new technologies, and to save time, a *diagnostic algorithm* described by Weismann and Datz[9] is the basis to follow a straightforward strategy of breast lesion assessment by diagnostic criteria in order to improve specificity and predictive values of breast US investigations.

## Conclusion

The progression of modern 2D, 3D and 4D breast ultrasound describing different features to analyse lesion morphology, document greyscale information and study the vascular supply makes these techniques important for differentiating benign from malignant breast lesions.

## Conflict of interest statement

There is no conflict of interest.

## References

[1] Weismann C, Hergan K, Aktueller Stand der 3D-/4D-Volumensonografie der Mamma (Current status of 3D/4D volume ultrasound of the breast). *Ultraschall Med* 2007;28:273–82.

[2] Weismann CF. Overview of new ultrasound technology and its application in breast imaging. *EJC Suppl* 2006;4:33–4.

[3] Weismann CF, Multidimensionale Mammasonographie: Technische Aspekte und diagnostische Einsatzmöglichkeiten [multidimensional breast ultrasound: technical aspects and diagnostic indications]. *Ultraschall Med* 2004;5:390–2.

[4] Weismann CF, 4D-Sonographie zur Evaluierung von Mammaläsionen (4D-ultrasound evaluation of breast lesions). *Ultraschall Med* 2005;5:437–8.

[5] Weismann CF. Ultra-som tridimensional da mama. In: Montenegro CAB, Rezende Filho J, Almeida Lima ML, editors, *Ultra-som Tridimensional Atlas Comentado*. Rio de Janeiro: Editora Guanabara Koogan S.A.; 2001, Vol. 6, pp. 151–72.

[6] Weismann CF.Three-dimensional sonography of the breast. In: Kurjak A, Kupesic S, editors, *Clinical Application of 3D Sonography*. New York, London: Parthenon Publishing; 2000, Vol. 24, pp. 215–28.

[7] Weismann CF. Recent advances in multidimensional 3D/4D breast imaging. In: Ueno E, Shiina T, Kubota M, Sawai K, editors, *Research and Development in Breast Ultrasound*. Berlin: Springer; 2005, pp. 146–50.

[8] Scherzer O, Schoisswohl A. A fast and robust algorithm for 2D/3D panorama ultrasound. *Real-Time Imaging* 2002;8(1):53–60.

[9] Weismann CF, Datz L. Diagnostic algorithm: how to make use of new 2D, 3D and 4D ultrasound technologies in breast imaging. *Eur J Radiol* 2007;64:250–7.

[10] Weismann CF. Role of colour Doppler ultrasound in breast imaging. *EJC Suppl* 2006;4(2):41–2.