Breast lesion markers for 3D ultrasound examinations of the breast.

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Aims and objectives

One of the advantages of 3D ultrasound is the possibility to have the whole breast scanned by technicians with batch or remote reporting by a dedicated breast radiologist [1,2]. However, feedback on concurrent focal abnormalities (e.g. palpable lesions) is lost. We therefore aimed to develop skin markers for 3D ultrasound that can be used for marking focal abnormalities without disturbing the interpretation of the 3D ultrasound dataset.

Methods and materials

Marker production:

Markers were molded using a mold that was designed and 3D printed in a rubber-like material, allowing for removal of the resulting markers. Spherical, conical, circular, and disk-shaped variants were molded in different sizes (Figure 1). The material used for the marker is EcoFlex-Gel® (Macungie, Pennsylvania USA), which is a commercially available Room Temperature Curing (RTC) silicon. This silicon proved suitable for US imaging and can also be used as phantom material [3]. After mixing the two components the silicon mixture is poured into the mold and is left to cure for two hours in a vacuum chamber for air removal. When the silicon is fully cured the markers can be removed from the mold for application.

Image acquisition:

3D ultrasound examinations were performed with the patient in supine position using a Siemens Acuson S2000 automated breast volume scanner (ABVS) system (Siemens, Erlangen) (Figure 2). In 5 patients undergoing 3D ultrasound examinations for clinical reasons the same 3D volume was imaged twice, once with and once without a marker in place. Ultrasound acquisition parameters were the same as used in clinical practice and varied between patients based on cup size. Acquisition settings between the scans with and without a marker in place were identical in each patient.

Image assessment:

Markers were assessed by an experienced breast radiologist for ultrasound compatibility using qualitative parameters; detectability, shadowing-, enhancement-, and displacement artifact. Interpretability of the images with and without markers was compared.

Usability assessment:

For application in clinical practice parameters on usability were evaluated. Application and removal of the marker, adhesion to the skin during scanning and material safety were taken into account for evaluation.

Images for this section:

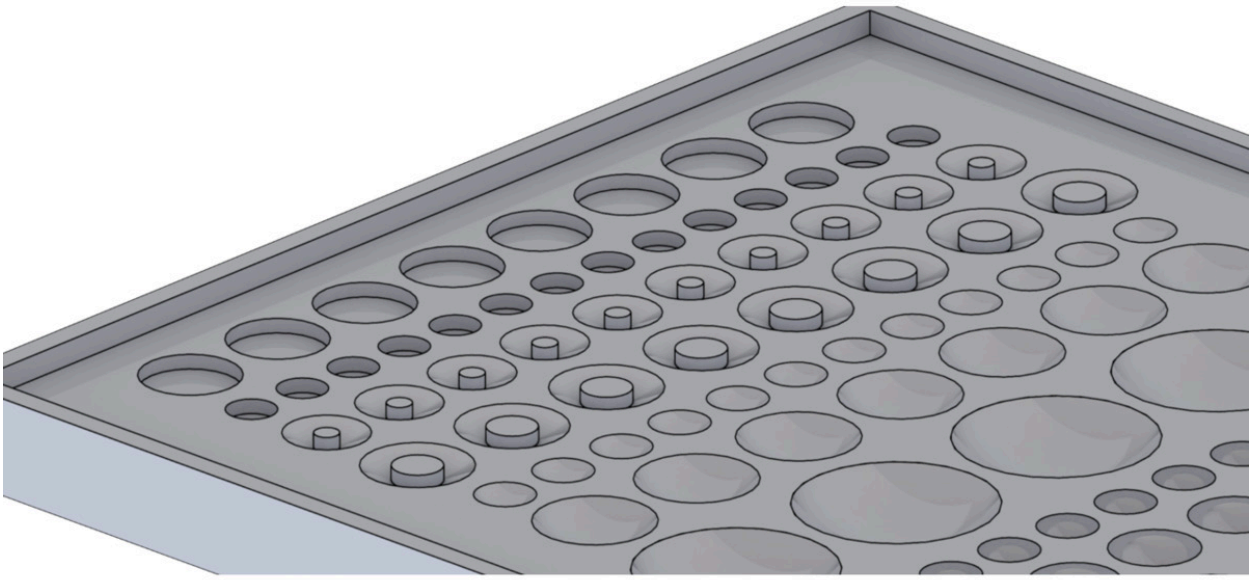

Fig. 1: Mold design used for pouring different sizes and shapes of markers.

Fig. 2: Siemens Acuson S2000 with ABVS arm used for acquisition of 3D ultrasound imaging.

Results

Production and application:

Production complexity of the silicon markers is low. Curing time allowed for effective degassing of the silicon. The markers are safe and easily applied to the skin. Adhesion is sufficient to prevent dislocation during the 3D ultrasound acquisition, multiple sequential acquisitions did not dislocate the marker.

Ultrasound compatibility:

Markers are clearly visible at skin level, presenting as small black circles in the coronal plane (Figure 3). In the transversal and reconstructed sagittal plane marker presence is more subtle (Figure 4 and 5). There is only minimal shadowing at the edges of the marker. This did not affect image interpretability.

Images for this section:

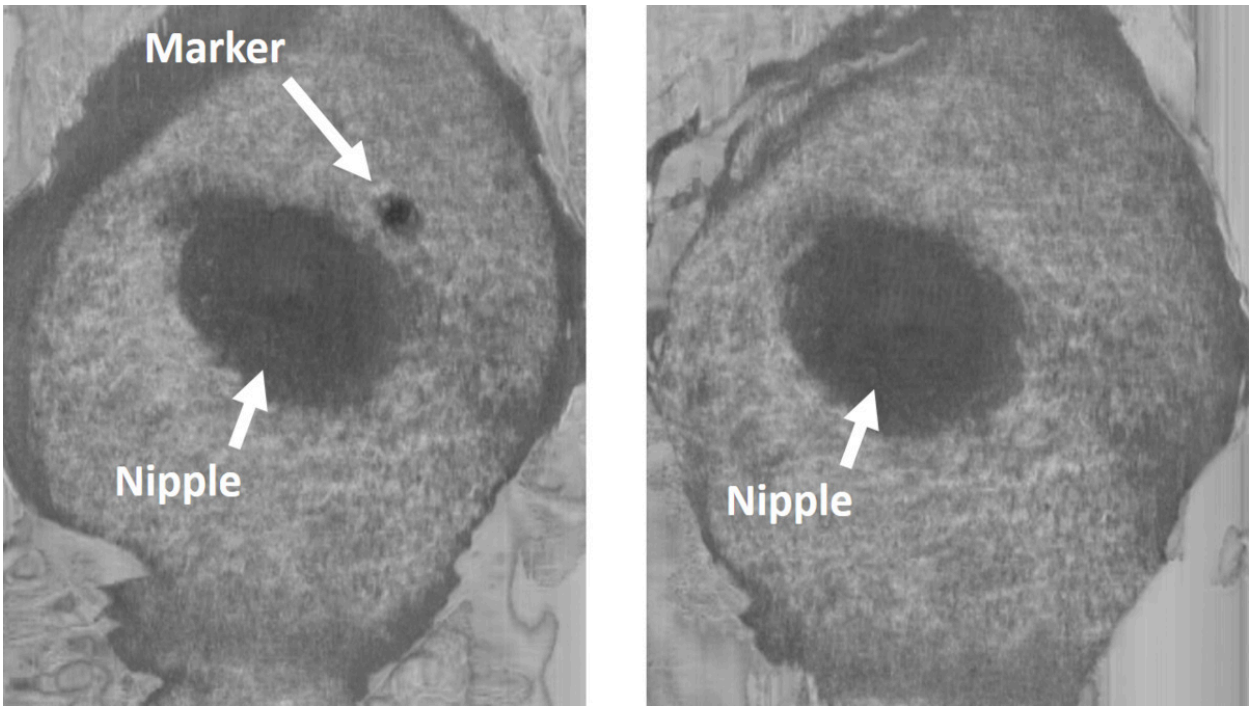

Fig. 3: Reconstructed coronal plane of scans with (left) and without (right) marker.

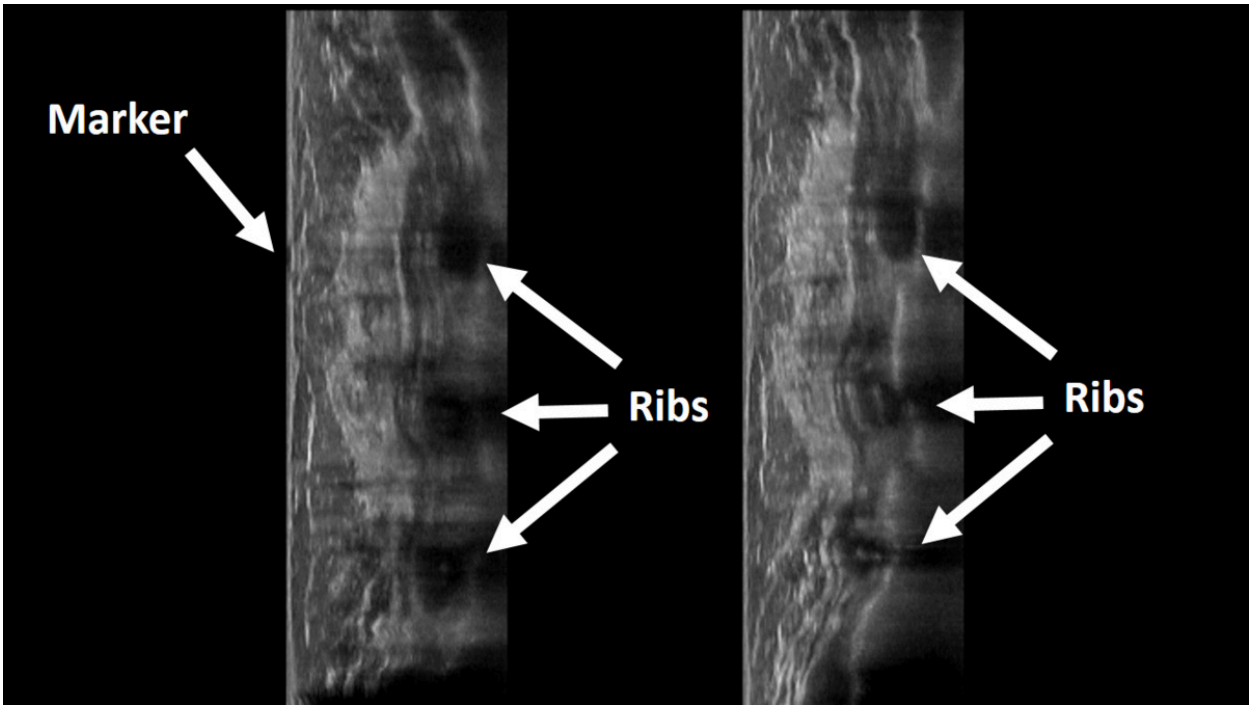

Fig. 4: Reconstruction of sagittal plane of scans with (left) and without (right) marker.

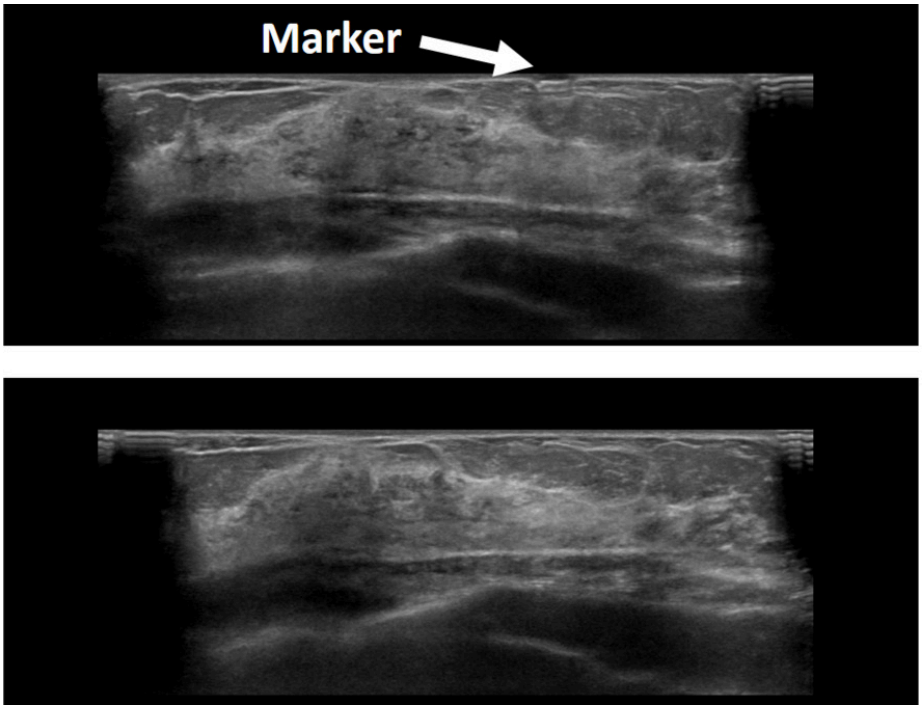

Fig. 5: Transversal plane of scan with (upper) and without (right) marker.

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Conclusion

Inexpensive, easy producible RTC silicon markers can be used for lesion marking in 3D ultrasound without affecting image interpretability.

References

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