Improved Diagnostic Accuracy for Breast Implant Rupture Through Strain Elastography – Results of a User-Based Evaluation Using Standardized Image Sets

H. Fritsch[1], L. Borchert[1], L. Paul[2], K. Hide-Moser[2], C. Vogel-Minea[3], C. Eichler[1]

[1]Breast Cancer Centre, St. Franziskus Hospital Münster, Münster, Germany
[2]Breast Cancer Centre, University Hospital Cologne, Cologne, Germany
[3]Breast Cancer Centre, Rottal Inn Kliniken, Eggenfelden, Germany

PS4-04-07

Abstract

Ultrasound is widely used to assess breast implant integrity, but its diagnostic accuracy is operator-dependent. This study examined whether strain elastography improves detection of implant rupture. Fifteen silicone implants were scanned with B-mode ultrasound and strain elastography in a standardized animal model. Ninety-nine observers reviewed B-mode images alone, then the corresponding elastograms, and indicated rupture status. With B-mode only, sensitivity was 81.4% and specificity 71.0%. Adding elastography increased sensitivity to 90.9% and specificity to 87.6%. Strain elastography therefore improves accuracy, enhancing true-rupture detection while reducing false positives.

Introduction

MRI is currently considered the gold standard for assessing the integrity of breast implants. Sonographic assessment, on the other hand, remains highly examiner-dependent and technically demanding. There is therefore a great need for new, objective ultrasound methods to avoid costly and limited availability of MRI examinations.
A promising option is **strain elastography**, which can be used to supplement conventional B-mode sonography. Previous studies describe a characteristic **three-layer elastography pattern** in intact implants, which is absent in defective implants.

We were able to confirm this phenomenon in an animal model: **10 out of 11 intact implants** showed the typical three-layer pattern and a **thin parallel line to the implant capsule**, while both features were absent in defective implants. Based on this, we investigated whether this finding could also improve diagnostics in a clinical context.

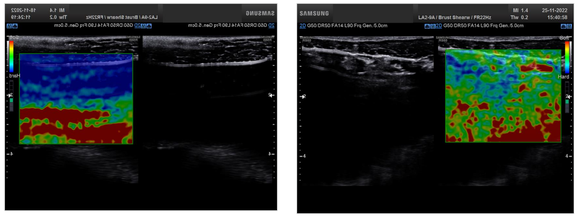


Figure 1) On the left is an intact implant in the chicken model (Sebbin 380 ml): A pattern of three parallel layers (typically blue-green-red) can be seen. On the right, the same implant in a ruptured state: no stratification can be seen.

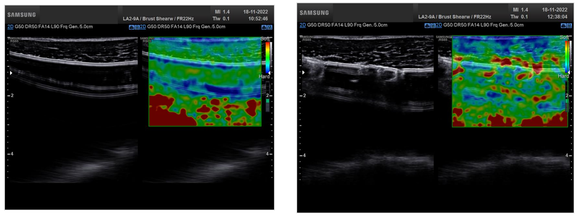


Figure 2) On the left, an intact implant in the chicken model (Sebbin, 310 ml): A thin blue layer is seen running parallel to the implant shell. On the right, the same implant in a ruptured state: the layer is no longer visible and is interrupted by a heterogeneous color pattern.

Methods and Materials

As part of ultrasound training courses, **99 physicians** with varying degrees of experience in breast ultrasound (from beginners to experts) were included. First, typical ultrasound images (B-mode and strain elastography) of intact and defective implants were demonstrated. Subsequently, **15 implants** (animal model) were shown in both modalities. The participants gave their assessment of the integrity of the implants ("intact" vs. "defective") using an app. A total of **1,485 assessments** were evaluated.

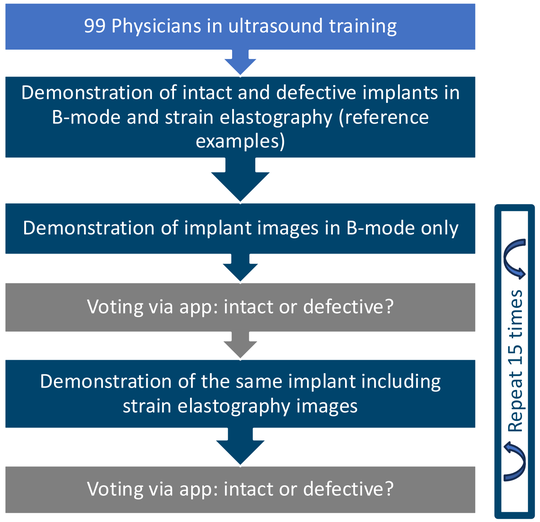


Figure 3) Overview of the experimental setup: Ninety-nine physicians in ultrasound training evaluated 15 silicone implants using B-mode and strain elastography images in two voting rounds via app.

Results

B-image alone:
Defective implants correctly detected in **645/792 cases**
Intact implants correctly detected in **492/693 cases**
→ **Sensitivity: 81.4%**, **Specificity: 71.0%**
These values correspond well with data in the literature, whereby the use of animal models enabled better standardization.

B-mode + strain elastography:
→ **Sensitivity: 90.9%, Specificity: 87.6%**

Discussion

B-mode sonography is an established method for assessing implant integrity, but its diagnostic accuracy remains limited due to user dependence and artifacts. MRI is considered very reliable, but is costly and time-consuming. Several studies show that high-resolution ultrasound can detect implant ruptures with high accuracy (1,2).
Elastography can provide additional information here: Both strain and shear wave elastography have been used experimentally to evaluate implants and allow for better differentiation of changes in the implant and capsule (3,4,5). Our data show that strain elastography increases sensitivity and specificity compared to B-mode and reduces false-positive findings. Standardized experimental models can offer reproducible imaging and training opportunities, as described in several studies (6,7). Nevertheless, clinical validation and consideration of artifact-related misdiagnoses remain. Overall, the current evidence supports an ultrasound-first approach, in which elastography can increase diagnostic certainty and reduce unnecessary MRI examinations.

Conclusions

The integration of **strain elastography** significantly improves diagnostic accuracy in assessing breast implant integrity.
It thus offers a promising addition to conventional sonography and could help reduce the number of necessary MRI examinations in the long term.

Contact

Dr. med Hanna Fritsch
PD Dr. med. Christian Eichler
St. Franziskus Hospital Münster, Breast Clinic, Germany
Email: Hanna.Fritsch@sfh-muenster.de
Christian.Eichler@sfh-muenster.de

This presentation is the intellectual property of the author/presenter. Contact them at Hanna.Fritsch@sfh-muenster.de for permission to reprint and/or distribute. Copies of this poster obtained through Quick Response (QR) Code are for personal use only and may not be reproduced without permission from SABCS® and the author.

References

1. Stivala A, Rem K, Leuzzi S, et al. Efficacy of ultrasound, mammography and magnetic resonance imaging in detecting breast implant rupture: A retrospective study of 175 reconstructive and aesthetic sub-pectoral breast augmentation cases. *J Plast Reconstr Aesthet Surg.* 2017;70(11):1520-1526. doi:10.1016/j.bjps.2017.05.051
2. Hillard C, Fowler JD, Barta R, Cunningham B. Silicone breast implant rupture: a review. *Gland Surg.* 2017;6(2):163-168. doi:10.21037/gs.2016.09.12
3. Stachs A, Dieterich M, Hartmann S, Stubert J, Reimer T, Gerber B. Diagnosis of ruptured breast implants through high-resolution ultrasound combined with real-time elastography. *Aesthet Surg J.* 2015;35(4):410-418. doi:10.1093/asj/sju057
4. de Faria Castro Fleury E, Gianni AC, Ayres V, Ramalho LC, Roveda D Junior, de Oliveira VM. Application of Breast Ultrasound Elastography to Differentiate Intracapsular Collection from Silicone-Induced Granuloma of Breast Implant Capsule Complementarily to Contrast-Enhanced Breast Magnetic Resonance Imaging. *Breast Cancer (Auckl).* 2017;11:1178223417737994. Published 2017 Nov 2. doi:10.1177/1178223417737994
5. Fritsch H, Celik M, Warm M, et al. Sonographic Assessment of Breast Implants Using Strain Elastography and Shear Wave Elastography in an Animal Model. *Anticancer Res.* 2024;44(2):497-501. doi:10.21873/anticanres.16837
6 Kashimann B, Prantl L, Michael-Jung E. Imaging of silicone breast implants with ultrasound-strain elastography: A first experimental study to establish criteria for accurate imaging of idle implants via ultrasound-strain elastography. *Clin Hemorheol Microcirc.* 2016;61(4):645-656. doi:10.3233/CH-151963
7. Kebe Radulović M, Vivoda Tomšič M, Cimerman D, Gutnik H, Stropan Fležar M. A novel combined animal tissue model for freehand and ultrasound-guided fine needle aspiration biopsy and smear preparation techniques training. *Diagn Cytopathol.* 2021;49(1):39-45. doi:10.1002/dc.24578

© Poster Template by Genigraphics® 1.800.790.4001 www.genigraphics.com