Acoustic radiation force impulse imaging value in differentiating benign and malignant breast nodules

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Purpose

Acoustic Radiation Force Impulse (ARFI) is a new sonographic technology that noninvasively assesses qualitative and quantitative tissue elasticity by measuring shear-wave velocities of a selected region of interest (ROI) (1,2,3) *(Fig 1*).

The aim of this study was to evaluate the role of acoustic radiation force impulse imaging (ARFI) for the differential diagnosis between benignancy and malignancy of breast tumors.

Images for this section:

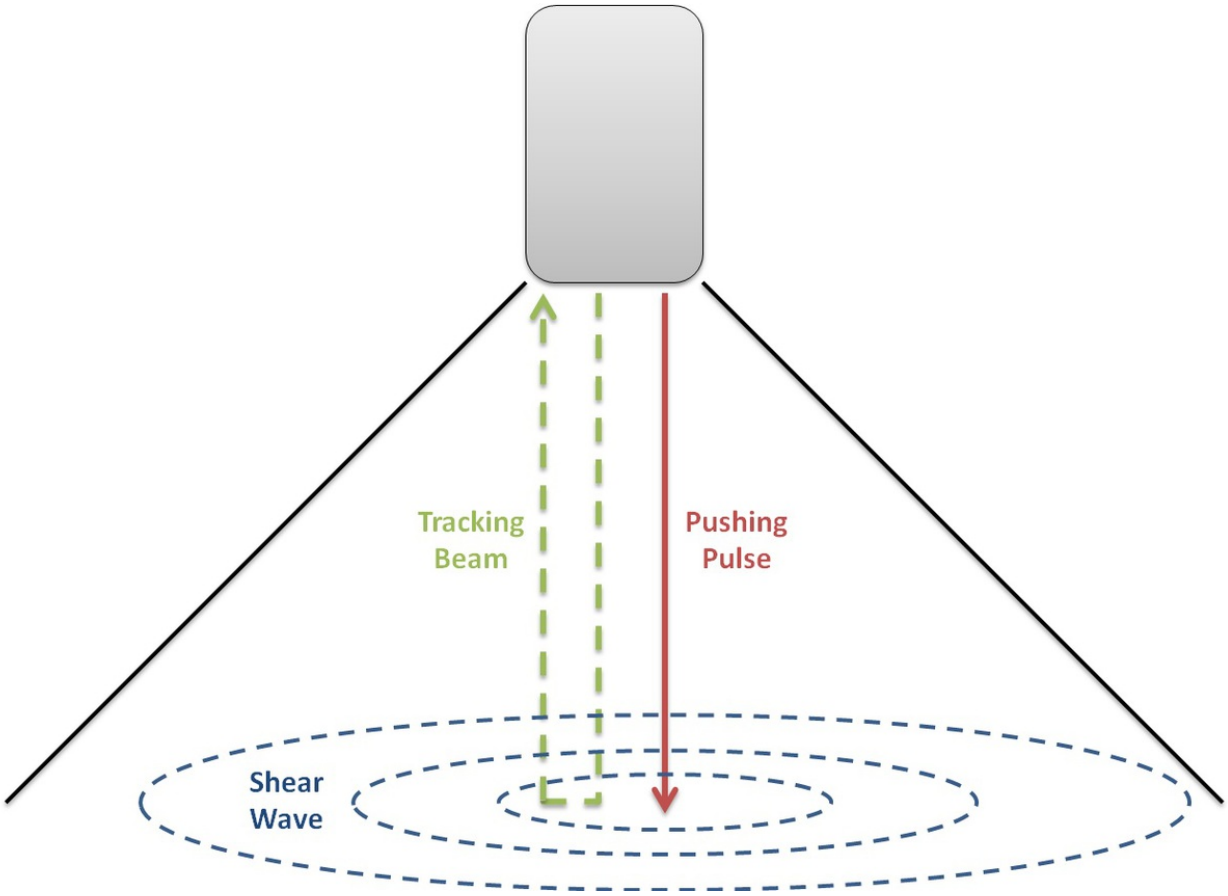

Fig. 1: A short-duration (0.03-0.4 millisecond) high-intensity acoustic "pushing pulse" is transmitted through tissue, creating its displacement. The displacements of tissue induce shear waves that travel perpendicular to the initial "pushing pulse". As the shear wave travels through tissue, the generated displacements are detectable using ultrasound tracking beams and are correlated with elapsed time, and shear wave speed is calculated (m/s).

Methods and materials

- The authors performed B-mode US and ARFI in 83 patients with breast lesions, subsequently characterized by percutaneous biopsy, between January 2013 and June 2013.
- Evaluation of color-coded tissue stiffness map and shear wave velocity measurements were performed using the application "*Virtual Touch tissue IQ*", availablein ACUSON S3000™ Siemens ultrasound machine.
- Shear wave velocity was measured using a linear array transducer with 9 MHz frequency.
- Shear wave velocity (SWV) was obtained within the lesion and in the surrounding parenchyma (*m/s*). SWV measurements and lesion-to-parenchyma ratio were calculated.
- For differentiation between benignancy and malignancy each parameter was compared using Mann-Whitney's or Student's t test. Receiver operating characteristic (ROC) curves were also plotted for each parameter and cut-off values were determined according to Youden's Index. Statistical significance was achieved if $p < 0.05$.

Results

- A total of 92 breast lesions were included (57 with benign and 35 with malignant diagnosis).
- Intra-lesional SWV was significantly higher for malignant neoplasms compared to benignancy (median of 9.14m/s vs. 3.45m/s; $p<0.001$). (*Fig 2, 3, 4, 5, 6)*
- Lesion-to-parenchyma ratio was also significantly higher for malignant lesions (3.046 vs. 1.443; $p<0.001$) *(Fig.7)*.
- No difference in parenchymal SWV was registered among groups ($p=0.071$) *(Fig.8)*.
- ROC curves revealed significant discriminative power for intra-lesional shear wave velocities [area under curve (AUC)=0.980; $p<0.001$] as well as for lesion-to-parenchyma ratio (AUC=0.950; $p<0.001$) *(Fig. 9)*.
- A cut-off value of 6.595m/s has a sensitivity and specificity of 88.6% and 96.4%, respectively. For lesion-to-parenchyma ratio a cut-off of 2.181 was found, providing a sensitivity of 88.6% and specificity of 91.1%.

Images for this section:

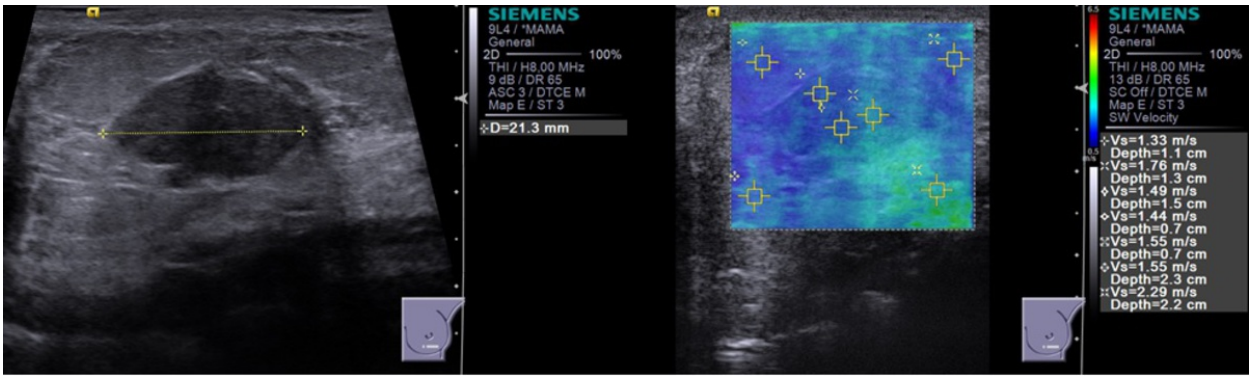

Fig. 2: Fibroadenoma with low shear-wave velocities.

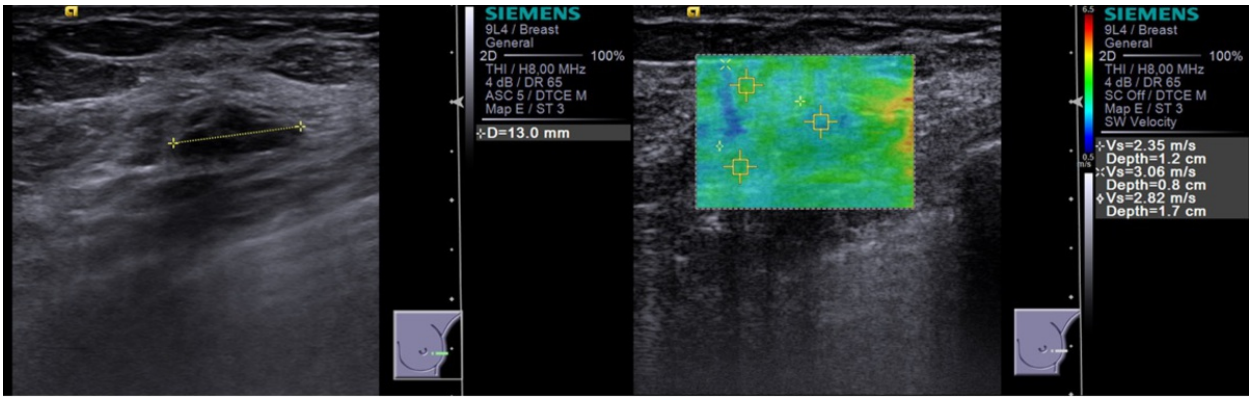

Fig. 3: Fibroadenoma with low shear-wave velocities.

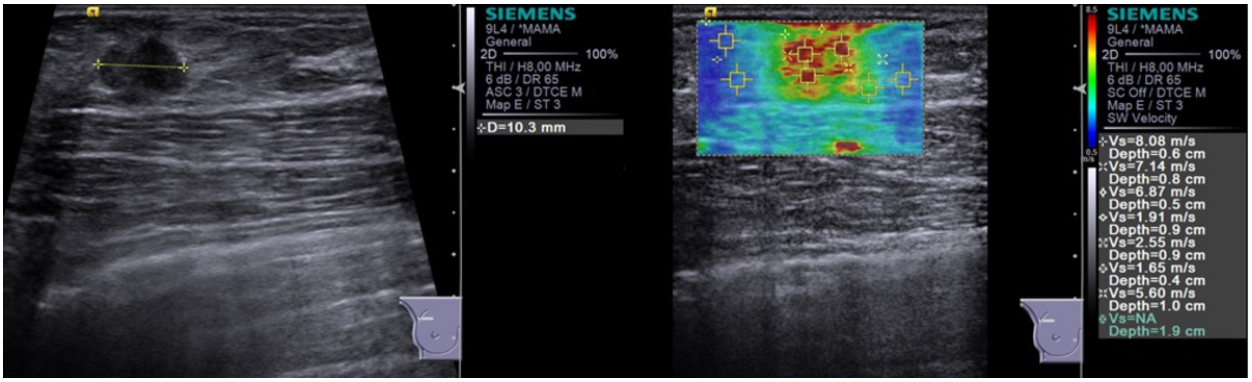

Fig. 4: Invasive ductal carcinoma with high intra-lesional shear-wave velocities.

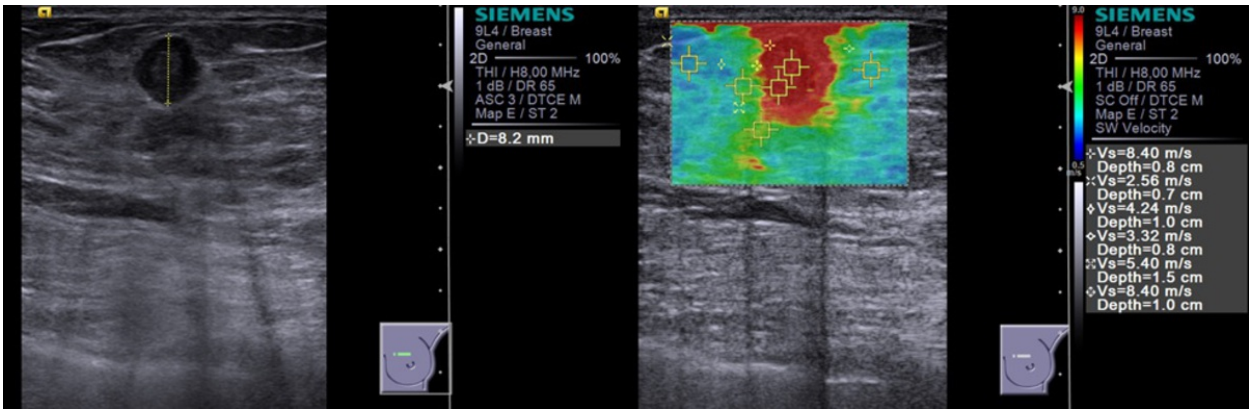

Fig. 5: Invasive ductal carcinoma with high intra-lesional shear-wave velocities.

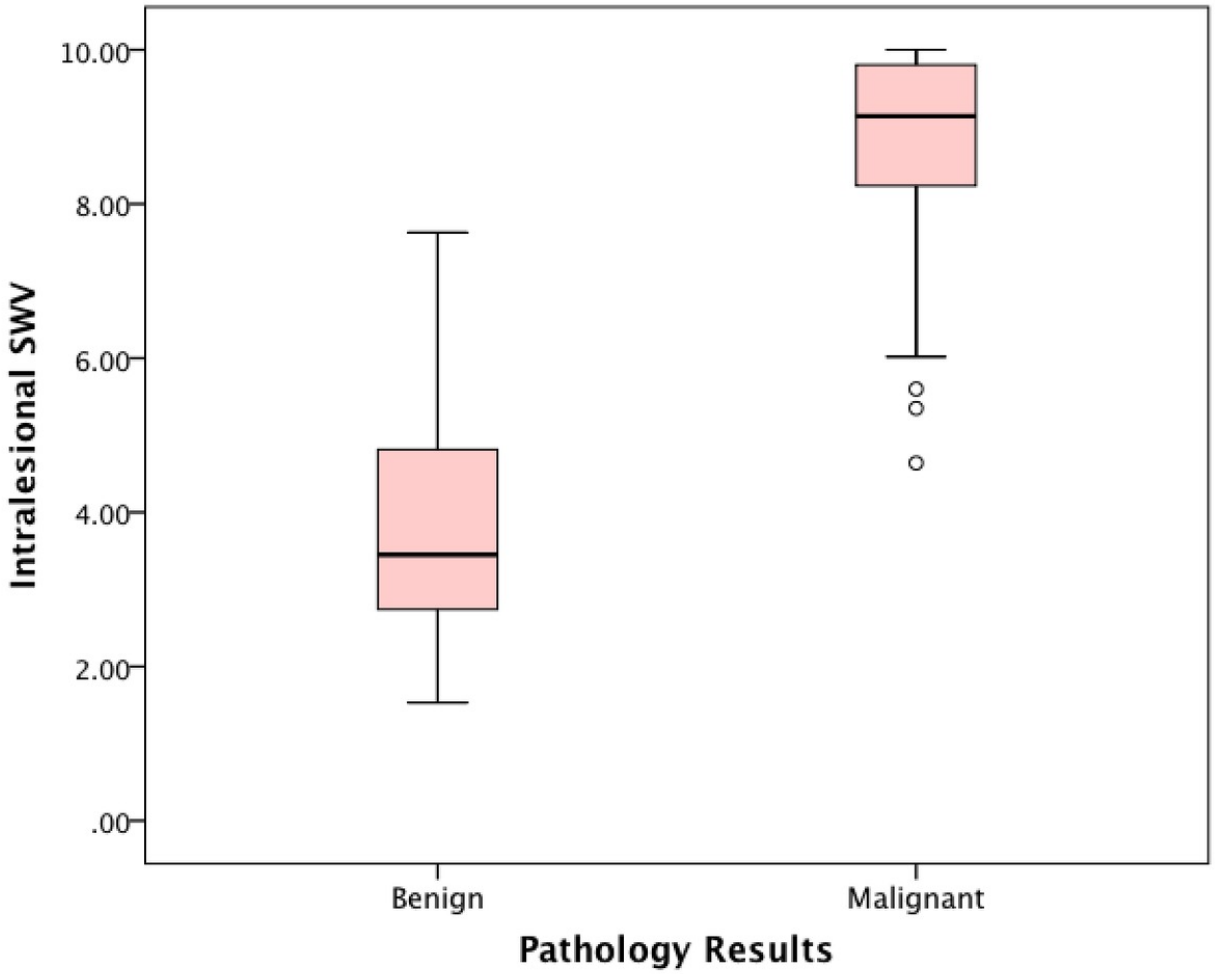

Fig. 6: Intra-lesional SWV was higher for malignant neoplasms compared to benignant lesions.

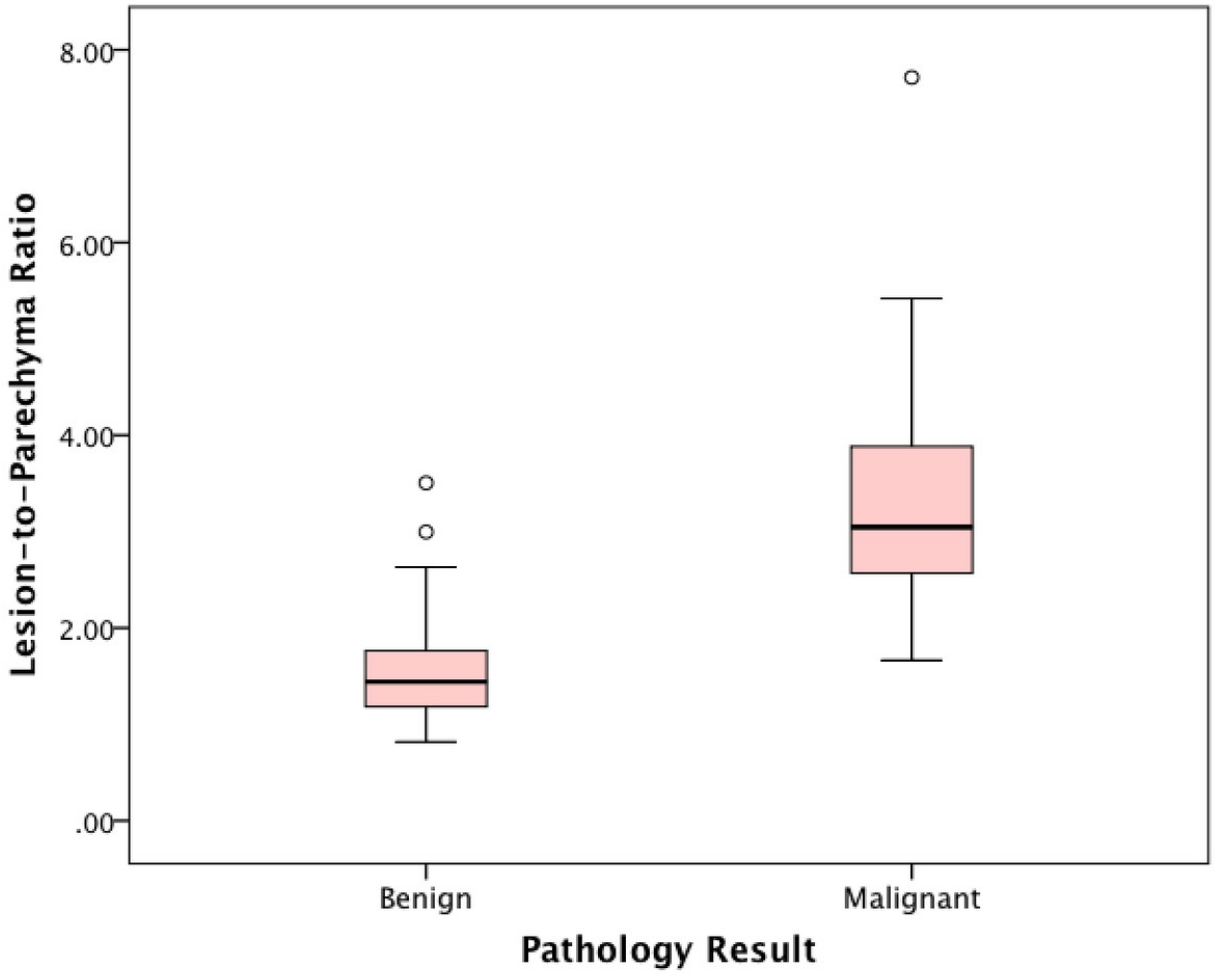

Fig. 7: Lesion-to-parenchyma ratio was higher for malignant lesions.

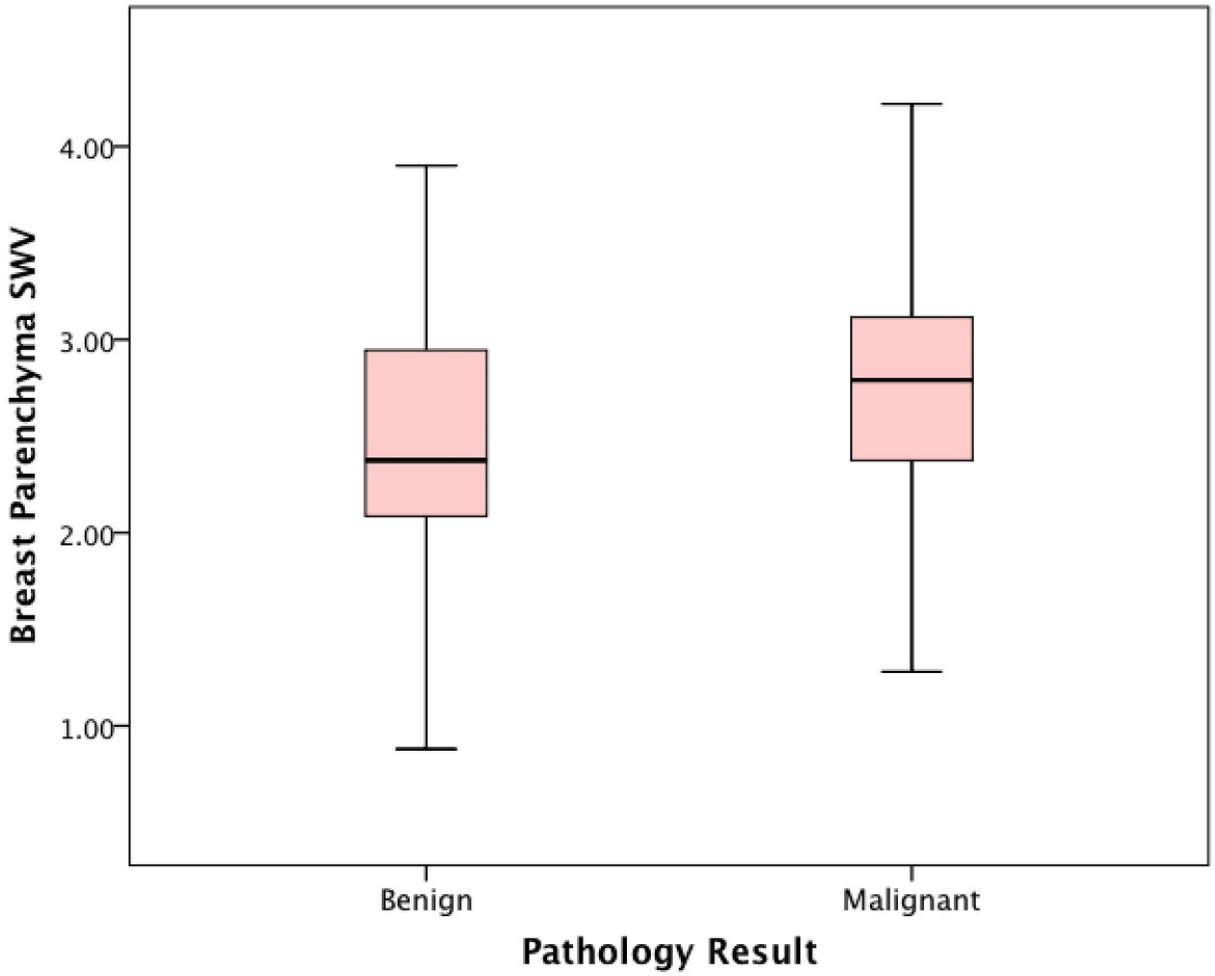

Fig. 8: There were no differences in parenchyma SWV between groups.

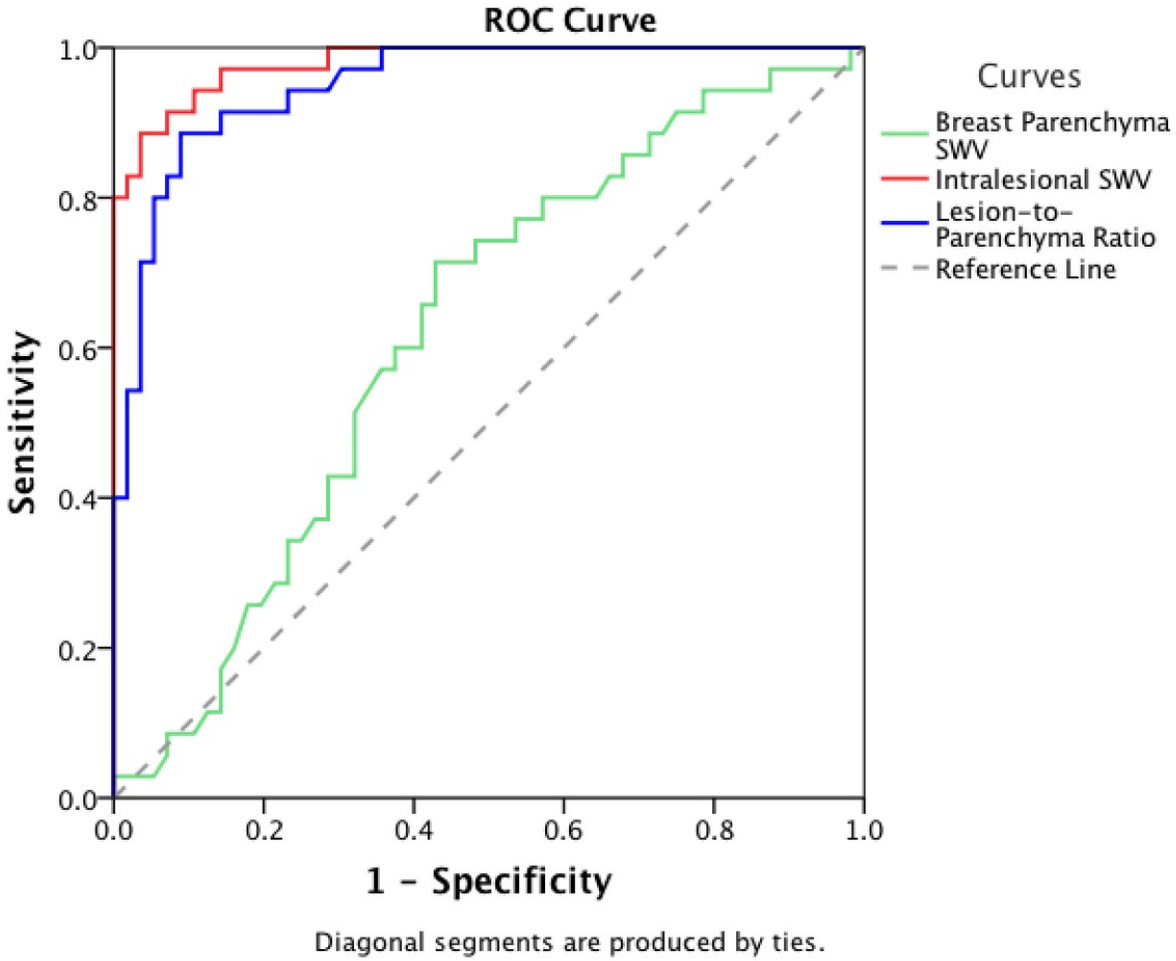

Fig. 9: ROC curves.

Conclusion

ARFI provides quantitative elasticity measurements that may be used as a potential biomarker for breast lesions characterization, reducing the number of unnecessary biopsies.

Personal information

References

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