

by Dr Richard G. Barr

Improving Prostate Cancer Screening with ShearWave Elastography

ShearWave Elastography has been shown to have higher sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) than existing modalities for the screening of prostate cancer

The current screening protocol for diagnosing prostate cancer consists of a screening test of prostate-specific antigen (PSA) measured in serum, typically combined with a digital rectal examination. When elevated levels of PSA are detected, the protocol calls for a transrectal ultrasound (TRUS)-guided prostate biopsy. Serious review of the two-step screening process has revealed major drawbacks, including over diagnosis in the early stage and missed cancers in the second [1, 2]. For instance, these drawbacks have led the United States Preventative Task Force to give the PSA test a “D” grade and to recommend against it, commenting that the “expected harms of PSA screening are greater than the potential benefit” [3].

A portion of the risk in the risk/benefit ratio for PSA screening comes from the performance of unnecessary biopsies in response to false positives. A recent study of the use of ShearWave Elastography (SWE) for examining the prostate, however, suggests that adding this imaging modality to the early stage of PC screening could reduce false positives, thus avoiding unnecessary invasive procedures for men who are not at risk of PC [4].

In this study, SWE was shown to have higher sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) than existing modalities—making it a potentially game-changing tool for the responsible detection of PC [4].

PROSTATE CANCER

According to The European Randomized Study of Screening for Prostate Cancer (ERSPC), “Prostate cancer is the second leading cause of cancer death in men in Western Europe and the United States. Worldwide, more than 670,000 men are diagnosed with prostate cancer every year, accounting for one in nine of all new cancers in males. It is the second most common cancer in men

after lung cancer. Around 225,000 cases are diagnosed each year in Europe alone and 240,000 in the USA.” [5].

Not all of those diagnoses are of fast-growing cancers; Cancer Research UK reports that “of all those with prostate cancer, about 94 out of every 100 men (94%) live for at least a year after they are diagnosed. About 85 out of every 100 men (85%) live for at least 5 years. And about 84 out of every 100 men (84%) live for at least 10 years [6]. Using SWE to prevent unnecessary biopsies by distinguishing between benign and malignant lesions would improve the cost benefit ratio of PSA screening. An imaging test that could assess tumor aggressiveness would be helpful in determining treatment strategies. Preliminary work suggests this may be possible with SWE [7].

“...Perhaps — especially in the current anti-screening climate — a modality with the attributes of SWE... could even tip the balance back in favor of prostate screening ...”

SHEARWAVE ELASTOGRAPHY

There are two forms of elastography used currently: strain elastography and shearwave. Because strain elastography requires the user to apply pressure to the body to deform the tissue in order to make its calculation, problems with reproducibility and issues of consistency across users are common. SWE differs from strain elastography in several ways: it is performed more quickly, is largely user-independent, and yields quantitative information about the tissue being imaged.

SWE creates a shear wave that passes through the tissue being imaged; because the stiffness of this tissue affects the wave’s velocity (the stiffer the tissue, the faster the shearwave travels), this method generates quantitative diagnostic information about the tissue elasticity. In the equipment used for this study, the Aixplorer™ from SuperSonic Imagine, the velocity for each pixel is expressed in kilopascals (kPa), and coded by color which is then overlaid on the appropriate B-mode image.

The anatomy of the prostate and its risk map are actually aligned with SWE as a modality for screening: SWE is best suited to imaging the largest of the four zones of

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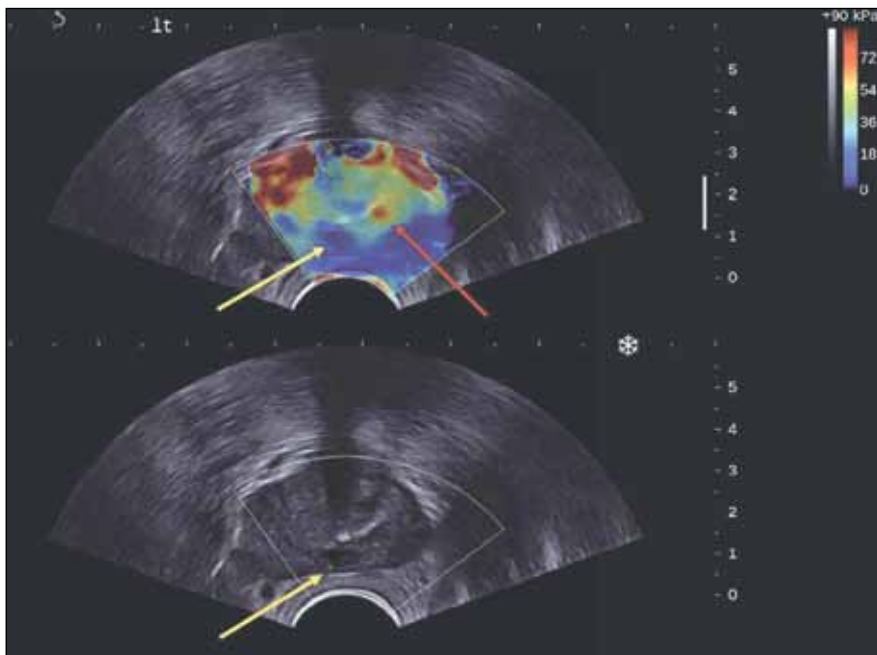


FIGURE 1. Comparison of ultrasound and SWE. This patient presented with a hypoechoic nodule on ultrasound (black lesion, with arrow). Shear wave elastography was performed, and the nodule was found to be of low stiffness (G20 kPa). Note the blue area with a yellow arrow. However, another lesion was found with a high stiffness (75 kPa) and was found on biopsy to be PC with Gleason grade 7. Note the red lesion with a red arrow. (Reproduced with permission from *Ultrasound Quarterly* March 2012).

the prostate, the peripheral zone. This is also the zone where up to 80% of cancers occur, and is thus the first place to look in detecting PC.

SWE FOR PROSTATE EVALUATION

One prospective study undertaken in Ohio, USA, drew its participants from patients scheduled for TRUS-guided biopsy after an initial screening had indicated an elevated PSA level and/or abnormal digital rectal examination result. A total of 53 patients joined the study. At the end, 26 foci of cancer were

detected in 11 of the participants, 5 of whom eventually had total prostatectomies. The result of those surgeries were then made available for comparison to the physicians performing the research.

SWE readings were taken on the Aixplorer, measuring the Young modulus (a measure of elasticity) in kPa for every nodule and area of suspicion with SWE velocity above the baseline prostate tissue. A radiologist then examined those same patients, identifying nodules and any other suspicious areas.

Finally, the urologist—without learning the results of the SWE imaging—performed a sextant biopsy according to standard clinical procedure. (Any abnormalities on B-mode alone were also examined by biopsy. When SWE-recorded abnormalities were not among the original biopsied tissue, additional samples were obtained after the completion of standard biopsy.)

The receiver operating characteristic (ROC) curve was generated using the Young modulus and the pathologic result (benign/malignant). In the peripheral zone of the prostate, nodules were identified on B-mode and documented and correlated with SWE values; the SWE and biopsy results were compared in each zone.

FINDINGS

The study calculated a value of 37 kPa as the cutoff between benign and malignant tissue on the basis of the receiver operating characteristic (ROC) curve. With this cutoff, the authors reported, the SWE had a sensitivity of 96.2% (25/26), a specificity of 96.2% (281/292), a PPV of 69.4% (25/36), and a NPV of 99.6% (281/282). This finding is in line with other preliminary studies employing shear wave elastography, which have compared it to current modalities and found it to possess sensitivity, specificity, and NPV all greater than 90% [8]. There were significant differences between the stiffness values of prostate cancer and benign etiologies (normal prostate tissue, acute inflammation, chronic

n	Pathologic Result	Minimum kPa	Maximum kPa	Mean kPa	SD
242	Benign	9	107	21.2	11.8
21	Atypia	14	38	20.6	5.3
26	Cancer	30	110	58.0	20.7
13	Acute inflammation	9	28	19.5	5.5
16	Chronic inflammation	13	63	27.3	15.5

TABLE 1. Summary of results (Reproduced with permission from *Ultrasound Quarterly* March 2012).

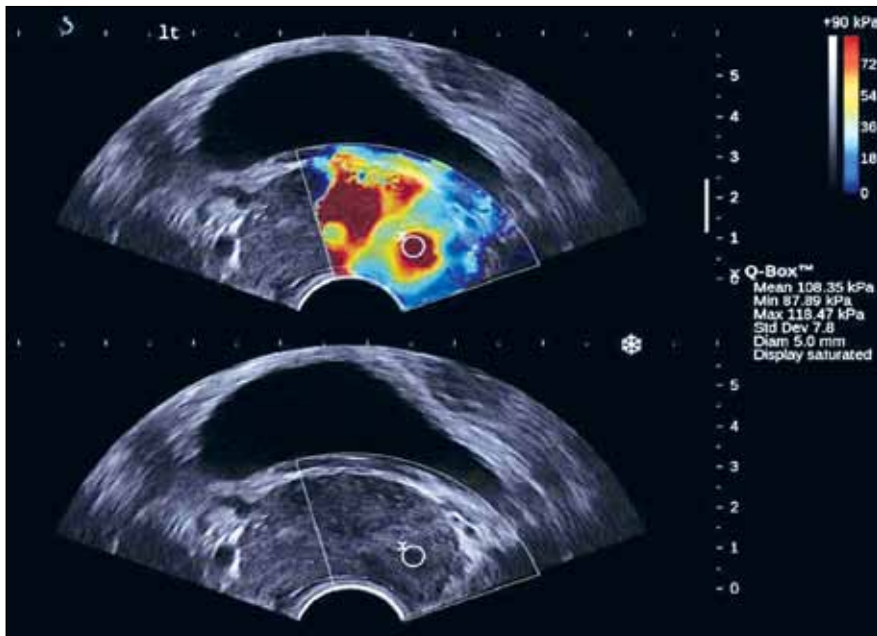


FIGURE 2. True positive for Gleason 6 carcinoma. This patient presented with a low PSA but firm left side on digital rectal exam. B-mode imaging and color Doppler produced no findings. Shear wave elastography presented this image. Note the posterior high stiffness lesion on the left side. This lesion read at a high stiffness (119 kPa) and was confirmed on biopsy to be a Gleason 6 carcinoma. (Reproduced with permission from *Ultrasound Quarterly* March 2012).

inflammation and atypia).

False positives are a major problem in prostate screening, of course. With SWE, of the 11 false-positive samples in the study, over half were secondary to calcifications noted on B-mode in benign tissue. This suggests that false positives could be further minimized with the eliminations of calcifications from biopsy—a possibility that deserves additional research.

CONCLUSION

While this study calls for more research reproducing and expanding on its results, it demonstrates the promise of using SWE for prostate screening. Further study could determine whether eliminating calcifications from biopsy is appropriate—a change that could reduce the overall number of biopsies and increase the percentage of positive biopsies.

Perhaps especially in the current anti-screening climate, a modality with the attributes of SWE constitutes a more responsible, more discerning form of PC detection, one that could even tip the balance back in favor of prostate screening.

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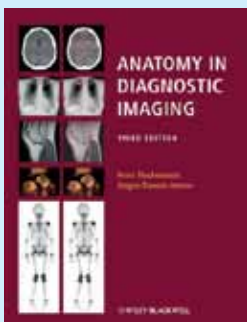
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Book review

Anatomy in Diagnostic Imaging, 3rd Edition

By Peter Fleckenstein & Jørgen Tranum-Jensen

Pub by Wiley-Blackwell, October 2014, 520 p, €70.40 paperback; €56.99



Now in its third edition, *Anatomy in Diagnostic Imaging* is an unrivalled atlas of anatomy applied to diagnostic imaging. The book covers the entire human body and employs all the imaging modalities used in clinical practice; x-ray, CT, MR, PET, ultrasound and scintigraphy. An introductory chapter explains succinctly the essentials of the imaging and examination techniques drawing on the latest technical developments.

In view of the great strides that have been made in this area recently, all chapters have been thoroughly revised in this third edi-

tion. The book’s original and didactically convincing presentation has been enhanced with over 250 new images. There are now more than 900 images, all carefully selected in order to be user-friendly and easy-to-read, due to their high quality and the comprehensive anatomical interpretation directly placed alongside every one.

Both for medical students and practising doctors, *Anatomy in Diagnostic Imaging, Third edition* will serve as the go-to all-round reference collection linking anatomy and modern diagnostic imaging