Print ISSN: 2321-6379
Online ISSN: 2321-595X

Original Article

Transrectal Ultrasound Elastography – Evaluating Clinical Implications to Differentiate between Benign and Malignant Lesion of Prostate: A Prospective Observational Study

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Abstract

Introduction: Elastography is a non-invasive imaging to depict relative tissue stiffness or displacement (strain) in response to impacted force, carcinoma prostate (Ca-P) tissue is stiffer than normal tissue. Shear wave elastography (SWE) is a modified real-time imaging technique that represents a substantial advance in ultrasound elastography. There is no consensus regarding the cut off value of elastography to differentiate between benign and malignant lesions.

Methods: The present study aimed to determine cut off value to differentiate between benign and malignant lesions of prostate and to test sensitivity, specificity, and positive predictive value (PPV) of SWE. It is a prospective observational study, done over 6 months at a single tertiary care center. The study included 50 patients. All patients underwent 12 cores prostate biopsies. Elastography of the involved segment compared with histopathology of core biopsy from the same segment.

Results: Mean age was 69.12 years. Serum prostate specific antigen ranged from 3.8 to 698 ng/dl. Out of 50, 23 patients had Ca-P, 27 patients had benign histology. Elasticity in Ca-P group ranged from 76.5 to 161.7 kPa, with mean of 109.39 kPa. Elasticity in the benign group ranged from 19.7 to 134.1 kPa, with mean of 69.94 kPa. Based on these mean elasticity values, we concluded 90 kPa as cut off value as a mean between benign and malignant values to differentiate between benign and malignant lesions. Sensitivity calculated based on this cut off value is 82.6%, specificity – 55.6%, PPV – 61.3%, and negative predictive value (NPV) – 78.9%.

Conclusions: This study concludes that 90 kPa on SWE can be used as cut off between benign and malignant prostate lesions with high sensitivity (82.6%) and specificity (55.6%) and PPV of 61.3% and NPV of 78.9%.

Key words: Elastography, Prostate cancer, Transrectal ultrasound

BACKGROUND

Elastography is a non-invasive imaging to depict relative tissue stiffness or displacement (strain) in response to impacted force. Stiff tissues deform less and exhibit less strain than compliant tissues in response to the same applied force.[1]

Traditionally, grayscale transrectal ultrasonography (TRUS) is used in the diagnosis of prostate disorders and to guide biopsy.[2] Biopsy protocols should be optimized to accurately detect carcinoma prostate (Ca-P), while also reducing the number of prostate biopsy cores and biopsy-related complications. Ca-P tissue is stiffer than normal tissue, which is occasionally found during the digital rectal examination (DRE). It is one of the earliest organs, for

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IJSS
www.ijss-sn.com

Month of Submission : 04-2020
Month of Peer Review : 05-2020
Month of Acceptance : 05-2020
Month of Publishing : 06-2020

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which elastography was proposed, applied, and being used. Transrectal elastosonography has already been established to be feasible in guiding biopsies and for improving the detection of prostate lesions.

Shear wave elastography (SWE) is a modified real-time imaging technique that represents a substantial advance in ultrasound elastography.[3] When SWE is applied, the transducer generates an acoustic radiation force using a special "supersonic" speed that moves multiple focus points following the Mach cone principle.[4] Then, the tissue is mechanically excited by the Mach cone impulse to generate small, localized tissue displacements (1–10 mm). These tissue displacements have been tracked using a compression sonoelastography system to calculate the shear wave propagation speed and the quantitative tissue stiffness based on Young's modulus and kPa.[5,6] The previous studies have shown that the Young's modulus of Ca-P was significantly greater than that of benign prostatic tissue; the sensitivity ranged from 43% to 96.2%, and the specificity ranged from 69.1% to 96.2% in various studies.[7-13] There have been large differences among the results of these studies, and the cut off value for clinically adequate distinction between Ca-P and benign tissue remains undetermined.

The present study aimed to test overall accuracy, sensitivity, specificity, and positive predictive value (PPV) of SWE to differentiate between benign and malignant lesions of prostate and to determine cut off value to differentiate Ca-P and benign tissue.

METHODOLOGY

Prospective observational study conducted over period of 6 months in a single tertiary care center.

The study included 50 patients.

Patients were advised TRUS with elastosonography [Figures 1 and 2] and systemic prostate biopsies based on DREs and elevated serum prostate specific antigen (PSA) levels. All patients underwent 12 core systemic prostate biopsies. A single observer was involved throughout the study.

Post-procedural histopathology report followed [Figure 3].

Elastography of the involved segment compared with histopathology of core biopsy from the same segment.

Variables taken into consideration are age, serum PSA level, elasticity value of a segment, and histopathology of the same segment.

RESULTS

The mean age was 69.12 years, ranging from 56 years to 82 years. Serum PSA ranged from 3.8 ng/dl to 698 ng/dl. Out of 50 patients, 23 patients had Ca-P confirmed with histopathology examination. Rest 27 patients had benign histopathology ranging from

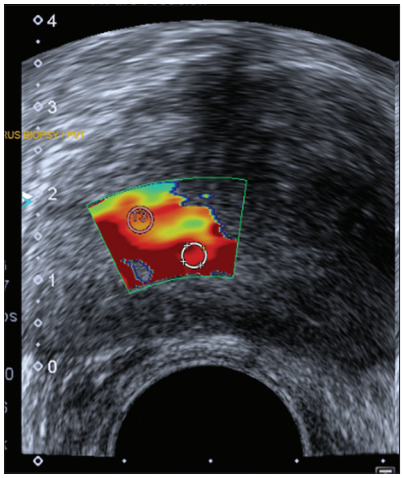

Figure 2: Elastography applied on same the suspected lesion and Elastography value measured (Red being highest value and blue being least)

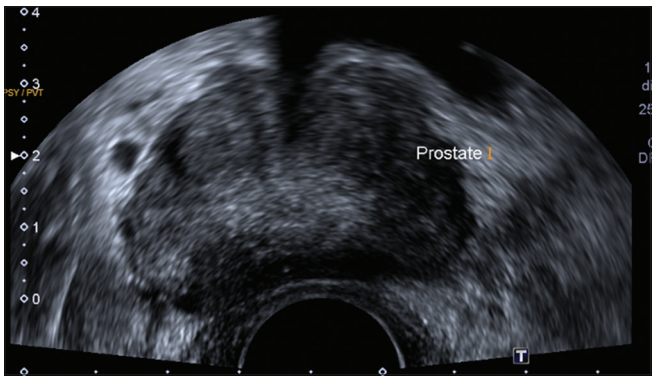

Figure 1: Normal TRUS image of prostate

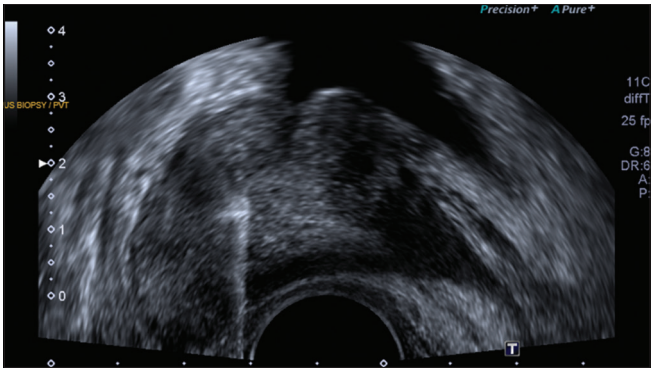

Figure 3: Biopsy taken from the same segment, which is later compared with Elastography value from the same segment

benign prostatic tissue, chronic prostatitis, and prostatic abscess to xanthogranulomatous prostatitis [Table 1]. The range of elasticity varied from 76.5 kPa to 161.7 kPa in the Ca-P group, with a mean of 109.39 kPa. The range of elasticity varied from 19.7 kPa to 134.1 kPa in benign prostate tissue group, with a mean of 69.94 kPaI [Table 2].

Thus, averaging both mean of benign and malignant elasticity values, 90 kPa was taken as cut off. Further, calculations were done based on that value.

Sensitivity of the study based on this cut off value is 73.91%, specificity is 76%, PPV 75.49%, and negative predictive value (NPV) 74.44% [Table 3]. All values are calculated using standard statistical formulas for sensitivity, specificity, PPV, and NPV.

DISCUSSION

SWE has been recently shown to be a useful technique for prostate examination, especially in diagnosing Ca-P. Previously, few studies have been conducted to measure its efficacy. Barr *et al.* reported that SWE showed a high sensitivity of 96.2%, specificity of 96.2%, PPV of 69.4%, and NPV of 99.6% for the detection of Ca-P when 37 kPa was used as a cut off value between benign and malignant lesions.[10] This study shows when low elasticity values are being taken as a cut off to differentiate between benign and malignant lesions, it provides high sensitivity and specificity. Ahmad *et al.* also showed that the sensitivity and specificity of SWE for Ca-P detection could each reach 90%.[7] No cut-off value was provided during this study. Woo *et al.* reported low sensitivity and variable specificity for the diagnostic value of SWE in the detection of Ca-P, even if the SWE parameters were significantly different between Ca-P and benign prostate tissues.[12] Porsch *et al.* showed that SWE was a poor predictor of malignancy for prostate lesions.[14] Considering these inconsistent results, we did plan our study to assess the diagnostic value of SWE for the detection of Ca-P based on elasticity. Based on mean elasticity values, we concluded 90 kPa as a cut off value. Taking this cut off into consideration, specificity and sensitivity were calculated. Values of sensitivity and specificity were quite high and acceptable for using 90 kPa as cut off value to differentiate between benign and malignant lesions. Thus, finding lesions more than 90 kPa elasticity on SWE can be considered malignant with 73.91% sensitivity and 76% specificity. Real-time quantitative SWE imaging is potential enough to change the clinical practice of Ca-P identification and screening by improving the localization of abnormal foci and allowing limited, targeted biopsies of suspicious areas, thereby reducing both complications and costs associated with the current practice of systemic prostate biopsies.

There are no specific cut off values as per the current literature available. Therefore, this study is interesting for future of TRUS guided biopsies, still, it is subjective for investigations. Based on the findings of this study and previous studies, we consider SWE to be a novel and non-invasive imaging technique that is superior to conventional TRUS for the assessment of tissue stiffness to provide information for the detection of Ca-P and biopsy guidance. There are no significant differences in intraobserver reproducibility among the measurements, practitioners should be trained in its application. Larger number of cases should be conducted to reveal the correlation between the Gleason score and the tissue stiffness of Ca-P. Multiparametric MRI (mpMRI) provides the best anatomical and functional imaging of the prostate compared with that of other imaging methods, and all related studies suggested that mpMRI could be used to trigger a targeted repeat biopsy for prostate cancer diagnosis.[15] Future research should be performed to evaluate the correlations between SWE and mpMRI with histopathology as the gold standard.

Table 1: Containing demographic profiles including patient's age, serum PSA levels, and histopathology reports

Age	69.12 years mean (56–82 years)
Serum PSA	60.83 ng/dl mean (3.8–698 ng/dl)
Histopathology	Number of patients
Adenocarcinoma prostate	23
Chronic prostatitis	8
Benign prostatic tissue	12
Prostatic abscess	6
Xanthogranulomatous prostatitis	1

PSA: Prostate specific antigen

Table 2: Range of elastography values of malignant and benign lesions with mean value

Elastography	Minimum (kPa)	Maximum (kPa)	Mean (kPa)
Malignant	76.5	161.7	109.39
Benign	19.7	134.1	69.94

kPa: Kilo pascle

Table 3: Calculating sensitivity, specificity, positive predictive value, and negative predictive value based on 90 kPa cut off for elastography

Parameters	Result (%)
Sensitivity	82.6
Specificity	55.6
Positive predictive value	61.3
Negative predictive value	78.9

CONCLUSION

To conclude, this study shows that 90 kPa on SWE can be used as cut off between benign and malignant prostate lesions with high sensitivity (82.6%) and specificity (55.6%) for the detection of Ca-P and is useful with PPV of 61.3% and NPV of 78.9%.

Limitations

Further studies with a multicenter design and larger number will be needed to assess the role of SWE in the detection of Ca-P. SWE can be combined with MRI for fusion biopsy to make the best use of both modalities.

Declarations

- Institutional Research Ethics Committee approval was obtained before the study (IEC Ref No: CSP-MED/19/NOV/57/198).
- The datasets used and/or analysed during the current study are available from the corresponding author on request.
- No conflicts of interest for any of the authors.

REFERENCES

1. Ginat DT, Destounis SV. US Elastography of breast and prostate lesions. Radiographics 2009;29:2007-16.
2. Salomon G, Köllerman J, Thederan I. Evaluation of prostate cancer detection with ultrasound real-time elastography: A comparison with step section pathological analysis after radical prostatectomy. Eur Urol 2008;54:1354-62.
3. Ma Q, Yang DR, Xue BX. Transrectal real-time tissue elastography targeted biopsy coupled with peak strain index improves the detection of clinically important prostate cancer. Oncol Lett 2017;14:210-6.
4. Sang L, Wang XM, Xu DY. Accuracy of shear wave elastography for the diagnosis of prostate cancer: A meta-analysis. Sci Rep 2017;7:1949.
5. Bercoff J, Tanter M, Fink M. Supersonic shear imaging: A new technique for soft tissue elasticity mapping. IEEE Trans Ultrason Ferroelectr Freq Control 2004;51:396-409.
6. Franchi-Abella S, Elie C, Correas JM. Ultrasound elastography: Advantages, limitations and artefacts of the different techniques from a study on a phantom. Diagn Interv Imaging 2013;94:497-501.
7. Ahmad S, Cao R, Varghese T, Bidaut L, Nabi G. Transrectal quantitative shear wave elastography in the detection and characterisation of prostate cancer. Surg Endosc 2013;27:3280-7.
8. Zhang M, Wang P, Yin B, Fei X, Xu XW, Song YS. Transrectal shear wave elastography combined with transition zone biopsy for detecting prostate cancer. Zhonghua Nan Ke Xue 2015;21:610-4.
9. Rouvière O, Melodelima C, Hoang Dinh A, Bratan F, Pagnoux G, Sanzalone T, *et al*. Stiffness of benign and malignant prostate tissue measured by shear-wave elastography: A preliminary study. Eur Radiol 2016;27:1858-66.
10. Barr RG, Memo R, Schaub CR. Shear wave ultrasound elastography of the prostate: Initial results. Ultrasound Q 20112;28:13-20.
11. Boehm K, Salomon G, Beyer B, Schiffmann J, Simonis K, Graefen M, *et al*. Shear wave elastography for localization of prostate cancer lesions and assessment of elasticity thresholds: Implications for targeted biopsies and active surveillance protocols. J Urol 2015;193:794-800.
12. Woo S, Kim SY, Cho JY, Kim SH. Shear wave elastography for detection of prostate cancer: A preliminary study. Korean J Radiol 2014;15:346-55.
13. Correas JM, Tissier AM, Khairoune A, Vassiliu V, Méjean A, Hélénon O, *et al*. Prostate cancer: Diagnostic performance of real-time shear-wave elastography. Radiology 2015;275:280-9.
14. Porsch M, Wendler JJ, Liehr UB, Lux A, Schostak M, Pech M. New aspects in shear-wave elastography of prostate cancer. J Ultrason 2015;15:5-14.
15. Mousavi SR, Rivaz H, Czarnota GJ. Ultrasound elastography of the prostate using an unconstrained modulus reconstruction technique: A pilot clinical study. Transl Oncol 2017;10:744-51.

How to cite this article: Shah D, Sai V, Ramasamy N, Thirunavukkarasu C, Kumaresan N. Transrectal Ultrasound Elastography – Evaluating Clinical Implications to Differentiate between Benign and Malignant Lesion of Prostate: A Prospective Observational Study. Int J Sci Stud 2020;8(3):64-67.

Source of Support: Nil, **Conflicts of Interest:** None declared.