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Strain elastography and Transrectal ultrasound: Importance in the prostate cancers diagnosis

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Abstract
Background and Objectives: Assess the efficacy of transrectal ultrasound in the identification of prostate cancer. This work aims to assess the utility of strain elastography in prostate cancer cases for the identification of lesions and guidance of further biopsies. This study aims to compare the sonoelastographic results with the data from biopsies by classifying the outcomes using grading techniques. The aim of this work is to establish a connection between histology and the outcomes of sonoelastographic and greyscale imaging.
Methods: Prospective investigation comprised thirty patients with elevated PSA levels and abnormal DRE results who were referred to a physician at the Department of Radiology, Sambhram Institute of Medical Sciences and investigation, Bangalore, Karnataka, India, between September 2017 and September 2018. All patients underwent a simultaneous transrectal ultrasound, real-time strain elastography, and a systematic 12-core biopsy. Additional targeted biopsies were then collected from trouble regions detected by the transrectal ultrasound and real-time strain elastography. The histopathological diagnosis was compared to the interpretations provided by each of these approaches.
Results: Transrectal ultrasonography was 78.57 percent sensitive, 81.25 percent specific, had a positive predictive value of 78.57 percent, and a negative predictive value of 81.2 percent for detecting prostate cancer. Elastography's sensitivity was 100%, specificity was 50%, positive predictive value was 63.64%, and negative predictive value was 100% when used to detect prostate cancer.
Conclusion: Sonoelastography is a potentially novel diagnostic strategy for the detection of prostate cancer, either when utilised independently or in combination with existing ultrasonography techniques. Elastography has a higher negative predictive value and sensitivity for ruling out prostatic malignancies than standard ultrasound, which both contribute to reducing the number of unnecessary biopsies.

Keywords: Sonoelastography, strain elastography, transient resonance ultrasound imaging, and transcutaneous ultrasound guided biopsy

Introduction
Medical professionals have a lot to worry about because prostate cancer is the second most frequent disease in males today and the leading cause of cancer-related death in the U.S. Prostate cancer diagnosis used to rely on digital rectal examinations and PSA levels because of the prostate's inconvenient position. Examining with this strategy was insufficient. In-depth examination of the prostate has been facilitated by the development of ultrasonography. A prostate biopsy is necessary to confirm a diagnosis of prostate cancer in men with high PSA levels and suspicious indications on digital rectal examination [1, 2, 3].
The prostate is typically imaged with transrectal ultrasonography (TRUS) at the moment. In contrast to normal prostatic tissue, tumors often seem hypoechoic when seen by ultrasound. Both the sensitivity and specificity of TRUS are poor since most hypoechoic foci that are observed are benign. Prostate multi-core biopsies can be performed with the use of TRUS for image guiding. As a rule, prostate cancer manifests as a solid mass. Prostate cancer detection and localization may be aided by a method that can map the prostate's elasticity. Ultrasound elastography's insight into tissue stiffness could facilitate better prostate cancer identification and help direct biopsies in the right direction. The purpose of our prospective study is to compare the accuracy of transrectal ultrasonography and elastography in locating and targeting biopsies from suspected lesions in a clinical context, with pathological diagnosis serving as the gold standard [4, 5, 6].

Materials and Methods
Thirty individuals with PSA levels >4 ng/ml and aberrant DRE results were included in the research. Researchers gathered data from September 2017 and September 2018.

All patients provided informed consent after having potential biopsy consequences outlined to them. Antibiotics were provided as a preventative measure before the operation. Transrectal ultrasonography, real-time strain elastography, and biopsy were performed on all patients at the same office visit. Histopathology analysis verified the ultimate diagnosis.

The siemens acuson S3000 was used to do transrectal ultrasonography of the prostate, and its end cavitary transducer had a 9–4 MHz range, a 174-degree field of view, and user configurable multi hertz imaging. After covering the probe with Xylocaine gel, the probe was inserted into the patient. Since the left lateral decubitus posture was well tolerated by all of the patients, it was used for the examinations. The volume, echogenicity, surface, calcification, vascularity, and presence of nodules of the prostate were evaluated using transverse and longitudinal ultrasound images. Size, placement in the gland, shape, echogenicity, border, and extension were evaluated for each nodule.

At the same time as the Ultrasound examination, Ultrasound Elastography was done using the same probe used for transrectal ultrasonography on a SIEMENS ACUSON S3000. Prostate strain elastography was performed transrectally in real-time. With the probe hovering above the area, the lesion will be in the focal point of the screen. The prostate was gently compressed and released to get the elastogram. Lesion stiffness was evaluated in comparison with the average elasticity of the surrounding tissue, which was measured by include at least 5 mm of normal nearby tissue. Kamoi et al. established a grading system to quantify the severity of the lesions in question [7, 8].

Prostate tissue was collected in the sagittal or axial plane. Using a biopsy cannon (18 G 25 cm), tissue samples were extracted for analysis. The protocol for the core biopsy was lengthened to include a total of 12 cores. Following biopsy, tissue samples were preserved in 38% formaldehyde solution for further histopathological investigation. If lesions are found, a targeted biopsy is performed under TRUS and elastography guidance, and the specimens are delivered to the histology department in two different containers.

For prostate cancer, the Gleason score was used to determine the aggressiveness of the disease. A tissue sample from the prostate and another from elsewhere in the body were individually evaluated by the pathologist, who then awarded a score between 1 and 5. The Gleason score was calculated by adding the two highest scores. After the treatment, just a few mild problems were noticed and managed.

Inclusion criteria

1. Increased PSA.
2. Abnormal results on digital rectal exam.
3. Prior negative biopsies but persistent concern for prostate cancer all point to the need for further investigation.

Exclusion criteria

1. Diarrheic bowel disorder IBD surgical removal of the rectum ileo-anal pouch.
2. Patients on anticoagulation whose international normalized ratio (INR) is more than 1.3.
3. Those who are unable to obtain informed permission or who are otherwise unwilling to have a biopsy.

Results

Forty patients with an abnormal digital rectal examination and an elevated prostate specific antigen level underwent transrectal ultrasound, transrectal real-time strain elastography, and transrectal systematic 12-cores biopsy with additional targeted biopsies from abnormal areas detected by transrectal ultrasound and transrectal real-time strain elastography.

Nineteen (47.5%) of the cases were malignant, whereas 21 (52.5%) were noncancerous. The prostate cancer was seen in all 19 tumors. There were 21 benign lesions found, 13 of which were benign prostatic hyperplasia and 8 were prostatitis.

Table 1: Distribution of benign lesion types

Types of Benign Lesions	Frequency	Percentage
Benign Prostatic Hyperplasia	13	62
Prostatitis	8	38
Total	21	100

Table 2: Lesions- age wise distribution

Age	Benign	Malignant	Total no of cases	Percentage of age distribution
50 - 60	5	2	7	17.5
60 - 70	5	4	9	22.5
70 - 80	9	10	19	47.5
80 - 90	2	3	5	12.5
Total	21	19	40	100

The average age of patients with malignancies in our study sample was 72 years (SD = 8.8), while the average age of patients with benign lesions was 67 years (SD = 9.6).

Table 3: Lesions by PSA level

PSA (ng/mL)	Benign	Malignant	Total no of cases	Percentage of distribution
<10	12	0	12	30
10 - 20	3	6	9	22.5
20 - 30	3	5	8	20
>30	3	8	11	27.5
Total	21	19	40	100

Table 4: Lesion distribution based on prostate size

Prostate size (cm^3)	Benign	Malignant	Total no of cases	Percentage of distribution
<30	8	6	14	35
30 – 40	6	6	12	30
40 - 50	2	2	4	10
>50	5	5	10	25
Total	21	19	40	100

The average prostate size in our study sample was 38 cm3 for malignancies, with a standard deviation of 19.9, and 38 cm3 for benign diseases, with a standard deviation of 17.7.

Table 5: Based on clinical findings, the distribution of lesions.

Clinical Findings	Benign	Malignant	Frequency	Percentage of Clinical Findings
Lower urinary tract symptoms	16	14	30	75
Hematuria	5	5	10	25
Total	21	19	40	100

Thirty of the forty patients complained of problems related to their lower urinary tract, such as urgency, hesitancy, or incontinence. Benign prostatic hyperplasia was found in 10 of the instances, while prostatitis was found in 6 of the cases; hence, all 16 cases were found to be benign. Prostate adenocarcinoma accounted for the remaining 14 cases. After hematuria, this was the most often reported symptom. Five of the ten patients who reported hematuria had benign causes, including three instances of prostatitis and two instances of benign prostatic enlargement. Five further cases were conclusively identified as prostate cancer.

Table 6: Transrectal Ultrasound Results And Associated Histopathology

Trus Findings	Histopathology	
	Benign	Malignant
Postive for malignancy (n=19)	5	14
Negative for Malignancy (n=21)	16	5
Total	21	19

Hypoechoic lesions, hypervascular lesions, and capsular irregularity were all considered. Twenty-nine potentially cancerous lesions were found with TRUS, representing 40% of the patients. Only five of these 19 cases actually involved cancer; the other 16 were benign tumors. 5 malignant lesions were missed by TRUS.

Analyzing the data statistically: Chi-square analysis reveals a strong correlation between TRUS and HPE (p=10.7) (P value- 0.01)

Our research showed that transrectal ultrasound has a sensitivity of 78.57 percent, specificity of 81.25 percent, a positive predictive value of 78.57 percent, and a negative predictive value of 81.2 percent.

Table 7: Distribution of lesions according to elastrographic grading

Elastography strain	Number of cases	Percentage of Distribution
II	11	27.5
III	13	32.5
IV	8	20
V	8	20
Total	40	100

Only 11 of the 40 instances were classed as Elastography grade II, while 13 were classified as Elastography grade III, and 8 were classified as Elastography grade IV or grade V. Eleven of the forty individuals had lesions that were deemed Elastography grade II. Histopathology revealed that three of the lesions were inflammatory, whereas five were benign enlargement of the prostate. On TRUS, these lesions showed no signs of malignancy. These lesions manifested as symmetric heterogeneous strain on elastography.

Elastography grade III was assigned to 13 of the 25 lesions. Five of the lesions were diagnosed as benign prostatic hyperplasia, three as inflammatory lesions, and three as prostate cancer after undergoing histology. Two of the tumors were initially diagnosed as malignant on transrectal ultrasound but were found to be prostatitis and benign prostatic hyperplasia upon histopathological examination. There was no correlation between the hypoechoic areas shown on grey scale ultrasound and the asymmetrical focal stiff lesions seen on elastography.

In Elastography, grade IV was assigned to 8 lesions. All of the tumor samples tested positive for prostate adenocarcinoma on histopathology. In transrectal ultrasound, these lesions show up as hypoechoic, and in elastography, they show central stiffness and periphery strain. Only 8 of the 40 individuals studied had lesions severe enough to be classified as Elastography grade V. Histopathology confirmed that each of these tumors was, in fact, a form of adenocarcinoma. Transrectal ultrasound reveals these lesions to be hypoechoic, and elastography reveals that the lesion and its surroundings are stiff. Our research indicates that the sensitivity of Elastography is 100%, the specificity is 50%, the positive predictive value is 63.64%, and the negative predictive value is also 100%.

Table 8: Cross-tabulation of elasticity grades and HPE

Elastography grade	Histopathology		Total
	Benign	Malignant	
I	0	0	0
II	11	0	11
III	10	4	14
IV	0	7	7
V	0	8	8
Total	21	19	40

According to the results of a chi-square test (value = 21.2), there is a statistically significant correlation between Elastography and HPE (P value –0.001).

Table 9: A cross-table of trus * elastography grade * HPE

HPE	Trus Findings		Elastography Grade			
	Positive	Negative	Ii	Iii	IV	V
Benign	5	16	11	10	0	0
Malignant	14	5	0	4	7	8

Table 10: Prostate Cancer Diagnostic Efficacy of Trus and Elastography

	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)
Trus	79.17	80.55	77.57	80.95
Elastography	100	50	63.64	100

Transrectal ultrasonography was used to determine the malignancy of 19 lesions in the research population. On histopathology, only 15 of the 19 lesions were found to be cancerous. Six of the 19 lesions that had moderate suspicion of malignancy on elastography (Grade III) turned out to be cancerous. Three further elastography results that were highly suspect of being malignant (Grades IV and V) all turned out to be prostatic adenocarcinomas. Elastography provided a 100% specificity and positive predictive value when we exclusively classified grade IV and grade V lesions as malignant.

Discussions

40 raised patients Prostate specific antigen levels and abnormal digital rectal examination findings were enrolled in our randomized trial, and all were analyzed with transrectal ultrasonography, transrectal real time strain elastography, and a systematic 12-core biopsy, aided by

targeted biopsies from abnormal areas identified by transrectal ultrasound. All of these procedures were compared to histopathology [9, 10].

Our study participants ranged in age from 53 to 88. Our study had 25 patients (83%). Jemal et al. found that age increases prostatic disease prevalence. Malignant tumors had a median age of 72 years, while benign tumors had a median age of 67.

Our research demonstrates that lower urinary symptoms like urgency, hesitance, and increased micturition frequency are the most common clinical presentation of prostatic disease. The lower urinary tracts of 80% of our patients had 21 benign and 19 malignant illnesses. Three benign and three malignant hematuria cases were reported by six patients (20%) [11, 12].

21 benign (52.5%) and 19 malignant (47.5%) lesions were found in the study group. All malignant growths were prostate adenocarcinoma tumors. 13 of the 21 benign lesions were benign prostatic hyperplasia (62.5%) and 8 were prostatitis (37.5%). Our research participants' PSA values were all 4 ng/ml or above. Thompson et al. and Schroder et al. showed that patients with benign prostatic hypertrophy and prostate inflammatory disorders also have PSA levels above 4 ng/ml. Our findings showed that the median PSA level for malignancy was 57ng/mL and for benign illnesses was 25.4ng/mL [12, 13].

Prostate volumes ranged from 8 cm3 to 89 cm3 in our investigation, with the mean being 38.2 cm3. 9 patients (23%) in our study had high-grade prostatomegaly, ranging from 52 to 89 cm3. Three had BPH (30%), three had prostatitis (5%), and three had prostatic cancer (43%). Chung et al. observed that an enlarged prostate was a good sign of malignancy in both BPH and prostate cancer. All patients received a 12-core systematic biopsy from Levine et al. A 12-core biopsy was more accurate than a sextant biopsy for prostate cancer diagnosis [13, 14].

TRUS detected hypoechoic localized lesions in 19 individuals (47%). Color Doppler ultrasonography showed hypervascularity in 15 lesions (71.4%) and avascularity in four (28.5%). Apple et al. found a wide range of prostate tumor ultrasound results. TRUS cannot diagnose prostate cancer by itself. Hypoechoic patches can identify tumors from homogeneous parenchyma, however most hypoechoic lesions are benign. Some tumors are hyperechoic, while many early-stage malignancies are isoechoic. TRUS's positive predictive value is 78.57% and its negative predictive value is 81.25%, according to our research. 11 of 14 TRUS-detected hypoechoic prostate lesions were cancer, whereas the other 3 were benign. TRUS missed lesions in three occasions. TRUS was 53.3% sensitive and 75% specific according to Terris et al., while our study found it to be 78.57 percent sensitive and 81.2 percent specific [14, 15].

Elastography graded 10 cases out of 40. These individuals' prostates showed a symmetrical heterogeneous strain without lesions on grey scale ultrasonography. All of these lesions were benign on histopathology. Elastography revealed eleven grade III lesions in our sample. Elastography showed a localized asymmetric stiff lesion in these patients, however it was unrelated to grey-scale hypoechoic area ultrasonography. Histopathology showed that 10 (73%) of these lesions were noncancerous and 3% were cancerous.

Five of the lesions in our sample were grade IV after elastography. Hypoechoic lesions with central stiffness and peripheral strain were seen on ultrasound. Histopathology showed that all of these growths were malignant. Six of our lesions were grade V elastography. The hypoechoic lesion and its boundaries were rigid on grey scale. All of these lesions proved malignant after histopathology [15, 16].

Elastography was employed by Kamoi et al. Elastography anomalies were absent in eight of thirty guys (27%). Aigner et al. discovered a similar pattern. Only three of the forty-three patients in their study with normal elastography developed malignancy, but all of our cases with normal elastography were benign [17, 8].

19 of the 40 people with abnormal elastography results were diagnosed with cancer. Real-time elastography gave false positives 10 times. Histology showed that 9 of these lesions were caused by benign prostatic hyperplasia and 2 by prostatitis, even though elastography had classed them as intermediate risk for cancer. Elastography had a 63.64% positive predictive value, compared to a previous study by.

According to Aigner et al., all Grade IV and V lesions were malignant. Our investigation showed that elastography was sensitive and had a low negative prediction value. Aigner et al. discovered a sensitivity of 74% and a negative prediction value of 93%, which was similar. Elastography's specificity and positive predictive value can be increased to 100% if only lesions with higher grades (Grades IV and V) are considered malignant. Real-time elastography is more sensitive and has a stronger negative predictive value than TRUS for prostate cancer detection, according to our early research. Thus, Elastography can successfully enhance the confidence level to rule out cancer and save unnecessary biopsies [19, 20].

Conclusion

Prostate cancer can be found by transrectal ultrasonography. In hypoechoic lesions, high vascularity suggests malignancy. For prostate cancer detection, transrectal ultrasonography has the following values: 78.57, 81.25, 78.57, and 81.2 percent for sensitivity, specificity, positive predictive value, and negative predictive value, respectively. For the identification of prostate cancer, elastography offers a 100% negative predictive value and a 63.64 percent positive predictive value. 100% specificity can be attained by elastography if only Grade IV and V lesions are cancerous. Because elastography has a better negative predictive value than ultrasonography and a higher sensitivity for ruling out cancers, it decreases the need for needless biopsies. Urology and elastography can aid in the quicker detection of malignancy.

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Conflict of interest

Nil

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