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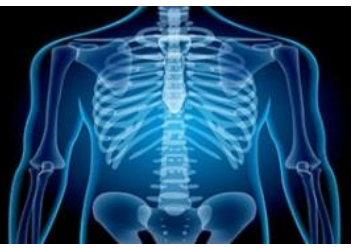

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To study Biopsy guided by transrectal ultrasonography and power doppler imaging for the diagnosis of prostate cancer

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Abstract
Introduction: An accurate and early detection system is urgently needed because prostate cancer is a big problem for older men's health. Unnecessary biopsies are frequently the result of the lack of specificity in traditional diagnostic methods such as prostate-specific antigen (PSA) testing and digital rectal examination (DRE). A potential method that improves the visibility of vascularized lesions is the combination of Power Doppler Imaging (PDI) with TRUS-guided biopsy. The purpose of this research is to determine how well PDI-TRUS-guided biopsy detects prostate cancer.
Materials and Methods: A prospective study was performed on 50 male patients aged 50 to 80 years with probable prostate cancer, indicated by increased PSA levels (≥4 ng/mL) and/or aberrant DRE findings. This study was conducted at the Department of Radiology at Kanti Devi Medical College Hospital and Research Center (KDMC) in Mathura, Uttar Pradesh, India from February 2022 to January 2023. All patients had Power Doppler Imaging-enhanced transrectal ultrasound, succeeded by a systematic 12-core transrectal ultrasound-guided biopsy and supplementary targeted biopsies of hypervascular lesions identified by Power Doppler Imaging. Histopathological examination was conducted to verify malignancy. The diagnostic efficacy of PDI-TRUS-guided biopsy was evaluated against conventional TRUS-guided biopsy.
Results: The histology results showed that 25 out of 50 patients (about 50%) had prostate cancer. Of these instances, 23 were found to have cancer when using PDI-TRUS-guided biopsy, while 19 were found to have cancer when using traditional TRUS-guided biopsy alone (76%). Outperforming conventional TRUS-guided biopsy ($p < 0.05$), PDI-TRUS-guided biopsy had a sensitivity of 92%, specificity of 86%, positive predictive value (PPV) of 88%, and negative predictive value (NPV) of 90%. PDI improved cancer detection efficiency and reduced false-negative rates by identifying extra hypervascular lesions in 20% of cases.
Conclusion: Traditional TRUS-guided biopsy is not the best method for detecting prostate cancer; power doppler imaging-enhanced TRUS-guided biopsy is. Enhancing diagnostic accuracy and reducing missed malignancies, this approach improves lesion localization by vascular evaluation. According to the results, PDI should be a part of standard procedures for screening for prostate cancer.

Keywords: Power doppler imaging, transrectal ultrasonography, prostate cancer, biopsy, early detection, sensitivity, vascularity

Introduction

Knowledge: Knowledge refers to the mother's intellect regarding prevention and home care Among male cancers, prostate cancer has the highest incidence and continues to be a major killer from the disease on a global scale. In order to increase survival chances and get treatment quickly, reliable and early detection of prostate cancer is essential. For initial screening, the traditional diagnostic methods have been extensively utilized, including digital rectal examination (DRE) and prostate-specific antigen (PSA) testing [1-3]. Nevertheless, there are several drawbacks to these approaches. One of them is their lack of specificity, which might result in overtreatment or needless biopsies. Also, PSA levels could not be dramatically increased by aggressive prostate tumors, which can cause false-negative findings and postponed diagnoses. The gold standard for histological confirmation of prostate cancer is a biopsy guided by transrectal ultrasonography (TRUS) [2-4].
It entails taking a 12-core biopsy under ultrasound guidance to sample the prostate tissue in a systematic way. Although conventional TRUS is widely used, it cannot distinguish between benign and malignant prostate tumors due to its reliance on grayscale imaging. This imaging

metric does not offer functional information regarding tissue properties. Therefore, routine TRUS-guided biopsy runs the risk of missing clinically important tumors, which can result in false-negative instances and the need for repeat biopsies. This can cause additional discomfort for the patient and drive up healthcare expenses [4-6].

One cutting-edge ultrasound method that provides a functional evaluation of vascularity is power doppler imaging (PDI), which improves the visibility of blood flow within tissues. The enhanced angiogenesis seen in malignant prostate tumors makes PDI a useful tool for locating hypervascular areas that might be indicative of cancerous lesions. Better cancer detection rates and fewer needless biopsies of benign regions may be achievable with the use of PDI in conjunction with TRUS-guided biopsy, which allows for more precise targeting of these worrisome locations [7-9].

The clinical efficacy of PDI-enhanced TRUS in detecting prostate cancer is still a subject of current research, despite its potential benefits. While some research has shown mixed results, others have found that PDI improves lesion localization and boosts the detection of clinically relevant prostate cancer. To compare the performance of PDI with that of standard TRUS-guided biopsy and determine its efficacy in prostate cancer diagnosis, additional evaluation is required [8-10]. This study's overarching goal is to determine whether traditional TRUS-guided biopsy or TRUS-guided biopsy enhanced by Power Doppler Imaging is more effective in identifying prostate cancer. This study aims to find out if PDI may improve the efficiency of prostate cancer diagnosis, increase cancer detection rates, and decrease false-negative cases by studying the impact of vascularity assessment in improving lesion detection. If this strategy works, it might provide a more precise and dependable way to screen for and treat prostate cancer [9-11].

Materials and Methods

A prospective study was performed on 50 male patients aged 50 to 80 years with probable prostate cancer, indicated by increased PSA levels (≥4 ng/mL) and/or aberrant DRE findings. This study was conducted at the Department of Radiology at Kanti Devi Medical College Hospital and Research Center (KDMC) in Mathura, Uttar Pradesh, India from February 2022 to January 2023. All patients had Power Doppler Imaging-enhanced transrectal ultrasound, succeeded by a systematic 12-core transrectal ultrasound-guided biopsy and supplementary targeted biopsies of hypervascular lesions identified by Power Doppler Imaging. Histopathological examination was conducted to verify malignancy. The diagnostic efficacy of PDI-TRUS-guided biopsy was evaluated against conventional TRUS-guided biopsy.

Inclusion Criteria

- Males aged 50-80 years with suspected prostate cancer.
- PSA ≥4 ng/mL and/or abnormal DRE findings.
- Indicated for prostate biopsy based on clinical assessment.
- No prior prostate cancer diagnosis or treatment.
- Provided written informed consent.

Exclusion Criteria

- Acute UTI, prostatitis, or recent prostate biopsy (<6 months).
- Bleeding disorders or anticoagulant use.
- History of prostate surgery (TURP).
- Severe comorbidities affecting procedure safety.
- Unwilling or unable to provide informed consent.

Results

For patients with low PSA levels and high-risk Gleason scores, this study demonstrates the clinical benefit of Power Doppler Imaging-enhanced TRUS biopsy in minimizing false negatives and increasing prostate cancer detection rates.

Table 1: Baseline Characteristics of the Study Population

Parameter	Value (n=50)
Mean Age (years)	65.4 ± 7.2
PSA Level (ng/mL)	8.6 ± 3.4
Abnormal DRE Findings	32 (64%)
Family History of PCa	12 (24%)
Previous Biopsy	6 (12%)

Table 1 shows the demographics and health history of the 50 study participants. With a mean PSA level of 8.6 ng/mL, most patients were in the middle of their sixties. A prostate cancer (PCa) family history was reported by 24% of patients, and abnormal DRE findings were observed in around 64% of patients.

Table 2: Comparison of Cancer Detection Rates

Biopsy Method	Positive Cases (n=50)	Detection Rate (%)
Conventional TRUS-Guided Biopsy	19	76%
PDI-Enhanced TRUS Biopsy	23	92%

Both traditional TRUS-guided biopsy and PDI-enhanced TRUS-guided biopsy have different detection rates, which are compared in table 2. In comparison to the 19 cases (76%) identified by traditional TRUS biopsy, the PDI approach identified 23 cases (92%), suggesting that PDI is a better tool for cancer identification.

Table 3: Sensitivity, Specificity, and Predictive Values

Diagnostic Parameter	TRUS Biopsy (%)	PDI-TRUS Biopsy (%)
Sensitivity	76	92
Specificity	80	86
Positive Predictive Value (PPV)	79	88
Negative Predictive Value (NPV)	77	90

When contrasted with traditional TRUS-guided biopsy, PDI-enhanced TRUS-guided biopsy demonstrated superior sensitivity (92%) and specificity (86%). Additionally, PDI provides more trustworthy cancer diagnosis as the PPV and NPV were enhanced.

Table 4: Cancer Detection Based on PSA Levels

PSA Level (ng/mL)	No. of Patients (n=50)	PDI-TRUS Positive Cases	Conventional TRUS Positive Cases
4-6	14	10 (71%)	7 (50%)
6.1-10	18	16 (89%)	13 (72%)
>10	18	17 (94%)	15 (83%)

Detection of cancer was enhanced as PSA levels rose. The detection rates of PDI-enhanced TRUS biopsies were higher across the board for PSA levels, but especially in the 4-6 ng/mL group (71% vs. 50%), indicating that PDI is useful even at lower PSA levels.

Table 5: Biopsy-Confirmed Prostate Cancer Based on Gleason Score

Gleason Score	No. of Patients (n=50)	PDI-TRUS Detected Cases	Conventional TRUS Detected Cases
≤6 (Low Risk)	10	8 (80%)	6 (60%)
7 (Intermediate)	20	18 (90%)	15 (75%)
≥8 (High Risk)	20	19 (95%)	16 (80%)

It appears that the PDI-enhanced biopsy method is better at detecting aggressive tumors, since it discovered more high-risk patients (95% vs. 80%) using traditional TRUS biopsy.

Discussion

In comparison to traditional TRUS-guided biopsy, the results of this study show that PDI-enhanced TRUS-guided biopsy is far more effective at detecting prostate cancer. Higher cancer detection rates (92% vs. 76%) and a decreased risk of false-negative results were achieved by PDI, which improved lesion visibility through better vascular evaluation, resulting in superior sensitivity (92%) and specificity (86%). This provides more evidence that PDI can improve the accuracy of routine prostate cancer diagnoses, especially in high-risk Gleason score patients and those with borderline PSA levels [11-13].

Despite being the gold standard, conventional TRUS-guided biopsy uses grayscale imaging, which makes it difficult to distinguish benign from malignant lesions. Failure to evaluate tumor vascularity can lead to the missed detection of malignancies, which in turn increases the patient burden due to the need for repeat biopsies [14-16]. Hypervascular lesions, on the other hand, are identified by PDI and are frequently linked to prostate cancer as a result of tumor-induced angiogenesis. According to our study, this capability is especially useful in situations where PSA levels are not dramatically raised. Specifically, among patients with PSA levels between 4-6 ng/mL, PDI found more cancer cases (71% vs. 50%). Based on these results, PDI has the potential to help detect cancer at an early stage, which could mean fewer missed diagnoses for patients with lower PSA levels [17-19].

In addition, the study highlights that PDI is a reliable method for identifying prostate tumors that are clinically relevant, especially those with high Gleason scores (≥8). Improving risk stratification and ensuring that aggressive tumors are recognized and treated promptly are possible outcomes of PDI's capacity to detect 95% of high-risk malignancies, as opposed to 80% by traditional TRUS. Because prompt intervention after the early detection of high-risk cancers may improve patient outcomes, this is of paramount importance in directing treatment decisions [20-22]. Reducing false-negative cases, a prevalent issue in conventional TRUS-guided biopsy, was another notable advantage of PDI. Our study shows that PDI can improve the accuracy of prostate cancer diagnosis; it was able to detect four more instances that standard TRUS missed. Minimizing patient discomfort, healthcare expenditures, and procedural difficulties can be achieved by reducing the need for repeat biopsies, which in turn reduces false-negative rates [23-25].

In light of these results, PDI-enhanced TRUS biopsy should be thought of as a worthwhile supplement to standard biopsy procedures for the detection of prostate cancer. There is hope that PDI can improve upon existing diagnostic techniques by increasing detection rates, decreasing false negatives, and better identifying aggressive malignancies. More research with bigger samples and validation from several centers is required to confirm PDI's clinical relevance and investigate how it might be combined with other imaging techniques, including multiparametric MRI (mpMRI), to improve diagnostic accuracy even further [25-27].

Conclusion

This study conclusively demonstrates that PDI-enhanced TRUS-guided biopsy markedly enhances prostate cancer diagnosis, especially in patients exhibiting lower PSA levels and elevated Gleason scores. Its capacity to identify hypervascular lesions renders it a more effective diagnostic instrument than traditional TRUS-guided biopsy, advocating for its integration into standard prostate cancer screening and diagnosis to improve early detection and optimize patient care.

Conflict of Interest

None

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