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THE VALUE OF ELASTOGRAPHY IN THE DETECTION OF PROSTATE CANCER – CLINICAL EXPERIENCE

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Abstract

The aim of this study was to evaluate the efficacy of real-time shear wave elastography (SWE) in prostate cancer diagnosis in patients with elevated prostate-specific antigen values and abnormal results on digital rectal examination. This study included 74 patients (mean age 68.3 years) with suspected prostate cancer – prostate-specific antigen>4 ng/mL and abnormal digital rectal examination. All patients scheduled for transrectal ultrasound biopsy of the prostate underwent standard transrectal ultrasonography and SWE.

The reported sensitivity and specificity of SWE in the various studies varied widely, from 43–96% and 33–96%, respectively. This study showed that patients with elevated levels of prostate-specific antigen, abnormal digital rectal examination, and negative SWE may not require a biopsy which could significantly reduce the number of biopsies performed.

Key words: prostate cancer, real-time shear-wave elastography, transrectal ultrasonography

Introduction. Prostate cancer is the second most common cancer in men, the fifth leading cause of death from cancer, and is the most common malignant entity in men in Europe [1]. Timely diagnosis is of key importance to the disease outcome. Screening includes digital rectal examination (DRE) and serum

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prostate-specific antigen (PSA). Elevated PSA levels or an abnormal DRE result require a systematic (10–12-point) biopsy under transrectal ultrasound. This method has two main disadvantages – unnecessary invasive testing in patients with unproven neoplasia and many false-negative results [2]. Increasing the number of targeted biopsies improves diagnosis, has more informative value for tumour volume and Gleason score, but carries out the risk of overdiagnosis of microscopic tumour foci, without excluding prostate cancer, higher morbidity and risk of infections, more costs [3, 4].

Magnetic resonance imaging (MRI) is the most commonly used method for imaging prostate cancer, especially in radical surgery patients [5, 6]. Although the sensitivity of the multiparametric MRI image is high, its specificity remains low, and its cost is high [7]. Conventional transrectal ultrasonography also has a limited range of sensitivity and specificity – from 40% to 50% for cancer detection [8, 9].

Prostate cancer has a higher cell density than the surrounding normal tissue. This increased cell density leads to a change in the tissues' elasticity, which allows it to be measured and demonstrated by sonographic elastography in real-time. Real-time sonoelastography (RTE) has been shown to visualize areas suspected of being malignant as "hard" lesions [10]. This method allows early detection of prostate cancer followed by targeted ultrasound biopsy.

This study aimed to evaluate the efficacy of real-time shear wave elastography (SWE) in prostate cancer diagnosis in patients who have elevated PSA levels and abnormal DRE results.

Methods. ***Patient selection.*** For the period August 2020 – September 2021, a total of 74 patients treated in two university hospitals underwent simultaneous transrectal ultrasonography with biopsy and real-time shear-wave elastography. Inclusion criteria were elevated PSA values ($> 4\,\mathrm{ng/ml}$) and an abnormal DRE.

BM SPSS Statistics v.26 was used for systematization, processing, and analysis of primary data. For all tests, a level of significance $P > 0.05$ was adopted. Descriptive statistics, nonparametric tests, correlation analysis, regression analysis, ANOVA, and Bonferroni post-hoc test were used for statistical analysis.

Real-time shear-wave elastography, Transrectal ultrasonography. All patients underwent TRUS and RTE with SonoScape™ ultrasound machine. Ultrasonic elastography examines the hardness of tissues as a physical property evaluated with the Young's modulus. There are two elastography methods: quasi-static or based on deformation and dynamic or on the shear wave. In the first method, transducer pressure is applied to the tissue, while in the second method, the tissue shear wave is induced by the system. All patients were examined in a lithotomy position. The prostate was measured by embedded software according to the formula by measuring three planes: $\mathrm{width} \times \mathrm{length} \times \mathrm{height} \times \pi/6$. Imaging was performed in the axial and sagittal planes, from the seminal vesicles to the apex of the gland. After measuring volume and routine image, the prostate was divided into 12 sections for SWE and subsequent biopsy (Fig. 1).

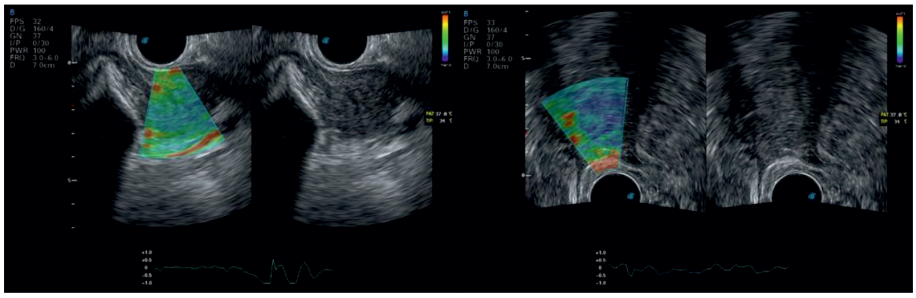


Fig. 1. Sagittal and transversal sonoelastography

Results. A total of 74 patients with 924 biopsy cores were assessed, $68.9 \pm 5.4\%$ ($n = 51$) with prostate cancer. The baseline patient characteristics are presented in Table 1, divided into three groups – low, medium, and high risk according to the D'Amico risk stratification classification, using PSA, Gleason score, and clinical stage [11].

T a b l e 1

Clinical characteristics of patients

	Cohort ($N = 74$)	Positive biopsy ($N = 51$)	Negative biopsy ($N = 23$)	P value
Age (mean ± SE)	68.3 ± 0.9	67.9 ± 1.2	69.2 ± 1.3	$P > 0.05$
PSA level (mean ± SE), ng/ml	11.8 ± 0.9	12.6 ± 1.2	10.0 ± 0.8	$P > 0.05$
DRE-abnormal cases, N	74	51	23	NA
TRUS-abnormal cases, N (%)	47 ($63.5 \pm 5.6\%$)	33 ($70.2 \pm 6.4\%$)	14 ($29.8 \pm 9.5\%$)	$P = 0.01$ ($Z = 2.6$)
Prostate volume, (mean ± SE), ml	61.9 ± 1.6	61.4 ± 2.1	63.1 ± 2.5	$P > 0.05$
Gleason score, 6–10, N (%)	NA	≤ 6 ($n = 21$; $41.2 \pm 6.9\%$) 7 ($n = 20$; $39.2 \pm 6.8\%$) 8 ($n = 6$; $11.8 \pm 4.5\%$) ≥ 9 ($n = 4$; $7.8 \pm 3.8\%$)	NA	NA
D'Amico's risk stratification, high, intermediate, and low, N (%)	NA	Low risk – 9 ($19.6 \pm 5.6\%$) Intermediate risk 32 ($69.6 \pm 6.4\%$) High risk – 5 ($10.9 \pm 4.4\%$)	NA	NA

There is no statistically significant difference in terms of age – 67.9 ± 1.2 vs. 69.2 ± 1.3, PSA level – 12.6 ± 1.2 vs. 10.0 ± 0.8, and prostate volume – 61.4 ± 2.1 vs. 63.1 ± 2.5 (for all $P > 0.05$) from the obtained data.

The hardness characteristics evaluated by SWE for benign and malignant prostate tissue are presented in Table 2.

The correlation between the SWE parameters and the Gleason score result is shown in Table 3. Both S (Mean stiffness) and R (Mean stiffness ratio) show a

Table 2

Differentiation between benign and malignant tissue /Mean stiffness (S) = (Young's modulus [R1] + Young's modulus [R2])/2, Mean stiffness ratio (R) = S of sector / lowest S of patient/

Parameter (mean ± SE)	Normal prostate tissue ($n = 51$)	Prostate cancer ($n = 23$)	P
S (kPa)	29.2 ± 1.1	68.0 ± 3.1	$P = 0.000$ (F=67.11)
R	2.9 ± 0.8	5.9 ± 0.4	$P = 0.000$ (F=28.11)

Table 3

Correlation of SWE Parameters with Gleason score

Parameter	Gleason score				R	P
(mean ± SE)	≤ 6 ($n = 21$)	7 ($n = 20$)	8 ($n = 6$)	≥ 9 ($n = 4$)		
S (kPa)	53.0 ± 0.7	63.1 ± 2.4	103.8 ± 2.1	116.8 ± 0.8	0.893	0.000
R	3.9 ± 0.1	5.8 ± 0.2	8.6 ± 0.7	12.1 ± 1.0	0.889	0.000

significant linear trend in Gleason score evaluation (R = 0.893, $P = 0.000$ for S and R = 0.889, $P = 0.000$ for R).

Discussion. Prostate cancer is the second most common cancer worldwide. Its high rates and asymptomatic course, even in advanced stages, necessitate the introduction of screening programmes for early diagnosis. In recent years, the most widely used screening tools have been digital rectal examination and prostate-specific antigens. The negative aspects of PSA screening are well described and known, while DRE has high subjectivity and low sensitivity in small tumour volumes [12]. The search for new screening mechanisms aims primarily at reducing unnecessary biopsies and identifying patients who would benefit from performing them, including genetic screening methods [13]. Magnetic resonance imaging is the most commonly used method for imaging prostate cancer. However, the sensitivity of multiparametric MRI imaging is high, its specificity remains low, and its cost is high. The first reports of prostate cancer localization and detection of benign from malignant prostate tissue are more than six years old [14]. However, the recommendations of the European Urological Association regarding new ultrasound methods, including elastography, indicate that additional data are needed for standardization and large-scale evaluation of indicators [15]. In our study, we evaluated the diagnostic value of SWE for the detection of prostate cancer. Our results showed that the SWE parameters differed significantly in prostate cancer and benign prostatic hyperplasia with a statistically significant difference, both in terms of Mean stiffness (S) – 29.2 ± 1.1 vs. 68.0 ± 3.1 ($P = 0.000$, F = 67.11), as well as with respect to Mean stiffness ratio (R) – 2.9 ± 0.8 vs. 5.9 ± 0.4 ($P = 0.000$, F = 28.11).

Several studies have reported exceptional values in differentiating benign from malignant tissue with SWE with almost perfect sensitivity (90–96.2%) and specificity (88–96.2%) [16, 17]. In our research, these values were slightly lower. The correlation between the degree of malignancy assessed by the Gleason score for S (53.0 ± 0.7; 63.1 ± 2.4; 103.8 ± 2.1; 116.8 ± 0.8) and R (3.9 ± 0.1; 5.8 ± 0.2; 8.6 ± 0.7; 12.1 ± 1.0) is also significant ($P = 0.000$) and linear. This result shows that stiffness from benign to malignant tissue results from cell differentiation.

After some technological improvements, we believe that SWE may become part of the standard protocol for diagnosing prostate cancer.

Conclusion. The presented study shows promising results for the use of SWE in the screening and early diagnosis of prostate cancer. SWE clearly distinguishes benign from malignant prostate tissue. SWE, compared to TRUS, allows targeted biopsy, which makes it a more accessible, non-invasive, and relatively inexpensive method that can be used in routine clinical practice and could significantly reduce the number of biopsies performed.

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