

TRANSPERINEAL VERSUS TRANSRECTAL PROSTATE BIOPSY: COMPARATIVE ANALYSIS OF EFFICACY AND SAFETY

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Abstract

Prostate cancer is the most frequently diagnosed cancer in men, and systematic ultrasound-guided biopsy continues to be the standard method for diagnosis. Although the transrectal (TR) approach is commonly used, it is associated with a higher risk of infection and bleeding complications. The transperineal (TP) biopsy technique was introduced to lower these risks while preserving similar diagnostic accuracy. The purpose of this study was to evaluate and compare cancer detection rates, histopathological findings, and complication rates between transperineal (TP) and transrectal (TR) prostate biopsy methods. Four hundred and sixteen men referred for prostate biopsy at the University Multidisciplinary Hospital for Active Treatment “Tsaritsa Yoanna - ISUL” between January 2022 and December 2025 were included in the study. The patients’ age ranged from 49 to 95 years (mean age 69.39 years, standard deviation – 8.365). The overall cancer detection rate was relatively similar – TR group (76.8%) vs. TP group (67.53%), while apparent differences are observed in ISUP grade. GG 1 is observed in 57% of patients in the TP group, while in the TR group, the percentage is significantly – 34%. Poorly differentiated prostate cancer (ISUP ≥ 4) is seen in 32% of patients who underwent TR biopsy, compared to 12% in the TP group.

Key words: prostate, cancer, biopsy, transperineal, transrectal

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Introduction. Prostate cancer is the second most commonly diagnosed cancer in men and the sixth leading cause of cancer death among men worldwide, with 1.46 million diagnoses and 396 792 deaths worldwide in 2022 [1]. Early detection of prostate cancer is crucial for its successful treatment. Therefore, screening programmes are implemented to enable its early diagnosis and timely management. While prostate cancer is a leading cause of cancer death among men, the death rate has been gradually decreasing recently. Today, the transrectal and transperineal approaches to prostate biopsy are the standard methods for the histological confirmation of prostate carcinoma. Although the transrectal (TR) approach has been commonly performed, it is associated with a higher likelihood of infectious and bleeding complications. The transperineal (TP) technique was introduced as an alternative to minimize these risks, while preserving a similar level of diagnostic reliability.

Multiple studies have been conducted to compare the detection rates and complication profiles of the TR and TP approaches. The TP approach has become increasingly favoured because of its advantages, including improved detection of tumours in the AFS (Anterior Fibromuscular Stroma) of the prostate and in apex of the prostate gland. Additionally, the TP approach for prostate biopsy, compared to the TR approach, has a lower infection rate and prevents rectal bleeding [2]. Furthermore, most studies suggest that TR and TP approaches yield similar results regarding cancer detection and cancer core rates [3–5]. Nevertheless, the effectiveness of the two methods in detecting cancer may differ across patients with varying ages, PSA values, and prostate sizes [6, 7]. In our study, prostate biopsies are typically performed using 14 cores – roughly 70% consist of targeted and perilesional sampling, with the remaining being systematic.

As a result, the European Association of Urology's prostate cancer guidelines increasingly suggest that the transperineal approach be regarded as the preferred method for performing prostate biopsies [8]. In 2003, BARZELL and WHITMORE [9] introduced a targeted transperineal prostate biopsy (TP-PBx) technique using a brachytherapy grid that divides the prostate into 24 zones. This grid minimizes human error and allows for precise, systematic sampling, improving the accuracy of biopsy localization.

The aim of this study is to compare the detection rates of the transrectal and transperineal approaches regarding their diagnostic accuracy for prostate cancer in both biopsy-naïve patients and those undergoing repeat biopsies, as well as the complications profile of the two approaches.

Materials and methods. Clinical cohort. Four hundred and sixteen men referred for prostate biopsy at the University Multidisciplinary Hospital for Active Treatment “Tsaritsa Yoanna - ISUL” between January 2022 and December 2025 were included in the study. The patients' age ranged from 49 to 95 years (mean age 69.39 years, standard deviation – 8.365).

Study design. The study is prospective, with the main objective of evaluating the role, advantages, and disadvantages of transrectal and transperineal fusion biopsy using a brachytherapy grid in the contemporary diagnosis of prostate adenocarcinoma.

Transrectal systematic prostate biopsy. In our patient cohort, a systematic transrectal Tru-Cut biopsy technique was used, with the collection of 10–14 biopsy cores (mean: 12.9). The indications for performing a primary transrectal biopsy at our institution have been significantly restricted and modified following the introduction of the transperineal approach for prostate biopsy: Patients with highly suspicious digital rectal examination (DRE) findings and/or markedly elevated PSA levels (total PSA > 50 ng/mL) and/or evidence of bone metastases or patients with significant comorbidities in whom even short intravenous anaesthesia carries a risk. Currently, in our centre there are no indications for performing repeat biopsy using the transrectal systematic approach. In such clinical cases, pre-biopsy MRI and a transperineal access are mandatory.

Operative technique of transperineal prostate biopsy using a brachytherapy grid and cognitive fusion in our institution. Since January 2022, our clinic has had the capability to perform biplanar transrectal and transperineal prostate biopsy with cognitive fusion, following the commissioning of the BK Specto ultrasound system with a biplanar transrectal transducer for TRUS biopsy and a biplanar transducer for stabilized transperineal biopsy (TPB) using a brachytherapy grid under cognitive fusion. A stepper and an arm are used to fixate the brachytherapy grid. Main indications for TPB in our study include: the presence of mpMRI with PI-RADS 3 lesions (in selected patients depending on PSAD, as well as the size and location of the suspicious area) and PI-RADS 4 and 5 lesions (in all patients), a previous negative biopsy, and a small-volume suspicious lesion and/or lesions located in the anterior part of the prostate and the apex. The disadvantages of TPB include the need for general anaesthesia in most cases, the requirement for more time and resources as the procedure is performed in an operating room, and a steeper learning curve.

Within our centre transperineal biopsy is currently performed under short-term intravenous anaesthesia following appropriate preoperative preparation. A mandatory requirement is careful review of the available mpMRI and the operator's thorough understanding of the target lesions. Subsequently, the coordinate grid of the brachytherapy template is used in the transverse plane to guide the biopsy needle toward the target areas, while the depth of sampling (apex/midgland/base) is controlled in the longitudinal view.

The biopsy protocol adopted in our hospital setting is sampling 10–14 cores from the target lesions and a mandatory 4–6 systematic biopsy cores from the peripheral zone of the prostate bilaterally.

Results. The average age of the patients is 69.012 years (50–95 years; standard deviation 8.365). Age distribution of patient who underwent prostate biopsy:

49–59 years: 58 patients (13.94%), 60–69 years: 146 patients (35.09%), 70–79 years: 165 patients (39.66%), above 80 years: 47 (11.29%). A previous prostate biopsy had been performed in 51 patients (12.25%), while an initial biopsy was performed in 361 patients (86.77%). Biopsy approach (TR/TP): transrectal biopsy – 142 patients (34.13%); transperineal biopsy – 274 patients (65.86%). A clear trend toward increased use of the transperineal approach over the study period was observed, consistent with contemporary urological practice (Fig. 1).

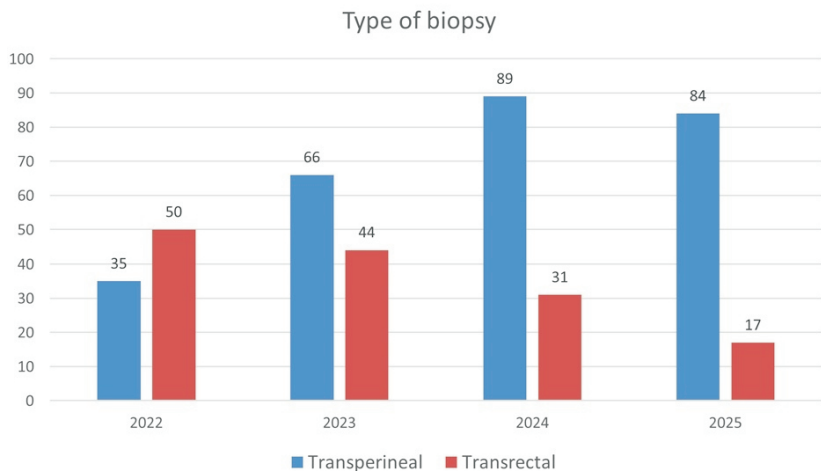


Fig. 1. With the refinement of the transperineal biopsy technique and the implementation of transperineal biopsy protocols, an upward trend in the use of transperineal biopsy over time has been observed at our institution

Plasma levels of total PSA: the mean tPSA level in our patient group was 19.746 ng/mL with a standard deviation of 23.12421 (range 0.77–100 ng/mL). Due to the logarithmic model of the tPSA assay, all values above 100 were recorded as 100 ng/mL in accordance with international practice. tPSA levels are presented as 0–4 ng/ml (4 patients, 0.96%), 4–10 ng/ml (176 patients, 42.30%), 10–20 ng/ml (136 patients, 32.69%), 20–50 ng/ml (55 patients, 13.22%), above 50 ng/ml (45 patients, 10.81%).

Multiparametric MRI (mpMRI) was performed in 289/416 patients (69.47%) prior to biopsy. During the study period, a marked and rapid increase was observed in the proportion of biopsies performed after prior multiparametric MRI (mpMRI): 41/85 patients in 2022 (48.23%), 64/110 in 2023 (58.18%), 92/120 in 2024 (76.66%), and 92/101 in 2025 (91.08%). This trend is attributed to both the leading role of mpMRI as a key determinant for proceeding with prostate biopsy, as well as the significant improvement in its accuracy and specificity with the use of ultrasound/MRI cognitive fusion hybrid technology (Fig. 2).

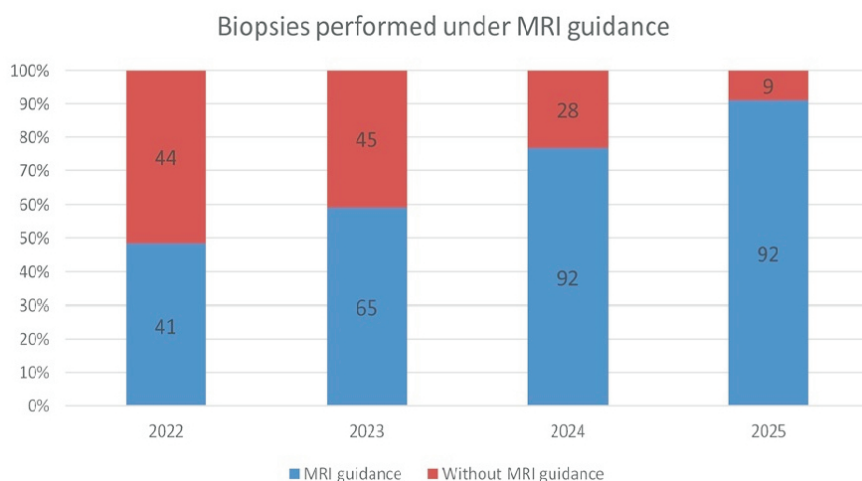


Fig. 2. Biopsies performed under MRI guidance, 2022–2025

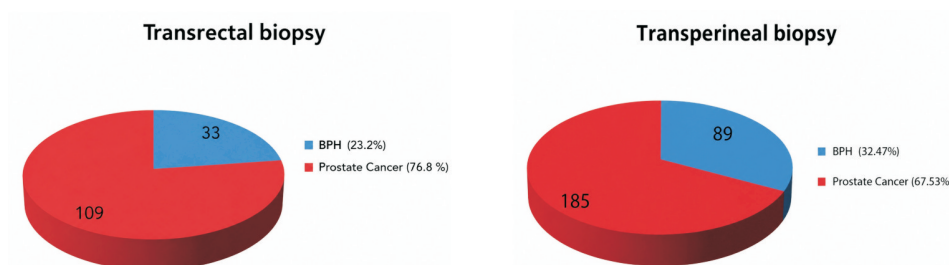


Fig. 3. Ratio of BPH and prostate cancer in TR and TP biopsies

Histological diagnosis: Out of a total of 416 patients who underwent biopsy, 122 (29.33%) were diagnosed with benign prostatic hyperplasia (BPH), while 294 (70.67%) were diagnosed with prostate adenocarcinoma (Fig. 3).

It should be noted that the patients in the two groups have relatively different characteristics – there is a tendency for more advanced cases in the TR group, while the TP group shows a tendency for higher precision and a greater number of indolent prostate cancer cases. This is particularly evident when analysing the group by Gleason score of the prostate biopsy in relation to the type of biopsy (TR or TP).

Gleason score sum of prostate biopsy and biopsy type (TR or TP).

To confirm the fact that patients undergoing transrectal biopsy and those who had the biopsy via the transperineal approach represent two groups with distinct clinical characteristics, a significant difference in the distribution of ISUP grades is observed between the two groups. This is likely due to the fact that in cases of high and very high PSA (above 50 ng/ml) and positive DRE, biopsy (mainly TR biopsy) is performed as soon as possible. As mentioned above, the overall prostate

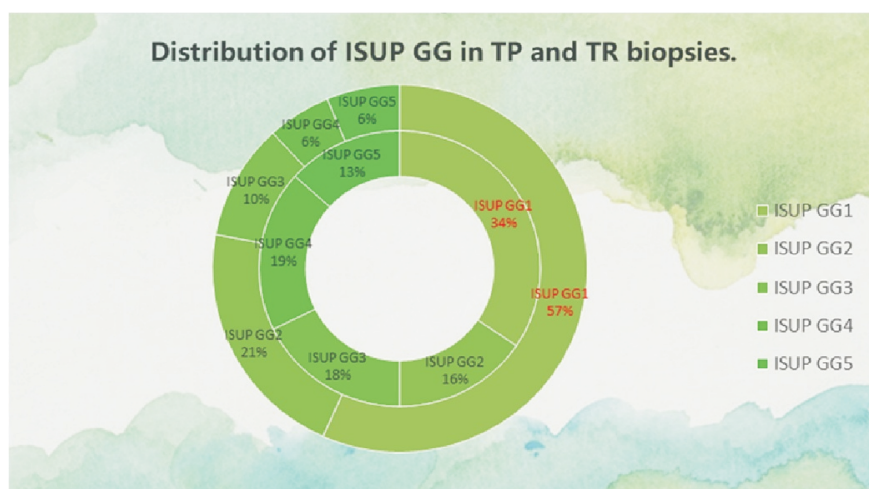


Fig. 4. ISUP (International Society of Urological Pathology) grade distribution according to biopsy type – outer ring TP, inner ring TR

cancer detection rate in both groups is relatively similar, but when analyzing the Gleason group, shown in Fig. 4, significant differences are apparent. GG 1 is observed in 57% of patients in the TP group, while in the TR group, the percentage is significantly lower at 34%. Poorly differentiated prostate cancer (ISUP ≥ 4) is seen in 32% of patients who underwent TR biopsy, compared to 12% in the TP group.

Discussion. Our results are broadly in line with those from the PREVENT [10] randomized trial, which found that transperineal (TP) and transrectal (TR) biopsies detected clinically significant prostate cancer at similar rates. Likewise, in our cohort, no significant difference was observed in the detection of prostate cancer between the two biopsy approaches. However, the transrectal (TR) cohort exhibited a significantly higher proportion of high-risk and very high-risk tumours, whereas the transperineal (TP) approach more frequently identified low- and intermediate-risk disease. In addition, the TP approach demonstrated a superior safety profile, with no infectious complications reported. These variations may be due to differences in patient populations, biopsy techniques, or sample sizes; however, both studies indicate that the transperineal (TP) approach is a safer choice for diagnosing prostate cancer.

As stated in the 2025 EAU Guidelines on prostate cancer the transperineal (TP) [8] approach is now advised as the preferred standard for prostate biopsy, largely replacing the transrectal (TR) method in most clinical practice. Evidence supporting this change shows that the transperineal (TP) biopsy has a reduced risk of infection, with sepsis occurring in approximately 0.1% of cases versus around 0.9% for the transrectal (TR) method, while maintaining comparable detection rates for clinically significant prostate cancer (csPCA). Additionally, transperineal

(TP) biopsy can be safely performed without the use of antibiotic prophylaxis.

However, our findings differ from those of XIANG et al. [5], who in their systematic review and meta-analysis of 11 studies, concluded that transperineal (TP) and transrectal (TR) prostate biopsies have similar diagnostic accuracy, showing no significant differences in overall cancer detection rates. Our study demonstrated comparable overall prostate cancer detection rates between the transrectal (TR) and transperineal (TP) approaches. However, the TR cohort showed a significantly higher proportion of clinically significant high-risk prostate cancers, whereas the TP cohort more frequently identified low- and intermediate-risk disease. These discrepancies may be due to differences in patient selection, biopsy techniques, or sample sizes, but overall they support the growing evidence that the transperineal (TP) approach is both safer and potentially more effective.

Our study's findings also align with those of ZATTONI et al. [11], who retrospectively compared transrectal (TR) and transperineal (TP) prostate biopsy outcomes in a cohort of 283 patients. In contrast with our observations, their study found no statistically significant difference in the detection of clinically significant prostate cancer between the transrectal (TR) and transperineal (TP) approaches. However, in line with our findings, the transperineal (TP) approach was linked to a lower risk of complications – especially prostate infections – compared to the transrectal (TR) method. Compared with their findings, our results showed comparable overall prostate cancer detection rates between the TP and TR approaches; however, the distribution of Gleason grade groups differed significantly, with the transrectal (TR) cohort characterized by a higher prevalence of very high-risk prostate cancers. Overall, these findings suggest that while both approaches effectively detect clinically significant prostate cancer, the transperineal (TP) method offers distinct safety advantages and may enhance detection across different risk categories.

It has been demonstrated that the method of cognitive fusion of data from mpMRI and ultrasound imaging, which utilises a stabilised brachytherapy grid, is as effective as software-based fusion, whilst being more cost-effective and reducing the duration of the procedure, although it does require greater operator expertise [12]. A significant advantage of stabilized TPB using a brachytherapy grid is that its results, through the recording of biopsy core coordinates, can be directly implemented into active surveillance protocols (by enabling repeat biopsies of the same regions to assess for progression) and into the increasingly popular focal therapy protocols for the prostate, facilitating easy identification of the target lesion(s).

Conclusions. At present, TPB is increasingly emerging as the gold standard for prostate cancer diagnosis. Its popularity is driven by significantly fewer severe infectious complications compared to transrectal biopsy and by more accurate detection of clinically significant prostate cancer, with fewer false-negative results and repeat biopsies. TPB is also more effective in detecting cancers located in the

apical and AFS zone of prostate. In addition, the growing use of local anaesthesia has improved its accessibility and logistical simplicity, making it more comparable to TRB.

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