scientific reports

Check for updates

OPEN

Accuracy and safety of in-office transperineal freehand cognitive fusion prostate biopsy under local anaesthesia without antibiotic prophylaxis

Sebastian Lenart[1,2]✉, Osama Shahin[3], Malavika Krishnakumar[4], Jefim Stepanow[5], Andreas Banner[5], Anton Ponholzer[1], Clemens Mikulits[1] & Lukas Oberhammer[2]

To evaluate the cancer detection rate (CDR), tolerability, and safety of transperineal prostate biopsy (TPPB) performed under local anesthesia (LA) without antibiotic prophylaxis in an outpatient setting via a freehand technique. Between January 2015 and April 2024, 763 consecutive patients underwent TPPB at a single center. Of these, 538 patients received no antibiotics. Biopsies were performed via a freehand MRI/ultrasound fusion technique under LA. Patient discomfort was assessed using a visual analogue scale (VAS), and complications were recorded using the Clavien-Dindo classification. Statistical analysis was conducted using non-parametric methods (α = 0.05). Among the 538 patients without antibiotic prophylaxis, the overall CDR was 61.7%, with clinically significant prostate cancer (ISUP ≥ 2) detected in 47.4% of the patients. No infectious complications occurred. The level of pain was generally low (mean VAS 2.7), and 91.6% of patients reported no or only mild pain. Complications were rare (1.1%), with urinary retention being the most common (0.9%), associated with larger prostate volume (> 50 mL). Combining systematic and targeted biopsy yielded the highest diagnostic accuracy (CDR 65.9%, p = 0.023). TPPB using a freehand technique under LA, without antibiotic prophylaxis, is a safe, effective, and well-tolerated in-office procedure. It achieves high diagnostic yield without infectious complications, offering a viable, cost-efficient alternative to traditional transrectal approaches—especially relevant amid increasing antibiotic resistance.

Keywords Transperineal prostate biopsy, Fusion biopsy, Prostate cancer

Prostate cancer (PCa) is one of the most commonly diagnosed cancers in men worldwide and ranks among the leading causes of cancer-related morbidity[1]. Multi-parametric magnetic resonance imaging (mpMRI) enables improved detection of clinically relevant PCa, which has led to transrectal (TRPB) MRI-fusion prostate biopsy being the standard for many years. Currently, the TPPB is increasingly recognized as a valuable alternative to traditional TRPB, suggesting evidence that TPPB method offers advantages: It is presumed to have an enhanced safety profile, particularly due to a lower risk of post-procedural infectious complications including sepsis, which are associated with TRPB and arise from contamination by the rectal flora. The incidence of cystitis, prostatitis, epididymitis, and sepsis ranges from 5 to 7% in TRPB. Despite the routine use of antibiotic prophylaxis, hospital admission rates to 2% have been reported[2]. Moreover, TPPB appears to eliminate the need for antibiotic prophylaxis, a valuable advantage in the context of increasing antibiotic resistance[3]. Recent randomized controlled trials (PREVENT, ProBE-PC, PERFECT and TRANSLATE) confirm these efforts or at least show a noninferiority[4–7].

[1]Department of Urology and Andrology, St. John of God Hospital Vienna, Johannes-von-Gott Platz 1, 1020 Vienna, Austria. [2]Present address: Department of Urology and Andrology, Paracelsus Medical University, Salzburg, Austria. [3]Uromerian.ch, Basel, Switzerland. [4]Department of Health Sciences Research, Amrita Institute of Medical Science and Research Centre, Amrita Vishwa Vidyapeetham, Kochi, Kerala, India. [5]Department of Urology and Andrology, Clinic Favoriten, Vienna, Austria. ✉email: sebastian.lenart@gmx.at

With respect to cancer detection rates (CDRs), recent studies have demonstrated that TPPB provides superior detection of PCa in the anterior regions, attributable to the improved accessibility of the anterior prostate gland through this approach[5,7].

A drawback for TPPB is its increased procedural complexity. This includes the frequent need for GA, since the TPPB approach has often been performed using a template-guided biopsy and thus requires hospitalization. However, the introduction of the freehand fusion technique now allows TPPB under local anesthesia (LA), making it feasible as an in-office procedure. This technique may not only increase patient comfort but also render hospitalization unnecessary. A few studies have demonstrated the feasibility of performing TPPB in an office-based setting, emphasizing their practicability, safety profile and diagnostic yield comparable to those of procedures conducted in hospital environments[8]. However, the generalizability of these findings is limited due to small sample sizes across studies. The largest study to date focusing on freehand TPPB without antibiotic prophylaxis, conducted in an outpatient setting, provides robust evidence for the safety and efficiency of this method, further consolidating its role as an accessible and patient-friendly option in modern PCa diagnosis[8].

The aim of this study was to evaluate the CDR, tolerability and safety of freehand TPPB under LA without antibiotic prophylaxis in an outpatient office setting.

Patients and methods

A total of 763 consecutive patients underwent TPPB at Uro Merian, Basel, Switzerland between January 2015 and April 2024. When this new biopsy technique was enrolled, antibiotic prophylaxis was considered standard before biopsy. The first 223 patients received antibiotics. In 2017, antibiotic prophylaxis was systematically omitted following institutional protocol changes and ongoing clinical study participation[8]. Since then, all TPPB at this centre have been routinely performed without antibiotics. In addition to the non-use of antibiotic prophylaxis, no anti-inflammatory agents or phytotherapeutic medications were administered to patients. There were no predefined exclusion criteria for antibiotic omission; all patients were managed uniformly unless contraindications emerged. Thus, 538 patients did not receive any antibiotics. A total of 505/538 (94%) patients had undergone mpMRI prior to biopsy. MRI was performed at a single MRI institute. All biopsies were performed by a single surgeon.

Technique

Patients were placed in the lithotomy position, and the perineum was thoroughly disinfected. A rectal ultrasound probe (linear probe, 7.5 MHz, Arietta V70, Hitachi) was inserted to guide the procedure. On either side of the midline, 10 ml of 1% lidocaine was administered to the perineal skin, subcutaneous tissue, and pelvic floor (periprostatic triangle between M. transversus perinei profundus, M. levator ani and M. sphincter ani externus) under ultrasound guidance. A 16-gauge (1.6 mm) needle was inserted through the anesthetized skin and served as an access sheath for the biopsy gun (Corazor 18GA/1, 200–240 mm, Uromed). All biopsies were performed with a double freehand technique, without the use of a needle guide, relying solely on the access sheath. Written informed consent was obtained from all patients prior to undergoing biopsy.

The optimal skin entry points, which were positioned 45° ventral and approximately 1.5 cm from the anus, were selected on the basis of the method described by Emiliozzi et al.[9]. This approach facilitates the targeting of any prostate region, enabling both systematic and targeted MRI/US fusion biopsies. The standard systematic biopsy protocol consisted of 10–12 cores, with the number of biopsies adjusted according to the individual prostate volume and following the Fan-scheme[10]. For suspicious lesions identified on mpMRI (≥ PI-RADS 3), additional targeted biopsies were performed, typically obtaining two or three cores per lesion.

Patient pain during the procedure was assessed using a visual analog scale (VAS) ranging from 0 to 10. A follow-up examination was conducted approximately four weeks after biopsy in the outpatient setting to assess the incidence of infections and other potential complications. Patients were advised to contact the office or the hospital at any time if they experienced any complaints. Infectious complications were defined clinically based on the presence of urinary tract symptoms (like dysuria or fever) and requiring antibiotic treatment. No systematic post-biopsy urine cultures were obtained, and asymptomatic bacteriuria was not recorded. Clinically significant complications, such as urinary retention and infections post biopsy, were categorized using the Clavien-Dindo grading system[11].

Statistical analyses and data visualization were conducted using R version 3.0.1. Ordinal data were analyzed with the chi-square test, whereas continuous data were assessed using the nonparametric Mann–Whitney U test. Spearman's rank correlation was employed to explore associations between independent variables for nonnormal distributions. All tests used a significance level of $\alpha = 0.05$. Data are reported as medians with their respective ranges. This study was approved by the local ethical commission IRB (Ethikkommission Nordwest- und Zentralschweiz / EKNZ 2019–01208).

Results

The baseline characteristics of the 538 male patients who underwent TPPB are presented in (Table 1). The median age was 66 years (47–87), the median prostate-specific antigen (PSA) concentration was 6.6 ng/ml (0–1400), the median prostate volume was 44 mL (15–200) as assessed by MRI, and the median PSA-density was 0.15 ng/ml^2 (0.0–31.11). A total of 505 patients (94%) received mpMRI of the prostate before biopsy with suspicious regions described in 480 patients (95%) classified as PI-RADS 3 in 51 (9.5%), PI-RADS 4 in 319 (59.3%) and PI-RADS 5 in 110 (20.4%). A total of 396 of the patients were biopsy-naïve (73.6%), whereas 140 (26%) underwent second or multiple biopsies (second: n = 106 (19.7%), third: n = 24(4.5%), fourth: n = 9 (1.7%), fifth: n = 1 (0.2%)). All patients with suspicious results on mpMRI received TPPB with targeted cognitive fusion cores with MRI/US

	Median (IQR)	
Age (year)	66 (60–72)	
Prostate volume (in ccm)	44 (32–60)	
PSA (ng/ml)	6.6 (4.6–9.8)	
PSAD (PSA density) (ng/ml^2)	0.15 (0.10–0.22)	
	N	%
PIRADS		
2	25	4.6
3	51	9.5
4	319	59.3
5	110	20.4
History of previous biopsies	140	26

Table 1. Baseline characteristics.

and systematic biopsy. Patients without mpMRI or PI-RADS 2 (n = 58, 10.7%) received TPPB with systematic biopsy cores only.

The localization of the suspicious regions was described with discrimination between the anterior, middle and dorsal and left or right hemispheres (right: anterior: 76 (14%), middle 96 (18%), dorsal 219 (41%); left: anterior: 66 (12%), middle 69 (13%), dorsal 151 (28%)). The median number of biopsy cores taken was 15 (4–20) and the median number of targeted biopsy cores was 3 (0–4).

The overall CDR was 61.7% (n = 332), with an ISUP distribution of: ISUP 1: 82 (24.7%), ISUP 2: 129 (38.9%), ISUP 3: 66 (19.9%), ISUP 4: 36 (10.8%), and ISUP 5: 19 (5.7%). The median maximal cancer affection per core was 7.12 mm (0.4-22 mm), which was 53.2% (0.5–100%). The overall CDR was 47,1% (n = 24), 60,8% (n = 194) and 74,5% (n = 82) for PI-RADS 3, 4 and 5 and 21,5% (n = 11), 43,6% (n = 139) and 70,0% (n = 77) for csPCA, respectively. The CDR for csPCa in patients without MRI or with PIRADS 2 (n = 58) was 39.7% (n = 23) with a median age of 75.7 years, a prostate volume of 49.8 mL, a median PSA of 28.5 ng/mL and mean number of prior biopsies in 1.48.

A total of 59.7% (n = 280) of the targeted biopsy cores were positive, with 7.5% (n = 25) being positive in the targeted biopsy cores only. A total of 48.5% of the cores were positive in the systematic biopsy, with 11.1% (n = 37) being positive in the systematic biopsy. When broken down by biopsy strategy, no difference was found in the detection rate of csPCa by targeted-only cores (3.9%) and systematic-only cores (5.1%). The combined approach resulted in the highest detection rate at 65.9% (n = 219, p = 0.023). These data support the additive diagnostic value of combining targeted and systematic biopsies. Compared with targeted biopsy or random biopsy alone, the combination of targeted biopsy and random biopsy led to the highest CDR (65.9%, n = 219; $p = 0.023$). The distributions of the localisations of positive cores are shown in (Table 2).

The overall CDR was similar for biopsy naïve patients (63.1%, n = 250/396) and patients with repeated biopsies (61.4%, 85/140). However, the detection rate of csPCa was significantly greater in biopsy naïve patients (81%, n = 199/250) than in those with a history of prostate biopsy (36%, n = 51/140; $p = 0.029$).

The mean pain intensity VAS score was 2.7 (0–8), whereas 45 patients (8.3%) reported no pain (VAS = 0), 336 patients (62.2%) mild pain (VAS = 1–3), 144 (26.7%) moderate pain (VAS = 4–6) and 13 patients (2.4%) severe pain (VAS = 7–8) and none very severe. None of the patients needed additive local analgesics and none of the procedures needed to be interrupted. Younger patients perceived significantly more pain than older patients did ($p < 0.001$), whereas neither prostate volume nor the number of biopsy cores taken was an influencing factor (Fig. 1).

The complications were all mild and occurred in 1.1% (n = 6) of all patients, where urinary retention (0.9%, n = 5) occurred most often, and were treated with intermittent catheterization (bleeding in the bladder: 0.2%, n = 1) (Table 2). An enlarged prostate volume was identified as a significant risk factor for complications (p < 0.001), with volumes exceeding the 50 mL threshold being associated with a higher incidence of urinary retention (Fig. 2).

Infectious complication did not occur in a single patient within 30 days of follow-up.

Discussion

Prostate biopsy remains a cornerstone in diagnosis and risk stratification, guiding treatment decisions. The conventional TR biopsy method is highly cost-effective and feasible in outpatient settings but lacks adequate patient safety, being associated with significant infectious complications, some of which can be severe, and the need for antibiotics. An alternative approach, the TPPB route, aims to reduce the rate of infectious complications, but its use as a template guided approach under general anaesthesia (GA) leads to the necessity of hospital stay and poses financial barriers. A cost analysis comparing TPPB under GA, TRPB under sedation, and TRPB under sedation against TRUS with LA revealed respective cost increases of 153, 90, and 150%, respectively[12]. Emerging LA-based freehand TPPB techniques have demonstrated feasibility for in-office use[8].

This study aimed to assess the feasibility of TPPB under LA without antibiotics as an office-based procedure, with a focus on CDR and complication rates. In our study, TPPB yielded CDRs of 61.7% (overall) and 47.4% (csPCa), which aligns with previous findings[13]. While the ProBE-PC-trial and PREVENT-trial primarily evaluated complications following TPPB, PERFECT and TRANSLATE examined the CDR between the two

	N	%
Cancer detection rate (overall)	332	61.7
ISUP		
1	82	24.7
2	129	38.9
3	66	19.9
4	36	10.8
5	19	5.7
No. of positive cores overall (ISUP 1/≥2)	143/546	
Localization of positive cores over all (ISUP 1/≥ISUP 2)		
Anterior	39/161	7.1/29.5
Mid	39/179	7.1/32.8
Posterior	65/206	11.9/37.7
Cases with targeted biopsy positive only (≥/ISUP 2)	13/332	3.9
Localization of positive cores in targeted biopsy only (ISUP 1/≥2)		
Anterior	2/4	5.9/11.8
Mid	2/4	5.9/11.8
Posterior	10/12	29.4/35.3
Cases with random biopsy positive only (≥/ISUP 2)	17/332	5.1
Localization of positive cores in random biopsy only (ISUP 1/≥2)		
Anterior	12/7	23.1/13.5
Mid	6/10	11.5/19.2
Posterior	8/9	15.4/17.3
Pain (VAS)		
No (0)	45	8.3
Mild (1–3)	336	62.2
Moderate (4–6)	144	26.7
Severe (7–8)	13	2.4
Any complications	6	1.1
Infections	0	0
Urinary retentions	5	0.9
Urosepsis	0	0
Macrohaematuria	1	0.2
Death	0	0

Table 2. Cancer detection rates and complications.

techniques[4,5,7,14]. The PERFECT trial aimed to identify differences in the CDR based on tumor location. They reported a greater CDR when the TPPB approach was used for anterior zone locations compared to posterior areas (ISUP ≥ 2: 40.6 vs 26.5; 44.3 vs. 59%), whereas TRANSLATE–which was powered for superiority—revealed a 5.7% higher detection rate for ISUP ≥ 2 tumors with TPPB. The two groups were also randomized on the basis of the localization of the MRI-targeted regions to ensure balanced allocation, although region-specific outcomes were not reported separately. However, only biopsy-naïve patients were included in the study, influencing the CDR. We performed a more anatomically precise differentiation between prostate regions and observed a relatively uniform CDR across prostate zones (see Table 2). However, of all detected tumors, one-third were located in the anterior prostate, with 12% being exclusively anterior lesions, which may have been missed by the TR approach, which is less reliable in sampling anterior regions of the prostate.

Detection rate of csPCa was lower in the group of patients with a history of prostate biopsy. This can be partly attributed to the high proportion of men on active surveillance who underwent confirmation biopsies. This finding is consistent with previous reports and highlights the need to interpret detection rates in the context of patient selection criteria[15].

Infections remain the main disadvantage of TR biopsy, necessitating antibiotics. The Global Prevalence Study of Infections in Urology (GPIU), conducted across 55 countries, reported infection rates of 10.2% for TRPB and 4.7% for TPPB ($p < 0.01$). The mortality risk was zero for TPPB and comparable to that of Robotic Radical Prostatectomy (RARP) for TR (0.12% vs. 0.13%)[16].

While recent randomized controlled trials (RCTs) (ProBE-PC, PREVENT, PERFECT, TRANSLATE) have prospectively evaluated the safety and efficacy of these techniques in a hospital setting, no significant differences in sepsis rates have been reported. Despite earlier assumptions favouring TPPB for lower infection rates, these trials suggest more nuanced differences revealing similar minor infection rates requiring brief hospitalizations, with no cases of sepsis in either group. ProBE-PC reported identical 30-day infection rates of 2.6% (TRPB) and 2.7% (TPPB), with stricter infection definitions (necessity of postprocedural antibiotic treatment) favoring TP

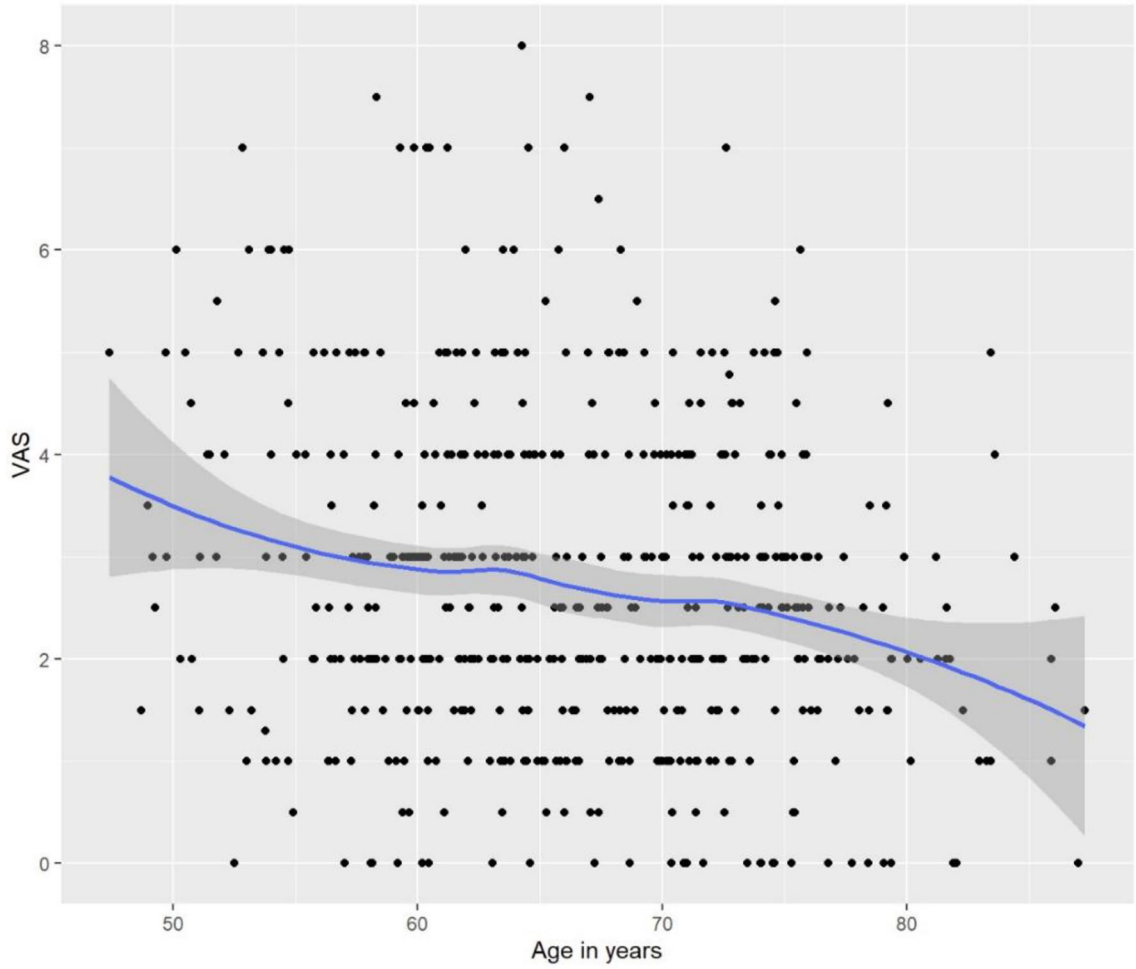


Fig. 1. Pain and age correlation.

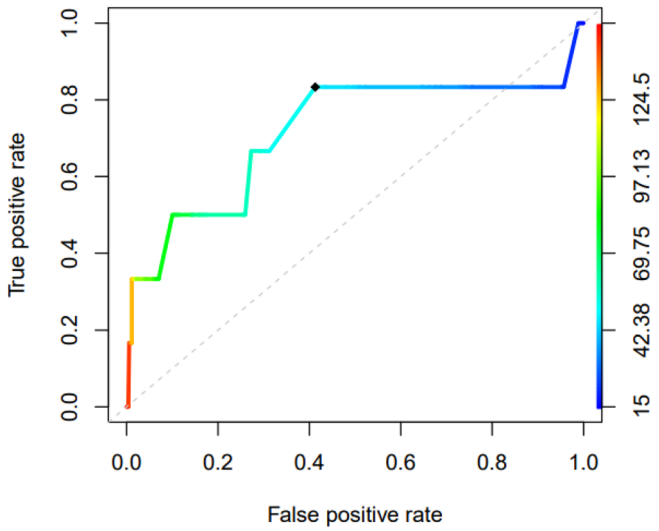


Fig. 2. Prediction of complication from prostate volume.

(1.4 vs. 1.7%). PREVENT reported no infections for TPPB vs. 1.4% for TRPB ($p = 0.059$). Notably, the TPPB in both trials were performed without antibiotic prophylaxis, whereas the TRPB adhered to antimicrobial stewardship protocols, including rectal cultures and targeted antibiotics. Although recent RCTs did not confirm superior infection outcomes for TPPB suggesting a setback for TPPB, adjusted rate differences (−0.3 to −1.4%) could translate into 6000–28,000 fewer infections annually in the U.S. and Europe with an estimated two million biopsies performed – some of which would lead to urosepsis[6]. Our study revealed not a single infection in TPPB within 30 days of follow-up.

Even before these RCTs, the European Association of Urology (EAU) recommended the TPPB approach for prostate biopsy, primarily in response to growing concerns about infections and the anticipated rise in antibiotic resistance linked to TR. Nevertheless, TRPB remains common because it is easy to use under LA[17]. Traditionally, TRPB has been preferred for in-office settings, whereas TPPB using a template approach usually requires GA. Our study revealed that TPPB under LA is feasible and well tolerated with a mean VAS of 2.7, eliminating the need for GA or spinal anaesthesia. A comparative study by Cricco-Lizza et al. reported mean VAS pain scores of 3.0 for TPPB under LA vs. 0.0 TP with sedation with significantly lower costs for the LA group ($961.64 vs. $2208.16)[18]. In our study, younger patients reported significantly more pain than the older patients did ($p < 0.001$). This finding is consistent with prior trials, including a placebo-controlled study on TRPB with a lidocaine-crème, which reported comparable results for the analgesia group and higher pain levels for the younger patient group (4.0 vs. 1.8; $p < 0.01$)[19], suggesting elevated pain perception in younger men. The PREVENT trial reported higher pain scores in the TPPB (3.6 vs. 3.0), yet the TPPB pain scores exceeded those in our cohort (2.7), as did the TRPB scores. Despite using the same LA technique, scores were higher in PREVENT than in the original study for this LA technique by Kubo et al. (2.9) but comparable to our findings[20]. Some studies used template-guided biopsy with a stepper; others preferred the freehand technique. We hypothesize that our use of two single entry points and a trocar-like access sheath minimizes tissue trauma and pain[9].

Although no infections occurred, urinary retention (UR) was the most common complication (0.9%), resolved with a single catheterization and avoided hospitalization or temporary indwelling catheter placement. An independent risk factor was prostate size, with a threshold value of 50 mL, which is consistent with other findings[21]. While an enlarged prostate volume appeared to correlate with urinary retention ($p < 0.001$), this observation was based on univariate analysis. No multivariable analysis was performed, which limits our ability to identify independent predictors. This should be explored in future research. While data on UR are mixed, major trials, such as PREVENT and ProBE-PC, have revealed no significant differences between TPPB and TRPB. However, template-guided TPPB may increase UR risk compared with freehand (10 vs. 1%, $p < 0.01$)[14,22]. While our findings align with RCTs like PREVENT and TRANSLATE, the lack of a direct comparator group within our own cohort—such as patients undergoing TRPB or TPPB with antibiotics—limits the ability to draw causal inferences. Future studies should include head-to-head comparisons in a randomized or matched-cohort design.

This study is inherently limited by its retrospective, single-center design and the involvement of a single operator, which may restrict the generalizability of findings to broader clinical contexts. Retrospective data collection may also lead to underreporting of complications, particularly less severe or delayed adverse events. However, a notable factor in interpreting our findings is the biopsy volume at the study centre. Most RCTs evaluating the TRPB and TPPB approaches have been conducted at high-volume academic institutions, which may not reflect routine clinical practice. With approximately 70 biopsies performed annually, our centre falls within the low- to mid-volume range. This enhances the relevance of our results, demonstrating that TPPB can be safely and effectively integrated into everyday urological care outside of high-volume environments. The ability to omit antibiotics, avoid infections, and maintain high diagnostic accuracy makes this approach attractive for office-based urology. Moreover, our TPPB technique can be performed with standard equipment, without the need for expensive devices or software-based biopsy systems. Our study did not include a formal cost analysis. Therefore, any suggestion of cost-effectiveness based on in-office TPPB under LA should be interpreted as a hypothesis for future evaluation.

Conclusion

Freehand TP prostate biopsy under LA without antibiotic prophylaxis is safe, well-tolerated, and diagnostically effective in a low- to midvolume outpatient setting. With a csPCa detection rate of 47.4%, no infectious complications, and only minor adverse events (UR 0.9%), this study supports the viability of TP biopsy as a cost-effective alternative to TR. Performed without GA or advanced fusion systems, the technique enables broad applicability while supporting antimicrobial stewardship. These findings increase the generalizability of existing RCT data to routine clinical environments.

Future research should focus on prospective, multicenter studies comparing freehand and template-guided TP techniques across various practice settings, as well as long-term oncologic outcomes and patient-reported quality of life measures. Cost-effectiveness analyses and standardized training protocols may further support the widespread adoption of this approach.

Data availability

The data that support the findings of this study are not publicly available due to the privacy of research participants but are available from the first author (S.L) upon reasonable request.

Received: 30 August 2025; Accepted: 3 October 2025
Published online: 11 November 2025

References

1. Sung, H. et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J. Clin.* **71** (3), 209–249 (2021).
2. Lim, D. G. et al. Comparison of a combined regimen of fosfomycin and ciprofloxacin with ciprofloxacin alone as antimicrobial prophylaxis for transrectal prostate biopsy in the era of high fluoroquinolone-resistant rectal flora. *Prostate Int.* **9** (3), 163–168 (2021).
3. Basourakos, S. P. et al. Role of prophylactic antibiotics in transperineal prostate biopsy: A systematic review and meta-analysis. *Eur. Urol. Open Sci.* **37**, 53–63 (2022).
4. Mian, B. M. et al. Complications following transrectal and transperineal prostate biopsy: Results of the ProBE-PC randomized clinical trial. *J. Urol.* **211** (2), 205–213 (2024).
5. Ploussard, G. et al. Transperineal versus transrectal magnetic resonance imaging-targeted biopsies for prostate cancer diagnosis: final results of the randomized PERFECT trial (CCAFU-PR1). *Eur. Urol. Oncol.* **7** (5), 1080–1087 (2024).
6. Hu, J. C. et al. Transperineal versus transrectal magnetic resonance imaging-targeted and systematic prostate biopsy to prevent infectious complications: the PREVENT randomized trial. *Eur. Urol.* **86** (1), 61–68 (2024).
7. Bryant RJ, Marian IR, Williams R, Lopez JF, Mercader C, Raslan M, et al. Local anaesthetic transperineal biopsy versus transrectal prostate biopsy in prostate cancer detection (TRANSLATE): a multicentre, randomised, controlled trial. *Lancet Oncol.* (2025).
8. Wetterauer, C. et al. Feasibility of freehand MRI/US cognitive fusion transperineal biopsy of the prostate in local anaesthesia as in-office procedure-experience with 400 patients. *Prostate Cancer Prostat. Dis.* **23** (3), 429–434 (2020).
9. Emiliozzi, P. et al. The value of a single biopsy with 12 transperineal cores for detecting prostate cancer in patients with elevated prostate specific antigen. *J. Urol.* **166** (3), 845–850 (2001).
10. Ristau, B. T. et al. Free-hand transperineal prostate biopsy provides acceptable cancer detection and minimizes risk of infection: evolving experience with a 10-sector template. *Urol. Oncol.* **36** (12), 528.e15-528.e20 (2018).
11. Dindo, D., Demartines, N. & Clavien, P. A. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann. Surg.* **240** (2), 205–213 (2004).
12. Altok, M. et al. Cost and efficacy comparison of five prostate biopsy modalities: a platform for integrating cost into novel-platform comparative research. *Prostate Cancer Prostat. Dis.* **21** (4), 524–532 (2018).
13. Uleri, A. et al. Is there an impact of transperineal versus transrectal magnetic resonance imaging-targeted biopsy in clinically significant prostate cancer detection rate? A systematic review and meta-analysis. *Eur. Urol. Oncol.* **6** (6), 621–628 (2023).
14. Berry, B. et al. Comparison of complications after transrectal and transperineal prostate biopsy: a national population-based study. *BJU Int.* **126** (1), 97–103 (2020).
15. Barone, B. et al. Reliability of multiparametric magnetic resonance imaging in patients with a previous negative biopsy: Comparison with biopsy-naïve patients in the detection of clinically significant prostate cancer. *Diagnostics (Basel)* **13** (11), 1939 (2023).
16. Alidjanov, J. F. et al. The negative aftermath of prostate biopsy: prophylaxis, complications and antimicrobial stewardship: results of the global prevalence study of infections in urology 2010–2019. *World J. Urol.* **39** (9), 3423–3432 (2021).
17. Cornford, P. et al. EAU-EANM-ESTRO-ESUR-ISUP-SIOG guidelines on prostate cancer-2024 update. Part I: Screening, diagnosis, and local treatment with curative intent. *Eur. Urol.* **86** (2), 148–163 (2024).
18. Cricco-Lizza, E. et al. Comparative effectiveness and tolerability of transperineal MRI-targeted prostate biopsy under local versus sedation. *Urology* **155**, 33–38 (2021).
19. Raber, M., Scattoni, V., Roscigno, M., Rigatti, P. & Montorsi, F. Perianal and intrarectal anaesthesia for transrectal biopsy of the prostate: a prospective randomized study comparing lidocaine-prilocaine cream and placebo. *BJU Int.* **96** (9), 1264–1267 (2005).
20. Kubo, Y. et al. Simple and effective local anesthesia for transperineal extended prostate biopsy: application to three-dimensional 26-core biopsy. *Int. J. Urol.* **16** (4), 420–423 (2009).
21. Kohl, T. et al. Comprehensive analysis of complications after transperineal prostate biopsy without antibiotic prophylaxis: results of a multicenter trial with 30 days' follow-up. *Prostate Cancer Prostatic Dis.* **25** (2), 264–268 (2022).
22. Urkmez, A. et al. Freehand versus grid-based transperineal prostate biopsy: A comparison of anatomical region yield and complications. *J. Urol.* **206** (4), 894–902 (2021).

Author contributions

S Lenart: Project and Project/Protocol development, Data collection, statistics, manuscript writing O Shahin: Project and Project/Protocol development, Data collection, manuscript writing M Krishnakumar: statistics J Stepanow: Manuscript writing A Banner: Manuscript writing A Ponholzer: Manuscript writing C Mikulits: Manuscript writing L Oberhammer: Manuscript writing.

Declarations

Competing interests

The authors declare no competing interests.

Ethical approval

All procedures performed in this study were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Written informed consent was obtained by all participants. This study was approved by the local ethical commission IRB (EKNZ 2019–01208).

Consent to participate

S. Lenart declares his consent to participate. O. Shahin declares his consent to participate. M. Krishnakumar declares her consent to participate. J. Stepanow declares his consent to participate. A. Banner declares his consent to participate. A. Ponholzer declares his consent to participate. C. Mikulits declares his consent to participate. L. Oberhammer declares his consent to participate.

Additional information

Correspondence and requests for materials should be addressed to S.L.

Reprints and permissions information is available at www.nature.com/reprints.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Open Access This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by-nc-nd/4.0/.

© The Author(s) 2025