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Patient tolerance and complication rates of transperineal prostate biopsy with coaxial technique under local anesthesia: initial experience of a single institution

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Abstract. – OBJECTIVE: Due to infectious complications of transrectal prostate biopsy (TRBx), the transperineal prostate biopsy (TPBx) technique is gaining popularity and is the first-line method in many institutions. We share our experience of the first 100 patients with TPBx, performed using the coaxial needle technique under local anesthesia.

PATIENTS AND METHODS: We retrospectively reviewed the records of the first 100 patients who had undergone TPBx between December 2022 and September 2023. Complication rates, cancer detection rates, patient tolerance, and pain response to the TPBx under local anesthesia at different steps of the procedure were collected.

RESULTS: The mean age, total prostate-specific antigen (PSA), prostate volume, and PSA density were 64.5±7.5 years, 8.82±12 ng/mL, 58.4±26.4 mL, and 0.17±0.18 ng/mL². Prostate cancer (PCa) was detected at histopathological evaluation in 51 patients. The mean positive core number and percentage of cancer involvement per core in patients who have PCa were 5.4±3.2 and 68.5±29.1, respectively. The mean pain score during the entire procedure was 2.85±1.48. When the steps are evaluated separately, the mean pain score during the probe placement step, local anesthetic, and sampling steps were 3.35±1.65, 2.54±1.45, and 0.9±0.82, respectively.

CONCLUSIONS: Transperineal prostate biopsy with coaxial needle technique under local anesthesia is a well-tolerated procedure with feasible complication rates and patient discomfort.

Key Words:
Prostate biopsy, Transperineal, Local anesthesia, Prostate cancer.

Introduction

Prostate cancer (PCa) is the most commonly diagnosed malignancy in men and also the leading cause of cancer-related deaths in men worldwide[1]. The diagnosis is based on prostate biopsy[2]. There is currently a lack of standardization for the prostate biopsy technique, and both transrectal prostate biopsy (TRBx) and transperineal prostate biopsy (TPBx) methods are used.

Although finger-guided TPBx has been performed since the 1920s, TRBx is more frequently performed by urologists than the transperineal approach due to the disadvantages of the conventional TPBx technique[3,4]. However, infectious biopsy complications have been reported to increase in the last decade, attributed to the rise of antibiotic resistance. TPBx technique is gaining popularity and is the first-line method in many institutions due to its lower rate of infectious complications[4]. In addition, 30% of TRBx procedures require repetition due to false negative results, and as many as 50% of cases may be mischaracterized[5]. TRBx frequently yields false-negative results and contributes to the underdiagnosis of clinically significant PCa due to inadequate sampling of the apical, middle, and anterior regions of the prostate[6].

The latest European Association of Urology (EAU) guideline[5] now favors transperineal prostate biopsy (TPBx) over transrectal prostate biopsy (TRBx) due to reduced infectious complications and increased detection rates for anteriorly located tumors. Different methods are utilized for transperineal prostate biopsy. Tradi-

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tional transperineal (TP) biopsies performed with a brachytherapy grid necessitate repeated entry through the perineum for each core, making them unsuitable for application under local anesthesia[7]. In the "single freehand" TP biopsy technique, while the ultrasound probe moves freely, the coaxial needle is fixed to the ultrasound probe using a needle guide; in the "double freehand" technique, no needle guide is used, and the physician guides the coaxial needle themselves[8]. It is stated that the double-freehand technique is more difficult to learn and can take several years to gain experience[9]. Meyer et al[10] stated that, without a needle guide to ensure in-plane visualization of the biopsy needle, freehand methods are difficult to learn and perform.

Following the EAU's recommendation, we have started performing TPBx and have used the single freehand coaxial needle technique under local anesthesia in our practice. Here, we share our initial experience of TPBx with the coaxial needle technique under local anesthesia with the first 100 patients.

Patients and Methods

Patient Selection

After our Institutional Review Board and Ethics Board approval was acquired (Ethical Board approval number: 2023-10/99), the records of patients who had undergone TPBx between December 2022 and September 2023 were retrospectively reviewed. Data were collected with respect to patients' age, digital rectal examination (DRE) findings, prostate-specific antigen (PSA) value, Prostate Imaging Reporting and Data System (PI-RADS) score, and prostate volume. Biopsy decisions were based on PSA level, PSA density, suspicious DRE, and/or multiparametric prostate magnetic resonance imaging (mpMRI) findings.

Patients who have acute urinary tract infections or coagulation abnormalities were excluded from the study.

Seventy-seven percent of the patients were evaluated with MRI before prostate biopsy and reported lesions with PI-RADS scores of 3, 4, and 5 were accepted as suspicious.

Biopsy Procedure

After detailed counseling, informed consent was obtained prior to the biopsy. Urinalysis, urine culture, and coagulation profile were done. All patients were given a single dose of pre-procedural intravenous cephalosporin (cefazolin sodium, 1 gr), and rectal preparation was done with rectal fleet enema just before the procedure for adequate rectal cleansing.

Patients were placed into the extended lithotomy position. For better exposure of the perineum, the scrotum was elevated from the perineum by adhesive medical tape. The perineal skin was cleansed with an iodine-based sanitizer. Afterward, a biplanar (sagittal and transverse planes) transrectal ultrasonography (TRUS) probe with an attached "angle and height adjustable transperineal biopsy needle guide" device (GTK154or GTK 155, Geotek, Ankara, Turkey) was inserted into the rectum, and the prostate was sonographically visualized from apex to the base.

The perineal entrance level of the coaxial needle was selected based on prostatic volume and anteroposterior height of the prostate. The preferred perineal entrance point was 15 mm superior to the anus and 15 mm lateral to the midline on both sides of the perineum. The skin was infiltrated with 2 mL of local anesthetic (LA) solution (Lidocaine 1%) with a standard 22 G injector. A 15 G, 10 cm coaxial Chiba-type needle (Geotek, Ankara, Turkey) was advanced through the needle guide device and positioned several millimeters away from the perineum. At this point, the coaxial needle was used for inserting the 22 G, 20 cm Chiba type needle (Geotek, Ankara, Turkey) into the perineum and the track from perineal skin to prostatic apex was infiltrated with 10 mL of LA solution (Lidocaine 1%). In addition, 5 ml of LA was injected at the prostate apex. Of note, the 15 G coaxial needle was still not inserted into the perineum; it provided stabilization of the 22 G Chiba needle during the anesthetic injection. The same steps were repeated on the contralateral side. Then, the 15 G coaxial needle was inserted into the perineum. The tip of the coaxial needle was pushed forward until 10 mm from the prostate apex and utilized as a re-entry conduit. Tissue samples were obtained through the coaxial needle under biplanar ultrasound guidance with an 18 G 20 cm disposable automatic biopsy gun (Estacore Pro, Geotek, Ankara, Turkey).

Twelve systematic cores were obtained from the prostate. In addition to the 12 mapping biopsies, at least three more samples were obtained from suspicious lesions described in MRI. The biopsy procedure is performed in the fan pattern, which includes bilateral biopsies of the posterior medial, posterior lateral, and anterior sectors of the peripheral zone of the prostate[10].

The procedure was intended to be performed as a day-case procedure and all the patients were discharged on the same day of the procedure if they voided successfully. No major complications were documented.

For pathological analysis, biopsy cores were sent in separate containers marked for each location and were analyzed by an experienced uropathologist. Detailed histopathology reports were given, noting tumor type, Gleason scores, tumor location, biopsy core length, number of positive cores, and percentage of the core involved.

Patients rated their pain response to the transperineal biopsy procedure at different steps. Questionnaires were used to collect pain scores for ultrasonography (US) probe insertion, local anesthetic injection, during the biopsy, and overall pain score. A visual analog scale (VAS) was used to evaluate pain, with zero indicating no pain and 10 indicating unbearable pain. Patients self-reported their pain on a VAS form immediately after the procedure and were asked to mark their satisfaction with the procedure on a VAS, with zero indicating not at all satisfied and ten indicating very satisfied. Anxiety levels were evaluated before the procedure using the State-Trait Anxiety Inventory (STAI), which ranges from 20 to 80, and the Beck Anxiety Inventory (BAI), which sums to a score of 0-63 points. Higher scores in both questionnaires indicate greater anxiety levels.

Statistical Analysis

All statistical analyses were conducted using the SPSS 16.0 (SPSS Inc., Chicago, IL, USA) program. The Kolmogorov-Smirnov test was used to check for the normality of variables. Descriptive statistics of the variables (mean, median, SD, and min-max values) were calculated. p-value<0.05 was considered statistically significant.

Results

A total of 100 patients were enrolled in our study group between September 2022 and October 2023. The mean age, total PSA, prostate volume, and PSA density were 64.5±7.5 years, 8.82±12 ng/mL, 58.4±26.4 mL and 0.17±0.18 ng/mL^2. Forty-five patients had suspicious palpable nodules on their digital rectal examinations. Twenty-three patients did not undergo mpMRI due to various reasons such as cardiac pacemaker and orthopedic prosthesis. PI-RADS 3, 4, and 5 lesions were detected in 42, 31, and 4 patients, respectively. Suspicious lesions were detected at the peripheral zone in 33 patients and at the transition zone in 44 patients. The mean diameter of lesions at MRI was 11.4±3.5 mm. The mean number of cores sampled was 13.6±1.85.

Prostate cancer was detected at histopathological evaluation in 51 patients. The cancer detection rate in our study group was 51%. The mean positive core number and percentage of cancer involvement per core in patients who have PCa were 5.4±3.2 and 68.5±29.1, respectively. Cancer detection rates of the patients with PI-RADS 3, 4, and 5 were 40%, 58%, and 100%, respectively.

It was confirmed that all patients had no pain (VAS score: 0) before the biopsy procedure. The mean pain score during the entire procedure was 2.85±1.48. When the steps are evaluated separately, the highest pain scores were recorded during the probe placement step (mean pain score 3.35±1.65). The mean pain scores during local anesthetic and sampling steps were 2.54±1.45 and 0.9±0.82, respectively. The lowest pain scores were recorded during the core sampling step; 36 patients reported no pain (VAS score: 0) during this step of the procedure. Mean Beck's depression inventory, State-Trait Anxiety Inventory (STAI)-I, and STAI-II scores were 10.87, 29.3±12, and 55.1±9.3, respectively.

No life-threatening or major complications, such as urosepsis, were observed in our study group. However, urinary retention developed in 3 (3%) patients within 24 hours after the biopsy procedure. Furthermore, hematospermia or hematuria was observed in 2 (2%) patients. The rectal bleeding rate was 0%. Patient characteristics and biopsy findings are detailed in Tables I and II.

Discussion

TRBx carries potential complications, including prostatitis, fever, hematuria, rectal bleeding, urinary retention, and sepsis-related hospitalization[11]. The reported rates of urinary tract infections and sepsis after TRBx are as high as 5.2% and 3.1%, respectively[12,13]. Moreover, serious complications necessitating hospital admission have been observed in up to 6.3% of TRBx patients[10]. On the other hand, TPBx is a percutaneous technique that does not perforate the rectum wall, thus eliminating the risk of introducing rectal bacteria into the sterile urinary tract and overcoming the potential infectious complications of TRBx[14,15]. A meta-analysis[14] indicated a 76% decrease in fever caused by infection following TPBx compared to

Table I. Demographics.

Variables	n	Mean	Median	SD	Min-Max
Age (years)	100	64.5	65	7.5	47-93
Total PSA (ng/mL)	100	8.82	7.1	12	1.8-120
Prostate volume (mL)	100	58.4	54	26.4	17-170
DRE positivity (n)					
No	55				
Yes	45				
PSA density (ng/mL^2)	100	0.17	0.12	0.18	0.03-1.6
Tumor detection rate					
No mpMRI	23/12 (52%)				
PI-RADS 3	42/17 (40%)				
PI-RADS 4	31/18 (58%)				
PI-RADS 5	4/4 (100%)				
Lesion localization in MRI (n)					
Transition zone	44				
Peripheral zone	33				
Lesion diameter in MRI (mm)	100	11.4	11	3.5	4-18
Number of cores sampled	100	13.6	12	1.85	12-18

DRE, Digital Rectal Examination; ISUP, International Society of Urological Pathology; MRI, Magnetic Resonance Imaging; PSA, Prostate-Specific Antigen, SD, Standard Derivation; mpMRI, multiparametric prostate Magnetic Resonance Imaging; PI-RADS, Prostate Imaging Reporting and Data System.

Table II. Cancer detection rates and pain scores.

Variables	n	Mean	Median	SD	Min-Max
Histopathology results (n)					
Benign	49				
Prostate cancer	51				
Positive core number	51	5.4	5	3.18	1-15
Percentage of cancer involvement per core	51	68.5	75	29.1	3-100
Core cancer involvement percentages					
0%-19%	5 (9.8%)				
20%-49%	5 (9.8%)				
50%-79%	16 (31%)				
80%-100%	25 (49)%				
ISUP grade					
ISUP 1	22 (43%)				
ISUP 2	10 (19.6%)				
ISUP 3	6 (11.7%)				
ISUP 4	9 (17.6%)				
ISUP 5	4 (7.8%)				
VAS during the entire procedure	100	2.85	3	1.48	0-6
VAS during probe placement	100	3.35	3	1.65	1-10
VAS during infiltration of LA	100	2.54	3	1.45	0-6
VAS during core sampling	100	0.9	1	0.82	0-3
Overall pain					
Painful	7				
Moderate pain	4				
Non-painful	89				
STAI I	100	29.3	24	12	5-48
STAI II	100	55.1	55	9.3	38-75
Beck's depression inventory	100	10.8	10	7	0-23
Complications (n)					
Urinary retention	3				
Hematospermia	1				
Hematuria	1				

ISUP, International Society of Urological Pathology; MRI, Magnetic Resonance Imaging; SD, Standard Derivation; STAI, State-Trait Anxiety Inventory; VAS, Visual Analogue Score; LA, Local Anesthesia.

the transrectal approach. Recognizing the reduced risk of infection, EAU recommends TPBx as the first choice in the latest guidelines[5].

TPBx can be performed using a conventional non-coaxial technique or with a coaxial technique. The conventional technique involves repeated perineal needle insertions for each biopsy, often requiring sedation, which limits its widespread use[10,16]. In the coaxial biopsy technique, a coaxial needle is inserted into the perineum, allowing the insertion of the biopsy needle through the coaxial needle without puncturing the perineum repeatedly. This approach enables the procedure to be performed under local anesthesia and has significantly expanded the utilization of TPBx[10,16]. However, this technique presents technical challenges in reaching and sampling the prostate tissue, as the prostate is located approximately 5-8 cm deep from the perineum skin. The operator must continuously visualize the needle under ultrasound during the procedure, which can be simplified with the use of needle guides designed specifically for TPBx[17]. The use of needle guides allows for greater needle mobility compared to grid-based transperineal biopsy[18].

Nonetheless, TPBx remains more challenging to learn than TRBx. These technical difficulties discourage many centers from transitioning to the transperineal technique for prostate biopsy. Furthermore, adopting a new technique may lead to longer procedure times and an increase in procedure-related complications. This retrospective study aims to examine the patient pain scores during the biopsy procedure and complication rates associated with the coaxial TPBx technique in a single center that has recently shifted from TRBx to TPBx.

Infectious Complications

Unlike TRBx, TPBx has shown significantly lower rates of infectious complications, with reported rates of urinary tract infection and sepsis as low as 0-1.6%[11,19,20]. Gilberto et al[20] reported that prostatitis or fever did not develop in any of the 283 patients in their TPBx study group. Our study group also did not experience any signs of prostatitis, fever, or sepsis. This demonstrates that the TPBx route effectively avoids infectious complications by bypassing the rectal flora during the biopsy process.

Urinary Retention

Urinary retention has been reported as a potential complication of prostate biopsy, and initially, the transperineal technique was thought to have a disadvantage in this regard[21,22]. Berry et al[21] reported a slightly higher incidence of urinary retention with the transperineal approach (1.9% *vs.* 1.0%), while other studies[23] have indicated an increase in urinary retention rates of up to 7.9% in the transperineal biopsy. However, these high rates of urinary retention were observed in studies[19,24] where biopsies were performed using a grid-based mapping transperineal approach. The increased risk of urinary retention following TPBx may be secondary to the use of general anesthesia, repeated perineal needle insertions, and the larger number of cores obtained. A study[24] reported urinary retention rates of 0% with coaxial and 4.2% with non-coaxial TPBx techniques. Another group stated that none of the patients experienced acute urinary retention in the first seven days after the TPBx[18]. In our study group, only 3 patients (3%) had experienced urinary retention. This result is in accordance with the existing literature and shows that, with the coaxial needle technique, the urinary retention rates are low even in the adopting phase of the new technique[18,24].

Bleeding

Hematuria has been reported to occur in 0-57% of patients after template-guided TPBx[11,25]. Babaei Jandaghi et al[24] reported that in their study group, none of the patients who underwent prostate biopsy with the coaxial method experienced hematuria, while 4.2% of the patients in the non-coaxial group developed hematuria. In our study group, the hematuria and rectal bleeding rates were 1% and 0%, respectively.

Cancer Detection Rates

A systematic review and meta-analysis[24] conducted in 2019 found no difference in cancer detection rates between TRBx and TPBx. Despite that, the transperineal approach has shown superiority in detecting anteriorly located prostate tumors[26]. Mygatt et al[27] reported that this is particularly significant because anterior tumors make up approximately 20% of all prostate tumors and are often larger, more likely to have positive margins, exhibit lower PSA levels, and are less easily palpable. Schaufler et al[28] reported similar cancer detection rates for 12, 16, and 20 core templates and proposed a minimum 12-core systematic biopsy template for TPBx. We have used a 12-core template. The overall cancer detection rate in our study group was 51%. The highest cancer detection rate was noted at PI-RADS 5 lesions (100%).

At this juncture, we would like to highlight a finding. When examining the rates of core involvement in patients with detected cancer, we noticed that the average core involvement was 68.5%. In our study group, 49% of the patients had 80-100% and 31% of the patients had 50-79% core cancer involvement in histopathology. Our hypothesis in this regard is that in transrectal biopsies, the needle enters the prostatic peripheral zone posteriorly and advances anteriorly. When the needle is fired for core retrieval, it advances approximately 22 mm and collects sample tissue, except for the distal 4 mm cutting edge. Considering that the peripheral zone is often compressed, particularly in patients with benign prostatic hyperplasia, we believe that a portion of this 18 mm core is actually obtained from the transitional zone. In contrast, in transperineal biopsies, the biopsy needle enters from the prostatic apex and proceeds parallel to the rectum towards the base. This trajectory ensures that the needle does not enter the transitional zone, allowing the entire biopsy to be obtained from the peripheral zone. It is worth noting that we did not take measurements regarding the length of cores obtained from each zone in our study, and we recommend further investigation of this subject.

Pain and Patient Tolerance

Pain during prostate biopsy can be managed through local, spinal, or sedation anesthesia. Among these options, local anesthesia is the most commonly used worldwide. Kanagarajah et al[29] conducted a systematic review that demonstrated that TPBx performed under local anesthesia is well-tolerated by patients and has low procedural abandonment rates. They have added that when assessing pain levels, patients rated local anesthesia infiltration as the most uncomfortable step of the biopsy procedure; therefore, with adequate coverage of local anesthesia, the subsequent stages of the procedure are tolerable[29]. Many studies[7,24] showed that patients undergoing multiple needle passes experienced significantly higher pain scores compared to those with a single or two entry point. These results support the use of coaxial techniques as they allow the operator to sample the prostate with fewer skin punctures[29]. Babai et al[24] observed less pain, as measured by the visual analog scale (VAS) score, in patients who underwent TPBx with the coaxial technique. Novella et al[7] reported mean VAS scores for patients who underwent TPBx with coaxial and non-coaxial techniques 2.20±1.20 and 2.90±1.73, respectively (p=0.01). Wetterauer et al[30] reported a median pain score of 2.0 for coaxial TPBx performed under local anesthesia. The mean pain scores in our study group were 3.35, 2.54, 0.9, and 2.85 for probe replacement, LA injection, core sampling, and overall, respectively. In addition, the maximum pain score was also noted during the probe placement procedure (VAS score: 10). As we see, the most painful part of the procedure is the probe placement step. It is also notable that the lowest pain scores were recorded during the core sampling step (mean VAS score: 0.9), and 36 patients reported no pain (VAS score: 0) during this step of the procedure. Our results show that, even in an inexperienced center, the TPBx procedure can be easily performed with adequate local anesthetic application.

Lopez et al[8] stated that while a considerable number of patients perceived the biopsy as moderate (22%) or very painful (14%), the majority of them (81%) considered it a tolerable procedure in their study group. In our study group, 7% of patients perceived the whole biopsy procedure as painful, 4% as moderate pain, and 89% as non-painful.

Conclusions

Transperineal prostate biopsy is a well-tolerated office-based procedure with low complication rates and patient discomfort. Besides, we observed high cancer detection rates with no infectious complications. Given the fact that the coaxial needle TPBx under local anesthesia is well tolerated by the patients and has lower rates of complications compared to TRBx, even in an inexperienced center, we believe that this technique will gain more popularity in the near future.

Conflict of Interest

The author Eriz Özden is the inventor of the needle guide GTK 155 used in the process, and the needle guide device is currently patent pending. Eriz Özden declares no other conflict of interest to report regarding the present study. Other authors declare that they have no conflicts of interest to report regarding the present study.

Authors' Contributions

All authors reviewed the results and approved the final version of the manuscript. Conceptualization: E.Ö. and N.H.; methodology: E.Ö. and E.Ö.; software: B.S.; validation: M.I. and N.H.; formal Analysis: N.H.; investigation: E.Ö., E.Ö; resources: M.I.; data curation: N.H. and M.I.; writing – original draft preparation: E.Ö. and E.Ö.; writing – review and editing: E.Ö. and E.Ö.; visualization: E.Ö.; supervision: E.Ö., E.Ö. and B.S.; project administration: E.Ö.

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Ethics Approval
The study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Ankara Dr. Abdurrahman Yurtaslan Oncology Training and Research Hospital (Decision No.: 2023-10/99).

Informed Consent
Informed consent was obtained from all subjects involved in the study.

Data Availability
The data supporting this study's findings are available on request from the corresponding author (E.Ö). The data are not publicly available because they contain information that could compromise the privacy of research participants.

References

1) Berenguer CV, Pereira F, Câmara JS, Pereira JAM. Underlying Features of Prostate Cancer-Statistics, Risk Factors, and Emerging Methods for Its Diagnosis. Curr Oncol 2023; 30: 2300-2321.
2) Kaufman JJ, Rosenthal M, Goodwin WE. Needle biopsy in diagnosis of prostatic cancer. Calif Med 1954; 81: 308-313.
3) Watanabe H, Igari D, Tanahasi Y, Harada K, Saito M. Development and application of new equipment for transrectal ultrasonography. J Clin Ultrasound 1974; 2: 91-98.
4) Vėželis A, Platkevičius G, Kinčius M, Gumbys L, Naruševičiūtė I, Briedienė R, Petroška D, Ulys A, Jankevičius F. Systematic and MRI-Cognitive Targeted Transperineal Prostate Biopsy Accuracy in Detecting Clinically Significant Prostate Cancer after Previous Negative Biopsy and Persisting Suspicion of Malignancy. Medicina (Kaunas) 2021; 57: 57.
5) Mottet N, van den Bergh RCN, Briers E, Van den Broeck T, Cumberbatch MG, De Santis M, Fanti S, Fossati N, Gandaglia G, Gillessen S, Grivas N, Grummet J, Henry AM, van der Kwast TH, Lam TB, Lardas M, Liew M, Mason MD, Moris L, Oprea-Lager DE, van der Poel HG, Rouvière O, Schoots IG, Tilki D, Wiegel T, Willemse PM, Cornford P. EAU-EANM-ESTRO-ESUR-SIOG Guidelines on Prostate Cancer-2020 Update. Part 1: Screening, Diagnosis, and Local Treatment with Curative Intent. Eur Urol 2021; 79: 243-262.
6) Deng YS, He YH, Ying WW, Liu HL, Li PZ, Ma CY, Ding ZS, Chen X, Wang JF, Zhou XF. Value of three biopsy methods in prostate cancer detection: a meta-analysis and systematic review. Eur Rev Med Pharmacol Sci 2021; 25: 2221-2234.
7) Novella G, Ficarra V, Galfano A, Riccardo Ballario, Giacomo Novara, Stefano Cavalleri, Walter Artibani. Pain assessment after original transperineal prostate biopsy using a coaxial needle. Urology 2003; 62: 689-692.
8) LopezJF, CampbellA, OmerA, Stroman L, Bondad J, Austin T, Reeves T, Phelan C, Leiblich A, Philippou Y, Lovegrove CE, Ranasinha N, Bryant RJ, Leslie T, Hamdy FC, Brewster S, Bell CR, Popert R, Hodgson D, Elsaghir M, Eddy B, Bolomytis S, Persad R, Reddy UD, Foley C, van Rij S, Lam W, Lamb AD. Local anesthetic transperineal (LATP) prostate biopsy using probe-mounted transperineal access system: multicentre prospective outcome analysis. BJU Int 2021; 128: 311-318.
9) Marra G, Marquis A, Tappero S, D'Agate D, Oderda M, Calleris G, Falcone M, Faletti R, Molinaro L, Zitella A, Bergamasco L, Gontero P. Transperineal free-hand mpMRI fusion-targeted biopsies under local anesthesia: technique and feasibility from a single-center prospective study. Urology 2020; 140: 122-131.
10) Meyer AR, Joice GA, Schwen ZR, Partin AW, Allaf ME, Gorin MA. Initial experience performing In-office ultrasound-guided Transperineal prostate biopsy under local anesthesia using the Precision Point Transperineal Access system. Urology 2018; 115: 8-13.
11) Urkmez A, Demirel C, Altok M, Bathala TK, Shapiro DD, Davis JW. Freehand versus Grid-Based Transperineal Prostate Biopsy: A Comparison of Anatomical Region Yield and Complications. J Urol 2021; 206: 894-902.
12) Liss MA, Ehdaie B, Loeb S, Meng MV, Raman JD, Spears V, Stroup SP. An update of the American urological association white paper on the prevention and treatment of the more common complications related to prostate biopsy. J Urol 2017; 198: 329-334.
13) Simsir A, Kismali E, Mammadov R, Gunaydin G, Cal C. Is it possible to predict sepsis, the most serious complication in prostate biopsy? Urol Int 2010; 84: 395-399.
14) Xiang J, Yan H, Li J, Wang X, Chen H, Zheng X. Transperineal versus transrectal prostate biopsy in the diagnosis of prostate cancer: a systematic review and meta-analysis. World J Surg Oncol 2019; 17: 31.
15) Tzeng M, Cricco-Lizza E, Al Hussein Al Awamlh B, Pantuck M, Margolis DJ, Yu M, Hu J. IDEAL Stage 2a experience with in-office, transperineal MRI/ultrasound software fusion targeted prostate

biopsy. BMJ Surg Interv Health Technol 2019; 1: e000025.

16) Stefanova V, Buckley R, Flax S, Spevack L, Hajek D, Tunis A, Lai E, Loblaw A; Collaborators. Transperineal Prostate Biopsies Using Local Anesthesia: Experience with 1,287 Patients. Prostate Cancer Detection Rate, Complications and Patient Tolerability. J Urol 2019; 201: 1121-1126.
17) Panzone J, Byler T, Bratslavsky G, Goldberg H. Transrectal Ultrasound in Prostate Cancer: Current Utilization, Integration with mpMRI, HIFU and Other Emerging Applications. Cancer Manag Res 2022; 14: 1209-1228.
18) Pedersen TB, Tiessen S, Karstoft J, Poulsen MH. Introduction of free-hand MRI-guided transperineal prostate biopsies as outpatient procedure. Dan Med J 2022; 69: A05220338.
19) Chang DTS, Challacombe B, Lawrentschuk N. Transperineal biopsy of the prostate—is this the future? Nat Rev Urol 2013; 10: 690-702.
20) Gilberto GM, Arcuri MF, Falsarella PM, Mariotti GC, Lemos PLA Neto, Garcia RG. Complication rates of transrectal and transperineal prostate fusion biopsies - is there a learning curve even in high volume interventional center? Int Braz J Urol 2023; 49: 334-340.
21) Berry B, Parry MG, Sujenthiran A, Nossiter J, Cowling TE, Aggarwal A, Cathcart P, Payne H, van der Meulen J, Clarke N. Comparison of complications after transrectal and transperineal prostate biopsy: national population-based study. BJU Int 2020; 126: 97-103.
22) O-Kum F, Jones A, Nigam R. Factors influencing urinary retention after transperineal template biopsy of the prostate: outcomes from regional cancer centre. World J Urol 2019; 37: 337-342.
23) Skouteris VM, Crawford ED, Mouraviev V, Arangua P, Metsinis MP, Skouteris M, Zacharopoulos G, Stone NN. Transrectal ultrasound-guided versus transperineal mapping prostate biopsy: complication comparison. Rev Urol 2018; 20: 19-25.
24) Babaei Jandaghi A, Habibzadeh H, Falahatkar S, Heidarzadeh A, Pourghorban R. Transperineal Prostate Core Needle Biopsy: Comparison of Coaxial Versus Noncoaxial Method in Randomised Trial. Cardiovasc Intervent Radiol 2016; 39: 1736-1742.
25) Gershman B, Zietman AL, Feldman AS, McDougal WS. Transperineal template-guided prostate biopsy for patients with persistently elevated PSA and multiple prior negative biopsies. Urol Oncol 2013; 31: 1093-1097.
26) Cowan T, Baker E, McCray G, Reeves F, Houlihan K, Johns-Putra L. Detection of clinically significant cancer in the anterior prostate by transperineal biopsy. BJU Int 2020; 126: 33-37.
27) Mygatt J, Sesterhenn I, Rosner I, Chen Y, Cullen J, Morris-Gore T, Barton J, Dobi A, Srivastava S, McLeod D, Brassell SA. Anterior tumors of the prostate: clinicopathological features and outcomes. Prostate Cancer Prostatic Dis 2014; 17: 75-80.
28) Schaufler C, Daigle R, Singhaviranon S, Gjertson CK, Albertsen PC, Ristau BT. How many cores are enough? Optimizing the transperineal prostate biopsy template. Urol Oncol 2022; 40: 191.e1-191.e7
29) Kanagarajah A, Hogan D, Yao HH, Dundee P, O'Connell HE. A systematic review on the outcomes of local anaestheticтransperineal prostate biopsy. BJU Int 2023; 131: 408-423.
30) Wetterauer C, Shahin O, Federer-Gsponer JR, Keller N, Wyler S, Seifert HH, Kwiatkowski M. Feasibility of freehand MRI/US cognitive fusion transperineal biopsy of the prostate in local anesthesia as in-office procedure experience with 400 patients. Prostate Cancer Prostatic Dis 2020; 23: 429-434.