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Can the probe movement direction affect pain in patients undergoing transrectal ultrasound-guided prostate biopsy?

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Ethics Committee Approval
The study was approved by the Alanya Alaaddin Keykubat University Faculty of Medicine Clinical Research Ethics Committee on June 25, 2025, with the decision number 11-06.
All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

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Abstract

Background/Aim: Prostate biopsy is the gold standard for prostate cancer diagnosis, but patient discomfort remains a major limitation. While numerous studies have investigated anesthesia and analgesia, the influence of transrectal ultrasound probe movement direction has not yet been examined in clinical studies. This study aimed to evaluate whether the direction of transrectal ultrasound probe movement affects pain perception and complication rates during systematic prostate biopsy.

Methods: In this retrospective cohort study, 246 patients undergoing 12-core transrectal ultrasound-guided biopsy between 2019 and 2025 were analyzed. Patients were stratified into three groups according to the probe movement sequence applied by the performing urologist. Pain was assessed using the visual analogue scale (VAS; 0–10) at five time points: probe insertion, probe manipulation, needle puncture, 30 minutes post-biopsy, and two hours post-biopsy. Complications within 30 days were recorded, including rectal bleeding, hematuria, fever, and urinary retention. Statistical analyses included one-way ANOVA with effect size estimation (η^2) for continuous variables and χ^2 or Fisher's exact test for categorical variables.

Results: Baseline characteristics and cancer detection rates were comparable across groups. Pain scores during probe manipulation (VAS 2), needle puncture (VAS 3), and 30 minutes post-biopsy (VAS 4) differed significantly among the groups, with Group B reporting the lowest values and Group A the highest (all $P<0.001$). No significant differences were observed for probe insertion (VAS 1, $P=0.30$) or two hours post-biopsy (VAS 5, $P=0.19$). Hematuria occurred in 40–42% of cases, rectal bleeding in 9.6–19.5%, and fever in 2.4–5.2%. Although these differences were not statistically significant (rectal bleeding, $P=0.09$; fever, $P=0.47$; hematuria, $P=0.94$; urinary retention, $P=0.86$), both rectal bleeding and fever were most frequent in Group A and least frequent in Group B.

Conclusion: Beyond anesthetic technique, probe maneuver direction significantly influences pain perception during transrectal ultrasound-guided biopsy. Group B's shorter cumulative probe trajectory (≈22–24% reduction) corresponded with consistently lower pain and fewer complications. To our knowledge, this is the first study to identify probe movement strategy as a determinant of biopsy tolerance. Incorporating this approach offers a simple, low-cost modification with potential to improve patient comfort and safety.

Keywords: prostate cancer, biopsy, VAS, pain, probe direction

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Introduction

Prostate cancer is one of the leading causes of morbidity and mortality among men worldwide, and histopathological confirmation remains the cornerstone for establishing a definitive diagnosis [1]. Among the diagnostic modalities, transrectal ultrasound-guided biopsy (TRUS-Bx) continues to be the most widely performed. Although the transperineal approach has gained increasing attention in recent years due to its lower risk of infectious complications, its longer procedure time and the need for specialized equipment have limited its routine use. By contrast, TRUS-Bx remains the predominant technique in clinical practice, owing to its practicality, accessibility, and diagnostic efficacy [2].

Despite its widespread adoption, TRUS-Bx is often associated with considerable discomfort and pain. Such pain is multifactorial, arising not only from needle punctures but also from probe insertion and manipulation during the procedure [3]. Indeed, several studies have demonstrated that probe maneuvering may induce greater pain than the needle punctures themselves [4]. Accordingly, optimizing analgesic strategies has become essential for improving patient tolerance and procedural success.

The periprostatic nerve block (PNB) remains the most widely applied analgesic technique during TRUS-Bx [5]. However, PNB alone may be insufficient to adequately relieve discomfort associated with probe insertion and manipulation [6]. Intrarectal local anesthesia (IRLA), which is simple, non-invasive, and well tolerated, has therefore been introduced as an adjunct. IRLA has been shown to effectively reduce pain, particularly during probe-related maneuvers [7]. Evidence suggests that in certain scenarios, IRLA may even provide superior analgesia to PNB without increasing complication rates, thereby maintaining its relevance as a contemporary analgesic method [8, 9].

More recently, combined regimens, most notably the use of PNB together with IRLA, have been proposed to address pain arising at different phases of the biopsy. Prospective studies and systematic reviews indicate that multimodal strategies yield lower pain scores across probe insertion, anesthetic infiltration, and biopsy puncture phases, without compromising safety [9, 10]. These findings highlight the multifactorial nature of TRUS-Bx-related pain and support the rationale for phase-specific multimodal analgesia.

In this context, the present study addresses a largely unexplored factor: the direction of probe movement during TRUS-Bx. Therefore, this study aimed to evaluate whether the direction of transrectal ultrasound probe movement affects patient-reported pain and complication rates during systematic prostate biopsy.

Materials and methods

This retrospective cohort study was conducted at the Department of Urology, Alanya Alaaddin Keykubat University Hospital between January 2019 and June 2025. A total of 246 patients met the inclusion criteria and were enrolled. Demographic and clinical data, including age, body mass index (BMI), serum prostate-specific antigen (PSA) levels, prostate volume, and cancer detection status, were extracted from institutional medical records.

Patients between 45 and 80 years with an abnormal digital rectal examination and/or elevated serum PSA levels (≥4 ng/mL) and complete clinical data were included in the study. Patients with active urinary tract infection, bleeding diathesis, use of anticoagulant or antiplatelet medication without appropriate discontinuation, anal or rectal pathology, previous prostate biopsy, known allergy to local anesthetics, or incomplete medical records were excluded.

The Alanya Alaaddin Keykubat University Faculty of Medicine Clinical Research Ethics Committee approved the study on June 25, 2025, with the decision number 11-06. All procedures involving human participants were conducted in accordance with the ethical standards of the Declaration of Helsinki and its later amendments.

Although the study had a retrospective design, all patients who underwent prostate biopsy routinely completed a standardized questionnaire including demographic data, pain scores, and post-procedural complications, with prior consent for potential future research use. Therefore, all data were obtained from this preexisting institutional database.

All patients received standard preparation, which included bowel cleansing with a rectal enema and prophylactic oral quinolone antibiotics that were started one day before the procedure and continued for five days after the biopsy.

For patients in all groups, 10 mL of 2% lidocaine gel in a 10 mL syringe was instilled into the rectum approximately 10 minutes before the biopsy.

The procedures were performed in the left lateral decubitus position under transrectal ultrasound guidance using an 18-gauge automatic biopsy gun. Twelve systematic cores were obtained from each patient.

Patients were divided into three groups according to the technique of the performing urologist: Group A (n=77), Group B (n=83), and Group C (n=86), each representing a distinct and consistently applied probe movement strategy that differed in manipulation pattern and the sequential order of biopsy cores, as summarized in Table 1. The corresponding schematic representations of probe trajectories for each group are illustrated in Figure 1.

Each of the three biopsy groups corresponded to a distinct urologist, each having been trained during residency with a different systematic biopsy sequence and probe movement technique. All were experienced and worked in the same department and followed identical preparation, anesthesia, and procedural protocols.

In Group A, biopsies were performed from the base toward the apex, starting on the right side and then proceeding to the left, following a medial-to-lateral order on the right and a lateral-to-medial order on the left.

In Group B, the urologist alternated between the right and left sides at corresponding depths. The sequence began at the base (right lateral, right medial, left medial, and left lateral) followed by the mid-gland in reverse order (left lateral, left medial, right medial, right lateral), and concluded at the apex using the same order as at the base.

In Group C, biopsies were obtained in a sequential right-to-left order at each depth level, consistently progressing from the base toward the apex, with cores taken as right lateral, right medial, left medial, and left lateral at every level.

Figure 1: Schematic representation of simplified geometric models of transrectal ultrasound probe movement directions within the rectum for Groups A, B, and C.

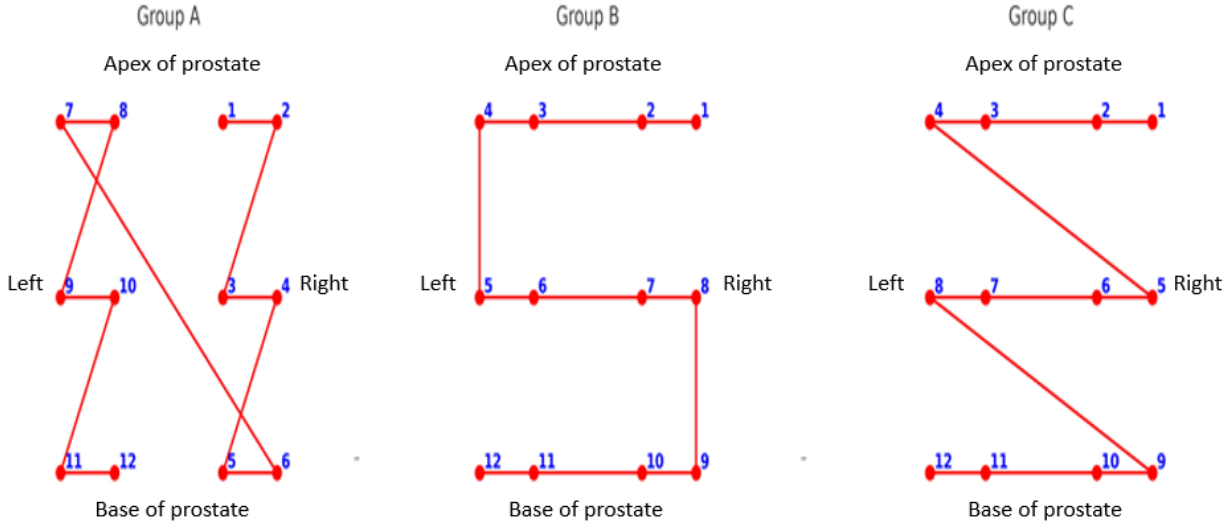

Table 1: Sequential order of transrectal ultrasound-guided prostate biopsy cores according to probe movement technique

Group A	Group B	Group C
1. Right base medial	1. Right base lateral	1. Right base lateral
2. Right base lateral	2. Right base medial	2. Right base medial
3. Right mid medial	3. Left base medial	3. Left base medial
4. Right mid lateral	4. Left base lateral	4. Left base lateral
5. Right apex medial	5. Left mid lateral	5. Right mid lateral
6. Right apex lateral	6. Left mid medial	6. Right mid medial
7. Left base lateral	7. Right mid medial	7. Left mid medial
8. Left base medial	8. Right mid lateral	8. Left mid lateral
9. Left mid lateral	9. Right apex lateral	9. Right apex lateral
10. Left mid medial	10. Right apex medial	10. Right apex medial
11. Left apex lateral	11. Left apex medial	11. Left apex medial
12. Left apex medial	12. Left apex lateral	12. Left apex lateral

Each urologist determined the biopsy order and corresponding probe movement direction according to their prior training and habitual technique acquired during residency.

Pain perception was assessed using the visual analogue scale (VAS; 0–10) at five specific time points. VAS 1 corresponded to probe insertion through the rectum. VAS 2 referred to probe manipulation within the rectum. VAS 3 represented needle puncture into the prostate. VAS 4 was recorded 30 minutes after the biopsy, and VAS 5 was recorded two hours after the biopsy.

Procedure-related complications occurring within 30 days after the biopsy were recorded, including rectal bleeding, hematuria, fever, and urinary retention. Cancer detection status was also noted.

We created a simplified geometric model to schematize the probe movement pattern and resulting cumulative distance ratios in systematic TRUS-guided biopsy. The model was designed on a two-dimensional coordinate grid, analogous to a standard squared mathematics notebook, where each square represented a fixed distance unit. Each biopsy core site was assigned to a specific coordinate corresponding to its anatomical position within the prostate (base, mid-gland, apex; right or left, medial or lateral).

For each group (A, B, and C), these coordinates were sequentially connected according to the biopsy order described in the previous section. The linear distance between consecutive points was then measured and summed to estimate the total probe trajectory. In this schematic system, the distance between two adjacent points on the grid was defined as a single unit, and the total cumulative movement was expressed as the sum of these unit distances.

This geometric modeling was performed with the assistance of an artificial intelligence tool (ChatGPT, OpenAI), which generated schematic figures illustrating the distinct probe trajectories for each biopsy group based on the manually defined coordinates and biopsy sequences provided by the investigators. The resulting diagrams visually demonstrate how probe movement patterns differed among the groups (Figure 1).

Statistical analysis

All statistical analyses were performed using IBM SPSS Statistics, version XX (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean (SD) and tested for normality using the Shapiro–Wilk test. For normally distributed continuous data (e.g., age, BMI, PSA, prostate volume, VAS scores), comparisons among the three groups were conducted using one-way analysis of variance (ANOVA). Test statistics were reported as F values with degrees of freedom (df), and effect sizes were expressed as eta squared (η^2). When the overall ANOVA was significant, Bonferroni-adjusted post-hoc tests were applied to identify pairwise group differences.

Categorical variables (e.g., cancer detection, complications such as rectal bleeding, hematuria, fever, urinary retention) were expressed as frequencies and percentages and compared using the χ^2 test. In cases where expected cell counts were <5, Fisher's exact test was applied.

A two-sided *P*-value of <0.05 was considered statistically significant. Effect sizes were interpreted according to conventional thresholds (η^2=0.01 small, 0.06 medium, ≥0.14 large).

Table 2: Baseline demographics and clinical characteristics

Variable	Group A (n=77)	Group B (n=83)	Group C (n=86)	Test statistic	*P*-value
Age, years	66.4 (6.1)	67.3 (6.0)	66.9 (5.8)	F(2,243)=0.55	0.58
BMI, kg/m²	25.3 (2.7)	25.5 (2.6)	25.1 (2.5)	F(2,243)=0.34	0.71
PSA, ng/mL	9.0 (6.4)	9.2 (6.6)	9.1 (6.5)	F(2,243)=0.07	0.93
Prostate volume, mL	42.1 (15.3)	41.8 (14.7)	42.5 (15.1)	F(2,243)=0.13	0.88
Cancer detected, n (%)	36 (46.8)	39 (47.0)	41 (47.7)	χ^2=0.02	0.99

* Values are presented as mean (SD) or n (%). Continuous variables were compared using one-way ANOVA (F values reported), and categorical variables using χ^2 test.

Table 3: VAS pain scores by time point and group

VAS Time Point	Group A (n=77)	Group B (n=83)	Group C (n=86)	F(df=2,243)	p-value	η^2	Post-hoc
VAS 1 – probe insertion	2.3 (1.0)	2.1 (0.9)	2.2 (0.9)	1.21	0.30	0.01	NS
VAS 2 – probe manipulation	3.8 (0.9)	2.0 (0.8)	2.9 (0.9)	28.10	<0.001	0.19	B<C<A
VAS 3 – needle puncture	4.0 (1.0)	2.9 (0.9)	3.4 (0.9)	22.70	<0.001	0.16	B<C<A
VAS 4 – 30 min post	2.0 (0.8)	1.1 (0.6)	1.5 (0.7)	26.40	<0.001	0.18	B<C<A
VAS 5 – 2 h post	0.8 (0.5)	0.7 (0.5)	0.7 (0.5)	1.68	0.19	0.01	NS

* Values are presented as mean (SD). Between-group differences were analyzed using one-way ANOVA (F statistics with degrees of freedom reported). Effect sizes are given as η^2. Post-hoc comparisons were performed with Bonferroni correction. NS=not significant.

Table 4: Procedure-related complications within 30 days

Complication	Group A (n=77)	Group B (n=83)	Group C (n=86)	χ^2	*P*-value
Rectal bleeding, n (%)	15 (19.5)	8 (9.6)	13 (15.1)	4.8	0.09
Fever ≥38 °C, n (%)	4 (5.2)	2 (2.4)	3 (3.5)	1.5	0.47
Hematuria, n (%)	31 (40.3)	34 (41.0)	36 (41.9)	0.1	0.94
Urinary retention, n (%)	2 (2.6)	2 (2.4)	3 (3.5)	0.3	0.86

* Values are presented as n (%). Group comparisons were made using χ^2 test.

Results

A total of 246 patients were included: Group A (n=77), Group B (n=83), and Group C (n=86). The groups were similar in terms of age (*P*=0.58), BMI (*P*=0.71), PSA (*P*=0.93), and prostate volume (*P*=0.88), with no statistically significant differences (Table 2).

Cancer detection rates were comparable among the groups (46.8%, 47.0%, and 47.7% for Groups A, B, and C, respectively), showing no meaningful variation (*P*=0.99) (Table 2).

Pain intensity differed significantly across the groups during probe manipulation, needle puncture, and early post-biopsy phases. VAS 2, VAS 3, and VAS 4 scores were lowest in Group B with mean (SD) values of 2.0 (0.8), 2.9 (0.9), and 1.1 (0.6), respectively, and highest in Group A with mean (SD) values of 3.8 (0.9), 4.0 (1.0), and 2.0 (0.8), respectively. This indicated a consistent gradient of B<C<A (all *P*<0.001). No significant differences were observed for probe insertion (VAS 1, *P*=0.30) or two hours post-biopsy (VAS 5, *P*=0.19) (Table 3).

Rectal bleeding occurred in 19.5%, 9.6%, and 15.1% of patients in Groups A, B, and C, respectively (*P*=0.09); fever in 5.2%, 2.4%, and 3.5% (*P*=0.47); hematuria in 40–42% (*P*=0.94); and urinary retention in 2–3% (*P*=0.86). Although rectal bleeding and fever were numerically higher in Group A and lowest in Group B, these differences were not statistically significant (Table 4).

According to geometric modeling, the estimated cumulative probe trajectory lengths were 20.6 units in the model with the core order corresponding to Group A, 16.0 units in the model corresponding to Group B, and 20.9 units in the model corresponding to Group C. Accordingly, the total distance traveled by the probe in the model fitting the biopsy core order in Group B was approximately 22–24% shorter than in the other two groups.

Discussion

While prostate biopsy is central to prostate cancer diagnosis, the procedure is associated with discomfort and risk. Pain, in particular, continues to limit patient tolerance and may influence willingness to undergo repeated biopsies when clinically indicated [1, 2]. Numerous studies have addressed pain management in TRUS-Bx, most focusing on the role of local anesthesia and analgesic techniques.

In contrast, the present study investigated a novel and previously unexplored determinant of patient discomfort: the direction of probe movement during systematic biopsy. To our knowledge, this is the first study to evaluate whether the cumulative trajectory of the probe, and consequently the manner in which cores are sampled, has a measurable effect on pain perception and complications.

Our results demonstrated that the sequence of probe movement significantly affected pain outcomes. Groups were comparable in baseline demographics, prostate volume, PSA, and cancer detection rates, thereby excluding these as confounding factors. However, VAS scores differed markedly: Group B patients consistently reported the lowest scores at the most painful phases of the biopsy (VAS 2, 3, and 4), whereas Group A patients reported the highest; Group C was intermediate. The differences were both statistically significant and clinically relevant, as indicated by large effect sizes (η^2=0.16–0.19).

Complications, such as rectal bleeding and fever, were numerically more frequent in Group A and least frequent in Group B, while hematuria and urinary retention occurred at similar rates across groups. Although these differences did not achieve statistical significance, the observed trends reinforce the pain data.

The majority of previous studies on TRUS-Bx–related pain have concentrated on anesthetic techniques. PNB has been established as the gold standard for pain control, yet it does not fully address discomfort during probe insertion and manipulation [5, 6]. To overcome these shortcomings, IRLA has been explored with mixed results. Some randomized studies have demonstrated clear benefits, while others have found no significant advantages [7, 8, 11].

Recently, combined regimens of PNB plus IRLA have been recommended, showing superior pain control across multiple

phases of the procedure without increasing complications [9, 10]. Although these interventions reduce pain intensity, they do not address a fundamental mechanical factor: the pattern of probe maneuvering itself.

Several authors have observed that probe insertion and movement may cause more severe discomfort than the biopsy puncture [3, 12]. Our findings not only confirm this observation but also extend it by demonstrating that the sequence of sampling, which dictates the cumulative path of the probe, independently contributes to pain perception. Importantly, while prior reports acknowledged mechanical discomfort, none have systematically analyzed the effect of movement direction on outcomes. Thus, our study adds a novel perspective to the existing body of evidence.

To provide a rational explanation for the observed pain differences, we developed a simplified geometric model to estimate the cumulative distance traveled by the probe in each group. Using a coordinate-based schematic on graph paper, and later digitalized into a grid model, we measured the trajectory length required to complete the 12-core biopsy sequence. The total distance was shortest in Group B (16.0 units) compared with Group A (20.6 units) and Group C (20.9 units), corresponding to a 22–24% reduction in probe travel. This indicates that Group B's technique was approximately 1.3-fold more efficient in terms of probe movement.

These geometric findings closely mirrored our clinical results, demonstrating a parallel relationship between the modeled probe trajectory and patient-reported pain scores. Patients in Group B consistently reported the lowest pain scores, while Groups A and C, whose trajectory lengths were nearly identical, reported higher VAS values. The strong concordance between the calculated probe travel distance and the observed pain outcomes suggests a causal link. Mechanically, a shorter probe trajectory can improve patient comfort by reducing anal canal stretching, mucosal friction, and sphincter irritation, thereby improving patient comfort. Although the model does not account for interindividual variations in prostate size or shape, it provides a reasonable approximation of probe mobility patterns based on directional differences. Therefore, the geometric analysis supports the hypothesis that reduced probe trajectory contributes to lower pain perception observed in Group B.

Future research employing three-dimensional imaging or motion-sensing technology could further validate and refine these findings.

Complication rates in our study were consistent with prior reports. Hematuria was observed in 40–42% of patients, rectal bleeding in 10–20%, and fever in 2–5%. These rates fall within the ranges previously described [2, 13]. Importantly, the numerical differences observed among our groups paralleled the pain results, with Group A showing the highest rates of rectal bleeding and fever, and Group B the lowest.

Although statistical significance was not achieved, the pattern suggests that more extensive probe movement may also increase the risk of mucosal trauma and bacterial translocation, and thus a predisposition to bleeding and infection. This hypothesis is supported by earlier reports highlighting the role of rectal wall trauma in biopsy-related sepsis [14, 15].

Our study provides new insight into a simple, non-pharmacological factor that may improve patient tolerance of TRUS-Bx. While anesthetic methods, such as PNB and IRLA, remain essential, the direction of probe maneuvering appears to be an independent determinant of both pain and potential complications.

From a practical perspective, adopting a biopsy sequence similar to Group B could be readily implemented without additional equipment or cost. Such an adjustment may enhance patient comfort, reduce anxiety associated with repeat biopsies, and ultimately improve adherence to diagnostic and surveillance protocols.

Moreover, this finding adds nuance to the ongoing debate regarding transrectal versus transperineal approaches. Although transperineal biopsy is increasingly favored for its lower infectious risk, transrectal biopsy remains widely used due to its accessibility and efficiency [16, 17]. Optimizing probe maneuver strategies may, therefore, represent an important means of reducing the drawbacks of TRUS-Bx, allowing it to remain a viable option in settings where transperineal biopsy is not readily available.

Limitations

Several limitations of our study warrant consideration. The retrospective, single-center design inherently limits generalizability. Pain assessment was based on VAS scores, which, although widely validated, remain subjective.

A potential operator-related confounding effect cannot be completely excluded, as each biopsy group corresponded to a different urologist who had been trained during residency with a distinct biopsy sequence and probe manipulation technique. Subtle inter-operator differences, such as variations in manual technique, applied pressure, or patient interaction, might have influenced pain perception independently of the probe trajectory. Although all three urologists were experienced and followed identical preparation, anesthesia, and procedural protocols, unrecorded factors, such as procedural tempo, could not be objectively assessed due to the retrospective nature of data collection.

The geometric model used in this study was based on schematic drawings rather than real-time probe tracking and, therefore, represents an approximation of actual movement. Nonetheless, the strong concordance between the calculated trajectory distances and the observed pain outcomes supports the validity of this approach. Finally, although trends in complication rates were observed, the study was not powered to detect statistically significant differences in relatively rare events, such as sepsis or urinary retention.

Conclusion

This study identifies probe movement direction as a previously unrecognized determinant of patient comfort and safety during systematic TRUS-Bx. The findings demonstrate that beyond anesthetic or analgesic methods, the sequence of probe maneuvering itself significantly influences pain perception and may also affect complication rates. Group B, characterized by the shortest cumulative probe trajectory, consistently showed the lowest VAS 2–4 scores and tended to experience fewer complications, such as rectal bleeding and fever, whereas Group A exhibited the highest values. These results indicate that optimizing the procedural technique, specifically the order and direction of probe movement, can meaningfully improve biopsy

tolerance independent of pharmacological intervention. Implementing such a simple, low-cost, and reproducible modification in clinical practice may improve both patient experience and procedural safety. To our knowledge, this is the first report to establish such an association, and prospective multicenter studies with larger cohorts and motion-tracking validation are warranted to confirm these novel findings.

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References

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA Cancer J Clin. 2021;71(3):209-49. doi: 10.3322/caac.21660.
2. Borghesi M, Ahmed H, Nam R, Schaeffer E, Schiavina R, Taneja S, et al. Complications After Systematic, Random, and Image-guided Prostate Biopsy. Eur Urol. 2017;71(3):353-65. doi: 10.1016/j.eururo.2016.08.004.
3. Chang SS, Alberts G, Wells N, Smith JA Jr, Cookson MS. Intrarectal lidocaine during transrectal prostate biopsy: results of a prospective double-blind randomized trial. J Urol. 2001;166(6):2178-80. doi: 10.1016/s0022-5347(05)65529-2.
4. Irani J, Fournier F, Bon D, Gremmo E, Doré B, Aubert J. Patient tolerance of transrectal ultrasound-guided biopsy of the prostate. Br J Urol. 1997;79(4):608-10. doi: 10.1046/j.1464-410x.1997.00120.x.
5. Nash PA, Bruce JE, Indudhara R, Shinohara K. Transrectal ultrasound guided prostatic nerve blockade eases systematic needle biopsy of the prostate. J Urol. 1996;155(2):607-9.
6. Luscombe CJ, Cooke PW. Pain during prostate biopsy. Lancet. 2004;363(9424):1840-1. doi: 10.1016/S0140-6736(04)16392-7.
7. Mallick S, Humbert M, Braud F, Fofana M, Blanchet P. Local anesthesia before transrectal ultrasound guided prostate biopsy: comparison of 2 methods in a prospective, randomized clinical trial. J Urol. 2004;171(2 Pt 1):730-3. doi: 10.1097/01.ju.0000108125.96072.ff.
8. Trucchi A, De Nunzio C, Mariani S, Palleschi G, Miano L, Tubaro A. Local anesthesia reduces pain associated with transrectal prostatic biopsy. A prospective randomized study. Urol Int. 2005;74(3):209-13. doi: 10.1159/000083550.
9. Giannarini G, Autorino R, Valent F, Mogorovich A, Manassero F, De Maria M, et al. Combination of perianal-intrarectal lidocaine-prilocaine cream and periprostatic nerve block for pain control during transrectal ultrasound guided prostate biopsy: a randomized, controlled trial. J Urol. 2009;181(2):585-91. doi: 10.1016/j.juro.2008.10.002.
10. Raber M, Scattoni V, Roscigno M, Dehò F, Briganti A, Salonia A, et al. Topical prilocaine-lidocaine cream combined with peripheral nerve block improves pain control in prostatic biopsy: results from a prospective randomized trial. Eur Urol. 2008;53(5):967-73. doi: 10.1016/j.eururo.2007.09.005.
11. Issa MM, Bux S, Chun T, Petros JA, Labadia AJ, Anastasia K, et al. A randomized prospective trial of intrarectal lidocaine for pain control during transrectal prostate biopsy: the Emory University experience. J Urol. 2000;164(2):397-9.
12. Kravchick S, Peled R, Ben-Dor D, Dorfman D, Kesari D, Cytron S. Comparison of different local anesthesia techniques during TRUS-guided biopsies: a prospective pilot study. Urology. 2005;65(1):109-13. doi: 10.1016/j.urology.2004.08.013.
13. Loeb S, Vellekoop A, Ahmed HU, Catto J, Emberton M, Nam R, et al. Systematic review of complications of prostate biopsy. Eur Urol. 2013;64(6):876-92. doi: 10.1016/j.eururo.2013.05.049.
14. Park DS, Hwang JH, Choi DK, Gong IH, Hong YK, Park S, et al. Control of infective complications of transrectal prostate biopsy. Surg Infect (Larchmt). 2014;15(4):431-6. doi: 10.1089/sur.2013.138.
15. Ghafoori M, Shakiba M, Seifmanesh H, Hoseini K. Decrease in infection rate following use of povidone-iodine during transrectal ultrasound guided biopsy of the prostate: a double blind randomized clinical trial. Iran J Radiol. 2012;9(2):67-70. doi: 10.5812/iranjradiol.7561.
16. Guo LH, Wu R, Xu HX, Xu JM, Wu J, Wang S, et al. Comparison between Ultrasound Guided Transperineal and Transrectal Prostate Biopsy: A Prospective, Randomized, and Controlled Trial. Sci Rep. 2015;5:16089. doi: 10.1038/srep16089.
17. Lane BR, Zippe CD, Abouassaly R, Schoenfield L, Magi-Galluzzi C, Jones JS. Saturation technique does not decrease cancer detection during followup after initial prostate biopsy. J Urol. 2008;179(5):1746-50. doi: 10.1016/j.juro.2008.01.049.