ORIGINAL RESEARCH

Application of Periprostatic Nerve Block and Pudendal Nerve Block in Transrectal Ultrasound-Guided Prostate Biopsy

Ting Liu, BM; Shaolin Wang, BM; Jin Song, BM; Hong Zhu, BM; Jingjing Zhang, BM; Peng Zhang, MM

ABSTRACT

Objective • To investigate the application effects of prostate perineural block combined with pudendal nerve block under transrectal ultrasound guidance in transrectal prostate biopsy.

Methods • Ninety patients who underwent their first transrectal prostate biopsy from November 2021 to July 2022 were included in the study. The patients were divided into three groups: Group A received prostate perineural block, Group B received intrathecal anesthesia, and Group C received pudendal nerve block combined with prostate perineural block. Perioperative indicators, pain levels, and occurrence of complications were compared among the three groups.

Results • Regarding perioperative indicators, after 5 minutes of anesthesia, Group B had the lowest mean arterial pressure (MAP) ($P < .05$), while Group A had the highest MAP ($P < .05$). The VAS scores in Groups B and C were lower than that in Group A during probe insertion, prostate puncture, and 2 hours after biopsy ($P < .05$). There were no significant differences in the occurrence of complications among the three groups ($P > .05$).

Conclusion • Compared to intrathecal anesthesia, the combination of prostate perineural block and pudendal nerve block provided more stable hemodynamics after 5 minutes of anesthesia. It effectively controlled pain compared to prostate perineural block alone. Nerve block anesthesia facilitated earlier postoperative ambulation, making it suitable for day surgery and in line with the Enhanced Recovery After Surgery concept. Additionally, it had no complications and can be considered for wider application. (*Altern Ther Health Med.* [E-pub ahead of print.])

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INTRODUCTION

Transrectal ultrasound-guided biopsy has become the standard procedure for diagnosing prostate cancer. In recent years, it has been suggested that sextant biopsy sampling may not be sufficient, and recommendations have been made to increase the number of cores to 10-12.[1] This development has led to an increase in the number of specimens in transrectal ultrasound-guided prostate biopsies to improve prostate cancer detection rates. However, this increased number of biopsy samples may cause pain issues, necessitating the search for appropriate pain relief methods. Advancements in technology have allowed clinicians to obtain more tissue samples, thereby improving the detection rate of prostate cancer. However, an increased number of cores without adequate analgesia can lead to cumulative pain and higher pain scores.[2] During the process of transrectal ultrasound-guided prostate biopsy, pain can be categorized into three stages: (1) local anesthesia, (2) insertion and manipulation of the rectal probe, and (3) tissue puncture and sampling of the prostate. Existing literature has indicated that various analgesic methods have been implemented to alleviate pain during transrectal ultrasound-guided prostate biopsy, and prostate perineural block anesthesia was once recognized as the standard analgesic technique for prostate biopsy. However, it may not provide sufficient analgesic coverage throughout the entire biopsy procedure.[3,4] For example, during the initial placement and manipulation of the rectal probe, prostate perineural block anesthesia may not provide optimal analgesic effects.[5,6] Currently, intrathecal anesthesia is considered the most effective analgesic method for prostate biopsy, but it may not be suitable for elderly patients in terms of hemodynamic stability and meeting the requirements of day surgery.

Current research suggests that combined analgesia is more effective in controlling pain than solely relying on prostate perineural block anesthesia.[7,8] The pudendal nerve

innervates the distal rectum and perineal region, and pudendal nerve block is used for local anesthesia in certain anorectal, rectal, and gynecological procedures.[9,10] However, its role in urological surgery has not been extensively studied. Therefore, the aim of this study is to compare the efficacy and safety of prostate perineural block combined with pudendal nerve block under ultrasound guidance in transrectal ultrasound-guided prostate biopsy, in order to provide evidence for exploring appropriate analgesic protocols for transrectal ultrasound-guided prostate biopsy.

MATERIALS AND METHODS

Subjects

From November 2021 to July 2022, 90 patients with an average age of 67.46 ± 5.92 years who underwent 13-core prostate biopsy for the first time (at least 12 cores in our hospital) were selected. The average body mass index (BMI) was (25.26 ± 2.46) kg/m, the average prostate specific antigen (PSA) level was (23.54 ± 5.02) μg/L, and the average prostate volume was (41.26 ± 4.03) ml. Inclusion criteria: (1) PSA > 4 μg/L; (2) nodules on digital rectal examination, or hypoechoic nodules on B-ultrasound or CT; (3) informed consent was obtained from patients. Exclusion criteria: (1) acute/chronic prostatitis; (2) colorectal diseases; (3) previous prostate biopsy history; (4) history of anorectal surgery; (5) patients with continuous oral anticoagulant or antiplatelet drugs. This study was approved by the hospital ethics committee, and all enrolled patients gave informed consent and signed the informed consent form.

Methods

Group A: Prostate perineural block under ultrasound guidance only. The specific procedure was as follows: The patient was placed in the lithotomy position, and a transrectal dual-plane ultrasound probe was fixed on a stepper. The probe was then inserted into the patient's rectum.

Step 1: Infiltration anesthesia of the perineal skin: Using 10 ml of 1% lidocaine (produced by Jichuan Pharmaceutical Group Co., Ltd., National Drug Approval Number H32025323), the perineal skin at the projected area of the prostate was infiltrated with anesthesia, with a range of 0.5 cm beyond the projected area.

Step 2: Infiltration anesthesia of the apex of the prostate capsule: Using a needle, injections of 1-2 ml of 1% lidocaine were administered at points 1, 3, 5, 7, 9, and 11 on the projected area of the perineal region.

Step 3: Prostate perineural block: Under transrectal ultrasound guidance, the position of the blood vessels within the neurovascular bundle of the prostate was observed (refer to Figure 1). The neurovascular bundle of the prostate was then located by identifying the blood vessels, followed by the injection of 5 ml of 1% lidocaine at the respective locations of the left and right neurovascular bundles using a spinal needle (refer to Figure 2). The appearance of a hypoechoic area in the prostate and seminal vesicles indicated successful anesthesia. After successful anesthesia, the biopsy procedure was performed 5 minutes later.

Figure 1. Ultrasound Localization of the Left and Right Vascular Bundles of Peripheral Prostatic Nerves

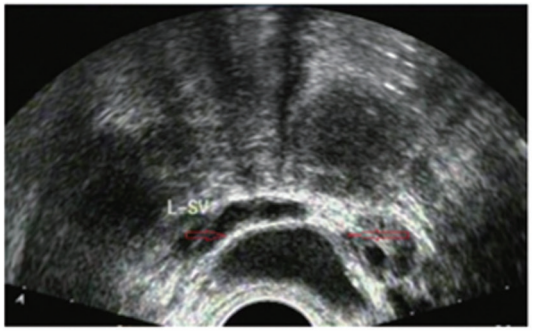
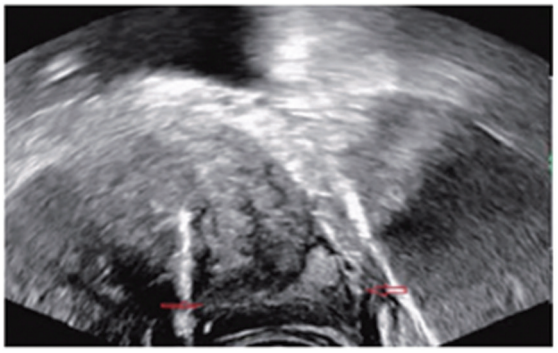


Figure 2. Anesthesia Injection was Guided by Ultrasound at the Location of the Left and Right Vascular Bundles of the Periprostatic Nerve



Group B: Spinal anesthesia was performed as follows: Upon entering the operating room, routine monitoring of electrocardiography (ECG), heart rate (HR), blood pressure (BP), and oxygen saturation (SpO_2) was conducted. Venous access was established in the upper limb. The patient was positioned in the right lateral decubitus position, and the puncture site was selected at the L2-3 intervertebral space. After disinfection and draping, a spinal needle was inserted, and upon successful puncture, spinal anesthesia was administered by injecting an appropriate amount of 0.5% bupivacaine diluted with cerebrospinal fluid at a rate of 0.2 mL/s into the subarachnoid space. The total volume of the spinal anesthesia solution was 1.5 mL. The level of blockade was controlled and not allowed to exceed T10.

Group C: Combined perineural block of the pudendal nerve and prostate perineural block were performed as follows: The patient was placed in a prone position, and a low-frequency convex array probe was used. The probe was moved inward from the midpoint of the intergluteal cleft (refer to Figure 3) to locate the ischial spine. At the level of the ischial spine, the sacrococcygeal ligament was visible as a strong echogenic structure, and the pudendal artery was visualized using color Doppler. The pudendal nerve was located between the ischial spine and the pudendal artery (refer to Figure 4). The puncture site was 2 cm outward from the inner side of the longitudinal axis of the probe. Using an in-plane technique, a sterile puncture needle was inserted downward and inward toward the ischial spine. The needle tip reached the ischial

Figure 3. Schematic Diagram of the Right PNB Ultrasound Probe Position and Needle Insertion Direction

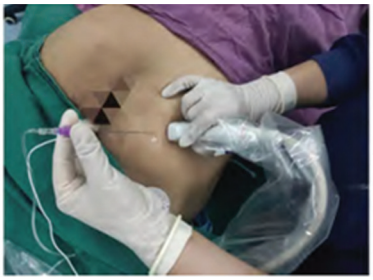
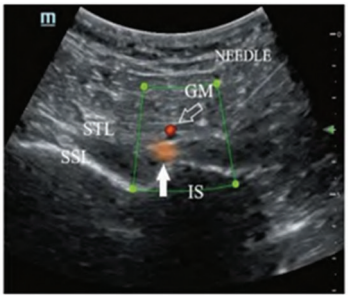


Figure 4. Ultrasound Image of Right Pudendal Artery and Pudendal Nerve (Level of Ischial Spine)



Note: Solid Arrows Indicate the Orange-Yellow Area, Pudendal Nerve; Hollow Arrow, Pudendal Artery.

Abbreviations: SSL, Sacrospinous Ligament; STL, Sacrotuberous Ligament; IS, Ischial Spine; GM, Gluteus Maximus

spine, and a distinct loss of resistance was felt upon penetration of the sacrococcygeal ligament. Initial electrical stimulation with a 1 mA current was used to elicit anal, scrotal, and perineal muscle contractions, followed by a reduction in the stimulation to 0.6-0.8 mA. After confirming the absence of blood upon aspiration, 5 mL of 1% lidocaine (produced by Jichuan Pharmaceutical Group Co., Ltd., National Drug Approval Number H32025323) was slowly injected. Successful injection was indicated by a significant decrease or disappearance of muscle contractions and the appearance of a spindle-shaped hypoechoic image on ultrasound. The same procedure was performed on the left side for pudendal nerve block (PNB). After completing bilateral PNB, the patient was placed in the lithotomy position for prostate perineural block, following the same steps as in Group A.

All biopsies were performed using the Hitachi Hi Vision 5500 system (Hitachi Aloka Medical, Tokyo, Japan) and the BD Mission disposable biopsy needle. The anesthesia process was carried out by two anesthesiologists, and the surgery was performed by the same group of doctors. All patients underwent a 13-core biopsy scheme, including 6 lateral sagittal and 6 transverse targeted biopsies, covering the base, middle, and apex regions. The biopsy specimens were numbered and reviewed by uropathologists.

Outcome Measures

Perioperative Indicators. Heart rate (HR), blood pressure (BP), respiratory rate (RR), and SpO_2 of the patients were recorded at 5 minutes before anesthesia (T0), 5 minutes after anesthesia (T1), immediately after the start of surgery (T2), 30 minutes after the start of surgery (T3), and at the end of surgery (T4).

Pain Assessment. Pain scores were assessed during the insertion of the ultrasound probe into the rectum, during the prostate puncture procedure, and 2 hours after the prostate puncture. All prostate puncture procedures were performed by the same group of doctors, and the visual analog scale (VAS) score was recorded by the same nurse. The VAS score ranged from 0 to 10, with 0 indicating no pain and 10 representing the most severe and unbearable pain. Scores of 1-3 indicated mild pain, 4-6 indicated moderate pain, and 7-10 indicated severe pain.

Complication Assessment. All patients were observed for 2 hours after the operation, and complications, as well as catheterization and ambulation status, were recorded for the three groups. These complications include bleeding, infection, urinary retention, urinary tract injury, nerve damage, urinary incontinence, allergic reactions, etc. We watch for signs or symptoms of these complications, such as hematuria, fever, urinary problems, pain, paresthesias, etc. By comprehensively monitoring and documenting the presence or absence of these complications, we can take the necessary steps in a timely manner to deal with potential problems and ensure patient safety and recovery.

Treatment of biological tissue specimens

Specimen processing occurs at the end of the research methodology, first, the specimen is sent to the laboratory to ensure its accuracy and traceability. In the laboratory, specimens are identified, numbered, and recorded. The specimen may then undergo steps such as segmentation, fixation and preservation, and sample preparation to meet different types of analysis or testing needs. This ensures full utilization of specimens and reliability of scientific data. The specimen processing process needs to follow laboratory guidelines and ethical standards to ensure the integrity of the data and the credibility of the results.

Statistical Analysis

Data were analyzed using Statistic Package for Social Science (SPSS) version 22.0 software (IBM, Armonk, NY, USA). Normally distributed continuous data were expressed as mean ± standard deviation ($\bar{x} \pm s$), and the t test was used for comparisons between two groups, while one-way analysis of variance (ANOVA) was used for comparisons among multiple groups. Categorical data were expressed as frequencies (percentages), and the chi-square test was used. $P < .05$ was considered statistically significant.

RESULTS

Comparison of general data

The selected patients were divided into three groups by random number table method, with 30 cases in each group. There were no significant differences in baseline data among the three groups (ts = 0.521, 0.544, 0.507, 0.518, Ps > .05), as shown in Table 1.

Comparison of perioperative indicators among the three groups

MAP, HR, SpO_2, and RR were compared among the three groups before and after anesthesia.

There were no significant differences in HR, MAP, RR, and SpO_2 at 5 min before anesthesia (T0) among the three groups ($P > .05$); The MAP of the three groups at 5 min after anesthesia (T1): Groups A and C was higher than Group B, the difference was statistically significant ($P < .05$);

There were no significant differences in HR, MAP, RR, and SpO_2 among the three groups at other time points ($P > .05$), see Table 2.

Comparison of VAS scores among the three groups at different times

The results of the study showed that there were significant differences in the VAS scores of different treatment groups at different time points. In the stage of probing into the rectum, the VAS score of Group B (VAS score: 1.96 ± 0.16) was significantly lower than that of Group A (VAS score: 4.05 ± 0.43) and Group C (VAS score: 1.97 ± 0.41). During the prostatic puncture procedure, the VAS score of Group B (VAS score: 2.31 ± 0.21) was also lower than that of Group A (VAS score: 2.96 ± 0.26) and Group C (VAS score: 2.87 ± 0.24). However, 2 hours after the biopsy, the VAS score of Group B (VAS score: 2.11 ± 0.24) was still significantly lower than that of Group A (VAS score: 3.5 6 ± 0.31) and Group C (VAS score: 2.49 ± 0.29). The VAS scores of patients in Group B were lower than those in Groups A and C during prostate biopsy and 2h after the end of biopsy when the probe entered the rectum (ts = 7.981, 9.261, 8.022, *Ps* < .05). See Table 3 for details.

Comparison of complications among the three groups

No serious complications occurred in the three groups, and the incidence of complications was not statistically significant ($\chi^2 = 0.562$, $P > .05$) Table 4.

Table 1. Comparison of General Data

Group	Age (years)	BMI (kg/m²)	PSA (μg/L)	Prostate volume (ml)
Group A	66.03 ± 5.68	25.12 ± 2.61	23.18 ± 2.12	41.21 ± 3.97
Group B	67.98 ± 5.93	25.49 ± 2.53	24.26 ± 2.31	40.89 ± 3.94
Group C	67.06 ± 5.79	24.89 ± 2.46	23.54 ± 2.29	41.56 ± 4.11
t	0.521	0.544	0.507	0.518
P value	.443	.421	.467	.453

Table 2. Comparison of MAP, HR, SpO_2, and RR Before and After Anesthesia Between Three Groups

Group	Indicators	Preanesthesia 5 min T0	Postanesthetic 5 min T1	Immediately after starting surgery T2	Surgery 30 min T3	After surgery T4
Group A	MAP/mmHg	104.66 ± 7.44	105.13 ± 7.82	104.86 ± 7.52	104.68 ± 7.46	104.64 ± 7.36
	HR/min⁻¹	76.53 ± 7.60	76.36 ± 7.63	76.68 ± 7.61	76.52 ± 7.58	76.61 ± 7.60
	SPO_2/%	98.83 ± 1.05	98.84 ± 1.03	98.82 ± 1.03	98.82 ± 1.02	98.83 ± 1.04
	RR/min⁻¹	20.26 ± 1.14	20.86 ± 1.22	20.30 ± 1.13	20.27 ± 1.13	20.25 ± 1.13
Group B	MAP/mmHg	106.66 ± 7.92	90.33 ± 10.71	102.76 ± 7.48	105.68 ± 7.56	106.65 ± 7.89
	HR/min⁻¹	77.26 ± 7.53	82.90 ± 6.22	77.14 ± 7.54	77.02 ± 7.52	77.23 ± 7.58
	SPO_2/%	98.03 ± 1.44	98.02 ± 1.32	98.53 ± 1.58	98.48 ± 1.56	98.65 ± 1.62
	RR/min⁻¹	20.20 ± 0.96	20.25 ± 1.12	20.26 ± 1.03	20.25 ± 1.13	20.21 ± 0.98
Group C	MAP/mmHg	104.66 ± 7.94	101.86 ± 7.82	103.68 ± 7.75	104.58 ± 7.89	105.78 ± 7.89
	HR/min⁻¹	73.43 ± 10.08	74.13 ± 10.36	76.56 ± 7.58	76.52 ± 7.43	75.89 ± 8.02
	SPO_2/%	98.76 ± 1.54	98.68 ± 1.67	98.72 ± 1.52	98.68 ± 1.23	98.82 ± 1.58
	RR/min⁻¹	20.40 ± 1.03	20.24 ± 1.02	20.31 ± 1.02	20.26 ± 1.04	20.27 ± 0.96

Note: 1 mmHg = 0.133 kPa

Table 3. Comparison of VAS Scores Among the Three Groups at Different Times

Group	Probe into the rectum	Prostatic puncture procedure	2 hours after biopsy
Group A	4.05 ± 0.43	2.96 ± 0.26	3.56 ± 0.31
Group B	1.96 ± 0.16	2.31 ± 0.21	2.11 ± 0.24
Group C	1.97 ± 0.41	2.87 ± 0.24	2.49 ± 0.29
t	7.981	9.261	8.022
P value	.000	.000	.000

Table 4. Comparison of Complications Among the Three Groups

	Rectal bleeding (%)	Hematuria (%)	Urinary retention (%)	Acute prostatitis (%)	Catheter removal (%)	Allergic reactions (%)	Mobilization out of bed (%)	Overall incidence (%)
Group A	2(6.67)	2(6.67)	0(0.00)	0(0.00)	26(86.7)	1(3.33)	29(96.7)	60(200)
Group B	1(3.33)	2(6.67)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)	3(10.00.)
Group C	1(3.33)	1(3.33)	0(0.00)	0(0.00)	28(93.3)	1(3.33)	29(96.7)	61(203)
χ^2								0.563
P value								.352

DISCUSSION

Although prostate biopsy is considered a minor procedure, it can still cause significant pain and discomfort, which may result in patient aversion, especially for those requiring repeat biopsies. Pain can occur at any stage of the biopsy, but it is most commonly experienced during probe insertion and tissue sampling.[11,12] The intense pain during this stage increases patient anxiety and reduces compliance during tissue acquisition, thus affecting the success of the procedure.

In 1996, Nash et al.[13] introduced the technique of periprostatic nerve block for prostate biopsy, and since then, several other analgesic techniques have been studied, including local anesthesia of the rectum, intrathecal anesthesia, inhalation anesthesia, selective low-dose spinal anesthesia, and perineal anesthesia.[13,14] Although intrathecal anesthesia alone can provide effective pain control, its increasing application has revealed limitations, such as inadequate suitability for elderly patients with significant hemodynamic fluctuations, previous lumbar spine surgery, lumbar spine deformities, or severe lumbar disc herniation, as well as for patients undergoing day surgery to adhere to Enhanced Recovery After Surgery (ERAS) principles. Therefore, the combined use of transrectal ultrasound-guided periprostatic nerve block and pudendal nerve block has shown advantages.

The advantage of this study is the use of a combined analgesic approach, that is, the combined application of periprostatic nerve block and pudendal nerve block. This approach has shown significant advantages in improving patient postoperative pain management. Specifically, this combined analgesic method has clinical significance in the following aspects: First, it has a significant pain control effect and helps to improve the patient's surgical experience and postoperative comfort. Secondly, this method can reduce the incidence of complications for patients and reduce the use of medical resources and medical costs. In addition, the

combined analgesic approach is particularly suitable for day surgery and can help improve operating room turnover. Finally, this method has high clinical applicability and can be widely used in other surgical procedures to improve postoperative pain management and overall patient care.

Pudendal nerve block has a wide range of applications, including providing perineal anesthesia in anal and rectal surgeries (e.g., hemorrhoidectomy).[10] However, its application in urological surgeries has been limited thus far, such as in urethral reconstruction and transurethral prostatectomy.[15] Promising results have been reported in some existing studies. Adsan et al.[13] reported their results in a small randomized placebo-controlled study and found that unilateral pudendal nerve block (26 patients) was superior to placebo (25 patients) in reducing pain during the biopsy and probe manipulation stages.

This study investigated the clinical value of combining transrectal ultrasound-guided periprostatic nerve block with pudendal nerve block as an anesthetic method to alleviate pain during all stages of transrectal ultrasound-guided biopsy. The results of this study demonstrated that the combined treatment of periprostatic nerve block and pudendal nerve block was superior to periprostatic nerve block alone, and there was no significant advantage in terms of removing the catheter, reducing urinary retention, and early ambulation with intrathecal anesthesia. In addition, hypotension and respiratory depression are more common complications in elderly patients undergoing spinal anesthesia, related to their decreased autonomic regulatory capacity. The hemodynamic instability observed in elderly patients during anesthesia is associated with cerebrospinal fluid volume, local anesthetic dose, and the spread toward the head. In recent years, with advances in medical technology, continuous monitoring of heart rate and blood pressure during surgery has become more stringent, allowing for timely adjustments as needed. In our study, several cases of hypotension were controlled effectively with ephedrine injection, and bradycardia was managed with intravenous atropine, without the occurrence of any serious incidents. The neural block anesthesia in this study provided relatively stable hemodynamics. Furthermore, the combined use of periprostatic nerve block and pudendal nerve block did not significantly increase the occurrence of medical complications, as seen from the incidence of complications.

The study results differed in three main aspects: 1) postoperative monitoring indicators, 2) VAS pain scores, and 3) complications. These differences and possible reasons: First, at 5 minutes before surgery (T0), there was no difference in heart rate (HR), mean arterial pressure (MAP), respiratory rate (RR), and oxygen saturation (SpO_2) between the three groups of patients. This suggests that the patient's physiological status before induction of anesthesia was largely consistent across the groups. At 5 minutes after anesthesia induction (T1), the MAP of Groups A and C was significantly higher than that of Group B, which may be due to different anesthesia methods. This suggests that Groups A and C may have experienced a more pronounced increase in blood pressure, which may require additional attention and management. Secondly, the VAS scores of patients in Group B during the prostate biopsy and within 2 hours after the biopsy were significantly lower than those in Groups A and C. This suggests that patients in Group B performed better in terms of pain perception. This difference may be because Group B received different analgesic methods or analgesic drugs, giving them an advantage in pain relief. A possible explanation is that patients in Group B received more effective analgesic treatment or a more appropriate type of analgesic. Finally, no serious complications occurred in all three groups, and complication rates were not significantly different between groups. This suggests that the three different anesthesia methods performed consistently with respect to postoperative complications.

Overall, these results suggest that there may be some differences in postoperative monitoring, pain relief, and morbidity among different anesthetic methods. These differences may arise from differences in the biological effects of different anesthetic methods, drug selection, or treatment regimens. However, further research and in-depth analysis are needed to determine the exact reasons for these differences and to determine which method is more effective and safer in specific situations. This may provide guidance for future clinical practice regarding the selection of appropriate anesthesia methods.

Since this study was a prospective randomized controlled trial with a small sample size, it had certain limitations primarily due to the limited number of patients. Additionally, the study did not stratify and compare age, BMI, and prostate volume between groups. Another significant limitation is that early postoperative pain perception assessment may have influenced pain scores. Nevertheless, the combined use of periprostatic nerve block and pudendal nerve block demonstrated effective pain control, minimized hemodynamic fluctuations, allowed for immediate catheter removal, reduced urinary retention, and facilitated early ambulation, making it a favorable choice for day surgery and for patients with lumbar spine deformities or a history of lumbar spine surgery who are otherwise unsuitable for intrathecal anesthesia. Considering the above reasons, ultrasound-guided transrectal periprostatic nerve block combined with pudendal nerve block is an ideal approach in terms of pain relief, complications, and other aspects and is worthy of promotion.

The combined analgesic approach used in this study facilitates rapid postoperative recovery and provides appropriate pain management for day surgery. This is because we observed that patients had lower pain scores with analgesia, meaning they were able to leave the operating room earlier and is thus suitable for day surgery. In addition, the long-lasting analgesic effect also allows the patient to maintain a good level of comfort for a sufficiently long period of time after the operation, which is crucial for the successful performance of day surgery. Furthermore, the low

complication rate demonstrates that the pain management approach employed is effective in maintaining the patient's overall health and safety, further emphasizing its suitability for day surgery. Therefore, the method of this study has broad clinical applicability, especially in day surgery scenarios.

ETHICAL COMPLIANCE

This study was approved by the ethics committee of the Second People's Hospital of Wuhu. Signed written informed consents were obtained from the patients or guardians.

FUNDING

This study did not receive any funding in any form.

AUTHOR DISCLOSURE STATEMENT

The authors have no potential conflicts of interest to report relevant to this article.

AUTHOR CONTRIBUTIONS

TL and PZ designed the study and performed the experiments, SW and JS collected the data, HZ and JZ analyzed the data, TL and PZ prepared the manuscript. All authors read and approved the final manuscript.

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