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Research Article

Levobupivacaine versus bupivacaine for spinal anesthesia in jackknife position: A randomized trial in pilonidal sinus surgery

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ABSTRACT

Background: This study aimed to compare the efficacy and clinical characteristics of levobupivacaine and bupivacaine for spinal anesthesia in the jackknife position during pilonidal sinus surgery.

Materials and Methods: The onset and maximum level of sensory block were similar between groups. Regression to S2 occurred significantly earlier in the levobupivacaine group (139.7 ± 7.3 min) compared with the bupivacaine group (165.2 ± 8.0 min, p=0.001). The duration of motor block was also shorter in the levobupivacaine group (125.8 ± 6.5 vs. 148.5 ± 7.2 min, p=0.001). Hemodynamic stability and side-effect profiles were comparable between groups.

Results: The onset and maximum level of sensory block were similar between groups. Regression to S2 occurred significantly earlier in the levobupivacaine group (139.7 ± 7.3 min) compared with the bupivacaine group (165.2 ± 8.0 min, p=0.001). The duration of motor block was also shorter in the levobupivacaine group (125.8 ± 6.5 vs. 148.5 ± 7.2 min, p=0.001). Hemodynamic stability and side-effect profiles were comparable between groups.

Conclusions: Levobupivacaine provides shorter motor block duration and faster recovery compared with bupivacaine, making it particularly suitable for short procedures performed in the jackknife position. Larger multicenter trials are warranted to validate these findings.

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1. Introduction

Pilonidal sinus disease is a frequent chronic disorder of the sacrococcygeal region, primarily affecting young adults, and surgical excision remains the treatment of choice [1]. Given the demographic profile of these patients, procedures are commonly performed in ambulatory settings, where anesthesia must balance efficacy with rapid recovery and safety [2]. Spinal anesthesia has become the preferred technique in anorectal surgery owing to its rapid onset, technical simplicity, cost-effectiveness, and favorable safety profile [2–4].

The characteristics of spinal anesthesia are determined by several factors, including the type, dose, and baricity of the local anesthetic, as well as patient positioning [5]. In perianal surgery, the prone jackknife position offers optimal surgical exposure [6]. However, the use of hyperbaric solutions in this posture carries the risk of unintended cephalad spread, potentially producing higher block levels and hemodynamic instability [4,7]. By contrast, isobaric solutions distribute more predictably, largely independent of patient position, and are increasingly employed for anorectal surgery [3,7,8].

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Bupivacaine is one of the most frequently used long-acting local anesthetics for spinal anesthesia, but its dose-dependent cardiotoxicity and neurotoxicity remain significant concerns [9]. Levobupivacaine, the pure S(–)-enantiomer of bupivacaine, demonstrates a more favorable safety profile with reduced cardiotoxicity and central nervous system toxicity, while providing comparable sensory blockade [9–11]. Recent trials and reviews consistently report that levobupivacaine yields equivalent sensory block characteristics but with shorter and less intense motor block, a property that is especially advantageous in day-case surgery [3,12].

Despite these advances, evidence remains limited regarding the comparative use of isobaric levobupivacaine and bupivacaine specifically in the prone jackknife position for pilonidal sinus excision. The gravitational and hemodynamic implications of this posture may differentially affect anesthetic spread and block quality. Given the potential advantages of levobupivacaine in reducing motor blockade and facilitating faster recovery, a focused evaluation in this surgical context is warranted.

Therefore, the present study aimed to compare spinal anesthesia induced with isobaric levobupivacaine versus isobaric bupivacaine in the prone jackknife position for pilonidal sinus surgery, with emphasis on sensory and motor block dynamics, hemodynamic stability, and patient and surgeon satisfaction.

2. Materials and Methods

This prospective, randomized, controlled clinical trial was conducted at a tertiary university hospital between 2010–2011. The study protocol was approved by the Institutional Ethics Committee of Yıldırım Beyazıt Training and Research Hospital, Ankara (Decision No. 23, dated 24.09.2010) and conducted in accordance with the Declaration of Helsinki and CONSORT guidelines. Written informed consent was obtained from all participants.

Forty adult patients aged 18–60 years (ASA I–II) scheduled for elective day-case pilonidal sinus surgery were included. Exclusion criteria were patient refusal, infection at the puncture site, allergy to amide-type local anesthetics, BMI>35 kg/m^2, contraindications to neuraxial anesthesia, significant systemic disease, or history of neurological disorder.

Randomization was performed in a 1:1 ratio using a computer-generated sequence. Group allocation was concealed in sealed opaque envelopes opened immediately before injection. Both patients and surgeons were blinded to group assignment; the anesthesiologist preparing the drugs was not.

Premedication consisted of intramuscular midazolam 0.03 mg·kg^{-1} (Dormicum®, Roche, Switzerland) administered 30 minutes before surgery. Standard non-invasive monitoring (SBP, DBP, MAP, HR, SpO_2) was applied, and a 20-G intravenous line was placed for lactated Ringer's infusion (7 mL·kg^{-1}·h^{-1}).

Spinal anesthesia was performed with a 22-G Quincke needle at the L3–L4 or L4–L5 interspace after confirming free CSF flow. Group L received 7.5 mg of 0.5% isobaric levobupivacaine, and Group B received 7.5 mg of 0.5% isobaric bupivacaine. Each drug was injected intrathecally over 20 seconds.

Sensory block onset was tested with the pinprick method (24-G needle). Onset time, highest sensory level, two-segment regression, and regression to S2 were recorded. Motor block was assessed using the Bromage scale (0–3). Hemodynamic variables were measured at baseline, 1, 3, 5, 7, and 10 minutes, then every 5 minutes. Hypotension (SBP < 90 mmHg or >30% decrease from baseline) was treated with ephedrine 5 mg; bradycardia (HR < 45 bpm) with atropine 0.5 mg.

Patient and surgeon satisfaction were scored on a 5-point Likert scale (0 = poor, 4 = excellent).

2.1. Statistical analysis and sample size

The sample size was calculated using G*Power 3.1 software. Based on previous studies reporting a mean difference of 20% in motor block duration between groups, an effect size (Cohen's d) of 0.72 was assumed. With α=0.05 and power (1–β)=0.80, a minimum of 28 patients per group was required. Considering possible dropouts, 30 patients were included in each group.

All data were analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were tested for normality using the Shapiro–Wilk test and are presented as mean ± SD, whereas categorical variables are shown as frequencies and percentages. Between-group comparisons of normally distributed variables were performed with the independent-samples t-test; non-normally distributed variables were assessed with the Mann–Whitney U test. Categorical variables were compared using the χ^2 or Fisher's exact test, as appropriate. A p value <0.05 was considered statistically significant.

3. Results

Forty patients were enrolled and randomized equally into two groups. All patients completed the study protocol. The two groups were comparable with respect to demographic variables and surgical duration (Table 1). Mean age was 25.0 ± 5.2 years in the levobupivacaine group and 27.5 ± 5.7 years in the bupivacaine group (p=0.23). Body weight, height, and mean surgical time were also similar between groups (all p>0.05).

Baseline systolic, diastolic, and mean arterial pressures and heart rate did not differ between groups. During the perioperative period, blood pressure and heart rate showed modest declines relative to baseline but remained within clinically acceptable ranges in both groups. No patient required intervention for severe hypotension or bradycardia. There were no significant intergroup differences in SBP, DBP, MAP, or HR at any time point (all p>0.05).

The median onset time of sensory block to L5 was shorter with levobupivacaine (4.4 ± 0.2 min) compared with bupivacaine (4.6 ± 0.3 min, p=0.015). The peak sensory level achieved was L2 in both groups. However, regression of the sensory block was faster in the levobupivacaine group: two-segment regression occurred at

58.8 ± 8.2 min with levobupivacaine versus 65.9 ± 6.9 min with bupivacaine (p=0.005), and regression to S2 occurred at 139.7 ± 7.3 min versus 165.2 ± 8.0 min, respectively (p=0.001). At serial assessments, sensory block levels were consistently higher in the bupivacaine group from 20 to 45 minutes after injection (all p<0.05). These findings indicate a shorter overall duration of sensory block with levobupivacaine.

Motor blockade differed significantly between groups. In the levobupivacaine group, the maximum motor block reached was Bromage 2, with 55% of patients achieving grade 1 and 45% grade 2; no patient de-veloped complete block (Bromage 3). In contrast, in the bupivacaine group, 30% of patients experienced complete motor block (grade 3), 35% grade 1, and 35% grade 2 (p=0.028). Median motor block scores from 25 to 45 minutes were consistently higher in the bupivacaine group (p<0.05).

Patient and surgeon satisfaction scores were high in both groups, with no significant differences observed. In the levobupivacaine group, 65% of patients and 70% of surgeons rated anesthesia as "excellent," compared with 55% and 65%, respectively, in the bupivacaine group (p>0.05).

Table 1. Demographic data and duration of surgery (mean ± SD).

	Group L (Levobupivacaine n=20)	Group B (Bupivacaine n=20)	p-value
Age (years)	25.0 ± 5.2	27.5 ± 5.7	0.23
Weight (kg)	75.0 ± 8.3	72.0 ± 8.9	0.31
Height (cm)	171.0 ± 5.1	168.0 ± 8.9	0.28
Duration of surgery (min)	52.0 ± 4.6	55.0 ± 8.8	0.17
ASA I/II (n)	15/5	14/6	0.72

ASA: American Society of Anesthesiologists; HR: Heart Rate;
MAP: Mean Arterial Pressure; CSF: Cerebrospinal Fluid.

Table 2. Median sensory block levels over time (median; min–max).

Time after injection	Group L (Levobupivacaine n=20)	Group B (Bupivacaine n=20)	p-value
1 min	S2 (S2–S1)	S2 (S2–S2)	0.017*
3 min	L5 (S1–L5)	L5 (S1–L5)	1.000
5 min	L5 (L5–L5)	L5 (L5–L5)	–
7 min	L5 (L5–L4)	L5 (L5–L4)	0.752
10 min	L4 (L5–L4)	L4 (L5–L3)	0.082
15 min	L3 (L4–L3)	L3 (L4–L3)	0.429
20 min	L3 (L3–L2)	L2 (L4–L2)	0.013*
25 min	L2 (L3–L2)	L2 (L3–L1)	0.008*
30 min	L2 (L3–L2)	L2 (L3–L1)	0.003*
35 min	L2 (L3–L2)	L2 (L3–L1)	0.004*
40 min	L2 (L3–L2)	L2 (L3–L1)	0.004*
45 min	L2 (L3–L2)	L2 (L4–L1)	0.005*

* Significant at p<0.05

Table 3. Characteristics of sensory and motor block (mean ± SD or n (%)).

Variable	Group L (Levobupivacaine, n=20)	Group B (Bupivacaine, n=20)	p-value
Onset of sensory block (min)	4.4 ± 0.2	4.6 ± 0.3	0.015*
Peak sensory block level	L2 (L2–L3)	L2 (L4–L1)	0.212
Two-segment regression time (min)	58.8 ± 8.2	65.9 ± 6.9	0.005*
Regression to S2 (min)	139.7 ± 7.3	165.2 ± 8.0	0.001*
Motor block (Bromage scale)	11/9/0 (55%, 45%, 0%)	7/7/6 (35%, 35%, 30%)	0.028*

* Significant at p<0.05

4. Discussion

This randomized trial demonstrates that both isobaric levobupivacaine and isobaric bupivacaine provide effective spinal anesthesia for pilonidal sinus surgery performed in the prone jackknife position. The two agents were comparable in terms of hemodynamic stability and overall patient and surgeon satisfaction. However, important differences emerged in sensory and motor block profiles: levobupivacaine was associated with shorter sensory block duration and a markedly lower incidence of complete motor block compared with bupivacaine.

A central concern in spinal anesthesia, particularly in the jackknife position, is the potential for exaggerated cephalad spread with baricity-dependent solutions, leading to high block levels and hemodynamic compromise [7]. In our study, the use of isobaric formulations avoided such complications, and hemodynamic parameters remained stable across groups. These findings are consistent with recent data indicating that isobaric local anesthetics yield more predictable spread and fewer hemodynamic perturbations in non-supine positions [4,13,14].

Levobupivacaine produced a slightly faster onset of sensory block and earlier regression compared to bupivacaine. Similar observations have been reported in orthopedic and obstetric populations [12,15], where levobupivacaine provided adequate anesthesia with shorter block duration, a property advantageous for ambulatory surgery [3]. Piacherski et al. compared isobaric levobupivacaine with bupivacaine in lower limb surgery and reported comparable peak sensory levels but shorter regression times with levobupivacaine [7]. Our results align with these findings and suggest that levobupivacaine may optimize turnover in day-case proctologic surgery.

Perhaps the most clinically relevant difference observed was in motor block intensity. Complete motor blockade occurred in nearly one-third of patients with bupivacaine but in none with levobupivacaine. This supports prior reports that levobupivacaine is associated with less intense motor block, a feature that improves early mobilization and discharge readiness [3,14,16,17]. A recent review on spinal anesthesia emphasized that reducing unnecessary motor block is crucial in enhancing postoperative recovery in day-case procedures [4].

From a pharmacological perspective, levobupivacaine offers a superior safety margin due to its reduced affinity for cardiac sodium channels and lower risk of central nervous system toxicity compared with racemic bupivacaine [11,18]. Recent comparative studies in cesarean delivery and perianal surgery confirm similar anesthetic efficacy but fewer adverse effects with levobupivacaine [8,19,20]. Our findings reinforce this safety advantage, as no major hemodynamic events or complications occurred in either group, though the reduced motor block seen with levobupivacaine may further minimize postoperative immobility-related risks.

Taken together, these findings suggest that isobaric levobupivacaine may represent a more suitable choice than bupivacaine for spinal anesthesia in prone jackknife procedures such as pilonidal sinus excision. Its favorable balance of adequate sensory anesthesia, lower motor blockade, and reliable hemodynamic stability makes it particularly well suited for day-case settings.

4.1. Limitations

The present study has some limitations. First, the relatively small sample size limits the detection of infrequent adverse events and reduces statistical power for secondary outcomes. Second, as this was a single-center study including only young, ASA I–II patients, the findings may not be generalizable to higher-risk or elderly populations. Finally, postoperative analgesic consumption and long-term recovery outcomes were not assessed, which could provide further insights in future studies.

5. Conclusions

In patients undergoing pilonidal sinus surgery in the prone jackknife position, both isobaric levobupivacaine and isobaric bupivacaine provided effective and safe spinal anesthesia. However, levobupivacaine was associated with faster sensory recovery and significantly less motor blockade, without compromising hemodynamic stability or satisfaction. These characteristics make levobupivacaine a more suitable option for ambulatory anorectal surgery, where rapid recovery and early mobilization are essential. Larger multicenter studies are warranted to validate these findings across broader surgical and patient populations.

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Conflict of Interest
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Data Availability
The datasets created and/or analyzed during the current study are not publicly available, but are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate
This study was approved by the ethics committee of Dışkapı Yıldırım Beyazıt Training and Research Hospital, Ankara, Türkiye (Approval Number: 2010/23; Date: 24.09.2010). Written informed consent was obtained from the participants. All methods were performed in accordance with relevant guidelines and regulations.

Author Contributions
Hamiyet Senol Çakmak: *conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing – original draft.*
Onur Ozlu: *methodology, software, validation, formal analysis, investigation, resources, data curation, writing – original draft, writing – review & editing, visualization, supervision.*

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