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ORIGINAL ARTICLE

Comparison of paravertebral block versus fast-track general anesthesia via laryngeal mask airway in outpatient inguinal herniorrhaphy

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Abstract
Purpose Outpatient inguinal herniorrhaphy (IH) can be successfully performed under general, regional, or local anesthesia. In this study recovery profile, postoperative pain scores, incidence of adverse effects, and patient and surgeon satisfaction were compared between paravertebral block (PVB) and fast-track general anesthesia (GA) via laryngeal mask airway (LMA) for outpatient IH.
Methods Sixty patients were randomly assigned to receive either PVB or GA under standardized protocols (group PVB: at T_9–L_1 levels, 5 mL of 0.5% levobupivacaine for both procedures, and continuous propofol sedation; group GA: GA with 2 mg kg^{-1} propofol induction and 2–4% desflurane maintenance via LMA, and routine antiemetic prophylaxis and multimodal analgesic treatment). Anesthesia-related, onset, recovery, and home discharge times, hemodynamic changes, pain, and incidence of adverse effects were compared.
Results Anesthesia-related time and onset time were longer, but recovery and home discharge times were shorter in group PVB. Verbal rating scores (VRS) at 30, 60, 120, and 180 min and 6, and 12 h post-surgery were significantly lower in group PVB patients. VRS at 18, 24, and 48 h were comparable in both groups. No patient in group PVB and eight patients in group GA needed meperidine in the post-anesthesia care unit, and time to first analgesic and first rescue analgesic requirements were significantly longer in group PVB.
Conclusion In outpatient IH, PVB with 0.5% levobupivacaine provided improved recovery, long-lasting analgesia, shorter recovery room stays, and earlier home readiness time than fast-track GA via LMA.

Keywords Paravertebral block · Laryngeal mask · Levobupivacaine · Desflurane · Inguinal herniorrhaphy

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Introduction

Inguinal herniorrhaphy (IH), a common surgical procedure, is mostly performed in the outpatient setting under general, regional, or local anesthesia. It has been found that neither the type of hernia nor the technique adopted to repair the inguinal hernia influences postoperative pain scores, while the anesthetic technique does [1–3].

'Fast-track anesthesia' is currently a popular procedure for surgeries performed in the outpatient setting and can be performed well using either regional and peripheral blocks or general anesthesia (GA) [4]. Fast-track anesthetic techniques aim at short action and fast recovery and, consequently, effective and immediate postoperative pain and nausea control and non-delayed discharge are essential [1–3]. For GA to be successfully used in the outpatient setting, it is important to provide adequate operating conditions and a rapid recovery without adverse effects, so it must be coupled with effective postoperative pain and nausea control. A number of different methods and medications are used with GA to accomplish fast-tracking during outpatient surgery [5, 6]. One of these, the laryngeal mask airway (LMA), has resulted in more patients being able to breath spontaneously and have the ability to move

and/or cough in the absence of neuromuscular blocking drugs. These advantages may alter anesthetic requirements and therefore modify recovery times [7].

Paravertebral block (PVB) has been reported to result in effective anesthesia, rapid recovery, and good postoperative analgesia for IH [8–13]. Nevertheless, PVB also has a number of disadvantages, such as additional time required to perform the block, possibility of block failure, and the need for training in its usage. Hadzic et al. [8] and Naja et al. [12] both compared PVB for IH with GA via tracheal intubation. They concluded that when the aim is to provide fast-track GA for outpatient IH, tracheal intubation, for which LMA usage is a standard practice, should be avoided.

The purpose of this study was to compare PVB and fast-track GA via LMA for outpatient IH—to the best of our knowledge for the first time—in terms of efficacy, recovery, postoperative analgesia, discharge times, adverse effects (AEs), and patient and surgeon satisfaction. We hypothesized that PVB would result in better postoperative control of pain, a shorter recovery period and discharge time (primary outcome variables) and also improved recovery over GA via LMA.

Materials and methods

After obtaining the approval of the Institutional Ethics Committee and written informed consent from all patients, we enrolled 60 American Society of Anesthesiologist (ASA) I–III patients, aged 20–70 years, who were scheduled for elective outpatient IH in this prospective study. Patients with known allergic reactions to any of the study medications, coagulopathy, infection at the block site, repeated IH, severe cardiovascular, respiratory, renal, hepatic, or metabolic diseases were excluded. All of the hernias were direct or indirect inguinal, primary, and fully reducible according to the Nyhus classification [14].

Patients were randomized using the sealed envelope method [envelopes contained the assigned anesthetic treatment (PVB or GA), and each patient withdrew an envelope (numbered 1–60) from a set of envelopes] to receive either PVB (group PVB, $n = 30$) or GA (group GA, $n = 30$). Patients were monitored during surgery and recovery, and the heart rate (HR), mean arterial pressure (MAP) and oxygen saturation (SpO_2) were recorded.

Due to the obvious differences between the two types of anesthesia, neither the patient nor the anesthetist who performed the block and also evaluated the patient in hospital could be blind to the group. Only the anesthetist who evaluated the post-discharge pain and AEs was blind to the group assignment.

All patients were premedicated with intravenous (IV) midazolam 20 mg and fentanyl 50 μg in the operation room. Patients in group GA received tenoxicam 20 mg IV before induction. Patients in group PVB received supplemental nasal oxygen (2 L min^{-1}), and those in group GA received 100% oxygen via a face mask for 2–3 min before the induction of GA.

In group GA, anesthesia was induced with propofol 2 mg kg^{-1} IV, and a LMA was placed for airway management. Anesthesia was maintained with desflurane 2–4% end tidal in combination with N_2O 67% in oxygen at 3 L min^{-1}. The inspired concentration of desflurane was adjusted as clinically indicated [15] [the objective being to maintain the HR and MAP within 30% of baseline value, to have no tachypnea (respiration rate >20/min), and to have no purposeful movements]. Episodes of clinically inadequate anesthesia were treated by increasing the inspired concentration of desflurane in proportion to the severity of disturbance being treated. If adequate anesthesia, indicated by the cessation or absence of patient movement could not be achieved by these means, then fentanyl was administered in 25 μg IV increments, and the total required dose was recorded. Before the end of the surgery, surgeons infiltrated the wound using levobupivacaine 0.25% and ondansetron 4 mg, and metoclopromide 10 mg IV were administered. Time from entry into the operation room to insertion of the LMA was recorded as anesthesia-related time in group GA. Surgeons were allowed to prepare and position the patients for the surgery. Time from end of LMA insertion to readiness for surgery was recorded as onset time.

For the PVB, the patients were in the sitting position, and the PB was performed unilaterally with a 22-gauge, 10-cm-long Quincke spinal needle using the standard technique of Hadzic and Vloka [16]. After walking off the transverse processes of T_9–L_1 vertebrae and inserting the needle 1 cm deeper to the superior ridge of the processes, the anesthetist injected 5 mL of 0.5% levobupivacaine + 1:400,000 epinephrine at each of the five levels. After the block had been administered, patients were returned to supine position. During surgery, patients in group PVB received an IV infusion of propofol at a rate of 10–70 μg kg min^{-1}, which was titrated to light sleep with easy arousability for intraoperative sedation. If adequate anesthesia could not be achieved, fentanyl was administered in 25-μg IV increments, as carried out for patients in group GA. Patients with inadequate surgical anesthesia were converted to GA and noted as an unsuccessful block.

Time from the entry into the operation room to the completed PVB procedure was measured as anesthesia-related time, and sensation was assessed by the pinprick test at 2-min intervals to document the dermatome levels blocked in group PVB. Patients were judged ready for

surgery when a complete loss of pinprick sensation was observed at the operation site. Time from completing PVB procedure to readiness for surgery was recorded as onset time.

The primary outcomes of the study were to detect the differences in postoperative pain scores, analgesic requirements, and recovery and discharge times. At the end of the surgery, propofol infusion was stopped and maintenance of desflurane was discontinued; the LMA was removed at the start of skin closure in group GA. Surgery times were recorded in both groups.

All patients were taken to the Phase 1 Post-Anesthesia Care Unit (PACU) where they were evaluated using a modified Aldrete score [17]. The verbal rating scores (VRS), in which 0 = no pain and 10 = the worst pain, was used to evaluate pain in the both PACU and after discharge. A modified Aldrete score of $\geq$9, VRS <3, and no postoperative nausea and vomiting (PONV) were accepted as acceptable criteria for allowing patients to bypass Phase 1 PACU; such cases went directly to the Phase 2 PACU. This bypass was recorded as the fast-tracking rate. If the patient was admitted to Phase 1 PACU, vital signs were determined continuously, and the presence of symptoms like PONV and pain were also recorded. Phase 1 PACU time was recorded as the time from admission to Phase 1 PACU to discharge to the Phase 2 PACU. Once in Phase 2 PACU, patients were assessed at 15-min intervals. When the post-anesthesia discharge scoring system [18] score was $\geq$9, patients could be discharged to home criteria. At the same time, actual discharge time as time from entry to the operating room to home readiness were also recorded for each patient.

VRS were recorded at 30, 60, 120, and 180 min and 6, 12, 18, 24, and 48 h after surgery, both at rest and at movement. Patients with a VRS $\geq$3 in PACU were treated with 1 mg kg^{-1} intramuscular (IM) meperidine. Before discharge, naproxen 50 mg and tramadol 100 mg, both to be taken orally (PO), were prescribed for the treatment of pain, and patients were informed on how to manage their pain after discharge. VRS $\geq$3 after discharge was accepted as the level necessitating an analgesic, and the patient was instructed to take naproxen 50 mg PO and continue this at 12-h intervals, regardless of the pain level, for the first 2 postoperative days. If the VRS of patient was $\geq$3 for 1 h despite having taken naproxen, the patient was instructed to take tramadol 100 mg PO. After discharge, patients were followed up for 2 days. An anesthetist who was blinded to the type of anesthetic technique used reviewed the VRS and analgesic needs at 24 and 48 h by phone. The first need for naproxen was recorded as time to first analgesic, and the need for tramadol was recorded as time to first rescue analgesic. Total consumption of oral tramadol for each patient was noted.

The secondary outcomes of the study were to detect differences in the incidence of AEs (nausea, vomiting, dizziness, difficulty to void) before/after discharge and patient/surgeon satisfaction. The same blinded anesthetist collected the data on AEs and patient satisfaction (unsatisfied/satisfied/very satisfied) by a phone interview after the patient had been discharged and also assessed surgeon satisfaction (unsatisfied/satisfied/very satisfied) after completion of the surgery.

All analyses were conducted using SPSS for Windows ver. 11.0 (SPSS, Chicago, IL). A power analysis based on previously published data [1] suggested that a minimum of 25 patients in each group would be required to detect a 30% difference in VRS scores for pain with a power of 80% and $\alpha = 0.05$. We also ran a pilot study (6 patients per group) for power analysis before the investigation for the discharge time. Based on these results, we determined that for a power analysis of 80% and $\alpha = 0.05$, discharge time required 29 patients per group [mean $\pm$ standard deviation (SD) 142 $\pm$ 44 and 178 $\pm$ 52, respectively]. Differences in demographic, anesthetic, surgical, recovery, and postoperative data in groups were compared with the independent samples *t* test for continuous data and the Mann–Whitney *U* test for non-parametric data, or by the chi-square with Fisher's exact test, Yates' continuity correction, or likelihood ratio (where appropriate) for categorical data. A $p < 0.05$ was considered to statistically significant. All categorical data are presented as number (*n*, %) and continuous data as the mean $\pm$ SD.

Results

The patients' characteristics and ASA physical status distribution were comparable in the two groups (Table 1).

Surgery times were similar for the two groups. Anesthesia-related time and onset time were significantly longer in group PVB than group GA. The fast-tracking rate was

Table 1 Patient characteristics and ASA physical status in the two patient groups

Patient characteristics	Group PVB ($n = 30$)	Group GA ($n = 30$)
Age (years)	57.2 $\pm$ 10.2	58.2 $\pm$ 10.9
Weight (kg)	74.0 $\pm$ 9.0	73.0 $\pm$ 12.3
Height (cm)	177.0 $\pm$ 8.4	175.1 $\pm$ 8.6
Sex (M/F)	29/1	28/2
ASA (I/II/III)	6/4/20	6/5/19

Values are given as the mean $\pm$ standard deviation (SD) for continuous variables

Data are not significantly different among groups

ASA American Society of Anesthesiologists, *PVB* paravertebral block, *GA* general anesthesia

significantly higher in group PVB. Phase 1 PACU time and time to home readiness were significantly shorter in group PVB. Actual discharge time in group PVB was approximately 15 min shorter than in group GA, and this difference was statistically significant ($p = 0.044$) (Table 2).

During surgery, mean propofol usage was 53.0 ± 19.3 (range 35–75) μg kg min^{-1} in group PVB, and mean end tidal desflurane concentration was 3.2 ± 0.7 (range 2–4)% in group GA. Four patients in group PVB and eight patients in group GA required fentanyl supplementation during the surgery. Both the number of patients requiring fentanyl supplementation and mean supplemental fentanyl usage were comparable in groups ($p = 0.182$ and $p = 0.161$, respectively). Hemodynamic parameters were stable and comparable in both groups during the surgery.

VRS at rest and at movement are were shown in Fig. 1. The VRS at 30, 60, 120, and 180 min and at 6 and 12 h at rest and at movement were significantly lower in group PVB than group GA. VRS scores at 18, 24, and 48 h were comparable in the two groups. Maximum VRS were 2.4 ± 1.4 at rest and 2.7 ± 1.6 at movement in group PVB and 3.5 ± 1.9 at rest and 3.9 ± 1.6 at movement in group GA.

No patients in group PVB and eight patients in group GA needed IM meperidine in PACU, and this difference was significant ($p = 0.005$). Time to first analgesic and time to first rescue analgesic were longer in group PVB than in group GA. Mean duration of analgesia was 15 h (range 5–23 h) in group PVB and 3 h (range 0–6 h) in group GA. Significantly more patients in Group GA needed oral tramadol after discharge ($p < 0.001$). Analgesic requirements, number of patients receiving tramadol, and how many times tramadol was received are shown in Table 3.

Adverse effects before and after discharge and patient and surgeon satisfaction are shown in Table 4. A statistically significant difference was only seen for nausea before discharge ($p = 0.034$). Both patient and surgeon satisfaction were comparable in the groups. For group GA, the surgeon assessed his satisfaction as unsatisfied in one patient because of the difficulty in performing the surgical technique due to inadequate muscle paralysis.

Discussion

The main criteria for the success of outpatient anesthesia practice are rapid recovery, adequate analgesia, prevention of PONV, and timely discharge [19–21]. In this study, the use of PVB was compared with fast-track GA via LMA. We found that PVA provided better and long-lasting postoperative analgesia, with more patients being able to bypass Phase 1 PACU, a shorter time to home readiness, and less PONV. In our study, despite our best attempts to provide a better analgesia with a pre-emptive non-steroidal anti-inflammatory drug (tenoxicam) and with local infiltration of the wound with a long-acting local anesthetic (levobupivacaine) in group GA, VRS of patients just after the surgery until 12 h post-surgery were significantly lower and postoperative analgesic requirements were lower in group PVB. Our findings of long-lasting postoperative analgesia in group PVB could result from the relative avascularity of the paravertebral space and hence the slow uptake of local anesthetic [10],

Table 2 Surgical, anaesthesia, recovery, and home discharge times and fast-tracking rates in the two patient groups

Outcomes	Group PVB ($n = 30$)	Group GA ($n = 30$)
Anesthesia-related time (min)[a]	13.4 ± 3.6*	5 ± 1.5
Onset time (min)[b]	17.0 ± 2.3*	7.1 ± 2.4
Surgery time (min)[c]	55.3 ± 17ns	57.1 ± 17.8
Phase 1 PACU time (min)[d]	26.0 ± 2.8*	41.2 ± 7.6
Fast-tracking rate[e]	26 (86.7%)*	5 (16.7%)
Time to home readiness (min)[f]	148.6 ± 32.2*	179.8 ± 49.0
Actual discharge time (min)[g]	234.4 ± 20.7**	249.0 ± 32.7

Values are given as the mean ± SD for continuous variables and as n, with the percentage in parenthesis, for categorical variables, as appropriate

[a] Time from entry into the operation room to perform PVB in group PVB or to insert the laryngeal mask airway (LMA) in Group GA

[b] Time from end of anesthesia-related time to readiness for surgery

[c] Duration of surgery

[d] Time from entry into Phase 1 Post-Anesthesia Care Unit (PACU) to discharge to Phase 2 PACU

[e] Bypass rate of Phase 1 PACU

[f] Time from entry into phase 2 PACU to discharge home

[g] Time from entry to the operating room to discharge home

* $p < 0.001$; ** $p < 0.05$; ns, not significant

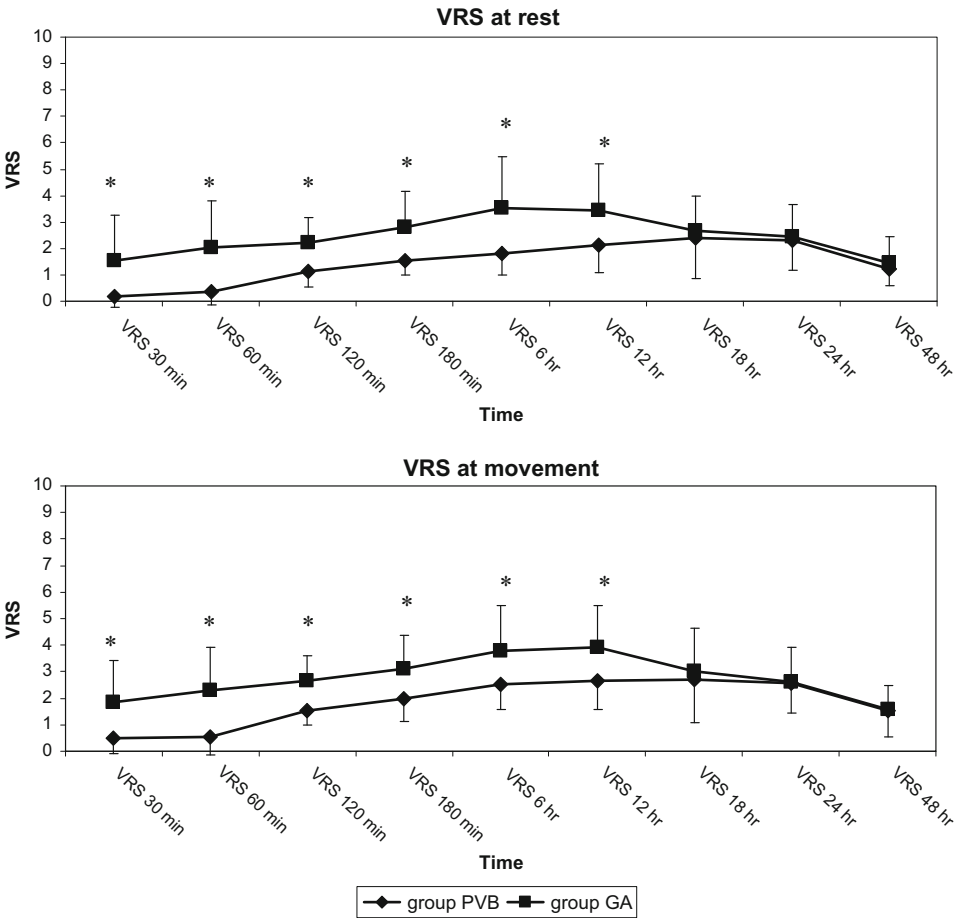

Fig. 1 Verbal rating scores (*VRS*) at rest and at movement in the two patient groups (*$p < 0.001$). *PVB* Paravertebral block, *GA* general anesthesia

Table 3 Analgesic requirements in the two patient groups

Analgesic requirements	Group PVB ($n = 30$)	Group GA ($n = 30$)
Number of patients requiring fentanyl supplementation	4 (13.3%)ns	8 (26.7%)
Number of patients requiring meperidine in PACU	0**	8 (26.7%)
Time to the first analgesic (h)[a]	16 (14.5–17.5)*	3 (1–7)
Time to the first rescue analgesic (h)[b]	19 (16–24)*	5.5 (1–9)
Number of patients requiring rescue analgesic (none/once/twice/three times or more)	23/3/4/0*	6/5/15/4

Values are give as the median with the range in parenthesis, or as *n*, with the percentage in parenthesis

[a] Time from discharge to receiving first analgesic (naproxen 50 mg)

[b] Time from discharge to receiving rescue analgesic (tramadol 100 mg)

* $p < 0.001$; ** $p < 0.05$; ns, not significant

which is the most significant attribute of the PVB technique.

Phase 1 PACU time, time to home readiness, and actual discharge time were found to be shorter in group PVB than in group GA, but anesthesia-related time and onset time were longer. Fast-tracking rate was also significantly higher in group PVB. The application of the PVB procedure in IH provided better postoperative analgesia, a stable intraoperative hemodynamic profile, and less frequent AEs, all of which resulted in the observed high fast-tracking rate and earlier home readiness in our study. These findings are consistent with those in previous reports [8, 9, 12, 13, 22]. Indeed, postoperative pain is a common reason for a delay in discharge [23, 24].

Outpatient anesthetic techniques must aim at short action and fast recovery and avoid factors contributing to delays in time to home readiness, such as pain and PONV [2, 25–27]. IH can be performed using a LMA, thereby obviating the need for both muscle relaxation and reversal drugs. The use of LMA instead of tracheal intubation

Table 4 Adverse effects and patient and surgeon satisfaction in the two patient groups

Adverse effects/patient and surgeon satisfaction	Group PVB ($n = 30$)	Group GA ($n = 30$)
AEs before discharge		
Nausea	1 (3.3%)**	8 (24.7%)
Vomiting	0 ns	1 (3.3%)
Dizziness	0 ns	4 (13.4%)
Difficulty to void	0 ns	1 (3.3%)
AEs after discharge		
Nausea	0 ns	3 (10%)
Vomiting	0 ns	0
Patient satisfaction (unsatisfied/satisfied/very satisfied)	0/12/18 (0/40/60%)ns	0/14/16 (0/46.7/53.3%)
Surgeon satisfaction (unsatisfied/satisfied/very satisfied)	0/13/17 (0/43.3/56.7%)ns	1/18/11 (3.3/60/36.7%)

Values are given as the mean ± SD for continuous variables and as *n*, with the percentage in parenthesis, for categorical variables

AE Adverse effect

** $p < 0.05$; ns, not significant

resulted in a higher fast-tracking rate, shorter home readiness times, and fewer nausea and vomiting incidents in comparison to the group of patients receiving GA in the study of Hadzic et al. [8]. The fast-tracking rate of group GA in our study was lower than that reported by Tang et al. (100%). Factors which may have positively affected the fast-tracking rate in this latter study compared to our results include a shorter mean duration of surgery [37 vs. 57 min (our study)], lower mean end tidal desflurane concentration [2.3 vs. 3.2% (our study)], maintenance of desflurane concentration using the bispectral index (BIS) monitor, lack of use of supplemental fentanyl, and institutional differences in evaluating the recovery and discharge times. Our use of desflurane to maintain anesthesia resulted in home discharge times in group GA comparable to those reported previously [1, 25, 29, 30].

Although home readiness time was shorter in group PVB than in group GA, this difference was not clearly evident in actual discharge time; rather, the increased time required for performing the PVB and to start the operation in group PVB are responsible for this difference. Performing the PVB in the preoperative holding area approximately 30–40 min before surgery allows the surgery to begin immediately when the patient is taken to the operating room and actual discharge time then can be shorten.

With the aim of performing a good fast-track GA, we took a number of precautions. To provide pre-emptive analgesia, we administered 20 mg tenoxicam IV, which other studies have shown to be effective [31–33]. Also, just before skin closure, we infiltrated the wound with 0.25% levobupivacaine for 2–3 h, which has also been shown to be effective [8]. As an anti-emetic prophylaxis to avoid PONV, we administered ondansetron 4 mg and metoclopromide 10 mg, both of which have been recommended by White and Watcha [34]. Despite these precautions, recovery times and fast-tracking rates were better in group PVB than in group GA.

A lack of training, the need for injection at several levels causing the technique to be unpleasant and difficult from the viewpoint of the patients, risk of pneumothorax, and epidural spread are potential disadvantages of PVB [8, 9, 13]. In our study, we did not have any failed blocks or pneumothorax. No patient complained of severe discomfort associated with the block, probably due to the administration of midazolam and fentanyl as premedication. Patient satisfaction did not differ between patients of group PVB and GA.

One of the two limitations of this study was difficulty in blinding, due to the obvious differences between the two types of anesthetic methods. This may have caused a bias in evaluating the results. Another limitation may be the small number of patients in the groups. By performing all of the blocks with staff experienced in this procedure, we had neither failed blocks nor major complications. Although our study has an 80% power for home discharge time, more patients will be needed to verify the AEs and failed blocks.

In this study, we attempted to compare PVB usage with fast-track GA via LMA coupled with multimodal anesthetic techniques. These procedures had not been compared previously with respect to outpatient IH. Tracheal intubation was avoided, and rapid emergence anesthetic agents, multimodal analgesic treatment and routine anti-emetic prophylaxis were used to improve the recovery in group GA. However, the use of PVB provided better and long-lasting analgesia, a higher fast-tracking rate, shorter home readiness time, and improved quality of recovery by decreasing the rates of nausea and severe postoperative pain.

In conclusion, under efficient training conditions, PVB can be a suitable alternative for fast-track outpatient IH.

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