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Comparison of Safety and Efficacy of Unilateral Paravertebral Block and Spinal Anaesthesia in Patients Undergoing Infraumbilical Surgery

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ABSTRACT

Background and Aims: Postoperative pain after infraumbilical surgery contributes to physiological and psychological morbidity. Unilateral spinal anaesthesia (SA) is widely used but is associated with side effects that may delay ambulation. Thoracolumbar paravertebral block (PVB) provides unilateral, segmental anaesthesia with prolonged analgesia. We compared the safety and efficacy, including postoperative analgesia, of unilateral PVB with SA in patients undergoing elective inguinal herniorrhaphy.

Methods: In this prospective randomised study, 124 adult patients (American Society of Anesthesiologists physical status I–II) undergoing elective unilateral inguinal herniorrhaphy were randomised to unilateral thoracolumbar PVB (Group P, n=62) or unilateral SA (Group S, n=62) with 0.5% levobupivacaine. Haemodynamic parameters were recorded intraoperatively; postoperative pain (Numerical Rating Scale), time to rescue analgesia, motor block, and adverse effects were recorded up to 12 hours. Data were analysed using IBM SPSS stats software, version 29 with independent samples t-test; P<0.05 was considered significant.

Results: Block failure occurred in 7/62 (11%) patients in Group P and none in Group S, giving effective sample sizes of 55 and 62, respectively. Mean arterial pressure was significantly better preserved in Group P throughout surgery (P<0.001). Time to first rescue analgesia (298.6±74.3 vs 161.4±25.0 min) and time to next analgesic dose were significantly longer in Group P (P<0.001). No patient in Group P developed complete motor block versus 44/62 in Group S. Postoperative nausea and vomiting occurred in 3 (4.8%) patients in Group S and none in Group P.

Conclusion: Although more technically demanding and time-consuming than SA, unilateral thoracolumbar PVB provided superior postoperative analgesia, better haemodynamic stability, minimal motor blockade, and fewer side effects, making it a safe and effective alternative to SA for infraumbilical surgery.

Keywords*: Hernia; herniorrhaphy; nerve block; pain, postoperative; spinal anaesthesia.*

INTRODUCTION

Inguinal herniorrhaphy is among the commonest infraumbilical surgical procedures and is increasingly performed as day-care surgery, which places a premium on rapid recovery and effective analgesia.[1-3] Persistent or poorly controlled postoperative pain after herniorrhaphy is not uncommon and can adversely affect quality of life.[4] Acute surgical pain also triggers neuroendocrine and metabolic stress responses — including a rise in catecholamines, cortisol, and other stress hormones — with attendant cardiovascular, respiratory, and immune consequences if inadequately treated.[8] Afferent neural blockade with local anaesthetics is regarded as one of the most effective methods of providing postoperative analgesia.[7]

Unilateral spinal anaesthesia (SA) is widely used for infraumbilical surgery because it provides dense, reliable sensory and motor blockade with generally stable haemodynamics.[6] However, dense motor blockade, hypotension, urinary retention, and postoperative nausea and vomiting (PONV) can delay ambulation and same-day discharge. Thoracolumbar paravertebral block (PVB) produces unilateral, segmental sensory and motor blockade and has been used successfully as both an anaesthetic and analgesic technique for inguinal hernia repair and other infraumbilical procedures, with reports of prolonged postoperative analgesia and fewer adverse effects than SA.[1,3,5,6,12,15] Because PVB spares lower-limb motor function and provides prolonged segmental analgesia, it has been proposed as a valuable alternative to SA for infraumbilical surgery, though it is technically more demanding to perform.[13,14]

We undertook this prospective randomised study to compare the safety and efficacy, including postoperative analgesia, of unilateral thoracolumbar PVB with unilateral SA in patients undergoing elective inguinal herniorrhaphy.

METHODS

This prospective randomised study was conducted in the operation theatre, recovery room, and general surgery wards of Medical College and Hospitals, Kolkata after approval by the Institutional Ethics Committee (approval no. MC/Kol/IEC/Non-spon/423/11-2016. Written informed consent was obtained from all participants.

Consenting adult patients of either sex, aged 18–60 years, with American Society of Anaesthesiologists (ASA) physical status I or II, scheduled for elective unilateral, uncomplicated infraumbilical (inguinal hernia repair) surgery were included. Patients with bleeding disorders, peripheral neuropathy, morbid obesity (body mass index >35 kg/m²), known hypersensitivity to local anaesthetics, use of antihypertensives/oral hypoglycaemic agents/selective serotonin reuptake inhibitors/monoamine oxidase inhibitors, significant cardiovascular, respiratory, renal, hepatic, or metabolic disease, chronic analgesic use, or pregnancy/lactation were excluded.

Assuming a large effect size (0.8) for the difference in postoperative Numerical Rating Scale (NRS) pain scores between groups, with a two-tailed alpha error of 0.05 and power of 0.90, a minimum of 62 patients per group (124 in total) was calculated using Epi Info software (version 7.2.0.1, CDC, Atlanta). Patients were randomised in a 1:1 ratio using a computer-generated random number sequence (OpenEpi) to receive either unilateral thoracolumbar PVB (Group P) or unilateral SA (Group S).

After 8 hours of fasting, all patients received oral ranitidine 150 mg the night before surgery, were cannulated with a wide-bore intravenous catheter, and received lactated Ringer's solution 10 mL/kg with supplemental oxygen by nasal cannula. Standard monitoring (electrocardiogram, non-invasive blood pressure, pulse oximetry) was instituted, and intravenous midazolam was administered after block placement for anxiolysis.

In Group P, PVB was performed with the patient sitting, under aseptic precautions, using a landmark-guided technique 2.5–3 cm lateral to the T11 spinous process. After the transverse process was contacted with a Tuohy needle and loss of resistance obtained on walking off its caudal edge, a catheter was inserted and 20 mL of 0.5% levobupivacaine was injected. In Group S, subarachnoid block was performed in the sitting position via a midline approach at the L3–L4 interspace using a 25G Quincke needle, with 3.0 mL of 0.5% levobupivacaine injected after confirming free flow of cerebrospinal fluid.

Sensory block was assessed by pinprick and graded on a 3-point scale (0 = sharp pinprick felt to 2 = no sensation), and motor block by the Modified Bromage scale. Heart rate, systolic/diastolic/mean arterial pressure, and oxygen saturation were recorded before and after the block and every 3 minutes for 15 minutes, then every 10 minutes until the end of surgery. Hypotension (systolic blood pressure <90 mmHg or a fall in mean arterial pressure >30% from baseline) was treated with intravenous fluids and mephentermine 6 mg; bradycardia (heart rate <60/min) was treated with intravenous atropine 0.6 mg.

Postoperatively, patients were monitored hourly for level of consciousness, vital signs, and adverse effects. Pain at rest was assessed using the NRS (0–10) at 2, 4, 6, and 12 hours; rescue analgesia (intravenous diclofenac 75 mg with ranitidine 150 mg) was given for NRS ≥4, and time to first and subsequent rescue analgesia was recorded. PONV was treated with intravenous ondansetron 4 mg.

Data were analysed using IBM SPSS statistics software, version 29. Continuous variables are expressed as mean ± standard deviation and compared using the independent samples t-test; categorical variables are expressed as numbers (percentages). A P value <0.05 was considered statistically significant.

RESULTS

Of 124 patients enrolled and randomised (62 per group), block failure occurred in 7 patients (11%) in Group P and none in Group S; these patients were excluded from analysis, giving an effective sample of 55 patients in Group P and 62 in Group S (Figure 1, Table 1). Demographic characteristics, gender distribution, ASA grade, and duration of surgery were comparable between groups (Tables 2 and 3).

The time taken to perform the block and the time to reach maximum block height were both significantly longer in Group P than Group S (P<0.001, Table 4). Complete motor block (Modified Bromage grade 3) occurred in 44/62 (71%) patients in Group S compared with none in Group P. Sensory block regression to the S2 dermatome took significantly longer in Group P than Group S (327.4±82.7 vs 192.6±31.1 minutes; P<0.001).

Mean arterial pressure was significantly better maintained in Group P than Group S at most intraoperative time points (P<0.001, Table 7, Figure 6), while diastolic blood pressure, though numerically lower in Group P, remained more stable with less fluctuation over time (Table 6, Figure 5). Heart rate trends differed between groups, with an initial decrease in Group P followed by a late intraoperative rise, while Group S showed an early rise followed by a gradual decline (Table 5, Figure 3). Systolic blood pressure trends did not differ significantly between groups on minute-to-minute analysis (Figure 4).

Postoperative NRS pain scores were significantly lower in Group P than Group S at the 2nd, 4th, and 6th postoperative hours (P<0.05, Table 8, Figure 7). Time to first rescue analgesia (298.6±74.3 vs 161.4±25.0 minutes) and time to the next analgesic dose (406.9±74.3 vs 280.3±35.0 minutes) were both significantly longer in Group P than Group S (P<0.001, Table 9, Figure 8).

Postoperative nausea and vomiting occurred in 3/62 (4.8%) patients in Group S and none in Group P; no episodes of bradycardia, hypotension, convulsions, or lower-limb paraesthesia were recorded in either group (Table 10).

TABLES

Table 1: Patient distribution in both groups

	Group P	Group S
No. of patients allocated	62	62
Block failure	7 (11%)	0 (0%)
Effective sample size	55	62

Table 2: Comparison of demographic distribution (mean ± SD)

Parameter	Group P (n=55)	Group S (n=62)
Age (years)	37.15 ± 8.72	39.79 ± 10.25
Height (cm)	155.49 ± 5.71	157.56 ± 7.99
Weight (kg)	50.50 ± 4.59	62.95 ± 5.23
BMI (kg/m²)	20.87 ± 4.99	25.30 ± 5.01

Table 3: Distribution of gender, ASA grade, and duration of surgery

Parameter	Group P (n=55)	Group S (n=62)
Male / Female	28 / 27	33 / 29
ASA Grade I / II	28 / 27	39 / 23
Duration of surgery (min, mean ± SD)	68.75 ± 7.89	67.02 ± 8.47

Table 4: Comparison of block characteristics

Parameter	Group P (n=55)	Group S (n=62)	P value
Time to perform block (min)	10.78 ± 2.63	4.74 ± 1.41	<0.001
Time to reach maximum block height (min)	14.13 ± 3.73	5.19 ± 1.51	<0.001
Modified Bromage scale (0/1/2/3)	32/15/8/0	0/0/18/44	—
Time to S2 segment regression (min)	327.36 ± 82.69	192.60 ± 31.06	<0.001

Table 5: Comparison of intraoperative heart rate (bpm, mean ± SD)

Time point	Group P (n=55)	Group S (n=62)	P value
Before block	85.44 ± 3.28	83.52 ± 14.99	<0.001
After block	79.89 ± 7.13	89.37 ± 18.41	<0.001
3 min	76.69 ± 8.86	88.74 ± 19.10	<0.001
6 min	76.75 ± 9.28	85.11 ± 16.98	<0.001
9 min	83.71 ± 13.17	83.55 ± 15.43	0.77
12 min	83.60 ± 12.27	80.95 ± 13.78	0.57
15 min	81.40 ± 12.20	79.11 ± 12.14	0.18
25 min	79.89 ± 12.65	77.47 ± 12.19	0.09
35 min	78.82 ± 11.50	76.68 ± 12.11	0.61
45 min	82.07 ± 12.13	76.00 ± 12.73	0.44
55 min	93.25 ± 18.18	75.90 ± 12.55	<0.001
65 min	82.95 ± 10.02	75.95 ± 11.27	0.99

75 min	81.69 ± 10.28	76.84 ± 10.74	0.36

Table 6: Comparison of diastolic blood pressure (mmHg, mean ± SD)

Time point	Group P (n=55)	Group S (n=62)	P value
Before block	70.35 ± 5.92	78.66 ± 7.88	0.04
After block	70.93 ± 6.20	75.24 ± 7.66	0.44
3 min	70.85 ± 6.12	72.02 ± 7.64	0.91
6 min	70.45 ± 5.77	72.23 ± 7.02	0.36
9 min	70.44 ± 5.60	72.37 ± 6.55	0.51
12 min	70.84 ± 5.49	71.50 ± 7.62	0.24
15 min	69.65 ± 5.39	72.27 ± 7.41	0.22
25 min	71.15 ± 5.44	72.85 ± 6.56	0.63
35 min	71.31 ± 4.20	73.60 ± 6.45	0.05
45 min	71.27 ± 3.76	73.69 ± 7.01	0.005
55 min	71.24 ± 3.59	74.37 ± 6.33	0.005
65 min	71.62 ± 3.28	74.79 ± 5.97	0.005
75 min	71.80 ± 3.56	75.39 ± 6.29	0.002

Table 7: Comparison of mean arterial pressure (mmHg, mean ± SD)

Time point	Group P (n=55)	Group S (n=62)	P value
Before block	90.35 ± 2.75	88.35 ± 9.89	<0.001
After block	88.89 ± 2.73	85.66 ± 10.20	<0.001
3 min	80.20 ± 4.67	82.52 ± 10.37	<0.001
6 min	80.76 ± 3.85	82.10 ± 9.37	<0.001
9 min	88.76 ± 5.21	83.42 ± 9.21	<0.001
12 min	93.76 ± 6.27	83.48 ± 9.65	0.014
15 min	90.89 ± 5.56	83.03 ± 9.73	<0.001
25 min	90.80 ± 5.05	83.03 ± 9.15	<0.001
35 min	90.07 ± 5.47	83.08 ± 8.96	<0.001
45 min	90.67 ± 4.79	83.74 ± 9.06	<0.001
55 min	95.58 ± 8.49	84.00 ± 10.08	0.245
65 min	80.16 ± 4.20	83.60 ± 9.57	<0.001
75 min	82.31 ± 5.82	84.45 ± 9.65	<0.001

Table 8: Comparison of postoperative NRS pain scores (mean ± SD)

Time point	Group P (n=55)	Group S (n=62)	P value
Immediately after surgery	0.73 ± 0.89	1.06 ± 1.02	0.268
2nd hour	1.25 ± 1.07	3.29 ± 0.68	<0.001
4th hour	2.20 ± 0.73	5.16 ± 0.81	0.049
6th hour	3.13 ± 0.57	4.87 ± 0.71	0.046
12th hour	5.95 ± 0.70	6.44 ± 0.66	0.292

Table 9: Comparison of analgesic requirement (min, mean ± SD)

Parameter	Group P (n=55)	Group S (n=62)	P value
Time to first rescue analgesia	298.55 ± 74.27	161.37 ± 25.02	<0.001
Time to next dose of analgesia	406.91 ± 74.30	280.32 ± 34.96	<0.001

Table 10: Comparison of side effects in the postoperative period

Side effect	Group P (n=55), n (%)	Group S (n=62), n (%)
Nausea and vomiting	0 (0%)	3 (4.8%)
Bradycardia	0 (0%)	0 (0%)
Hypotension	0 (0%)	0 (0%)
Convulsion	0 (0%)	0 (0%)
Lower limb paraesthesia	0 (0%)	0 (0%)

FIGURE LEGENDS

Figure 1: Study flow diagram.

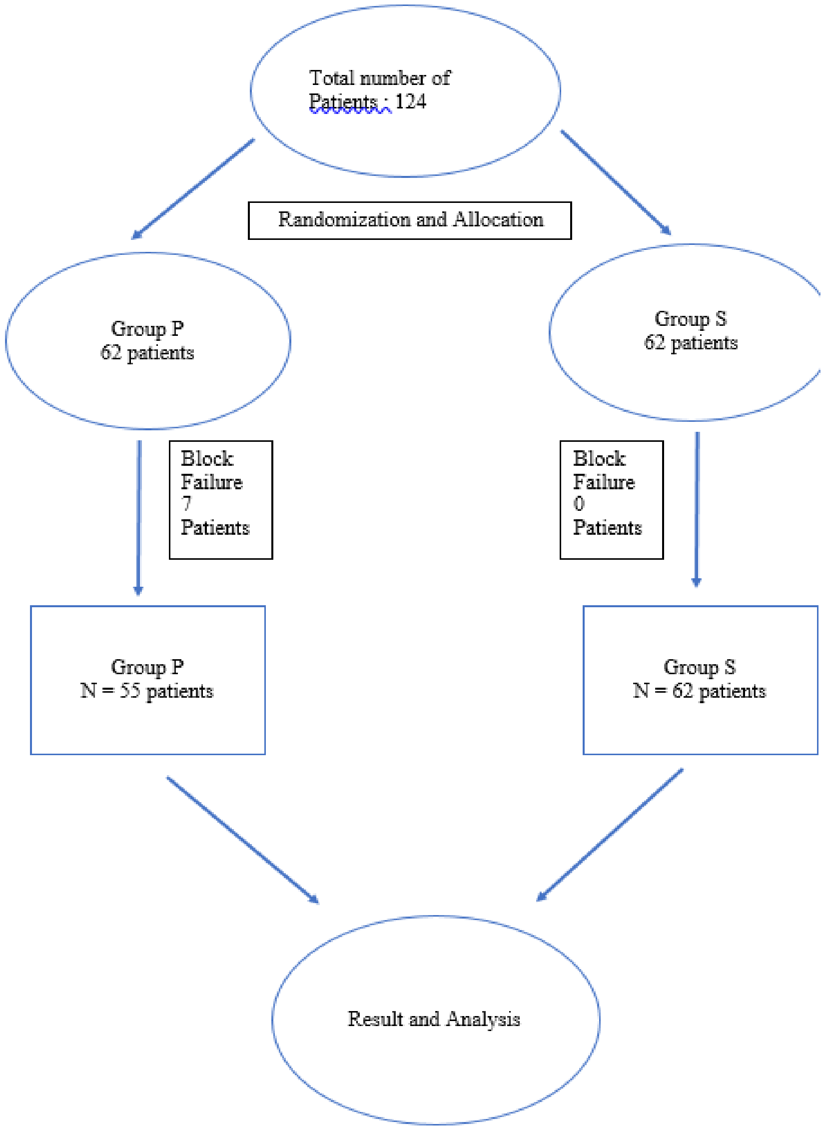


Figure 2: Line graph representing the trend of heart rate in both groups.

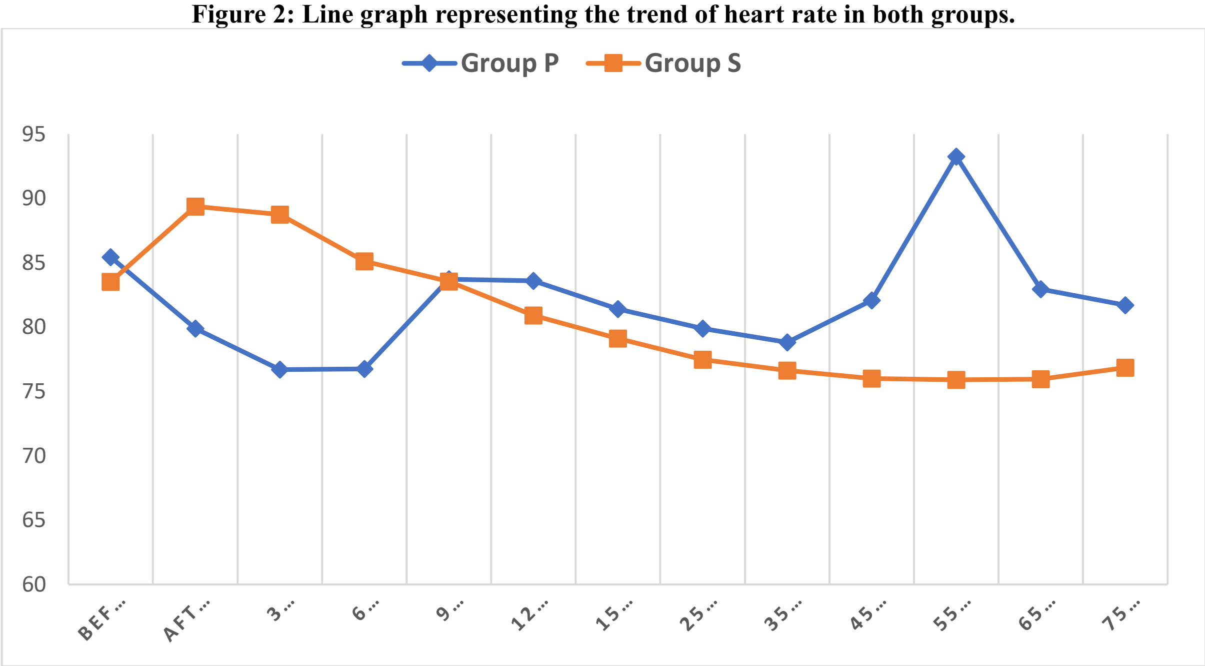


Figure 3: Line graph representing the trend of systolic blood pressure in both groups.

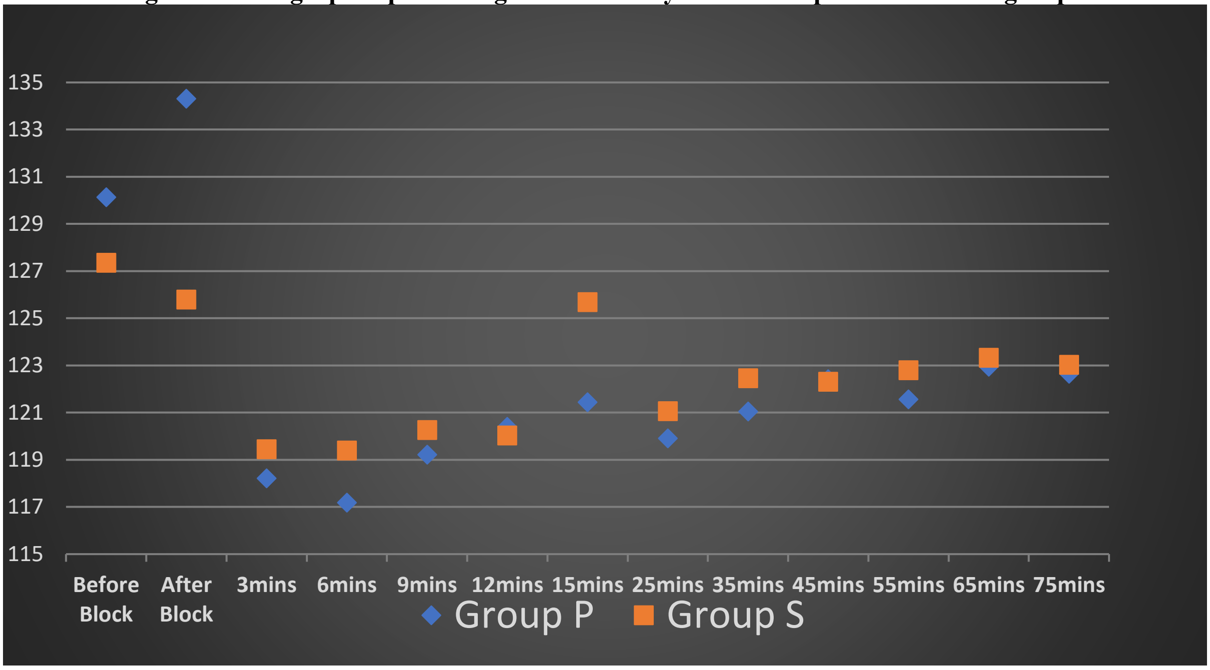


Figure 4: Line graph representing the trend of diastolic blood pressure in both groups.

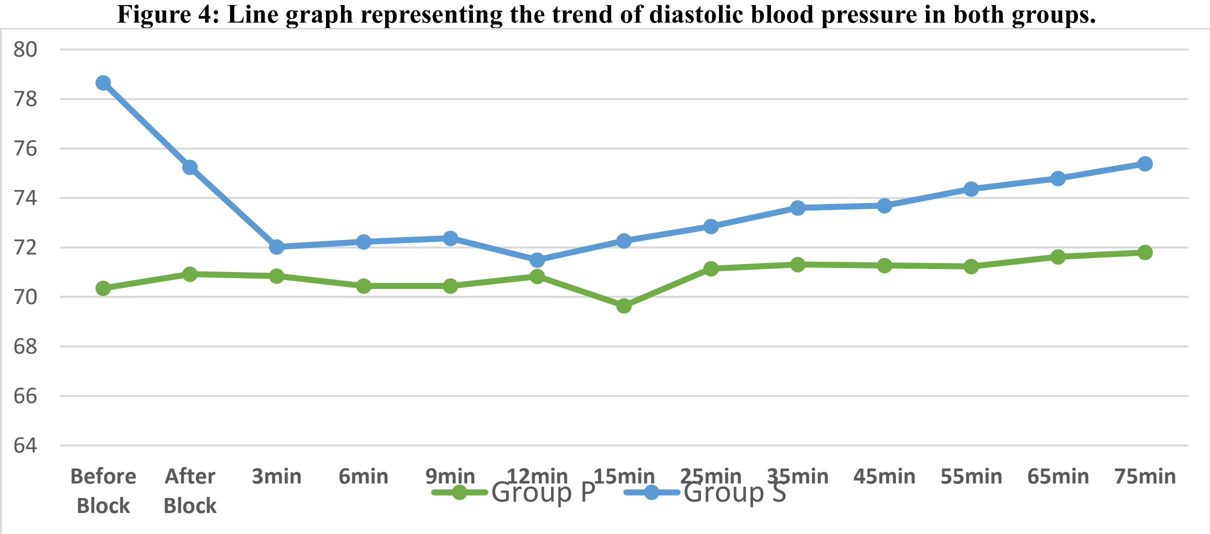


Figure 5: Line graph representing the trend of mean arterial pressure in both groups.

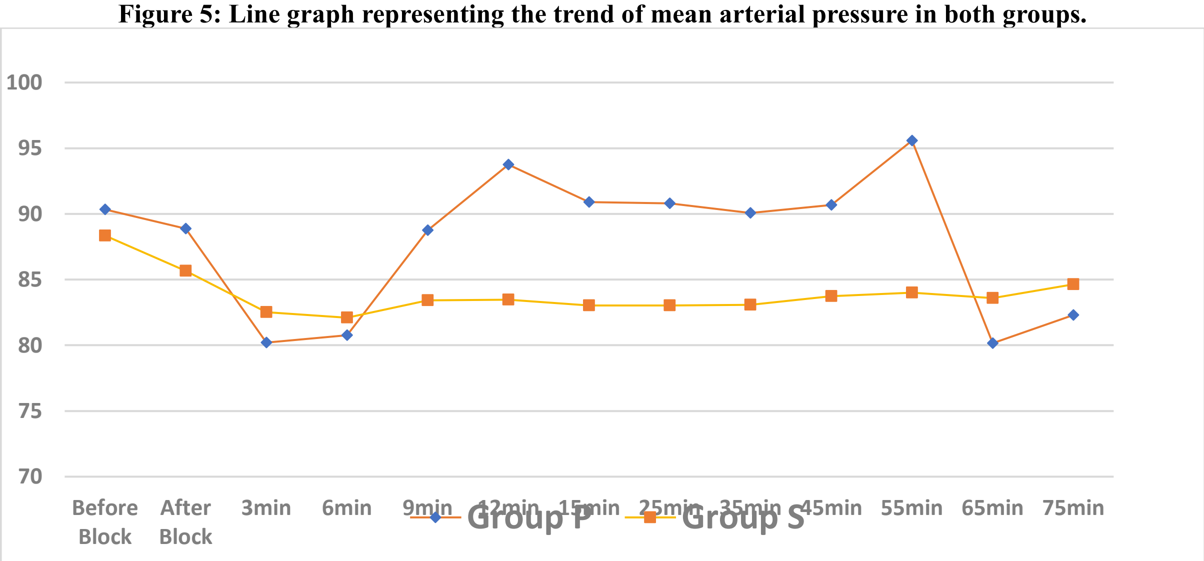


Figure 6: Bar graph representing the Numerical Rating Scale pain scores at various postoperative intervals.

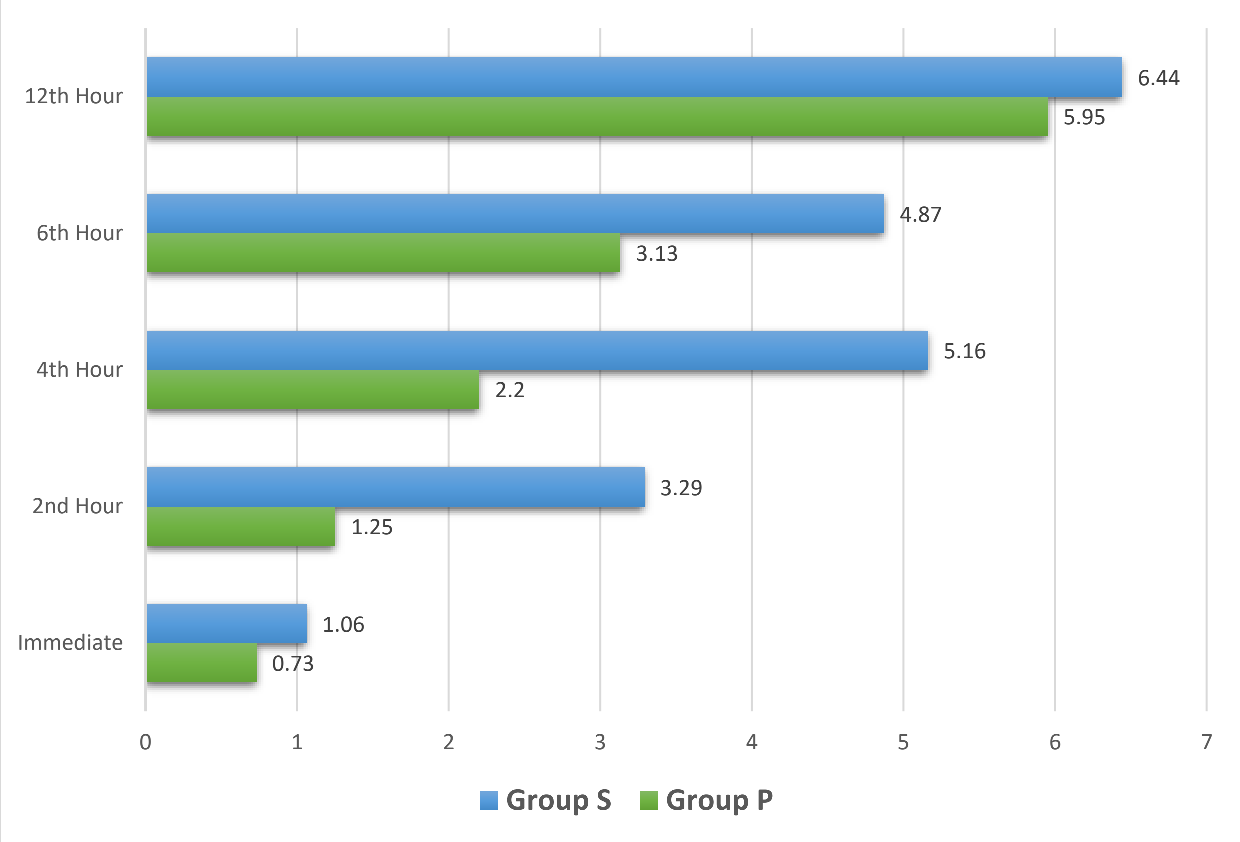
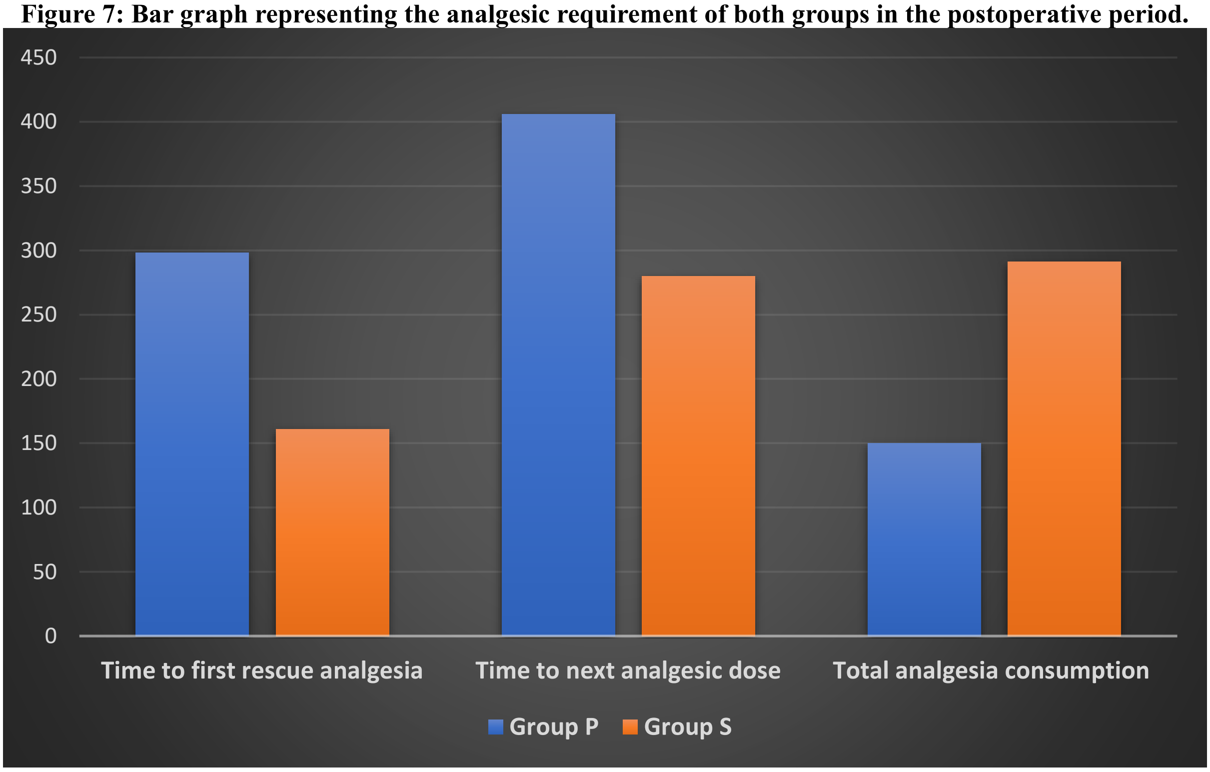


Figure 7: Bar graph representing the analgesic requirement of both groups in the postoperative period.



DISCUSSION

In this prospective randomised study, unilateral thoracolumbar PVB provided better intraoperative haemodynamic stability, prolonged postoperative analgesia, and minimal motor blockade compared with unilateral SA in patients undergoing infraumbilical (inguinal hernia repair) surgery, consistent with its established role as a safe alternative anaesthetic and analgesic technique for this indication.[1,3,5,6]

Inguinal hernia repair is commonly performed as day-care surgery, which demands rapid recovery with satisfactory analgesia and minimal side effects such as PONV.[16,17] Choice of anaesthetic technique for such surgery is guided by pain control, cost-effectiveness, level of postoperative surveillance and nursing care, and the risk of adverse effects.[18,19] While general anaesthesia and SA remain the predominant techniques used for infraumbilical surgery, PVB has increasingly been used as both an anaesthetic and analgesic technique for hernia repair.[23,24]

We found that mean arterial pressure was significantly higher, and diastolic blood pressure more stable, after PVB than after SA throughout surgery, indicating less haemodynamic derangement with PVB — consistent with its more limited sympathetic blockade compared with SA.[25,26] Because PVB does not appreciably reduce peripheral vascular resistance, blood pressure changes were more uniform, allowing safer early transfer to the recovery area.

Consistent with previous reports,[5,27] postoperative analgesia was significantly better after PVB, with lower NRS scores at 2, 4, and 6 postoperative hours and a longer time to first and subsequent rescue analgesia. This likely reflects the slower systemic absorption of local anaesthetic from the relatively less vascular paravertebral space, prolonging nerve root blockade.[1,28,29] No patient receiving PVB developed complete motor block, compared with 71% of patients receiving SA, consistent with other comparative studies showing better preservation of motor function with PVB and hence potential for earlier ambulation and bladder recovery.[3,6,29]

The technical demands of PVB were reflected in the significantly longer time required to perform the block and to achieve maximum block height, and in a clinically relevant block failure rate of 11%, for which general anaesthesia was substituted. This is consistent with reports that PVB carries a steeper learning curve and higher failure rate than SA, particularly without ultrasound guidance.[30,32] Some patients receiving PVB reported residual discomfort along the testicular margin of the operative site postoperatively, possibly reflecting incomplete coverage of the T12 dermatome by a single-level injection; other authors have suggested two- or four-segment PVB technique to improve dermatomal coverage.[33,34,35]

Adverse effects were infrequent in both groups; only 3 patients receiving SA developed PONV, and no episodes of pneumothorax, hypotension, bradycardia, or lower-limb paraesthesia occurred in either group.

This study has limitations. It was not possible to blind either the anaesthetist or the patient to the technique used, given the obvious clinical differences between PVB and SA. Two-segment sensory regression time was not recorded. As the department was in the early phase of adopting PVB, the block was performed using a landmark-guided (blind) technique in the absence of bedside ultrasound facilities, which may have contributed to the observed failure rate.

CONCLUSION

Although more technically demanding and time-consuming to perform than spinal anaesthesia, unilateral thoracolumbar paravertebral block provided superior postoperative analgesia, better intraoperative haemodynamic stability, minimal motor blockade, and fewer adverse effects in patients undergoing infraumbilical (inguinal hernia repair) surgery. It may be considered a safe and effective alternative to spinal anaesthesia in this setting, particularly where prolonged postoperative analgesia and early ambulation are priorities.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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