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Paravertebral block versus unilateral spinal anesthesia for inguinal hernia repair - A comparative clinical trial

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ABSTRACT

Background: Inguinal hernia repair can be performed under satisfactory anesthetic conditions using general, regional, and peripheral nerve block anesthesia. **Aims and Objectives:** The aim of this study is to evaluate whether two-segment paravertebral block (PVB) can sustain as a viable alternative to unilateral spinal anesthesia (SA) as well by comparing the time to ambulation (primary outcome), duration of post-operative analgesia, and incidence of adverse events. **Materials and Methods:** We carried our study in 60 male patients, of the American Society of Anesthesiologists physical status I and II, aged 18–65 years, scheduled for a unilateral inguinal hernia repair procedure. The patients were divided randomly into two groups of 30 each. Experienced anesthesiologist gave unilateral SA and PVB, and the outcome measures of this study recorded were time to ambulation, time to first analgesic (duration of post-operative analgesia), total rescue analgesic consumption in the first 24-h period, and incidence of adverse events. **Results:** Demographic characteristics in both the groups were comparable. The time to ambulation in unilateral SA was significantly more prolonged ($P < 0.001$) than PVB. The time to the first analgesic in Group-P was significantly longer than PVB. Total rescue analgesic (IV tramadol) consumption in the first 24 h was significantly lower ($P < 0.05$) in Group-P in comparison to Group-S. Adverse events were fewer but not significant in Group-P than in Group-S. **Conclusion:** Two-segment PVB is a safe alternative to spinal anesthesia in unilateral inguinal hernia.

Key words: Early ambulation, inguinal hernia repair, paravertebral block, spinal anesthesia

INTRODUCTION

Inguinal herniorrhaphy is most commonly performed surgical procedure in males, and there is increasing trend of performing this surgery on day care basis emphasizing early ambulation. Inguinal hernia repair can be performed under satisfactory anesthetic conditions using general, regional, and peripheral nerve block anesthesia. Unilateral spinal anesthesia (unilateral spinal anesthesia [SA]) is widely used nowadays as it provides intense sensory and motor blockade. It provides optimal anesthesia, with stable hemodynamics and minimal adverse events.[1]

The concept of paravertebral block (PVB) pioneered by Hugo Selheim of Leipzig in 1905 provides unilateral anesthesia and low degree of post-operative analgesia requirement and less post-operative nausea vomiting (PONV). It has been administered for unilateral procedures such as thoracotomy, breast surgery, chest wall trauma, hernia repair or renal surgery, and cholecystectomy. It has been used with success, both as anesthetic and analgesic techniques, for inguinal herniorrhaphy. It provides an analgesia equivalent to extensive peripheral nerve block for inguinal herniorrhaphy, offering an alternative method of post-operative pain management with fewer adverse events. It has been found to be more advantageous than conventional spinal anesthesia for inguinal hernia repair, in terms of early ambulation and better post-operative pain scores. It being segmental in nature, can be expected to produce some advantages regarding hemodynamic stability and early ambulation, and may be a viable alternative.[2-4]

We carried out this study to evaluate whether two-segment PVB can sustain as a viable alternative to unilateral SA as well, by comparing the time to ambulation (primary outcome), duration of post-operative analgesia, and incidence of adverse events.

MATERIALS AND METHODS

We carried our study in 60 male patients, of the American Society of Anesthesiologists (ASA) physical status I and II, aged 18–65 years, scheduled for a unilateral inguinal hernia repair procedure. The study period was between January 2016 and May 2017 and was carried out after obtaining the institutional ethical committee approval. Consent was obtained from all the patients. Initially, 100 patients were enrolled in the study. 40 patients were excluded as they did not meet the inclusion criteria. 60 patients were divided randomly into two groups of 30 each [Figure 1]. We followed the methodology used by Mandal *et al.*[1]

Inclusion Criteria

The following criteria were included in the study:

1. Patients undergoing unilateral inguinal hernia repair procedure,
2. Patients above 18 years of age.

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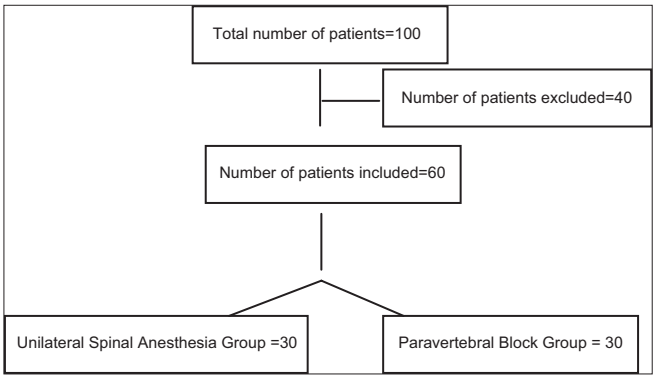

Figure 1: Flow diagram showing patient selection and randomization. Group S patients ($n = 30$) were administered unilateral spinal anesthesia and Group P patients ($n = 30$) received paravertebral block

Exclusion Criteria

The following criteria were excluded from the study:

1. Patients' refusal,
2. Morbid obesity,
3. Coagulopathy and significant cardiovascular, respiratory, renal, hepatic or metabolic disease,
4. Patients with a history of substance abuse, mental dysfunction, active gastrointestinal reflux, chronic analgesic use, and allergy to local anesthetics.

The study was an experimental double-blinded randomized controlled study. Patients were randomized, following a sealed envelope method, to receive either a PVB (Group-P) or unilateral spinal anesthesia (Group-S). Intra- and post-operative data were recorded by residents not participating in the study.

Blocks were performed by anesthesiologist experienced in the technique, with the patient in sitting position with adequate hemodynamic monitoring such as pulse oximeter, electrocardiogram, and blood pressure monitor. All resuscitation equipment was available by the side of the patient.

All the patients received IV midazolam before block placement to decrease anxiety and discomfort during the procedure while maintaining a meaningful patient contact. The unilateral PVB was performed in a sitting position. With aseptic precautions, a point, 3 cm lateral to the cephalad aspect of spinous processes of T10 and L1 vertebrae was marked. This point corresponded to the transverse process of the vertebra below in case of T10 and the caudad edge of the homologous transverse processes of L1. Local infiltration with lignocaine (1%) was given at this point. A Tuohy needle (18G) was inserted perpendicular to the skin in all planes to contact the respective transverse processes (usually at a depth of about 2–4 cm in the thoracic region and 5–8 cm in the lumbar region). The needle was then withdrawn a bit and walked off the transverse process by redirecting the needle to the cephalad in case of thoracic PVB and caudad in case of lumbar PVB. The needle was angled slightly medially. At a depth of 1–2 cm from the transverse process, a "loss of resistance" to normal saline was felt. After negative aspiration of blood and cerebrospinal fluid, 15 ml of bupivacaine (0.5%) at T10 and 5 ml of bupivacaine (0.5%) at L1 were injected slowly. After the block, the patients were repositioned to a supine position.

The patients in Group S were preloaded with 10 ml/kg of RL. With aseptic precautions, unilateral SA was performed using the midline approach with a 27-G Whitacre needle at the L3-4 or L2-3 intervertebral space in the lateral decubitus position, with the operation side dependent. The subarachnoid injection contained 8 mg of hyperbaric bupivacaine (5 mg/ml). The patients were then maintained in the same position for 15 min. At the end of the procedure, the patients of both groups received similar dressings extending from T9 to L4. The observer had access to the patients only after the dressings were applied at the end of the block procedure.

In both the groups, we assessed the onset of unilateral pin prick discrimination at 5 min and every 5 min, thereafter, up to 30 min. The absence of onset of pinprick discrimination within 15 min was taken as a "block failure."

We considered PVB as the "successful" one if the following criteria were met:

i. Onset of loss of pinprick discrimination started within 15 min,
ii. Sensory block (T10-L2) was achieved within a maximum time of 30 min.

Successful unilateral spinal anesthesia was defined as surgical anesthesia (loss of pinprick sensation at L1 and complete motor block) on the dependent side only, while the non-dependent side maintained somatic sensibility to the pin prick test at L1 and motor block lesser than the first degree. A peak level of sensory block was noted.

The motor block was evaluated using the modified Bromage scale,[5] measured at the peak of sensory block [Table 1].

After surgery, the patients were transferred either to the recovery room or directly to the ward under strict monitoring. The senior anesthesiologist supervising all cases made this decision of triaging the patients. The eligibility criterion to bypass the recovery room was a modified Aldrete's score of ≥9.[6]

Postoperatively, the data were collected at 2, 4, 6, 12, and 24 h by recovery room residents, not involved in the study. They were blinded to the anesthetic technique due to the presence of identical dressings and a formal request of not-to-ask any question regarding patient's experience about the block.

The outcome measures of this study were as follows:

1. Time to ambulation,
2. Time to first analgesic (duration of post-operative analgesia),
3. Total rescue analgesic consumption in the first 24-h period and
4. Incidence of adverse events.

Post-operative pain was assessed with the visual analog scale (VAS) score of 0–10 (0 = no pain and 10 = worst imaginable pain).

The data were analyzed by SPSS for Windows (version 17) statistical package (SPSS Inc., Chicago, IL). The data were expressed as mean ± standard deviation (SD). Discrete categorical data were presented as n (%); continuous data were given as mean±SD. Differences in demographic, surgical, anesthetic, and post-operative data were tested by independent Student's *t*-test (continuous data), Pearson Chi-square test, or Fisher's exact

test, as appropriate (categorical data). A $P < 0.05$ was considered as statistically significant. The data were analyzed by SPSS for Windows (version 17) statistical package (SPSS Inc., Chicago, IL).

RESULTS

Demographic characteristics (age, weight, height, and ASA class), pre-operative vital parameters, and intraoperative vitals were comparable in both groups. Intraoperative propofol consumption was higher ($P < 0.001$) in Group P. There was no significant difference in the duration of surgery and duration in the operation room among the groups. Time to perform block ($P < 0.001$) and time to surgical anesthesia ($P < 0.05$) were significantly greater in Group-P as compared to Group-S [Table 2].

Our other findings were as follows:

1. The time to ambulation in unilateral SA with 8 mg hyperbaric bupivacaine (316 ± 33 min) was significantly more prolonged ($P < 0.001$) than PVB (231 ± 93 min).
2. The time to the first analgesic in Group-P (341 ± 66 min) was significantly longer ($P < 0.001$) than Group S (209 ± 18 min).
3. Sensory block was also found to be greater ($P < 0.001$) with PVB (476 ± 92 min) than with unilateral SA (239±28 min).
4. The total analgesic requirement was significantly lower in Group-P ($P < 0.05$) than in Group-S in the first 24 h postoperatively.
5. There was a significant difference in VAS scores between the two groups. It was the lowest at 2 h in both groups. The VAS scores were highest at 6 h in group-P and at 4 h in group-S.
6. Total rescue analgesic (IV tramadol) consumption in the first 24 h was significantly lower ($P < 0.05$) in group-P in comparison to Group-S, 118 ± 51 mg versus 165±39 mg, respectively.
7. Adverse events were fewer but not significant in Group-P than in Group-S. Four patients (12.5%) in group-S and three patients (10%) in the group-P experienced episodes of post-operative nausea and vomiting (PONV) and were treated with IV ondansetron (4 mg).
8. Recovery room bypass was achieved in 12 patients (40%) in group-P ($P < 0.001$) compared to none in the group-S.
9. In group-P, no patient required urinary catheterization, whereas three patients (10%) in the group-S required it [Table 4].

Table 1: Bromage score (3/2/1/0)

Grade	Criteria	Degree of block
0	Free movement of legs and feet	Nil (0%)
1	Just able to flex knees with free movement of feet	Partial (33%)
2	Unable to flex knees, but with free movement of feet	Almost complete (66%)
3	Unable to move legs or feet	Complete (100%)

Table 2: Demographic profile, baseline, and intraoperative vital parameters

Parameter	Group P (n=30)	Group S (n=30)	P
Age (years)	50.5±5.8	48.4±9.7	NS (0.3130)
Weight (kg)	59.8±5.1	61.5±5.8	NS (0.2329)
Height (cm)	163.3±8.1	162.3±6.7	NS (0.9179)
Asa i/ii (%)	21/9 (70/30)	18/12 (60/40)	NS (0.2778)
Pre-operative pulse (bpm)	77.9±8.2	73.3±6.9	S (0.0221)*
Pre-operative map (mmHg)	99±1	99±1	NS (1.000)
Pre-operative spo2 (%)	73±8	74±9	NS (0.6509)
Iv fluids (ml)	936±139	957±148	NS (0.5732)
Ephedrine requirement (boluses of 6 mg)$	0	2	NS
Propofol (mg)	129±28	96±19	<0.001*

*Significant (P<0.05): $Pearson Chi-square test used, results are presented as a number of patients. For others, Student's independent sample t-test used, results are presented as mean±SD. Group P, paravertebral group; Group S, unilateral spinal group, SD: Standard deviation, NS: Non-significant

DISCUSSION

PVB block is used as anesthesia for surgical procedures such as breast surgery, thoracotomy, inguinal hernia repair, and renal surgery predominantly in unilateral procedures as well in chest trauma (rib fracture) for analgesia. PVB can also be used for surgical anesthesia in patients with serious comorbidites such as chest infection, and bronchial asthma who could not tolerate general anesthesia or neuraxial blocks.[7]

In case of inguinal hernia surgery which is predominantly done under central-neuraxial anesthesia, PVB, which has segmental block, offers an attractive alternative in terms of better

Table 3: Block characteristics and OR duration

Parameter	Group P (n=30)	Group S (n=30)	P
Time to perform block (min)	10.3±1.9	7.2±1.5	<0.001*
Time to surgical anesthesia (min)	18±7	9±6	<0.001*
Duration of surgery (min)	62±15	62±13	NS (1.000)
Duration in OR (min)	91±15	87±12	NS (0.2588)
Bromage scores (3/2/1/0)$	0/12/8/2	24/0/0/0	<0.001*

*Significant (P<0.05): $Pearson Chi-square test used, results are presented as a number of patients. For others, Student's independent sample t-test used, results are presented as mean±SD. Group P, paravertebral group; group S, unilateral spinal group; OR, operating room. SD: Standard deviation, NS: Non-significant

Table 4: Recovery times and adverse events

Parameter	Group P (n=30)	Group S (n=30)	P
Time to ambulation (min)	231±93	316±33	<0.001*
Time to first analgesic (min)	341±66	209±18	<0.001*
Time to complete sensory regression (min)	476±92	239±28	<0.001*
Total rescue analgesics (tramadol in mg)	118±51	165±39	<0.005*
Patients experiencing PONV (%)	3 (10)	4 (12.5)	NS
Urinary catheterization	0	3 (10)	NS
Recovery room bypass (%)	12 (40)	0	<0.001*

*Significant (P<0.05): $Pearson Chi-square test used. For others, Student's independent sample t-test used. Results are presented as mean±SD, number of patients (%), total amount (mg). Group P, paravertebral group; Group S, unilateral spinal group; Figures in parenthesis are in percentage; PONV: Post-operative nausea and vomiting, SD: Standard deviation, NS: Non-significant

hemodynamic control, prolonged post-operative analgesia, and decreasing complications such as PONV, urinary retention, and delayed ambulation.[8]

PVB is considered to be a viable alternative in old-aged patients with comorbid condition. However, it has some disadvantages like learning curve required, the possibility of block failure and longer time required to perform the block, chances of pneumothorax, and inadvertent intravascular injection.[9]

In our study, two-segment PVB for inguinal hernia repair was found to be a viable alternative to unilateral SA in achieving shorter time to ambulation and longer post-operative analgesia, with minimal adverse events. The time to ambulation was shorter in group-P as compared to that in group-S ($P < 0.001$). This finding is in accordance with Mandal *et al.*, Aswin and Suresh, and Nikam *et al.*[1,2,10] This might be due to the fact that early ambulation being possible in group-P in spite of the persisting sensory block as it was segmental in nature. This persisting block provided prolonged pain relief even when the patient had started ambulating. In group-S, due to the non-segmental nature of block, the patient enjoyed pain relief only for a brief period after starting ambulation.

Poor recovery room bypass was found in Group-S, probably due to a higher grade of motor block ($P < 0.001$). This is in accordance with the study of Mandal *et al.*[1]

The sensory block persisted longer ($P < 0.001$) with PVB than with unilateral SA. This reduced the rescue analgesic consumption in patients of Group-P. This is similar with the finding of Ozkan *et al.* and Mandal *et al.*[1,11] Prolonged duration of analgesia could be explained by the comparatively less vascularity of the paravertebral space and greater volume of LA.

Intraoperative propofol consumption was higher in group-P. This is similar to the findings of Mandal *et al.* and Aswin and Suresh.[1,10] The slower onset of block and less magnitude of deafferentiation (segmental block) might be the cause.

Both single and multiple PVB injections were used for open inguinal hernia repair. Saito *et al.* showed that local anesthetic injected in the ventral area of the lower thoracic paravertebral space, at the T11 level, resulted in an extended unilateral block, not just confined to the intercostal nerves, but also involved the lumbar dermatomes. They favored the single-injection, multi-segmental, PVB, as an acceptable one, instead of multiple insertions of a needle. Although multiple-segment PVB injections provided very good anesthetic condition in a short time, they were not comfortable for patients and also increased the chances of pleural puncture and pneumothorax.[12]

Lönnqvist and Hildingsson reported that the psoas muscle interrupted the paravertebral space at the level of T12. With this idea, in the present study, we used 2-segment PVB at the T10 and L1 levels, to increase the patient's comfort and success rate and to decrease the adverse events. This also reduced the time to perform the block.[13]

To the best of our knowledge, very few studies (three) compared PVB with unilateral SA, drawing an impression that both techniques are useful, with minimal adverse effects. Our study has also observed a shorter home readiness time, long-lasting post-operative analgesia, and improved quality of recovery, indicating that PVB can be a safe alternative to unilateral SA.

Limitations of PVB are that the technique is time-consuming, rarely practised, chances of pneumothorax, and inadvertent intravascular injection of LA, which increases with the number of injections.[14,15]

Better hemodynamic control in the unilateral SA had reduced the incidence of PONV, comparable with PVB. The block failure rates were comparable in both the groups (Group P = 18.3%: Group S = 16.7%). This failure rate in group-P was higher than the findings of Mandal *et al.* who found a failure rate of 15.4% and 14.3% in Group P and S, respectively.[1] However, the failure rate was comparable with Coveney *et al.*[16] A possible explanation of such a finding could be relative inexperience with the paravertebral technique and the inconsistent nature of the block, especially without any nerve stimulation or ultrasonic guidance. In case of the spinal technique, higher failure rates could be attributed to the use of a finer (27-G) pencil-point needle and strict criteria for successful unilateral SA in the present study.

The small study population limited us to draw a conclusion about failure rate and complications precisely. Moreover, we were in the initial phase of practising the PVB procedure. Despite achieving satisfactory time to ambulation, we could not perform an inguinal hernia repair on an ambulatory basis, as it largely depended on infrastructural support.

CONCLUSION

From our study, we found two-segment PVB as a safe alternative to spinal anesthesia in unilateral inguinal hernia. Its advantages are shorter time to ambulation and longer post-operative analgesia, with minimal adverse events. An anesthesiologist who is well-conversant with the paramedian epidural block can easily learn PBV. PVB should be practised under the supervision of experts so that this technique can be revived well for ambulatory surgery.

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