Original Article

Novel use of erector spinae plane block in laparoscopic surgery

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ABSTRACT

Background and Aims: Thoracic epidural and paravertebral blocks are gold standard analgesic techniques but they are associated with complications. Erector spinae plane (ESP) block is safer with comparable pain relief. ESP block is an established technique for postoperative pain relief. Its intraoperative use as an adjuvant to general anaesthesia (GA) is not yet known. The aim of this study was to assess the efficacy of ESP as an adjuvant to GA during laparoscopic surgery. **Methods:** This was a randomised controlled trial. Using a computer generated random number table, 50 patients were randomly allocated into two groups. Group G (n = 25) received GA and group GE (n = 25) received bilateral ESP (ultrasonography guided) block using 20 ml of 0.25% bupivacaine at the level of the transverse process of T6 before the induction of GA. **Results:** Group GE showed reduced requirement of fentanyl ($P < 0.0001$) and inhalational agents ($P < 0.0001$) with significant reduction in systolic blood pressure ($P < 0.0001$), diastolic blood pressure ($P < 0.0001$) and mean heart rate as compared to group G. **Conclusion:** ESP block is an easy, safe, excellent adjuvant to GA which reduces the requirement of analgesics and inhalational agents.

Key words: Epidural analgesia, erector spinae plane block, laparoscopy, ultrasound

INTRODUCTION

Haemodynamic changes during laparoscopic surgery are attributed to the induction of pneumoperitoneum. Cases are conventionally managed with general anaesthesia (GA), supplemented by epidural or paravertebral blocks. Complicated laparoscopic surgeries require modification in the existing anaesthetic techniques.[1] The ideal anaesthetic technique for laparoscopic surgery should maintain stable haemodynamics, provide rapid recovery, be associated with minimal nausea, vomiting and adequate analgesia postoperatively.

Erector spinae plane (ESP) block is a novel regional technique, described by Forero *et al*. for thoracic neuropathic pain.[2] It is a paraspinal interfascial plane technique with potential applications. ESP block is beneficial in managing acute and chronic pain, and is an established technique for postoperative pain relief.[3] Nevertheless, its use intraoperatively as an adjuvant is not much known. Thoracic epidural and paravertebral blocks are well-established analgesic techniques, but are associated with complications like pneumothorax, vascular puncture, nerve damage, etc.[4] On the contrary, ESP block has a better safety profile and comparable pain relief. As the site of injection is distant from the pleura, major blood vessels and the spinal cord, ESP block has relatively few complications. ESP block has analgesic effect on somatic and visceral pain by blocking the dorsal and ventral rami. Additionally, sympatholysis is achieved by its effect on the rami communicantes that include sympathetic nerve fibres, as the local anaesthetic (LA) spreads through the paravertebral space. Bilateral ESP

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block has been reported to be as effective as thoracic epidural analgesia.[5] As the LA widely spreads cranially and caudally in ESP block,[6-8] we hypothesised that along with analgesic activity, ESP block can be used to obtund the haemodynamic response to pneumoperitoneum, due to its sympatholytic activity.

The aim of this study was to assess the efficacy of ESP block as an adjuvant to GA during laparoscopic surgeries. The primary objective was to assess the intraoperative haemodynamic response. The secondary objectives were to assess the intraoperative analgesic and inhalational agent requirements and adverse effects of the procedure, if any.

METHODS

After institutional ethics committee approval (IESC/FP/2020/24) and registration of the study in the Clinical Trials Registry of India (CTRI) (2021/09/036754), this prospective, randomised controlled trial was conducted in a tertiary care hospital over a period of six months. The study was done in accordance with the principles of the Declaration of Helsinki.

Patients between 18 and 60 years of age, with American Society of Anesthesiologists (ASA) physical status I and II, undergoing laparoscopic surgeries (appendicectomy, cholecystectomy, hernia repair and diagnostic gynaecological surgery including hysterectomy) with an expected duration of less than 2.5 hours were included in the study. Patients who refused participation, and those with history of significant systemic ailments or undergoing emergency surgeries were excluded.

We enroled 50 patients. They were randomised into two groups of 25 each using a computer generated balanced allocation table. Group GE received GA with ESP block; group G received GA.

Preoperative evaluation was done, informed consent was taken and baseline vitals were recorded. With the patient in the sitting position, a preliminary ultrasound scan was done to define and mark the required thoracic level (T6-T7), bilaterally. Under all aseptic precautions, 2-3 ml of 2% lidocaine skin infiltration was given at the site of block. Using a high frequency linear probe, scan was done from lateral to medial side in a sagittal view and the landmarks including the transverse process at T6 level and the three layers of muscles arranged from posterior to anterior (trapezius-rhomboid-erector spinae) were identified. A 90 mm 22 gauge spinal needle was advanced in a cephalad to caudad direction using an in-plane needling technique, aiming towards the tip of the transverse process. After gentle contact with the T6 transverse process, with good needle visualisation and after recurrent aspiration, 20 ml of bupivacaine (0.25%) was administered on each side. Spread of drug anterior to erector spinae muscles was noted (elevating erector spinae muscles from transverse process with a good caudal and cephalic spread). The patient was made supine and after preoxygenation with 100% oxygen, GA was administered with intravenous (IV) fentanyl 2 μg/kg and propofol 2 mg/kg. Atracurium 0.5 mg/kg was given and endotracheal intubation was done. Patient was maintained with isoflurane in oxygen and air mixture (50%), titrated according to the blood pressure (BP) between 0.5 and 1.5% with a fresh gas flow of 4 L/min and top-up doses of injection atracurium. If heart rate (HR) or mean arterial pressure exceeded 20% of baseline, IV fentanyl 0.5 μg/kg was given, isoflurane dial setting was increased in a standard sequence of 0.2% and the total requirement of both was recorded. HR and BP were recorded every 15 min from the insertion of laparoscopic ports till the end of surgery. Neuromuscular reversal (0.05 mg/kg neostigmine, 0.004 mg/kg glycopyrrolate) was administered and trachea was extubated after the patient had regained adequate tone and reflexes.

The sample size was calculated assuming an effect size for systolic blood pressure (SBP) of 0.8 between the groups, alpha error 0.05 and power of 80%. The calculated sample size was 48 (using G POWER software version 3.1.9.4). However, we enroled 50 patients (25 in each group) with block randomisation technique to compensate for attrition. Allocation concealment was done by keeping the random allocation number enclosed in a sealed opaque envelope. The envelope was opened by an anaesthesiologist not involved in the study. The drug preparation was done by the anaesthesiologist who was involved in administration of anaesthesia and patient care. Monitoring and data collection was done by another doctor not involved in drug administration.

MedCalc® statistical software version 20.013 (MedCalc Software Ltd, Ostend, Belgium) was used for statistical analysis. Quantitative data was analysed by independent Student's 't' test. Final interpretation was done using 'Z' test (standard normal variant) with 95% significance. Qualitative analysis was done by Chi-square test.

RESULTS

During the study period, 50 patients were enroled and included in the study. None of the patients were excluded during the study period; 50 patients were included in the final data analysis [Figure 1].

Patients in both the groups did not show statistically significant differences in their age (P = 0.1884), gender (P = 0.175), weight distribution (P = 0.8053) and ASA physical status (P = 0.34). The duration of surgery was comparable in both the groups (P = 0.3256).

Reduction in HR in the GE group was not statistically significant at 15 minutes (P = 0.1822), but later there was a progressive downsloping of HR which was statistically significant. (Baseline mean HR: GE group – 74.76/min, standard deviation (SD) 6.6913; G group – 76.2 beats/min, SD – 7.3699, P = 0.4923, not significant; HR at the end of surgery: GE group –76.6 beats/min, SD – 6.1577; G group – 82.48 beats/min, SD – 7.7035, P = 0.0004 (significant)). However, HR was higher than baseline in both groups during the first 15 min [Table 1].

Differences in SBP and diastolic blood pressure (DBP) at baseline and at pneumoperitoneum between both groups were statistically insignificant. But there was a remarkable reduction in SBP and DBP in GE group with statistical significance at 15, 30, 45 min, 1 h and at the end of surgery with $P < 0.0001$ [Figure 2; Table 2]. Fentanyl requirement was significantly low in group GE with $P < 0.0001$ [Figure 3]. Isoflurane requirement in group G was nearly twice than in group GE, with $P < 0.0001$ [Figure 4].

DISCUSSION

In this study, ESP block with GA showed a significant reduction in the requirement of analgesic and inhalational agents and offered better haemodynamic control compared to GA alone. ESP block has been shown to provide complete surgical anaesthesia for

Table 1: Mean heart rate (beats/min)

Heart rate (beats/min)	GE		G		*P*
	Mean	SD	Mean	SD	
Baseline	74.76	6.6913	76.2	7.3699	0.4923
At pneumoperitoneum	87.56	7.5943	90.72	8.8625	0.1822
15 min	84.12	7.474	88.64	5.9223	0.0218
30 min	79.88	7.623	88.72	5.712	0.0001
45 min	78.8	6.1577	88.96	4.8087	0.0001
1 hour	77.08	7.0252	84.52	4.1041	0.0001
End of surgery	76.6	5.9161	82.48	7.7035	0.004

P<0.05 is significant, Independent Student's "*t*" test, was applied. GE: General anaesthesia + Erector spinae plane block, G: General anaesthesia. SD: Standard deviation

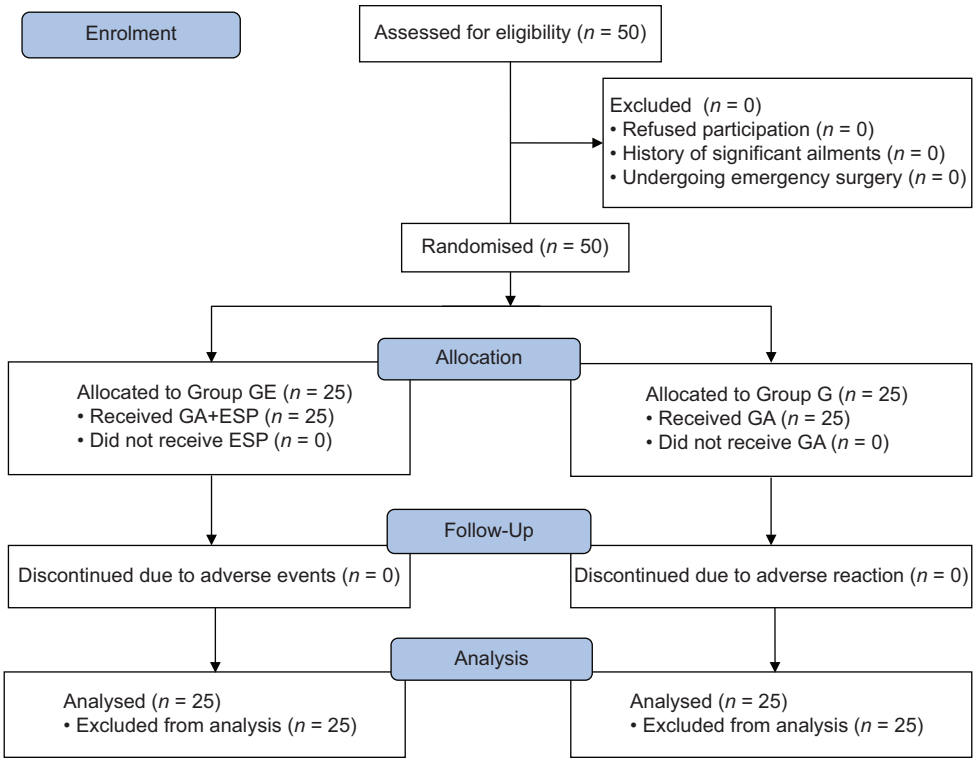

Figure 1: Consolidated standards of reporting trials (CONSORT) flow diagram. GA – General anaesthesia; ESP: Erector spinae plane block; n: number

Table 2: Systolic and diastolic blood pressure (mmHg)

Time	Mean SBP (mmHg)			Mean DBP (mmHg)		
	GE	G	*P*	GE	G	*P*
Baseline	128.12±8.477	127.32±6.5366	0.71	84.04±8.6626	83.48±7.06	0.8032
At pneumoperitoneum	110.04±7.547	113.88±8.0897	0.0887	73.4±8.7702	74.12±7.2072	0.7524
15 min	110.88±6.4376	127.84±8.5082	<0.0001	72.88±8.0225	84.72±9.3252	<0.0001
30 min	109.52±4.2438	125.4±5.4237	0.0001	72.4±6.8557	83.56±6.4941	0.0001
45 min	108.8±3.8079	125.56±6.1446	0.0001	69.88±5.2545	82.76±8.0275	0.0001
1 hour	107.72±5.1358	124.04±5.5564	0.0001	67.72±5.2402	82.04±8.2587	0.0001
End of surgery	107.48±6.0904	123.4±6.2048	0.0001	69.88±5.2545	82.76±8.0275	0.0001

Data is represented as mean±standard deviation and compared with independent Student's "t" test, *P*<0.05 is significant, GE: General anaesthesia + Erector spinae plane block, G: General anaesthesia, SBP: Systolic blood pressure, DBP: Diastolic blood pressure

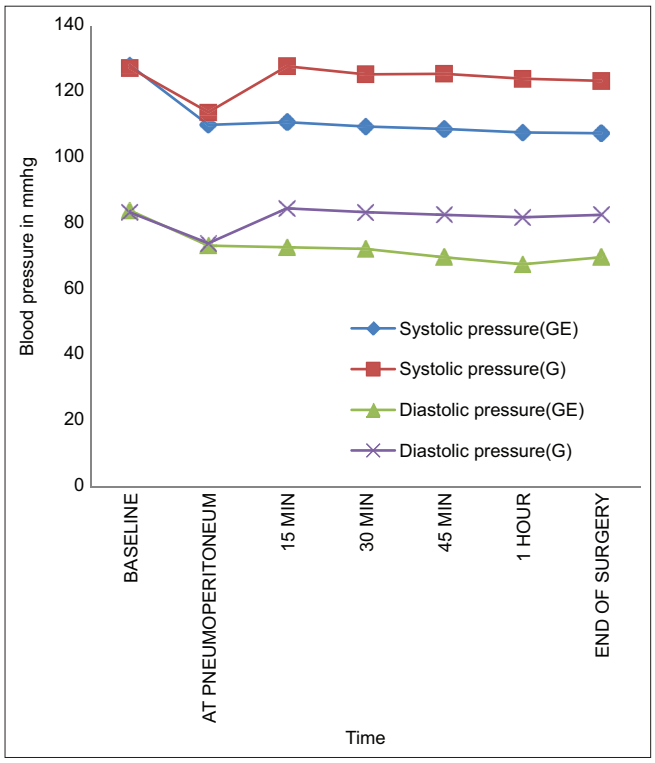

Figure 2: Mean systolic and diastolic blood pressure (mmHg) GE – General anaesthesia + Erector spinae plane block, G – General anaesthesia

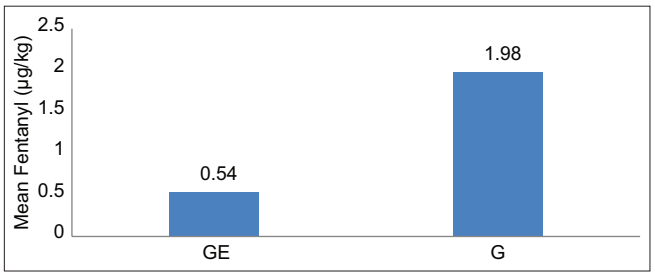

Figure 3: Intraoperative fentanyl requirement (µg/kg). GE – (General anaesthesia + Erector spinae plane block), G – General anaesthesia

breast surgeries.[9] It has also been used as part of multimodal analgesia in lumbosacral spine surgeries and as a postoperative opioid-sparing technique following laparoscopic surgery.[10,11]

Laparoscopic surgeries have significant haemodynamic changes attributed to the induction of pneumoperitoneum. Increased intra-abdominal pressure and hypercarbia are the main challenges to combat during laparoscopic surgery. Increased intra-abdominal pressure causes a gross increase in systolic, diastolic and mean arterial pressures. Conventionally, anaesthesiologists use thoracic epidural or paravertebral block to attenuate the haemodynamic changes during laparoscopic surgery, and these require expertise, are expensive and not advisable in coagulopathy.[12,13] It may also be associated with complications like inadvertent dural puncture, pleural puncture, pneumothorax, vascular puncture, nerve damage, catheter breakage or catheter site infection, etc.[14] In such a scenario, the anaesthesiologist finds the need for a less expensive, less invasive technique to achieve the effects similar to thoracic epidural.

Bilateral ESP block has become a favoured and ideal modality for postoperative analgesia. The intraoperative usage of ESP block and its significant advantages in obtunding the haemodynamic response, has not been explored. There is a paucity of literature in this area. Our study pioneers the intraoperative use of ESP block to produce stable haemodynamics during laparoscopic surgeries. It is based on cadaveric studies by Diwan S. *et al*.[15] and the hypothesis that the LA spreads along the ventral and dorsal rami of spinal nerves causing sympathetic blockade which attenuates the pressor response.

In cadaveric studies, bilateral ESP block showed extensive spread of LA from T1 to T11 with involvement of epidural, neural foraminal and intercostal spread when injected at the level of T6. It anaesthetises the spinal nerves by spreading through the costotransverse foramen of Cruveilhier, accompanying the dorsal ramus and artery to the paravertebral space.[12] ESP

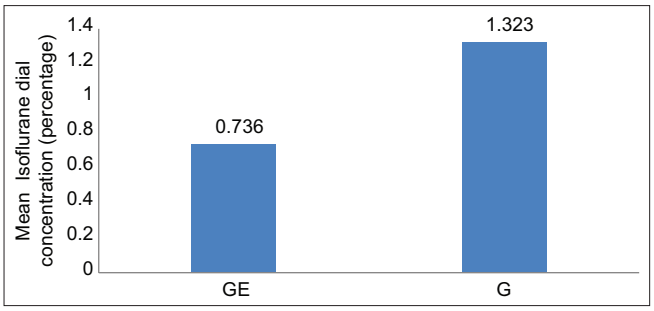

Figure 4: Isoflurane requirement (% of dial concentration)

block is a safe alternative to epidural and paravertebral block due to the usage of transverse process as a barrier to avoid injuring the pleura. Hence, complications like pneumothorax and pleural puncture are avoided.

In our study, 20 ml of 0.25% bupivacaine was deposited at T6 on each side, as this volume was shown to spread from T1 to T7 and T4 to T12 in a case report, and had provided effective analgesia.[3] The effect of this block provided remarkable haemodynamic stability and advantages. On observing the HR, we found that initially HR was higher than baseline in both groups. But the successive HR recordings showed statistically significant progressive downsloping with the block. However, throughout the procedure, the HR remained higher than the baseline values in both groups. This can be attributed to the sensitisation of the myocardium to the catecholamines produced following pneumoperitoneum.[16] SBP and DBP at the induction of pneumoperitoneum were similar in both groups but progressive recordings showed a statistically significant reduction of SBP and DBP with ESP block. This establishes the use of ESP block as an adjuvant to GA, as a novel addition to the anaesthesiologist's armamentarium for providing good analgesia, sympatholysis and lower BP during laparoscopic surgery.

In the current study, the fentanyl requirement was remarkably low with ESP block. The mean additional dose of fentanyl required was as low as 0.5 µg/kg, which grossly improved awakening and reduced opioid-related side effects. This advantage makes it a novel preferred method. Isoflurane requirement in group G was twice as compared to group GE. Intraoperative awareness was questioned immediately in the postoperative recovery room, and was absent in all our patients. Hence, by using ESP block, the requirement of inhalational agents decreased by half. No adverse effects were noted due to ESP block.

The limitations of this study are that the volume of the drug was not titrated to height, depth of anaesthesia was not monitored and agent analyser was not available. Benefits of additives to LA, and efficacy in prolonged surgeries and the postoperative period need to be assessed in future studies. To further quantify the stress response, catecholamine levels can be measured in further studies.

CONCLUSION

ESP block is a novel, safe, minimally invasive, economical and effective block which can be used as an adjuvant to GA during laparoscopic surgeries. It decreases the requirement of opioids and inhalational agents and provides adequate sympatholysis without any adverse effects.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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