

Erector spinae plane block and transversus abdominis plane block for postoperative analgesia in cesarean section: A prospective randomized comparative study

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Abstract

Background and Aims: Erector spinae plane (ESP) block is an interfascial plane block given at the paraspinal region and provides effective visceral and somatic analgesia. Transversus abdominis plane (TAP) block is also an interfascial block that provides adequate somatic pain control. We conducted this study to compare the analgesic efficacy of ESP and TAP blocks with ropivacaine for 48 h after the cesarean section.

Material and Methods: Sixty patients scheduled for elective cesarean section under spinal anesthesia, randomly divided into ESP block ($n = 30$) or TAP block ($n = 30$) groups. After completion of surgery, ultrasound-guided ESP or TAP block was given using 0.2% ropivacaine (0.2 ml/kg on either side). Postoperatively visual analogue scale (VAS) score and analgesic requirement of each patient was assessed at regular interval for 48 h by a blinded investigator. Statistical analysis was done using SPSS version 21. Student's *t*-test and Chi-square test were used for demographic and other data.

Results: ESP block provided prolonged analgesia compared to the TAP block, and the mean time to first rescue analgesia was 43.53 h and 12.07 h, respectively ($P < 0.001$). The requirement for total analgesic was also significantly less in the ESP group compared to the TAP group ($P < 0.001$).

Conclusion: ESP block provided prolonged analgesia with a significant decrease in analgesic requirement compared to TAP block and can be used as a standard technique for post-cesarean analgesia.

Keywords: Analgesia, elective cesarean section, ropivacaine, transversus abdominis plane block

Introduction

An ideal analgesic modality comprising effective, reliable, and safe analgesia is mandatory after a cesarean section as the majority of patients report a moderate-to-severe intensity of pain affecting the overall quality of life.^[1]

The postoperative analgesic efficacy of the transversus abdominis plane (TAP) block has already been used as a

component of the multimodal analgesic approach in cesarean patients.^[2] It provides adequate somatic analgesia with little or no visceral blockade.^[3]

Erector spinae plane (ESP) block is a para-spinal regional anesthesia technique that allows local anesthetic dispersion into the interfascial plane between the transverse process and the erector spinae muscles, attaining a paravertebral spread of three and four vertebral levels cranially and caudally,

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respectively,^[4] covering the ventral as well as dorsal rami inhibiting both visceral as well as somatic pain.^[5-7]

Thus, we hypothesized that ESP block would be equal to or better than the transversus abdominis plane (TAP) block and conducted a randomized, prospective study to compare the postoperative analgesic efficacy of ESP block and TAP block in patients undergoing elective cesarean section under spinal anesthesia with the primary aim to compare the time for rescue analgesic administration and secondary aim to compare the total dose of analgesic required and the severity of postoperative pain via VAS (visual analogue scale) score both at rest and on movement for up to 48 h.

Material and Methods

The study was conducted after approval for this study was provided by the Institutional Ethics Committee (reference number MGMCH/IEC/JPR/2018/16). The study was registered prospectively with the Clinical Trials Registry-India (Registration No. CTRI/2018/12/016494). Informed and written consent from all the subjected was taken before initiation of study procedures. The study protocols adhered to the ethics guidelines of the 2013 Declaration of Helsinki.

All the parturients scheduled for elective cesarean section under spinal anesthesia during the period of 2 months (from December 2018 to January 2019) and fulfilling the inclusion criteria were enrolled in the study. Inclusion criteria were American Society of Anesthesiologists physical status I, II, or III and a normal singleton pregnancy (with a gestational age of at minimum 37 weeks). Exclusion criteria were the inability to comprehend or participate in pain scoring system, systemic coagulopathy, anatomic abnormalities, allergy to study medication, and localized infection. We randomized the enrolled patients into 2 groups equally: ESP group—Each patient received bilateral ESP block and the TAP group—Each patient received a bilateral TAP block.

For randomization, the permuted block randomization method was used. The generation of the randomization scheme was done using the website for randomization (<http://www.randomization.com>). The process of randomization was executed by DDJ using block randomization. Subsequently numbered, sealed, opaque envelopes were arranged and supplied to investigators AM and DJ, who performed and supervised both the block performance, respectively. All the patients were blinded to the allocated intervention. Investigator KV was assigned to observe and record the post-intervention parameters of all the patients and was blinded to the study groups.

All patients received 40-mg pantoprazole peroral 2 h before surgery and a visual analogue scale (VAS), graded from (0 = no pain and 100 = worst possible pain), was explained. In the operating room, an 18-gauge intravenous cannula was secured in the nondominant hand or arm. Standard monitoring (ECG, noninvasive blood pressure, and pulse oximetry) was instituted. Spinal anesthesia was accomplished in all patients in the sitting position after determining the midline and intervertebral spaces of the L3–4 and L4–5 using a 25-gauge spinal needle (B. Braun Melsungen, Germany) with 12.5 mg hyperbaric bupivacaine. The patients were swiftly placed in the supine position with left uterine displacement. Spinal anesthesia was considered successful once T6 bilateral block, determined by the deficit of cold by ice cube and touch by blunt pin discrimination, after 5 min of spinal injection was checked. Anesthesia and surgical treatment were followed in the usual manner.

At the end of the surgery, with the patient fully monitored, the ESP block or TAP block was accomplished under ultrasonographic guidance using a linear array (6–13 MHz) transducer (FUJIFILM Sonosite, Inc. Bothell, Washington).

Erector spinae plane block

For block performance, patients were turned laterally to one side and the T9 spinous process was marked; the transducer probe was shifted from the midline, 3cm laterally to visualize the T9 transverse process and erector spinae muscle [Figure 1a]. A 21-gauge needle was inserted in the plane cranial to caudal till the tip of the needle reached into the fascial plane between erector spinae muscle and transverse

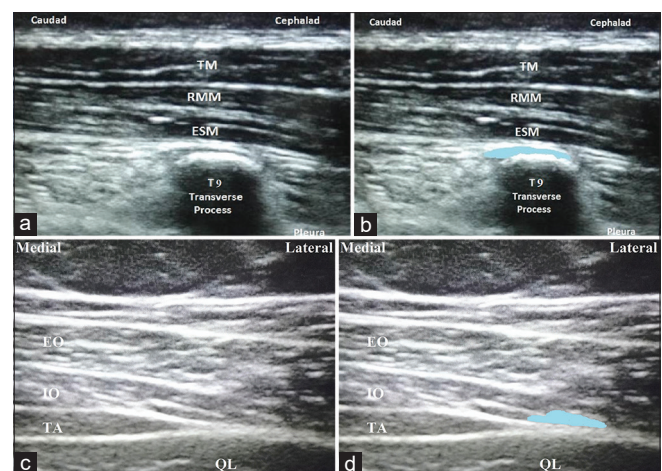


Figure 1: (a) Ultrasound preinjection image of ESP block. (Original image). (b) Ultrasound post-injection image of ESP block. (Original image). (c) Ultrasound preinjection image of posterior approach of TAP block. (Original image). (d) Ultrasound post-injection image of posterior approach of TAP block. (Original image). TM: Trapezius muscle, RMM: Rhomboid major muscle, ESM: Erector spinae muscle, LA: local anesthetic drug, and blue colored area: deposition site of local anesthetic, EO: External oblique muscle, IO: Internal oblique muscle, TA: Transversus abdominis, QL: Quadratus lumborum

process. The position of the needle tip was checked by hydrodissection with 2 ml normal saline; thereafter, a total of 0.2% ropivacaine 0.2ml/kg was injected. The spread of injectate was observed ultrasonographically [Figure 1b]. Likewise, the same block procedure was performed on the other side.

Transversus abdominis plane block

The posterior approach for the TAP block was used. With the patients in the supine position, the transducer probe was first placed posterior to the midaxillary line between the costal margin and the iliac crest and moved more posteriorly to view the point where transversus abdominis ends and tails off turning into the aponeurosis. Quadratus lumborum was seen posteromedial to the aponeurosis [Figure 1c]. The injection site was at the TAP between the internal oblique and transversus abdominis posterior to the midaxillary line and near the aponeurosis. A total of 0.2% ropivacaine 0.2ml/kg was injected after hydrodissection [Figure 1d]. Likewise, the same block procedure was performed on the other side.

The following outcome measures were noted by an investigator blinded to the allotment:

Primary outcome measure:

- Time for rescue analgesia administration:
It was noted, considering the time of completion of respective block procedure (i.e. deposition of the required amount of local anesthetic drug into the desired plane) on each side as the reference point (time 0).
- Rescue analgesia or first postoperative analgesia (Diclofenac 75mg intravenously) was considered when VAS \geq 40 was observed.

Secondary outcome measures:

- The total dose of analgesic required in the first 48 h after surgery:
Diclofenac 75mg bolus intravenously was considered in when VAS \geq 40, and the total number of doses of analgesic required for upto 48 h was calculated.
- The severity of postoperative pain:
The intensity of postoperative pain was recorded for all the patients using the visual analogue scale (VAS) score (0 = no pain and 100 = worst possible pain) both at rest and on the movement.

The movement was defined as:

- a. For the first 24 h post block performance:
 - i. Movement of lower limbs such as flexion and extension.
 - ii. Movement of the trunk by turning side-wards from a supine position either on the patient's right side or left

side.

- b. For the next 24 h post block performance:
 - i. Movement while sitting from the supine position.
 - ii. Movement while walking without any assistance to atleast 10 steps on a leveled surface.

The VAS score was assessed at various predetermined time intervals considering the time of completion of respective block procedure (i.e., deposition of the required amount of local anesthetic drug into the desired plane) on each side as "time 0" (2, 4, 6, 12, 24, 36, 48h).

The visual analogue scale (VAS) used for pain assessment was a continuous scale comprising a horizontal line of 10 cm length, anchored by "no pain" (score of 0) and "worst imaginable pain" (score of 100). The patients were asked to place a line perpendicular to the VAS line at the point that represents their pain intensity. Then, with a ruler, the score was estimated by measuring the distance (mm) on the 10 cm line between the "no pain" anchor and the patient's mark, providing a range of scores from 0–100.

Statistical analyses

A sample size calculation (Sample Size Calculation byMEDCALC 16.4 version software) showed that 53 patients were required in each group, based on a 5.43 mean time difference for rescue analgesia administration between the 2 groups.

$$n = 2(Z_{\alpha} + Z_{1-\beta})^2 \sigma^2 / \Delta^2$$

Power of study = 80%

Allowable error = 5%

Primary outcome = time of rescue analgesia administration.

However, this was a time-bound study and had to be completed within a framework of 2 months, from December 2018 to January 2019. Hence, we enrolled all the patients scheduled for elective cesarean section and fulfilling the inclusion criteria during the above-mentioned period of 2 months in this study, which turned out to be a total of 60 patients. Thus, a sample size of 60 patients with 30 patients in each group was obtained for the study.

Statistical analysis was performed using SPSS, version 21 for Windows statistical software package (SPSS Inc., Chicago, IL, USA). The Categorical data were expressed as numbers (percent) and were compared using the Chi-square test among groups. The quantitative data were expressed as mean and standard deviation and were compared by students *t*-test. Probability if less than 0.05 was considered to be significant.

Results

Our study group comprised 60 patients, with 30 patients randomly allocated to each group. There was no deviation from the protocol. The patient's demographics were similar with no significant differences among both groups [Table 1].

Time for rescue analgesia administration (Injection diclofenac 75 mg intravenously) was significantly

Table 1: Demographic and other data

Demographic data	Group: ESP		Group: TAP	
	Mean	SD	Mean	SD
Age (years)	28	3	30	3
Weight (kg)	69	5	70	4
Height (cm)	152	5	153	4
Previous caesarean				
0	28		27	
1	2		3	
Surgical duration (min)	45	10	44	9

Values are mean±SD. ESP: Erector spinae plane, TAP: Transversus abdominis plane

Table 2: Total dose of analgesic required in the first 48 h

Total analgesic dose in 48 h*	Group: ESP		Group: TAP	
	No.	%	No.	%
0 dose	8	26.66	0	0
1 dose	22	73.33	0	0
3 dose	0	0	6	20.00
4 dose	0	0	21	70.00
5 dose	0	0	3	10.00
Total	30	100.00	30	100.00

Values are number. ESP: Erector spinae plane, TAP: Transversus abdominis plane.

*Diclofenac 75mg bolus was given when VAS ≥40

Table 3: VAS at rest and movement

Time interval*	VAS†	Group: ESP		Group: TAP	
		Mean	SD	Mean	SD
2 h	Rest	0	0	0	0
	Movement	0	0	0	0
4 h	Rest	0	0	8.67	3.46
	Movement	0	0	11.67	6.48
6 h	Rest	0	0	15.00	5.72
	Movement	0	0	20.00	7.43
12 h	Rest	0	0	31.00	5.48
	Movement	10.00	0	37.00	5.35
24 h	Rest	18.33	3.79	29.67	5.56
	Movement	20.00	0.00	32.00	4.07
36 h	Rest	22.00	4.07	29.33	3.65
	Movement	28.67	4.34	34.00	5.63
48 h	Rest	21.33	6.29	32.33	4.30
	Movement	25.67	5.68	35.00	5.09

Values are mean±SD. ESP: Erector spinae plane, TAP: Transversus abdominis plane. * Time interval was noted considering the completion of block procedure as "Time 0". †Visual analogue score (VAS) (0=no pain and 100=worst possible pain)

longer in Group ESP (mean: 43.53 h) as correlated to Group TAP (mean: 12.07 h) $P < 0.001$ [Figure 2].

In Group ESP, the requirement for analgesic over 48 h was reduced significantly in comparison to Group TAP. 22 patients of the ESP group required a single dose of analgesic and 8 patients required no analgesic (average number of analgesic dose = 1) while 3, 4, and 5 doses of analgesic were required by 6, 21, and 3 patients, respectively, in TAP group (average number of analgesic dose = 4) over a period of 48 h, which was statistically significant ($P < 0.001$) [Table 2].

The VAS was significantly lower in the group ESP than in the group TAP, taking into account VAS at rest and with movement at all times post-caesarean section [Table 3].

There was no statistically significant variation in oxygen saturation level, heart rate, and mean blood pressure.

Discussion

Post-caesarean section analgesia is a major concern and should include approaches that enhance early recovery, mobilization and facilitates breastfeeding without systemic side effects which can be achieved effectively and safely by using regional anesthesia techniques.^[8,9]

One such regional technique is the TAP block which is already an established entity that has been used as a component of the multimodal analgesic approach in cesarean section. It blocks the thoracolumbar nerves T10 to L1 and provides adequate somatic analgesia with little or no visceral blockade.^[3] Another technique is ESP block, which blocks the ventral as well as dorsal branches of the spinal nerves^[10,11] along with the communicating branches

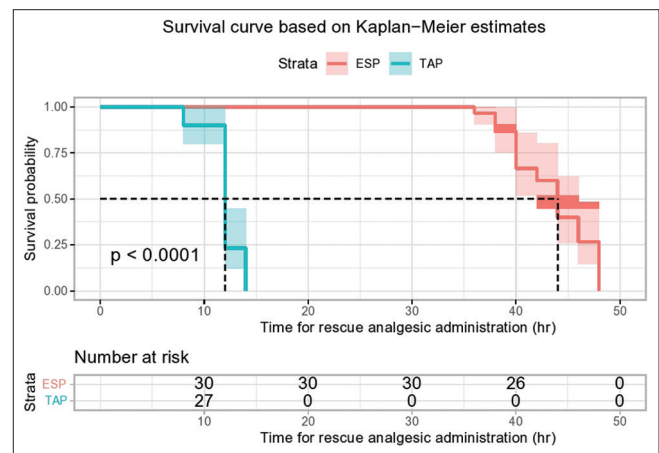


Figure 2: Time for rescue analgesia administration (hours)–Kaplan Meier Survival Curve. ESP: erector spinae plane block, TAP: transversus abdominis plane group

that augment the sympathetic chain catering sympathetic block and to visceral analgesia.^[5]

A study using the TAP block with 0.5% ropivacaine in post-cesarean section^[12] reported a reduction in total morphine use over a period of 24 h (median 18 mg) as compared to the control group (median 31.5 mg). A significant reduction in the VAS score was also noted in the active group when compared to the control group (96 mm vs. 77 mm, $P = 0.008$). These findings were comparable with results of our study in which there was drastic reduction in total analgesic use over a period of 48 h with average 4 doses of analgesic (diclofenac) required with TAP block (mean time to rescue analgesia administration: 12.07 h) as compared to average 1 dose of analgesic requirement with ESP block (mean time to rescue analgesia administration: 43.53 h) and significantly reduced VAS scores at rest and at movement.

Mankikar *et al.* in their study evaluated the analgesic efficacy of TAP block after cesarean section and found that time for rescue analgesia was 9.53 h.^[2] In our study, time to rescue analgesia requirement was 12.07 h with TAP block, while with ESP block, it was 43.53 h.

On the other hand, the initial publications of ESP block centered mainly on thoracic analgesia and reported decreased pain scores and perioperative opioid consumption (oral morphine equivalents 218 mg vs. 548 mg)^[13] In our study when used for post-cesarean section pain relief, it showed comparable analgesic profile in terms of reduction in pain scores and total analgesic consumption, as evidenced by requirement of average 1 dose of analgesic (diclofenac 75 mg) over a period of 48 h with mean time to rescue analgesia administration of 43.53 h.

A case report of ESP block at T5 level using a continuous catheter technique in a patient with multiple unilateral rib fractures reported a significant reduction in pain score within 2 min of the performance of the regional block documented with a numerical rating scale of 0/10 at rest and 1/10 on coughing.^[14] In our study also, when ESP block was used for post-cesarean section pain relief, the patients reported significant reduction in pain; assessed with visual analogue scale (VAS <40) score both at rest and movement at all the time intervals for 43.53 h in comparison to the TAP block where VAS <40 was maintained both at rest and movement until 12.07 h.

A series of 11 cases of ESP block for abdominal surgery, including laparoscopic surgery was conducted. Two of the 11 patients receiving the ESP block did not require general anesthesia while most of the patients maintained

a numerical rating scale (NRS) for the pain of 0–2/10 postoperatively.^[15] Similar postoperative pain relief in patients undergoing cesarean section was observed in our study.

In our study, we followed patients for 48 h and observed that only 1 dose of diclofenac 75 mg (in 73.33% patients) was required for post-cesarean pain relief in patients receiving bilateral ESP block with a VAS <40 both at rest and at movement for 43.53 h which was the mean time to rescue analgesia requirement. Similar analgesic profile was seen in a series of 4 cases where preoperative bilateral ESP block with 0.5% ropivacaine at T7 transverse process level was administered to patients undergoing ventral hernia repair. They reported a median (range) 24 h opioid consumption of 18.7 mg (0.0–43.0 mg) oral morphine with highest and lowest median (range) pain scores of 3.5 (3.0–5.0) and 2.5 (0.0–3.0) on an 11-point numerical rating scale in the first 24 h.^[4]

Several other publications of ESP block reported extensive multidermatomal analgesia in thoracic neuropathic pain,^[11] breast cancer surgeries where total opioid consumption was found to be decreased by 65% at 24 h compared to the control group^[16] with few descriptions to its efficacy in repair of ventral hernias or bariatric surgery^[5,6] and in our study also, there was 75% reduction in total analgesic consumption, i.e. single dose of analgesic required with ESP block compared to average 4 doses of analgesic requirement with TAP block over 48 h.

A case report using bilateral ESP block for post-cesarean section analgesia at T9 level with 20 ml of 0.5% bupivacaine reported providing effective and long-lasting postoperative analgesia^[17] and our study showed comparable effect with a significant reduction in analgesic consumption, VAS score over a period of 48 h and mean time of rescue analgesia administration of 43.53 h with ESP block.

The ESP block promises to provide prolonged craniocaudal spread attaining a paravertebral spread of three and four vertebral levels cranially and caudally respectively facilitating extensive somatic and visceral analgesia thus having an effect profile comparable to that of retrolaminar and paravertebral blocks.^[16,18,19] Other advantages of ESP block make it a rather simple, safe, and reliable surrogate to any other modality of pain relief as it includes the ultrasonic target which is represented by the transverse process that can be easily viewed, the point of injection being a musculofascial plane which is distant from the pleura, neuroaxis, and large vascular structures,^[5] and since erector spinae muscle comprises of muscles and tendons that stretch through the cervical, thoracic, and lumbar areas, a solitary injection of 20–30 mL in adults results into anesthesia of multiple dermatomes^[6] facilitating the approach to be at points rather far from the surgical zone.^[5]

The primary outcome of the study showed good postoperative analgesia with both the regional anesthesia techniques. But the analgesia was significantly long-lasting with ESP block with time to rescue analgesia requirement of 43.53 h when compared to TAP block, in which time to rescue analgesia requirement was 12.07 h. As per secondary outcomes, reduced analgesic consumption with ESP block (75%), i.e. average single dose of analgesic vs. average 4 doses of analgesics in comparison to TAP block over 48 h with significantly improved VAS scores at each observation time was noticed.

Although the practicable effect of local anesthetic spread through the non-osseous spaces between the adjoining vertebrae into the paravertebral space should be investigated over and above, in the current study, we did not estimate the dermatomal levels of the block, as we concentrated on analgesic consumption and demands.

In conclusion, our study proves that ESP block is a novel, predictable, secure, and safe option for post-cesarean section pain. Hence, based on its duration of action and effectiveness against the TAP block, we have adopted ESP block as default post-cesarean analgesia technique in our institution. In addition, the ESP block would surely provide a clinical advantage in patients with substantial pain.

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Conflicts of interest

There are no conflicts of interest.

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