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Original Article

Anaesthesia Section

Ultrasound-guided Transversus Abdominis Plane Block and Ultrasound-guided Erector Spinae Plane Block for Postoperative Analgesia in Caesarean Section: A Randomised Clinical Study

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ABSTRACT

Introduction: Pain is the most unpleasant subjective feeling comprising of innumerable emotional and psychological components that require medical advice for relief, regardless of the cause. Transversus Abdominis Plane (TAP) block and Erector Spinae Plane (ESP) block are effectively studied blocks that provide adequate pain control.

Aim: To compare postoperative analgesic efficacy in pregnant women undergoing caesarean section under spinal anaesthesia with Ultrasound (USG)-guided TAP block and USG-guided ESP block.

Materials and Methods: In this institution-based interventional randomised clinical study, two categories comprising 30 subjects in group I with USG-guided bilateral TAP block and group II with USG-guided bilateral ESP block using Ropivacaine were involved. Visual Analogue Scale (VAS) was used to compare analgesic efficacy. Other parameters for analysis included time of first rescue analgesia, total number of administrations of rescue analgesia within 24 hours, together with Adverse Drug Reactions (ADRs). Statistical analysis was done using Statistical Package for the Social Sciences (SPSS) version 21.0. Student's t-test and Chi-square test were used for data analysis.

Results: Subjects in group I had a mean age of 24.9±4.66 years while those in group II were 25.5±3.99 years. The VAS score at 24 hours in group I was 7.22±0.89 and in group II was 6.8±0.83, which was statistically significant with a p-value of 0.0241. USG-guided ESP block was superior to USG-guided TAP block, providing analgesia for 24 hours. Following the first dose, there was a significant delay in rescue analgesia and a reduction in the total administration of rescue analgesia within 24 hours. The first rescue analgesia in group I was at 10.66±2.32 hours and in group II was at 16.66±2.53 hours, with a p-value of 0.0001 indicating a statistically significant difference. No ADRs were reported in either group of participants.

Conclusion: ESP block provided a prolonged duration of analgesia, as shown by a decrease in the total VAS score. There was also a significant reduction in the total number of administrations of rescue analgesia within 24 hours when compared to TAP block, suggesting that ESP block provides superior analgesia. Hence, for pain relief in postcaesarean section individuals, ESP block can be regarded as a novel potent option.

Keywords: Pain, Rescue analgesia, Surgical, Visual analogue scale

INTRODUCTION

Pain is the most common internalisation and conscious interpretation of noxious stimuli. Traditional methods of pain relief after major intra-abdominal surgeries included systemic medications and the use of local anaesthetic on the skin where there is a surgical wound. Additionally, regional anaesthetic techniques and nerve blocks were utilised for effective pain management. As a result, postoperative complications and various drawbacks associated with the use of opioids were significantly reduced, leading to enhanced recovery. Patients undergoing a caesarean section have reported experiencing moderate to severe pain that has impacted their overall quality of life [1]. Therefore, a perfect analgesic method that is effective, reliable, and safe is required.

Recently, USG-guided block has been identified as a method that results in greater localisation and drug deposition. The analgesic effectiveness of TAP block has already been tested in postoperative caesarean patients [2,3]. TAP block contributes to the analgesic effect in relation to the anterior and lateral abdominal wall. This technique delivers local anaesthesia to the area between the internal oblique and transversus abdominis muscles, thus interrupting innervation to the abdominal skin, muscles, and parietal peritoneum by targeting the spinal nerves [4,5].

In surgical techniques and for pain management, a newer regional anaesthetic technique called ESP block has also been explored. This block is known to provide paraspinal regional anaesthesia. It delivers anaesthesia to the area between the transverse process and erector spinae muscles. This block helps achieve the inhibition of visceral and somatic pain transmission [6]. An ideal analgesic modality comprising effective, reliable, and safe analgesia is essential after a caesarean section, as the majority of patients report moderate-to-severe pain intensity that impacts their overall quality of life [1].

This study was conducted to delineate the efficacy of postoperative analgesia among subjects undergoing elective caesarean section under spinal anaesthesia using USG-guided TAP block and USG-guided ESP block.

MATERIALS AND METHODS

The randomised, single-blinded clinical trial was conducted in the operating theatre followed by the postoperative recovery ward of Obstetrics at Mata Gujri Memorial Medical College and Lions Seva Kendra Hospital in Kishanganj, Bihar, India from September 2020 to August 2022. The research was carried out following permission from the Institutional Ethics Committee (MGM/IEC-47/2020) along with

consent from the hospital authorities. It was also registered with the Clinical Trials Registry of India (CTRI) under REF/2024/04/082787.

Inclusion criteria: The study included cases admitted for elective caesarean section at Mata Gujri Memorial Medical College, with a gestational age of at least 37 weeks and a normal singleton pregnancy. American Society of Anaesthesiologists (ASA) I and II subjects aged between 20 and 40 years with body weight between 45 and 90 kg were included in the study.

Exclusion criteria: Patients showing refusal of the study techniques and those patients who were contraindicated for spinal anaesthesia were excluded from the study.

Sample size calculation: Sample size was calculated using the formula:

$$N = \frac{2SD^2 (Z\alpha_{/2} + Z\beta)^2}{d^2}$$

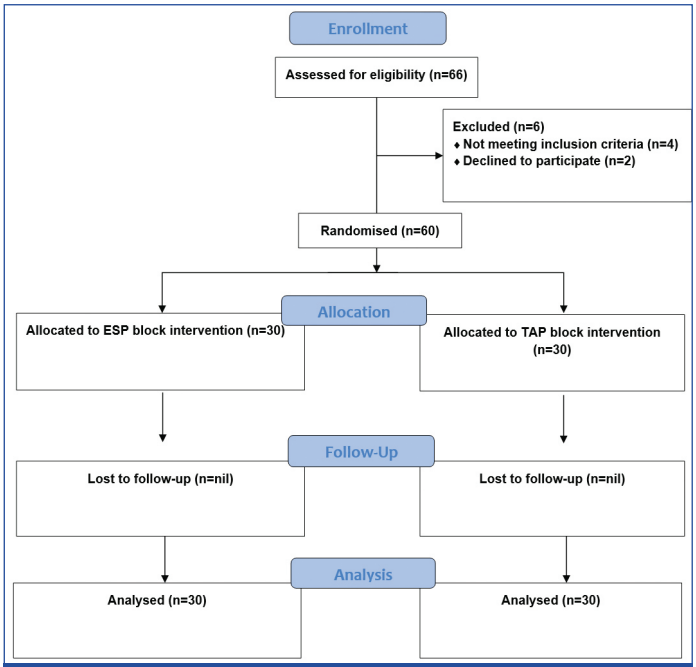
SD- Standard deviation

$Z\alpha_{/2}$= 1.96 at type 1 error 5%

$Z\beta$= 0.842 at 80% power

d= effect size= difference between mean values

After substituting the values, the total sample size was 60. Therefore, two groups were recruited by random allocation, with 30 participants in each group [Table/Fig-1].



[Table/Fig-1]: CONSORT 2010 flow diagram.

Study Procedure

A total of 60 adult female subjects under spinal anaesthesia were lined up for elective caesarean section as per the above-mentioned criteria. Informed consent was obtained from subjects before participating in the research. They were randomly categorised into group I as subjects with TAP block and group II as subjects with ESP block using computer software. The primary outcome variables were the perception of pain in the postoperative period measured by the VAS score. The secondary outcome variables are the first rescue analgesia, the total number of administrations of rescue analgesia within 24 hours, together with ADRs. All the data were collected on a proforma to elicit personal characteristics, vital parameters, and pain scoring from the study participants.

Visual Analogue Scale (VAS): The VAS score consists of a 10 cm horizontal line denoting 'no pain' and 'worst pain imaginable' on the right and left end, respectively. The subjects were instructed to draw a line. The score is interpreted in millimeters as the distance from the left end of the scale to the mark. VAS score ratings from 0-0.4 cm were considered no pain; 0.5-3 cm mild pain; 4-7 cm moderate pain; and 7-10 cm severe pain.

USG-guided TAP block technique: In the supine position, 0.2% ropivacaine, 0.2 mL/kg on each side was administered under ultrasound guidance with in-plane needling depositing the local anaesthetic in the desired plane between the internal oblique and transversus abdominis muscles following the standard technique of TAP block. The utilisation of ultrasound provided the exact deposition of the local anaesthetic on the neurovascular surface.

USG-guided ESP block technique: In the lateral position under aseptic precautions, a USG-guided probe was positioned 3 cm lateral to the T9 spinous process. Then, from a superior to inferior approach, a 22-gauge needle was inserted in-plane. A 0.2% ropivacaine, 0.2 mL/kg on each border was administered under ultrasound guidance following the standard technique of the ESP block.

Prior to the surgery, a complete preanaesthetic evaluation was performed on each subject according to the standard technique. Subjects were explained regarding the VAS score. Preoperative advice and instructions for "Nil Per Orally" were given. On the day of surgery, medications were prepared uniformly in volume, i.e., 0.2% of 0.2 mL/kg body weight ropivacaine in labeled syringes. As per current standards, preoperative aspiration prophylaxis was ensured. Intravenous access was secured using an 18G cannula, and a standard protocol for assessment of the patient prior to spinal anaesthesia was followed in the operating room. Before spinal anaesthesia, baseline values for heart rate, mean arterial pressure, respiratory rate, and SpO_2 were noted. Conventional spinal anaesthesia was administered to both groups using the standard technique. The duration of the procedure was recorded. Towards the end of the procedure, another set of vitals was recorded five minutes before the intervention as a baseline record to detect any drastic haemodynamic changes after the intervention. The two intervened groups are:

Group I: USG-guided TAP block with 0.2% ropivacaine at 0.2 mL/kg body weight [7].

Group II: USG-guided ESP block with 0.2% ropivacaine at 0.2 mL/kg body weight [8].

The vital parameters of each subject were recorded again five minutes after the procedure, and then the patients were transferred to the recovery room. In the recovery room, the patients were monitored for haemodynamic changes, heart rate, mean arterial pressure, respiratory rate, and SpO_2 at 15 minutes, 30 minutes, and one hour, respectively. Subsequently, the patients were transferred to the ward with clear instructions to monitor blood pressure and heart rate at 0, 2, 4, 6, 12, 18, and 24 hours.

Following the procedure, a blinded investigator noted the following observations in both the groups:

1. VAS scores at the end of 0, 2, 4, 6, 12, 18, and 24 hours.
2. Duration from intervention to the first rescue analgesia in minutes.
3. Total number of administrations of rescue analgesia in the initial 24 hours (using a standard dose of 2 mg/kg of body weight of tramadol for each dose of rescue analgesia).

Any postoperative side-effects such as nausea, vomiting, and pruritus in each group were also noted. In this manner, all the data were systematically collected for each patient. Later, a master chart was prepared for statistical analysis.

STATISTICAL ANALYSIS

Statistical analysis was conducted using Statistical Analysis of Social Sciences (SPSS) version 21.0, a Windows statistical software

package (SPSS Inc., Chicago, IL, USA). The Chi-square test was used to compare categorical data among the groups. Student's t-test was used for quantitative data to express the mean±standard deviation. All the data were tabulated, compiled, and statistically analysed. An alpha level of five percent was considered as the cut-off for statistical significance.

RESULTS

All the demographic details did not show a statistically significant difference [Table/Fig-2].

Parameters	Group I	Group II	p-value
Age (years)	24.9±4.66	25.5±3.99	0.63
Height (cm)	163.9±4.57	162.7±4.52	0.29
Weight (kg)	65.33±8.59	64.5±7.31	0.68
ASA I/II	26/4	25/5	0.71
Time of first rescue analgesia (hrs)	10.66±2.32	16.66±2.53	0.0001
Duration of surgery (mins)	52.1±8.91	53.2±8.04	0.65
Number of rescue analgesia	2.9±0.65	1.26±1.48	0.0001

[Table/Fig-2]: Demographic characteristics of Group I and Group II.
The quantitative data were expressed as mean and standard deviation and were compared by Student's t-test

Regarding the time of the first rescue analgesia, in group I it was 10.66±2.32 hours, compared to 16.66±2.53 hours in group II. The p-value was 0.0001, indicating a statistically significant difference between the two groups. No postoperative side-effects were observed in either group.

[Table/Fig-3] displayed the difference in VAS scores between group I and group II subjects. The VAS scores were statistically significant at 2, 4, 6, 12, 18, and 24 hours. For both blocks, the VAS scores during the first postoperative hour were zero. VAS scores at postoperative hours 2, 4, 6, 12, 18, and 24 were significantly lower in Group II.

Time	Group I	Group II	p-value
0 hour	0.9±0.79	0.66±0.65	NA
2 hrs (V8)	1.67±0.61	0.7±0.64	0.0001
4 hrs (V9)	4.13±0.99	2.13±1.35	0.0001
6 hrs (V10)	4.05±1.03	3.5±1.3	0.0458
12 hrs (V11)	4.8±1.5	2.95±1.29	0.0001
18 hrs (V12)	5.4±1.12	4.92±0.72	0.0253
24 hrs (V13)	7.22±0.89	6.8±0.83	0.0241

[Table/Fig-3]: Mean difference in VAS score at 0, 2, 4, 6, 12, 18 and 24 hours between group I and group II patients.
The quantitative data were expressed as mean and standard deviation and were compared by Student's t-test

There was no statistically significant difference in Systolic Blood Pressures (SBP) at 2, 4, 6, 12, 18, and 24 hours. Similarly, there were no statistically significant differences in heart rates at 2, 4, 6, 12, 18, and 24 hours. Group II also demonstrated a significantly lower need for rescue analgesia, as evidenced by a reduction in the total number of administrations of rescue analgesia. Group II showed a longer time of approximately 16 hours for the first rescue analgesia, while group I had a mean duration of nearly 10 hours, indicating that the ESP block provided a longer duration of analgesia.

[Table/Fig-4] presented a multivariate logistic regression analysis between age in years, height in cm, weight in kg, Body Mass Index (BMI), duration of surgery, two-hourly postoperative SBP, heart rate, respiratory rate, number of rescue analgesia, and time for rescue analgesia with TAP block. There was a statistically significant association between the time of rescue analgesia in the TAP block, with a p-value of 0.03.

[Table/Fig-5] demonstrated a multivariate logistic regression analysis between age in years, height in cm, weight in kg, BMI, duration of surgery, two-hourly postoperative SBP, heart rate, respiratory rate, number of rescue analgesia, and time for rescue analgesia with ESP block. There was a statistically significant association with the ESP block for the number of rescue analgesia and time for rescue analgesia, with p-values of 0.02 and 0.03, respectively.

	Coefficients	Standard error	t stat	p-value	Lower 95%	Upper 95%
Intercept	102.15	88.63	1.15	0.26	-89.32	293.63
Age	0.11	0.08	1.29	0.21	-0.074	0.30
Height	-0.38	0.54	-0.70	0.49	-1.57	0.79
Weight	0.41	0.68	0.61	0.55	-1.05	1.88
Body mass index	-0.94	1.80	-0.52	0.60	-4.85	2.95
Duration of surgery	-0.13	0.12	-1.04	0.31	-0.40	0.13
Postoperative SBP (0 hr)	0.01	0.05	0.32	0.74	-0.09	0.13
V8 (2 hrs)	-0.01	0.08	-0.20	0.84	-0.20	0.16
V9 (4 hrs)	0.05	0.05	0.94	0.36	-0.06	0.17
V10 (6 hrs)	-0.02	0.06	-0.40	0.69	-0.17	0.12
V11 (12 hrs)	0.03	0.08	0.41	0.68	-0.14	0.20
V12 (18 hrs)	0.02	0.05	0.43	0.66	-0.09	0.14
V13 (24 hrs)	-0.04	0.08	-0.47	0.64	-0.22	0.14
Heart rate	0.00	0.07	0.07	0.94	-0.15	0.16
Respiratory rate	-0.06	0.24	-0.26	0.79	-0.58	0.45
Number of rescue analgesic	0.37	1.20	0.31	0.75	-2.23	2.98
Time for first rescue analgesic in hour	-1.40	0.38	-3.61	0.03	-2.23	-0.56

[Table/Fig-4]: Multivariate logistic regression between age in years, height in cm; weight in Kg, BMI, duration of surgery; 2 hourly postoperative SBP; Heart Rate (HR); Respiratory Rate (RR); Number of rescue analgesia and time for rescue analgesia with TAP block.
SBP: Systolic blood pressure; TAP: Transversus abdominis plane; VAS: Visual Analogue Scale score; and V8-V13 denotes VAS score at 2, 4, 6, 12, 18 and 24 hours

	Coef-ficients	Standard error	t stat	p-value	Lower 95%	Upper 95%
Intercept	127.27	143.30	0.88	0.39	-182.32	436.87
Age	0.02	0.07	0.31	0.75	-0.13	0.18
Height	-0.63	0.86	-0.73	0.47	-2.50	1.23
Weight	1.01	1.09	0.91	0.37	-1.36	3.38
Body mass index	-2.72	2.88	-0.94	0.36	-8.95	3.50
Duration of surgery	-0.08	0.10	-0.81	0.43	-0.32	0.14
Postoperative SBP (0 hr)	0.03	0.04	0.69	0.50	-0.06	0.12
V8 (2 hr)	-0.06	0.04	-1.43	0.17	-0.17	0.03
V9 (4 hrs)	0.00	0.05	0.14	0.88	-0.11	0.12
V10 (6 hrs)	0.08	0.08	1.05	0.30	-0.08	0.26
V11 (12 hrs)	0.09	0.03	2.52	0.02	0.01	0.18
V12 (18 hrs)	-0.01	0.05	-0.32	0.75	-0.14	0.10
V13 (24 hrs)	-0.03	0.05	-0.63	0.53	-0.16	0.08
Heart rate	-0.06	0.06	-1.02	0.32	-0.21	0.07
Respiratory rate	-0.35	0.19	-1.88	0.08	-0.77	0.05
Number of rescue analgesia	3.75	0.98	3.81	0.02	1.62	5.88
Time for first rescue analgesic in hour	-0.30	0.28	-1.05	0.03	-0.91	0.31

[Table/Fig-5]: Multivariate logistic regression between age, height in cm; Weight in Kg, BMI, duration of surgery; 2 hourly Postoperative SBP; Heart Rate (HR); Respiratory Rate (RR); Number of rescue analgesia and time for rescue analgesia with ESP block.
SBP: Systolic blood pressure; ESP: Erector Spinae Plane; V: Visual analogue scale score and V8-V13 denotes VAS score at 2, 4, 6, 12, 18 and 24 hours

From the multivariate logistic regression analysis, it can be concluded that the time for rescue analgesia and the number of rescue analgesia were associated with ESP blocks, while only the time for rescue analgesia was associated with the TAP block.

DISCUSSION

The study was conducted among caesarean section subjects under spinal anaesthesia to compare postoperative analgesia of USG-guided TAP versus USG-guided ESP block through VAS score, time of first rescue analgesia needed in each group in order to evaluate analgesic duration, total consumption of analgesics in the first 24 hours, and adverse drug events. The demographic details among the two groups did not show any statistically significant difference. The difference in VAS scores between group I and group II subjects was statistically significant at 2, 4, 6, 12, 18, and 24 hours. No statistically significant difference was observed in the SBP between the two groups at 2, 4, 6, 12, 18, and 24 hours. There was an absence of a statistically significant difference in heart rate at 2, 4, 6, 12, 18, and 24 hours between the two groups.

TAP block was introduced by Rafi in 2001 and later modified by McDonnell NJ et al., [1]. This block anaesthetises the somatic supply of the anterior rami of spinal nerves with little or no visceral blockade [3]. In 2016, the USG-guided ESP block, explained by Forero M et al., anaesthetised the paraspinal region and was used in thoracic neuropathic pain [9-12]. Postcaesarean section analgesia is an area that requires review with the ESP block. It facilitates speedy recovery, movement, and breastfeeding without systemic side-effects [12,13]. Furthermore, the ESP block technique acts on the ventral and dorsal branches of spinal nerves [14,15] and communicating branches, resulting in sympathetic block and visceral analgesia [9].

The ESP plane block group required significantly less (p-value=0.0001) rescue analgesia, with 1.26±1.48 compared to 2.9±0.65 for group I, the TAP plane block group. Group II showed a longer duration of approximately 16.66±2.53 hours to the first rescue analgesia compared to 10.66±2.32 hours in Group I, and this was statistically significant with a p-value of 0.001. Boules ML et al., reported that 0.25% bupivacaine in postcaesarean section cases had a longer duration of block in the ESP group than in the TAP group. Additionally, the mean VAS score at rest during the first 24 hours decreased by 0.32 units within the ESP group, while the median tramadol consumption in the TAP group was higher than in the ESP group [16]. Similar findings were noted by Kamel AAF et al., where there was a significant decrease in total analgesic use over 24 hours. There was a statistically significant prolonged time to the first morphine dose in the ESP group compared to the TAP group. Postoperatively, there was a significant decrease in overall morphine consumption statistically in the ESP group over 24 hours, with a p-value of 0.01 [8].

The time to the need for rescue analgesia in this study was 10.66±2.32 hours with the TAP block and 16.66±2.53 hours with the ESP block. This finding was supported by Malawat A et al., where the ESP block resulted in prolonged analgesia (43.53 hours) compared to the TAP block (12.07 hours). Thus, the ESP block required less total analgesic than the TAP group [7], which was once again confirmed in present study. Mankikar MG et al., observed the analgesic effect of the TAP block following caesarean section and inferred that the time to rescue analgesia was 9.53 hours [2], which was close to present study observed value.

In one case report, an ESP block was administered at the T5 position using the continuous catheter technique for a patient with multiple unilateral rib fractures. It was observed that within two minutes following the regional block, a marked decrease in pain score was seen [17]. This principle of the ESP block was also applicable in present study, where postcaesarean section pain relief with the ESP block was significant, as evidenced by the reduction in VAS scores.

In the present study on postcaesarean pain relief, during the 24-hour observation period, only one dose of analgesic was required in subjects receiving bilateral ESP blocks with a VAS score <4 at rest and with movement for an average of 16.66 hours, which was the mean time to the need for rescue analgesia. A nearly identical analgesic effect was found in patients undergoing ventral hernia repair, where bilateral ESP blocks with 0.5% Ropivacaine at the T7 transverse process were administered preoperatively [6].

The ESP block has been reported to provide extensive multidermatomal analgesia in thoracic neuropathic pain [13], breast cancer surgeries, where total opioid consumption was reduced by 65% at 24 hours compared to the control group [18], with explanations for its efficacy in ventral hernia repair or bariatric surgery [7,8]. Present study showed a nearly 75% decrease in total analgesic consumption, with only a single dose of analgesic required over 24 hours with the ESP block, compared to an average of three doses required with the TAP block. The number of rescue analgesia instances in the TAP block was significantly higher than in the ESP block (p-value=0.0001); the time to the first rescue analgesia was significantly longer in the ESP block (p-value=0.001). Therefore, the pain-free period is much longer with the ESP block.

This research observed a decrease in analgesic consumption, VAS scores over 24 hours, and a mean time of 16.66 hours for rescue analgesia administration with the ESP block. This finding was comparable to a study that used bilateral ESP blocks for postcaesarean section analgesia at the T9 level with 20 mL of 0.5% bupivacaine, which provided potent and lasting analgesia postoperatively [19]. The ESP block results in a longer craniocaudal extension, providing a paravertebral spread up to three and four vertebral levels cranially and caudally, respectively, causing somatic and visceral analgesia. This demonstrates its efficacy compared to retrolaminar and paravertebral blocks [18,20,21].

The ESP block is a distinct and reliable choice compared to other pain relief methods. The target site is the transverse process, and the injection site is in the musculofascial plane, which is distant from the pleura, neuroaxis, and vascular structures [7]. Since the erector spinae muscle consists of muscles and tendons that extend through the cervical, thoracic, and lumbar areas, a single injection of 20-30 mL can provide anaesthesia for multiple dermatomes in adults [8].

As the primary outcome, both regional anaesthetic techniques were effective for postoperative analgesia. The ESP block showed significant analgesia for a longer duration, with a time to the need for rescue analgesics of 16.66 hours compared to the TAP block, where the time to the need for rescue analgesics was 10.66 hours. Regarding the secondary outcome, decreased analgesic consumption (only one dose needed) was observed with the ESP block compared to three doses with the TAP block over 24 hours, along with an improvement in VAS scores at each time period.

Therefore, authors investigated the pain perceptions of patients to compare USG-guided TAP and ESP block for postoperative analgesia in caesarean section as novel work in this part of eastern India. Hence, authors found that the ESP plane block was superior to the TAP block in providing postoperative analgesia.

Limitation(s)

The dermatomal levels of the block were not estimated in current study as study mainly focused on analgesic consumption and demands. Lastly, this single-centre study conducted in a rural medical college may have limited external validity.

CONCLUSION(S)

In this study, the ESP block resulted in a prolonged duration of analgesia and a significant delay in the first dose of rescue analgesia.

There was also a reduction in the total number of administrations of rescue analgesia in the initial 24 hours for the ESP block compared to the TAP block, further suggesting that the ESP block provides superior analgesia. Additionally, adverse effects were absent in both groups. Considering the duration of action and its effectiveness, bilateral USG-guided ESP block provided superior and extended postoperative analgesia with minimal analgesic need compared to bilateral USG-guided TAP block. Furthermore, the ESP block would be a boon to patients with substantial pain. The study concludes that for postcaesarean section pain, the ESP block is a distinct, effective, and dependable choice.

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