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# Comparative Study Between Transversus Abdominis Plane Block and Intravenous Patient-controlled Analgesia After Spinal Anesthesia in Elective Cesarean Sections

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## Abstract

**Background:** One of the most popular surgical procedures worldwide is the caesarean section (CS). Both the mother and the newborn experience postoperative discomfort, particularly in the first 48 h after birth.

**Objective:** To assess the pain-relieving effectiveness of patient-controlled analgesia (PCA) with ultrasound-guided transversus abdominis plane (TAP) block following cesarean delivery.

**Patients and methods:** After getting ethical permission, 50 cases were finally enrolled, and they were allocated randomly to one of two groups. In group I, cases undergo spinal anesthetic with 2.2 ml of 0.5% bupivacaine +25 µg fentanyl, followed by TAP block when the procedure is complete. Patients in Group II get spinal anesthesia with 2.2 ml 0.5% bupivacaine and 25 µg fentanyl, followed by PCA after the procedure is complete.

**Results:** According to the study's findings, the TAP group's heart rate was considerably lower than the PCA group's after 15 min, 2 h, and 4 h. Despite this statistical discovery, the patients' overall health was not impacted by clinical monitoring, and the women were unaffected.

**Conclusion:** This study highlighted that both groups showed efficient postoperative pain control after cesarean section. In addition, TAP block was not as effective as PCA in relieving postoperative pain, as evidenced by the lower VAS recordings in the PCA group.

**Keywords:** Caesarean section, Patient-controlled analgesia, Transversus abdominis plane

## 1. Introduction

One of the most frequent major surgical operations is a caesarean section. Of 179 surgical operations, the caesarean section's postoperative pain was the tenth most painful.<sup>1</sup>

Importantly, efficient postoperative pain management is a crucial component of improved postoperative healing; it shortens hospital stays and lowers hospital expenses while improving healing and lowering postoperative mortality.<sup>2</sup>

Regional analgesic methods, acetaminophen, non-specific NSAIDs or COX-2-specific inhibitors,

and opioids are only a few examples of the multimodal analgesia treatments that have become commonplace. The selection of analgesic combinations should take into account both the side effect profile of these mixtures as well as their analgesic efficacy. So, even if a particular analgesic regimen offers superior pain relief, if it is also linked to more side events, it may not be therapeutically advantageous. Opioids and other necessary drugs to treat nausea, constipation, vomiting, respiratory depression, urine retention, and drowsiness are therefore only available under strict limitations. As a result, the utilization of non-opioid analgesics may enhance the quality of recovering for surgical patients.<sup>3</sup>

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A local anesthetic is injected into the facial plane among the transverse abdominis and the inner oblique muscles as part of the TAP block analgesic technique. Rafi et al. published the initial description of it in 2001.<sup>4</sup> During lower abdomen surgery, TAP block has been found to decrease the need for postoperative pain medication.<sup>5</sup>

Because persons and medications have different pharmacokinetic and pharmacodynamic properties, intravenous PCA is a successful strategy for managing postoperative pain.<sup>6</sup>

After surgery, patients can manage their own analgesic (painkiller) self-administration using tools made for the PCA purpose. PCA involves using a programmable pump to administer modest dosages of opioids (like morphine) intravenously on one's own (by pressing a button). According to earlier research, patients frequently prefer PCA over more conventional pain management techniques, such having a nurse give them an analgesic when they ask for one.<sup>7</sup>

This work aimed to evaluate the analgesic effectiveness of ultrasound-guided TAP block with PCA afterward cesarean section regarding pain relief. Secondary outcomes: patient satisfaction, hemodynamics, sedation score, early ambulation, and side effects.

## 2. Patients and methods

The research, a prospective comparative randomized trial, was done at the Department of Anesthesia and Intensive Care, Faculty of Medicine, Al-Azhar University.

### 2.1. Ethical consideration

After receiving the approval of the ethical committee and the patients' informed consent at the hospitals run by Al-Azhar University, the study will be carried out. Once the patients have given their consent for the type of anesthesia, the study procedure will be outlined to them.

### 2.2. Sample size

The calculated sample size is 50 patients. The patients will be randomly assigned using a random number table to receive either combined spinal anesthesia or TAP block (Group I) or combined spinal anesthesia and PCA (Group II). Each group consists of 25 patients ( $n = 25$ ). Group I: patients receive spinal anesthesia with 2.2 ml 0.5% bupivacaine plus 25 µg fentanyl, followed by TAP block after the surgery ends; and Group II: patients receive spinal anesthesia

with 2.2 ml 0.5% bupivacaine plus 25 µg fentanyl, followed by PCA after the surgery ends.

### 2.3. Inclusion criteria

Individuals having an elective CS range in age from 21 to 35 with a body mass index (BMI) of 25–30 kg/m<sup>2</sup>.

### 2.4. Exclusion criteria

Patients with spinal anesthesia refusal, pregnancy-induced hypertension (preeclampsia), gestational diabetes, concurrent cardiovascular disease, documented coagulation abnormality or history of abnormal bleeding, psychological disorders, history of Nalbuphine hypersensitivity, patients in ASA groups III, IV, or V, local contraindications to the technique, and a BMI greater than 30 kg/m<sup>2</sup> should not undergo the procedure.

### 2.5. Preoperative preparation and examination

Patients from all groups will have their medical histories reviewed, and their vital organs will be clinically examined (heart, chest, and reviewing lab results for anomalies, as well as other exclusion criteria and evaluation of patients' ASA physical state). Every patient will be tracked using electrocardiography, pulse oximetry, and a non-invasive blood pressure monitor.

All patients will get 1000 cc of ringer lactate. Granisetron 1 mg IV Pantoprazole sodium 40 mg IV.

### 2.6. Methods

#### 2.6.1. Drugs

20 mg of bupivacaine HCL 0.5% in 4 ml (Sunny-pivacaine). 20 ml/100 mg Bupivacaine HCL vial (Sunnypivacaine) 20 mg/1 ml of nalbuphine HCL (Nalufin). 30 mg/2 ml of ketorolac tromethamine (Ketolac). 1 mg/1 ml of granisetron (Granitryl). 40 mg of sodium pantoprazole (Controloc).

#### 2.6.2. Equipment

25-gauge Quincke needle. SonoPlex STIM cannula 21 G. PCA infusion pump of 100 ml. Ultrasound device.

#### 2.6.3. Technique

Using a 25-gauge Quincke needle, spinal anesthesia will be administered at the L4–L5 level while the patient is seated. Each patient will receive a total volume of 2.7 ml (bupivacaine plus fentanyl) over the course of 30 s after the free flow of cerebrospinal fluid

has been confirmed. Following the block, patients will be immediately turned to the supine position. Patients will be randomized into two groups at random following the procedure: TAP block group: A high-frequency ultrasound probe will be positioned transverse to the abdomen wall among the costal margin and iliac crest while the patient is supine, and the skin will be prepared with povidone iodine solution. The needle will be inserted into the ultrasound probe's plane right beneath the probe and progress until it reaches the plane that divides the transversus abdominis and internal oblique muscles. The probe must travel medially along the superficial path of the needle entrance point before returning to its initial position in the mid-axillary line as the needle is guided deeper. The TAP will be visualized expanding with the infusion of local anesthetic solution (appearing as a hypoechoic space), after which 2 ml of saline will be injected to check the correct needle position.<sup>8,9</sup> Each side will get an injection of a total of 20 ml (10 ml of bupivacaine 5 mg/ml and 10 ml of normal saline) (right and left). And PCA group: Each patient in this group will receive a loading dose of intravenous 5 mg nalbuphine hydrochloride. When a button is pressed, a PCA pump module can provide bolus doses of 0.5 ml with a 15-min lockout period to the patients in order to provide them with more analgesia at predetermined levels (5 ml per hour). The 100-ml PCA setup will be made up of normal saline, 1 mg of granisetron, 60 mg of ketorolac, and 40 mg of nalbuphine HCL.

#### 2.6.4. Intraoperative monitoring

Blood pressure (BP) by NIBP Electrocardiography. Oxygen saturation (spO<sub>2</sub>).

#### 2.6.5. Measurements

After surgery, patients' level of pain was calculated utilizing a visual analogue scale (VAS). Also, the patients' post-surgery nausea and vomiting, hospital stay length, length of ileus relapse following surgery, and patient satisfaction level were assessed. After surgery, patients will be monitored for 24 h. Visual analogue scale: A 10-cm linear VAS was utilized to measure each subject's level of pain, with 0 denoting 'no pain' and 10 denoting 'the most severe pain.' Scores for pain will be calculated at the time of the injection (T0). Reassessment is necessary 15 min, 2, 4, 8, 16 and 24 h following operation. The same intervals will be used to record vital signs: NIBP's measurement of blood pressure and Saturation of oxygen (spO<sub>2</sub>). Up to 24 h after the injection, any side symptoms, such as nausea, vomiting, pruritis, hypotension, bradycardia, and respiratory depression, will be observed and recorded.

#### 2.6.6. Management of breakthrough pain (analgesic consumption)

If the analgesia being used is insufficient to relieve the pain, patients from any group will receive three mg of nalbuphine intravenously as needed.

#### 2.7. Statistical analysis

The statistical program for social sciences, version 23.0 (SPSS Inc., Chicago, Illinois, USA), was utilized to analyze the data. When the distribution of the quantitative variables was parametric (normal), the data were shown as mean, standard deviation, and ranges; however, when the dispersion was non-normal, the data were expressed as

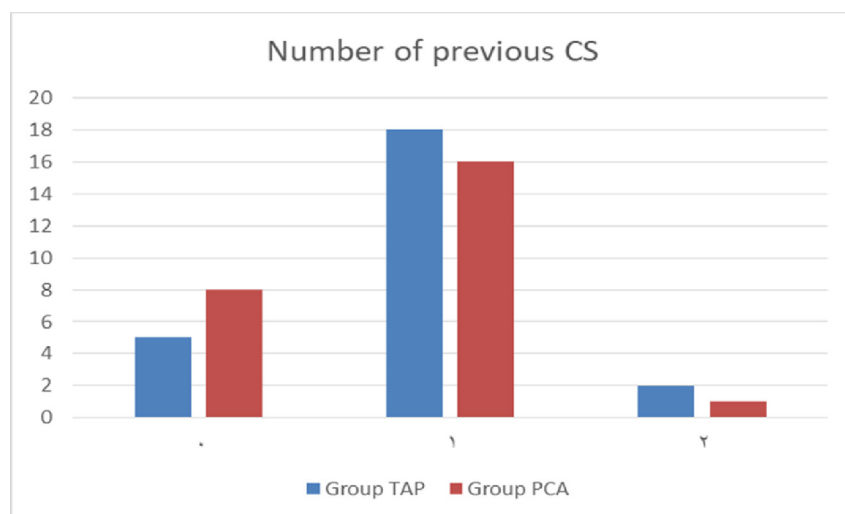


Fig. 1. Number of previous CS in both groups.

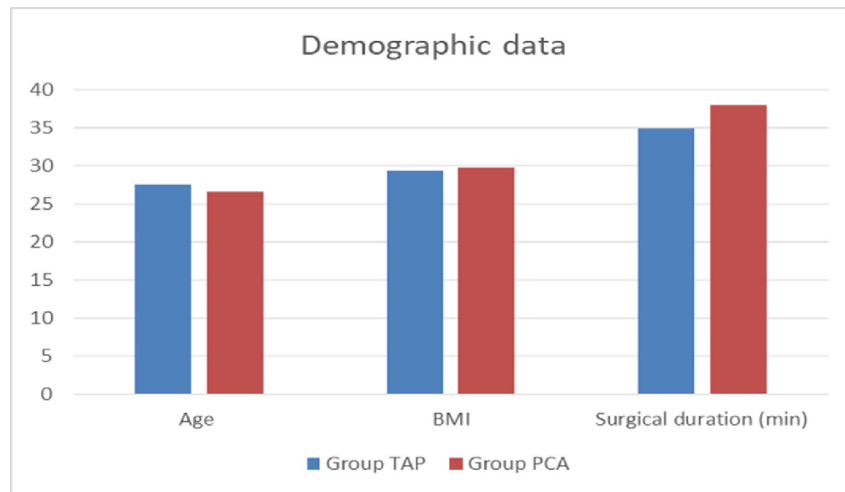


Fig. 2. Comparison of the demographic data in both groups.

median and interquartile range (IQR). Numbers and percentages also served to represent qualitative aspects. Using the Kolmogorov-Smirnov and Shapiro-Wilk tests, the data were examined for normality.

The following tests were done: For multiple-group comparisons of non-parametric data, use the Kruskal-Wallis test, and for comparisons involving more than two means, use the one-way analysis of variance (ANOVA). Tukey's test was utilized as a post-hoc technique for multiple comparisons between different variables. Two means were compared using the relevance independent-samples *t*-test. Mann For two-group comparisons in non-parametric data, use the Whitney *U* test. The Fisher's exact test and the Chi-square test were utilized solely to contrast groups using qualitative data where the predicted count in any cell was <5. The confidence interval was set at 95%, while the acceptable margin of error was set at 5%. Due to this, the following *P* value was considered significant: *P* value for likelihood *P* values under 0.05 were regarded as significant. *P* values of <0.001 were considered to be very significant. *P* values > 0.05 were regarded as unimportant.

Table 1. Comparison of the two groups based on demographic variables.

Demographic variables	Group TAP (n = 25)	Group PCA (n = 25)	<i>P</i> value
Age (year)	27.64 ± 4.49	26.61 ± 3.96	0.316
BMI [wt/(ht) <sup>2</sup> ]	29.35 ± 2.97	29.84 ± 2.57	0.567
Previous CS N (%)			0.617
0	5 (20)	8 (32)	
1	18 (72)	16 (64)	
2	2 (8)	1 (4)	
Surgical duration (min)	35 ± 11	38 ± 9	0.459

*P* value > 0.05 non-significant.

Data expressed as mean ± SD, N (%).

### 3. Results

In this research, we looked at the effectiveness of TAP block and IV PCA as postoperative analgesics after cesarean delivery. During the study period, 62 pregnant women were recruited and assessed for eligibility, based on the predefined inclusion and exclusion criteria. Of the 62 parturients, twelve were excluded for different reasons (preeclampsia = 3, inadequate spinal anesthesia = 3, analgesic protocol violation = 6) (Figs. 1 and 2, Table 1).

This table showed that demographic information, the findings of the current research showed that there were no substantial variations amongst the two groups regarding age, BMI, the length of the procedure, or the number of prior cesarean sections (*P* value > 0.05) (Fig. 3, Table 2).

The data in this table indicated that after 15 min, T2, and T4 were substantially distinct across the groups. T8, T12, and T24 values showed no substantial variations among the groups (*P* > 0.05) (Fig. 4, Table 3).

This table demonstrated that there was a substantial distinction (*P* 0.05) between the studied groups in terms of median arterial blood pressure (mmHg) after 15 min, T4 and T2. In terms of T8, T12, T0, and T24, there was not a substantial distinction among the examined groups (*P* value > 0.05) (Fig. 5, Table 4).

This table showed that there was a significance among the researched groups regarding VAS Score after (15 min), T2, and T4, T8, and T12 (*P* value < 0.001). While there was no a significance among the researched groups regarding VAS Score T0 and T24 (*P* value > 0.05) (Fig. 6, Table 5).

This table showed that there was a significance between the studied groups regarding negative

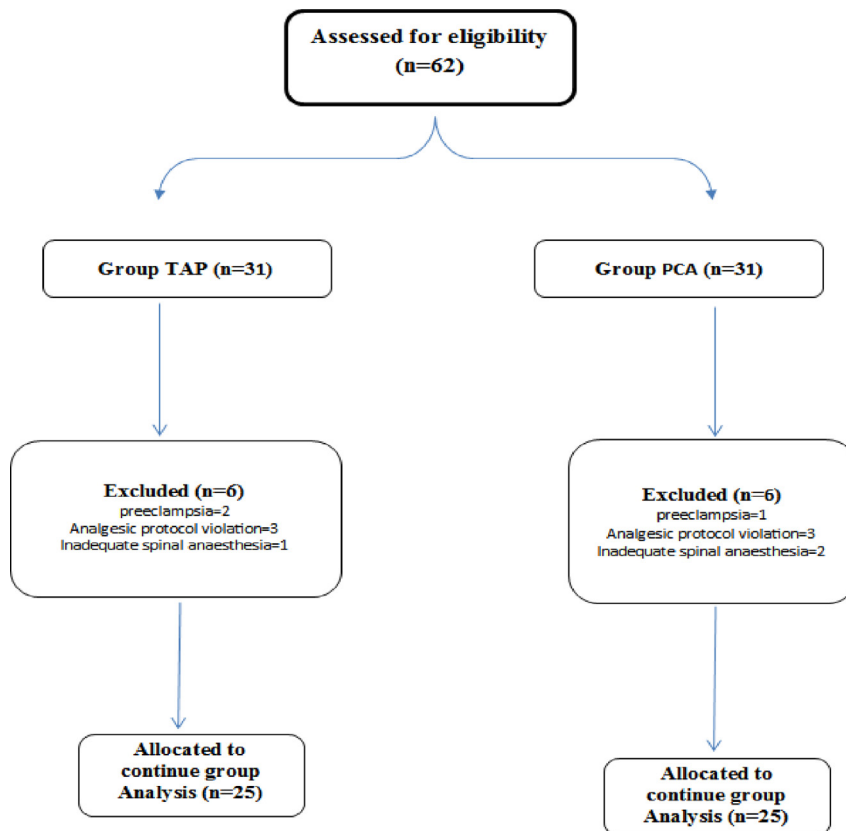


Fig. 3. Flow chart of the study process.

outcomes (Nausea, vomiting and pruritus) ( $P$  value  $< 0.01$ ). While there was no a significance between the studied groups regarding negative outcomes (hypotension and bradycardia) ( $P$  value  $> 0.05$ ) (Fig. 7).

#### 4. Discussion

In our research, 0.25% isobaric marcaine was used to reduce local anesthetic systemic toxicity (LAST).

Table 2. Comparison of study groups' heart rates (beats per minute).

Hear rate (beat/min)	Group TAP (n = 25)	Group PCA (n = 25)	P value
T0	79.81 ± 11.25	77.80 ± 11.66	0.605
After 15 (min)	68.78 ± 9.51	74.81 ± 10.98	0.0291*
T2	72.9 ± 7.6	82.3 ± 7.1	<0.001**
T4	72.8 ± 6.9	83.7 ± 6.7	<0.001**
T8	72.6 ± 9.4	74.9 ± 7.9	0.272
T12	71.6 ± 8.7	73.0 ± 9.1	0.115
T24	71.9 ± 9.2	74.9 ± 7.5	0.139

By use of F-One-Way Analysis of Variance; Tukey's test uses several comparisons across groups and is a PostHoc test.

There are substantial variations between the values in each row with various letter values at ( $P$  0.05).

$P$  value  $> 0.05$  NS.

\* $<0.05$  S.

\*\* $<0.001$  HS.

Marcaine was injected in an amount of 10 ml, and saline was injected in an amount of 10 ml. A systemic threshold can be exceeded by local anesthesia toxicity in truncal regional anesthesia blocks. Rahiri et al. supported this in a current meta-analysis by assessing the systemic local anesthetic levels after perioperative single-shot TAP or rectus sheath block, Rahiri et al. They revealed that 8.6% of cases had systemic amounts over the LAST threshold, which is a commonly recognized limit.<sup>10</sup>

Finding a compromise among using a LA, which offers efficient analgesia while reducing the danger of LAST, is a challenge for anesthesiologists. Because of physiologic changes brought on by higher sensitivity, pregnancy can result in an increased risk of LAST. Nonetheless, it is possible to explain lower protein binding, increased heart activity, vascularity, and tissue blood flow, as well as enhanced neuronal vulnerability to LA. TAP block for CS requires the injection of considerable doses of local anesthetic agent bilaterally in such a high vascular location due to the effects of pregnancy.<sup>11</sup>

The findings of the present research demonstrated that, despite the fact that pain perception levels (as assessed by the VAS) declined in both groups within the first 24 h after operation, the PCA group's VAS

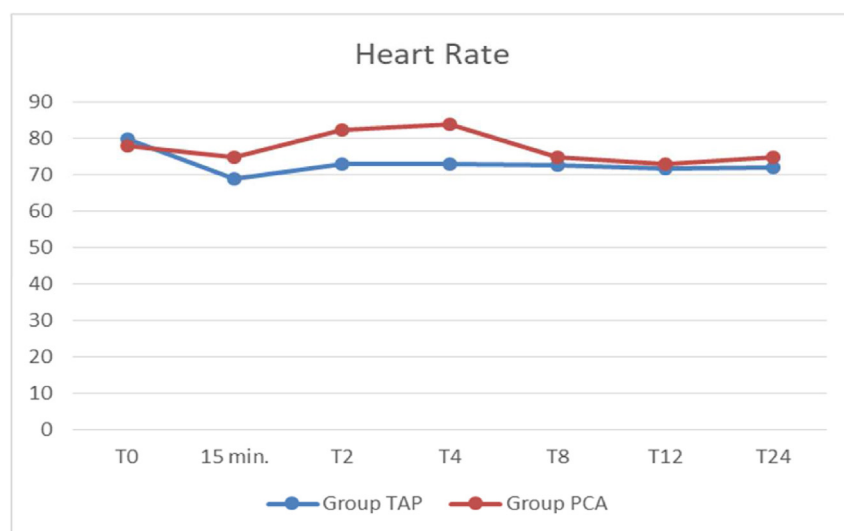


Fig. 4. Comparison of study groups' heart rates (beats per minute).

values were substantially lower than those of the TAP block group's (group A). The TAP block for acute pain relief after CS was evaluated and compared to standard or control practice in the meta-analysis performed by Champaneria et al. The study found that TAP block was more efficient than control for both pain while resting and pain when moving, i.e., it considerably reduced pain while resting when compared to control or no TAP block.<sup>12</sup>

In order to examine the efficiency of high doses of TAP block vs. low doses, Ng et al. undertook a meta-analysis in 2018. Their meta-analysis's findings revealed that postoperative analgesia and opioid-sparing impacts were similar in both groups (low and high dose groups) in terms of opioid intake, time to first request, and 24-h pain levels. As a

consequence, it was established that local anesthesia would not provide any extra advantages over a certain dose threshold. Additionally, post-cesarean TAP block methods using modest dosages may decrease the possibility of local anesthetic toxicity while preserving analgesic effectiveness.<sup>11</sup> This is consistent with what we discovered.

Those in our research who got IV PCA (group B) had substantially lower pain ratings at 2, 4, and 6 h than those in the TAP block (group A). Nalbuphine has been used in place of morphine to decrease the well-known adverse impacts of that drug, such as itching, respiratory depression, and postoperative nausea and vomiting. However, the respiratory depression that nalbuphine causes as both an antagonist and an agonist has a ceiling effect, making it less dangerous than morphine. The frequency of adverse effects, including pruritus and PONV, decreases while using nalbuphine as opposed to morphine. Yeh et al. utilized a variety of morphine and nalbuphine combinations in patients having open gynecological surgeries and showed no variation in PCA requirements during the time following surgery.<sup>13</sup>

In contrast to TAP block, which solely affects the anterior abdominal wall's somatic pain, the systemic effects of PCA drug combinations on visceral pain may account for PCA's benefit over TAP block in terms of pain reduction and patient satisfaction.

Contrary to our findings, Erbabacan et al. came to the conclusion that intravenous PCA and 30 ml of TAP block are equally efficient in relieving pain after lower abdominal operations. Also, a comparison of TAP block and IV PCA showed that the former is seen as a better strategy since it can prevent the systemic effects of morphine utilized in

Table 3. Comparison of the median arterial blood pressure (in mmHg) among the groups under investigation.

Median arterial blood pressure (mmHg)	Group TAP (n = 25)	Group PCA (n = 25)	P value
T0	85.09 ± 7.86	84.21 ± 5.47	0.605
After 15 (min)	78.88 ± 9.51	81.06 ± 5.28	0.0291*
T2	80.74 ± 5.04	78.34 ± 3.99	<0.001**
T4	88.10 ± 5.70	84.44 ± 6.14	<0.001**
T8	76.19 ± 7.1	83.13 ± 6.42	0.272
T12	78.71 ± 6.15	75.28 ± 7.45	0.015*
T24	78.48 ± 5.67	75.88 ± 4.97	0.139

By use of F-One-Way Analysis of Variance.

Tukey's test uses several comparisons across groups and is a PostHoc test.

There are substantial variations between the values in each row with various letter values at (P 0.05).

P value > 0.05 NS.

\*<0.05 S.

\*\*<0.001 HS.

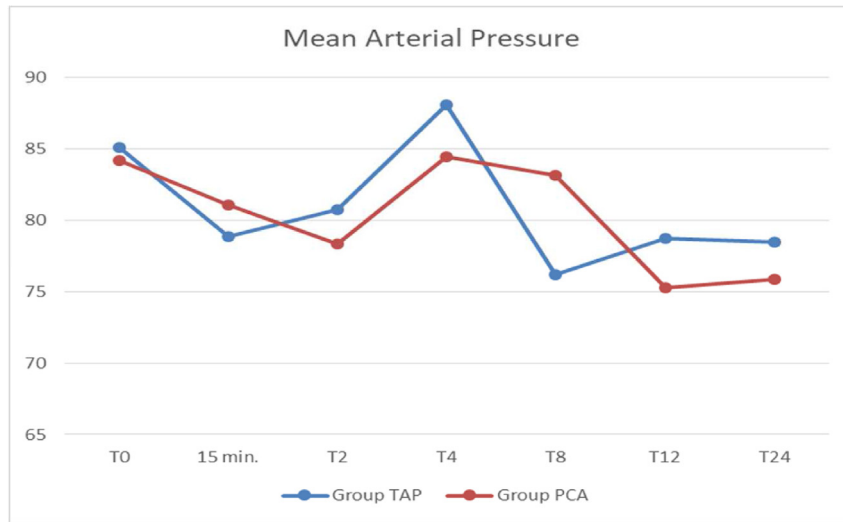


Fig. 5. Comparison of the median arterial blood pressure (mmHg) of the investigated groups.

Table 4. VAS score comparison between the investigated groups.

VAS S	Group TAP (n = 25)	Group PCA (n = 25)	P value
T0	3.06 ± 0.84	2.26 ± 0.86	0.105
After 15 (min)	2.41 ± 0.76	2.18 ± 0.73	0.029*
T2	4.56 ± 1.44	3.12 ± 0.78	<0.001**
T4	3.06 ± 1.21	2.37 ± 0.71	<0.001**
T8	3.90 ± 1.22	1.46 ± 0.43	<0.001**
T12	2.72 ± 0.99	1.12 ± 0.25	<0.001**
T24	2.53 ± 1.08	1.23 ± 0.39	0.139

Using: H=Kruskal Wallis test; several group comparisons are made utilizing the Mann-Whitney test.

There are substantial variations between the values in each row with various letter values at (P 0.05).

P value > 0.05 NS.

\*<0.05 S.

\*\*<0.001 HS.

PCA and because its analgesic impact begins earlier.<sup>14</sup> This study, however, focused on lower abdominal procedures rather than CS, which do not include the discomfort from postpartum uterine contractions.<sup>14</sup>

Table 5. Comparison of the researched groups based on negative outcomes.

Negative outcomes	Group TAP (n = 25)	Group PCA (n = 25)	P value
Hypotension	5 (20)	3 (12)	0.105
Bradycardia	2 (8)	6 (24)	0.129
Nausea	8 (32)	11 (44)	<0.01*
Vomiting	3 (12)	9 (36)	<0.01*
Pruritus	1 (4)	5 (20)	<0.01*

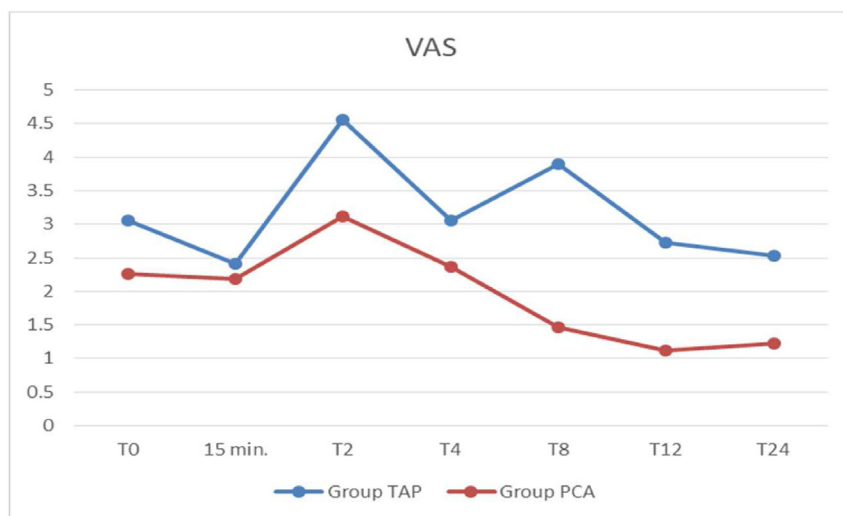


Fig. 6. VAS score comparison between the investigated groups.



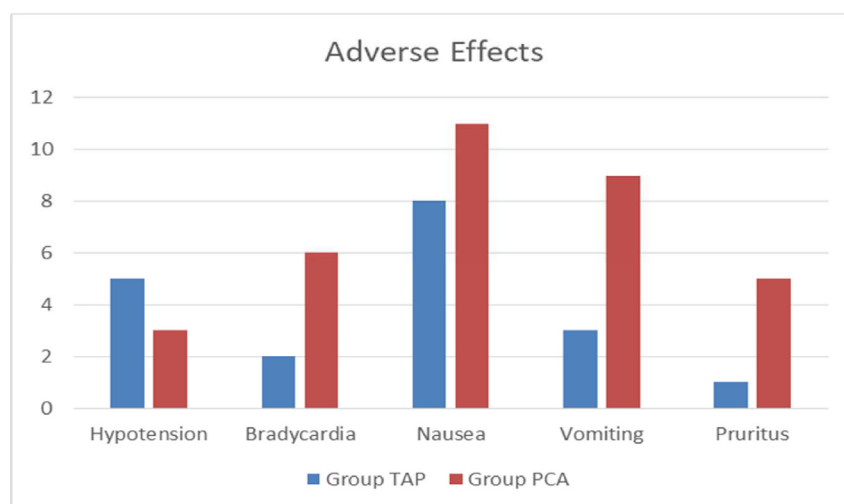


Fig. 7. Comparison of the researched groups based on negative outcomes.

According to the study's findings, the TAP group's heart rate was substantially lower than the PCA group's after 15 min, 2 h, and 4 h. There were no statistically substantial variations between the two groups in the subsequent recordings ( $P > 0.05$ ). This might be because nalbuphine, which is used in IV PCA, has a vasodilator effect. Thus, our findings support the conclusions made by Erbabacan et al. that the TAP block group's heart rate readings were significantly lower than those of the PCA group. Yet, this can be linked to patients experiencing less pain and less sympathetic system activity. Although there was no substantial variation in the median values of arterial pressure, the findings do not support this impact; however, this impact can be related to the vasodilation impact of the morphine utilized in PCA.<sup>14</sup> Notwithstanding this statistical conclusion, clinical observation revealed no impact on the patients' overall health and no impact on the women.<sup>14</sup>

When compared to women in 'group TAP,' nausea and vomiting were noted to be substantially more common in 'group PCA.' This variation might be due to the nalbuphine dosage used in the PCA group. It has been shown that postoperative nausea, vomiting, and antiemetic needs have decreased. Salem et al. showed that women in group B had nausea and vomiting at much higher rates than women in group A. This variation might be due to the nalbuphine dosage used in the PCA group. It has been shown that postoperative nausea, vomiting, and antiemetic needs have decreased.<sup>15</sup> However, Abouhi et al. claimed that there were statistically substantial variations in the prevalence of nausea and vomiting among the research groups.<sup>16</sup> Whereas Mohamed et al. demonstrated that after the first hour of follow-up, women in the IV PCA group had

substantially higher levels of nausea and vomiting than women in the TAP Block group.<sup>17</sup>

Siddiqui et al. noted no statistically significant decrease in nausea score in a meta-analysis to assess the clinical benefit of TAP block on nausea alone, which is in contrast to our findings. However, the various doses that were employed could be to blame for this nausea score in a meta-analysis to assess the clinical benefit of TAP block on nausea alone, which is in contrast to our findings.<sup>18</sup> However, the various doses that were employed could be to blame for this.<sup>18</sup> Similar to this, Mäkelä et al. revealed that IV PCA cases had elevated nausea at 4 h and elevated vomiting at 8 h after taking oxycodone, a drug that has an emetic effect.<sup>19</sup>

The reason why those studies' findings diverged from ours is that they used different doses than what we did in our investigation.

#### 4.1. Conclusion

This study indicated that following a caesarean section, both groups demonstrated effective postoperative pain management. Additionally, the lower VAS recordings in the PCA group showed that PCA was more effective than TAP block at reducing postoperative pain. In terms of respiratory depression, hypotension, and bradycardia, neither group experienced any major problems. Postsurgical nausea and vomiting were more frequent in the PCA group.

#### Authorship

All authors have a substantial contribution to the article.

## Disclosure

The authors have no financial interest to declare in relation to the content of this article.

## Conflicts of interest

The authors declared that there were no conflicts of interest.

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