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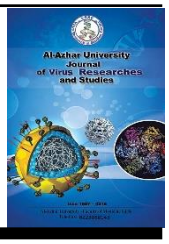

Analgesic Effect of Erector Spinae Plane Block versus Transversus Abdominis Plane Block After Elective Cesarean Section

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Abstract

To evaluate the pain severity level of Erector Spinae Plane (ESP) block compared to Transversus Abdominis Plane (TAP) block after elective cesarean section. This study enrolled sixty women aged 21-40 years with American Society of Anesthesiologists (ASA) II or III, scheduled for elective cesarean section receiving intrathecal anesthesia without analgesia. US-guided bilateral ESP or TAP block using ultrasound with injection of 20ml bupivacaine 0.25% at the end of surgery after skin closure. Pain severity was the primary outcome and secondary outcome included the first request of analgesia, the total dose of analgesic consumption, any complication and patient satisfaction. Visual analogue score was statistically significant lower in the ESP group. The mean time to first rescue analgesia was 12.43 ± 0.98 hr and 22.42 ± 1.28 hr in TAP group and ESP group, respectively, with (p < .001) and the 24h postoperative analgesic consumption was significantly lower in ESP group than TAP group with median (10mg vs 30mg) pethidine over 24h. Patient satisfaction was significantly higher in the ESP group. No adverse effects or complications were observed in our study. In this study, comparable postoperative pain relief was provided by US-guided bilateral ESP and TAP block, ESP block was associated with longer duration of analgesia, lower VAS pain score at rest and at movement, and lower total pethidine consumption during the first 24h compared to TAP block.

Keywords: Erector spinae plane block, Transversus abdominis plane block, Cesarean section, Ultrasound

1. Introduction

Cesarean section (CS) is a common procedure that has been growing worldwide over the past few decades [1]. Therefore, more interest is growing to achieve better perioperative management and outcome of CS in form of enhanced recovery after surgery (ERAS) concept [2]. Effective analgesia allows early

mobilization, increases breastfeeding success, and fast recovery; it reduces hospital stay, costs and indeed a comfort to surgeons and increases the overall patient satisfaction [3,4].

Systemic opioid is commonly used as one of the pain control approaches, however, there are side effects such as pruritus, nausea, and vomiting.5 Peripheral nerve blocks have become vital for multimodal opioid-sparing analgesia in a multitude of surgical procedures. [6]. Transversus abdominis plane (TAP) block is a common procedure, and it has been shown to provide effective postoperative analgesia for different types of lower abdominal surgeries including the CS [7-9]. TAP block is a regional injection of local anesthetic (LA) between the transversus abdominis muscle (TAM) and internal oblique muscle (IOM) planes at which the sensory nerves of the anterolateral abdominal wall; intercostal (T6-T11), subcostal (T12), and ilioinguinal/iliohypogastric nerves (L1) that innervate the abdomen will blocked**.**

Erector Spinae Plane (ESP) block is a novel interfascial plane block that allows LA dispersion into the interfascial plane between the transverse process (TP) and the erector spinae muscles (ESM) that its first use was for the treatment of chronic pain, [10] but recently it has been used as a postoperative regional analgesia technique in different surgeries from the shoulder to hip regions [11,12]. The aim of this study was to evaluate the analgesic effect of ultrasound (US) guided ESP block compared to TAP block as postoperative analgesia after elective CS under spinal anesthesia by using the visual analogue scale (VAS) to evaluate the pain severity as a primary outcome.

2. Patients and Methods

This prospective, randomized, single-blinded, controlled study was approved by the ethical committee of Al-Azhar Faculty of Medicine, Al-Zahraa University Hospital and performed in accordance with the Declaration of Helsinki. Written informed consent was obtained from all study participants.

2.1 Inclusion criteria:

Sixty parturient with the age range of 21-40 years with American Society of Anesthesiologists (ASA) II or III, were scheduled for elective CS. All parturient were anesthetized by intrathecal anesthesia without analgesia in this study. The design of the study adheres to the CONSORT guidelines.

2.2 Exclusion criteria:

- Patients with coagulopathy
- Peripheral vascular diseases
- Sickle cell anemia
- Cardiac, Renal, or Hepatic disease**.**
- Chronic pain medication
- Any neurological disease
- History of sensitivity to LA
- Psychiatric disease
- Failed spinal anesthesia
- Patient refusal
- Infection at the site of injection
- Patients with ASA > III
- Body mass index (BMI) > 35**.**

Patients were randomly divided using computer-generated random numbers that were placed in separate opaque envelopes into two groups: ESP and TAP, with 30 patients in each group **.**

Preoperative assessment was done for all included patients and premedication in form of 50mg ranitidine intravenous (IV) was given and 10-15ml/kg of ringer lactate solution was infused over 15min as a preload. The monitor was attached to the patients in the form of blood pressure,

electrocardiogram (ECG), and pulse oximeter. Spinal anesthesia was performed into the L3-4 or L4-5 interspaces with a 25-gauge spinal needle with the patient in a sitting position and 12.5mg hyperbaric bupivacaine 0.5% was slowly injected for both groups. Then, the patient was placed in the supine position with left uterine displacement. CS was performed in the usual manner and then the patients were transferred postoperative into the postanesthetic care unit (PACU) where the block was performed **.**

All blocks were done by the same anesthesiologist and using Sono Scape A5 US machine (China) with a linear array US transducer probe (5- 10 MHz) and the 20-G short bevel needle (Visioplex, Ecouen, France) that used for injection of 20ml 0.25% bupivacaine bilaterally in each group**.**

US-guided TAP block was performed after proper skin sterilization and the patient in the supine position, the probe was placed transversally on the anterolateral abdominal wall in the midaxillary line between the iliac crest and the costal margin identifying the TAP that is between IOM and TAM where 20ml 0.25% bupivacaine was injected bilaterally in each side. While US-guided ESP block was performed with the patient in the lateral position, the vertebrae were counted from cephalad to caudal direction until the T9 spinous process was reached, and at this level using the US, the probe was placed vertically 3cm lateral to the midline to visualize the back muscles (trapezius and ESM) superior to the TP where 20 ml 0.25% bupivacaine was injected bilaterally in each side**.**

Administration of IV analgesia was considered when Visual Analog Scale (VAS >4) was observed by a qualified nurse. Pethidine 10mg was given IV and another VAS assessment was done after 3min. If the patient was still in pain, a repeated dose of pethidine was given until patient satisfaction was reached. Assessment parameters in PACU included the following: VAS at rest and movement at 2hr, 4hr, 8hr, 12hr, and 24hr that was used to assess the pain severity, the time of the first request of analgesia, the total dose of analgesic consumption in the first 24hr after the surgery, the frequency of analgesic request , hemodynamic state; mean arterial blood pressure (MAP), heart rate (HR), peripheral oxygen saturation (SpO2), any complications, and patient satisfaction**.**

The overall patient satisfaction with analgesia was assessed 24hr after CS: using four-point scale judged by each patient [13] as follow: Poor = 1 (not satisfied) (unsuccessful block), Fair = 2 (not much satisfaction) (required analgesic supplementation), Good = 3 (satisfaction) (complaint but no analgesic supplementation) and Excellent = 4 (no complaint).

2.3 Statistical analysis

The required sample size was calculated using the MEDCALC 16.4 version software. Based on previous reports [14–16] the mean time difference for rescue analgesia administration was 3hr between the two groups. The minimum sample size was 36 patients to get a power level of .80, an alpha level of .05 (two-tailed). 60 patients were enrolled for compensation for any drop out of patients**.**

Data were collected, revised, coded, and entered into the Statistical Package for Social Science (SPSS Inc., Chicago, IL, USA, version 21). The Kolmogorov-Smirnov test was used to check the normality of data. The quantitative data were presented as mean, standard deviations, and ranges, when their distribution found normal while not normally distributed data, were presented as median with inter-quartile range (IQR). Also, qualitative variables were presented as numbers and percentages. The comparison between groups with qualitative data was done by using the Chi-

square test. The comparison between two independent groups with quantitative data and normal distribution was done by using an independent t-test while for not normal distribution, the Mann–Whitney U-test was used as a test of significance**.**

The time-to-event variables were evaluated using the Kaplan-Meier method, and the Log-rank test was used to compare the groups. A two-sided ($p < .05$) was considered statistically significant. Bonferroni correction was used for the analysis of VAS score, statistical significance was adjusted to ($p < .01$), as there were multiple measurements from 5-time points.

2.4 Patient preparation:

Personal Control of any coexisting medical disease, and prophylactic antibiotic with induction of anesthesia.

3. Results

Thirty women were enrolled in each group (Figure 1). There was no significant difference between groups in age, height, weight, duration of surgery, ASA, and parity between both groups as shown in Table 1.

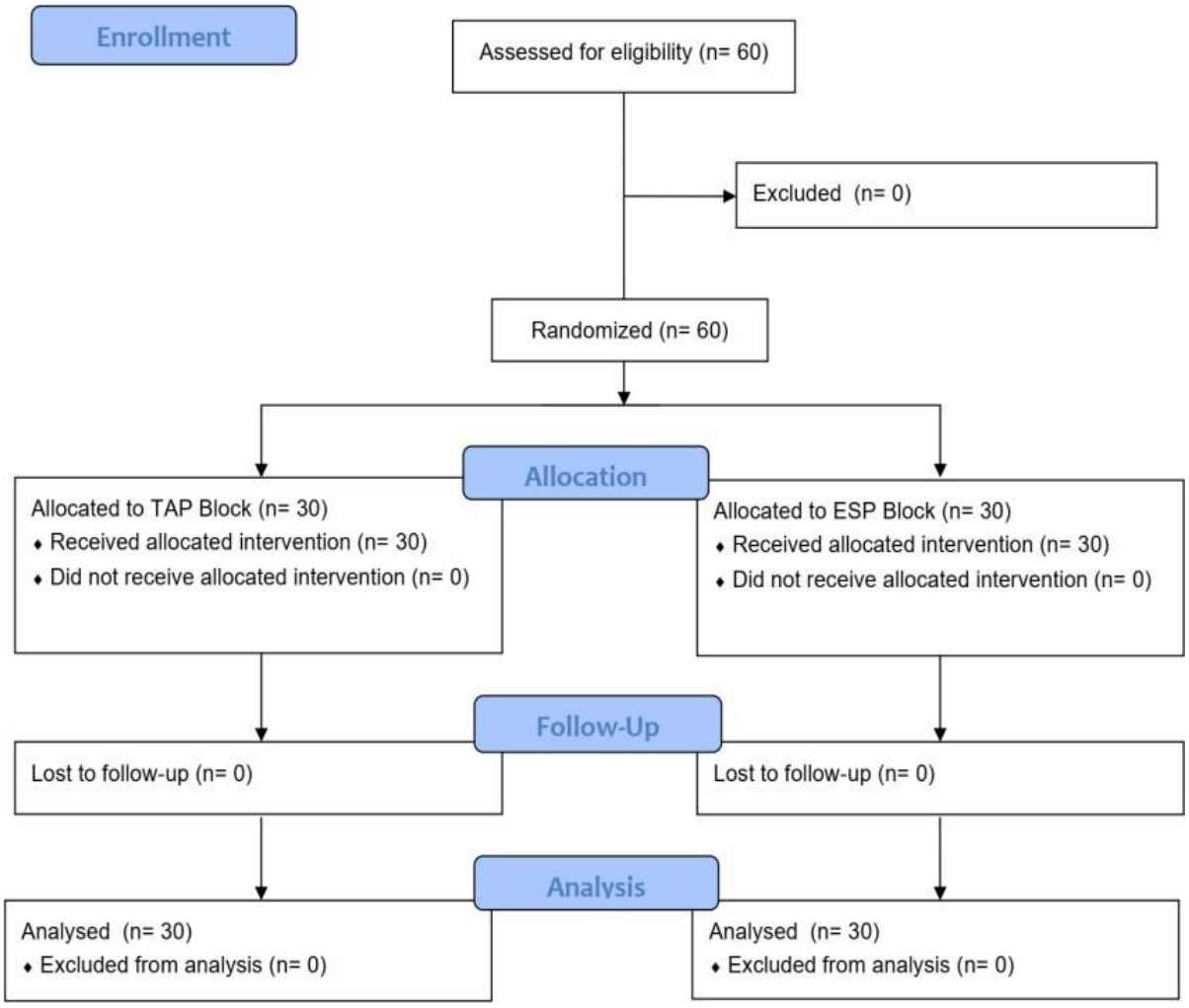

Figure (1): Overview of SLNB. SLNB = sentinel lymph node biopsy; SLN = sentinel lymph node; non-SLN = non-sentinel lymph node.

Table (1): Demographic and characteristic data of the patients included in the study.

Data	TAP (N=30)		ESP (N=30)		p
	Mean	SD	Mean	SD	
Age (year)	27.87	3.309	28.43	2.897	.483
Weight (kg)	69.43	7.610	69.17	8.542	.899
Height (cm)	163.40	5.43	164.70	5.32	.308
Duration of Surgery (min)	49.27	5.600	50.33	5.490	.462
	N (%)		N (%)		p
Previous Caesarean					
0	10 (33.3%)		5 (16.7%)		.673
1	5 (16.7%)		7 (23.3%)		
2	7 (23.3%)		8 (26.7%)		
3	6 (20%)		7 (23.3%)		
4	2 (6.7%)		3 (10%)		
ASA, N (%)					
II	22 (73.4%)		26 (86.6%)		.193
III	8 (26.6%)		4 (13.4%)		

Variables are presented as mean ± standard deviation (SD) or Number and present. **P > .05: Non- significant, P < .05: Significant, P < .01: Highly significant.* ASA: American society of anesthesiology; ESP: erector spinae plane; TAP: transversus abdominus plane; *t*: t-independent test; N: number; x^2: Chi-square test.

3.1 Visual Analog Scale:

VAS score was not statistically significantly difference at 2h and 4h postoperatively between the two groups, however, VAS score was significantly lower in ESP group than in TAP group at 8hr, 12hr, and 24hr at rest and at movement as ($p < .001$) as shown in Figure 2 and Figure 3.8.

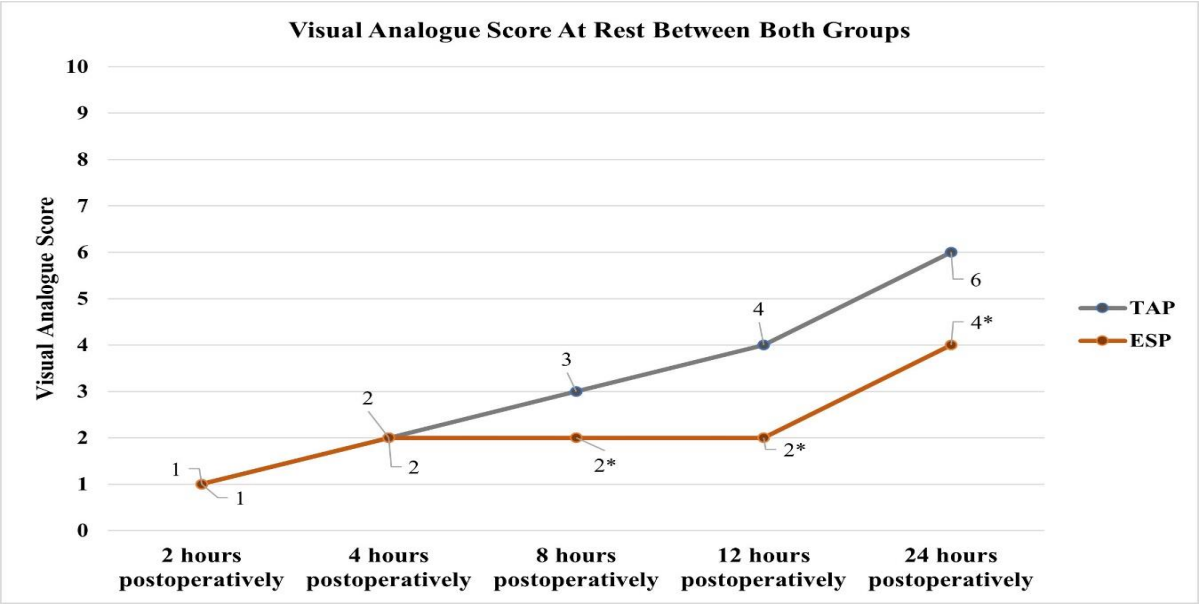

Figure (2): Visual analogue score at rest in both groups. Asterisk means that VAS score was significantly lower in ESP group than in TAP group at 8hr, 12hr, and 24hr at rest.

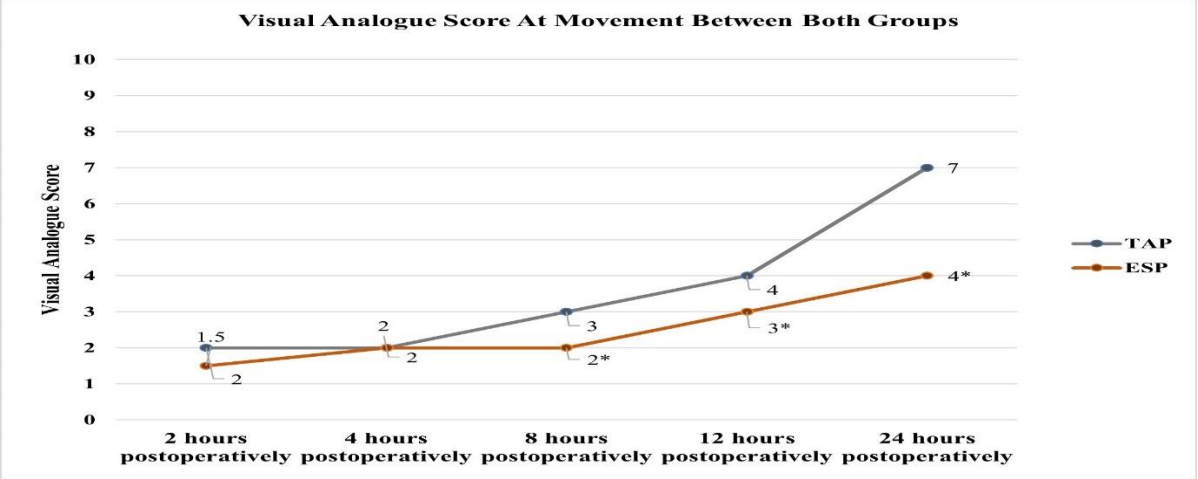

Figure (3): Visual analogue score at movement in both groups. Asterisk means that VAS score was significantly lower in ESP group than in TAP group at 8hr, 12hr, and 24hr at movement.

3.2 Visual Analog Scale:

Hemodynamic states were assessed at preoperative and intraoperatively at every 10min till the end of the CS and at 2hr, 4hr, and 6hr postoperatively. No significant difference was observed between ESP and TAP groups in HR, MAP, and SpO2 at preoperative, intraoperative and postoperative as ($p > .05$).

3.3 Duration and First rescue analgesia:

The mean time to first rescue analgesia was significantly longer in ESP group than in the TAP group with mean 22.42 ± 1.28 hr and 12.43 ± 0.98 hr, in the ESP and TAP groups, respectively with ($p < .001$). Duration of analgesia was statistically longer in the ESP group with log-rank $x2(1) = 70.507$, ($p < .005$) as shown in Figure 4.

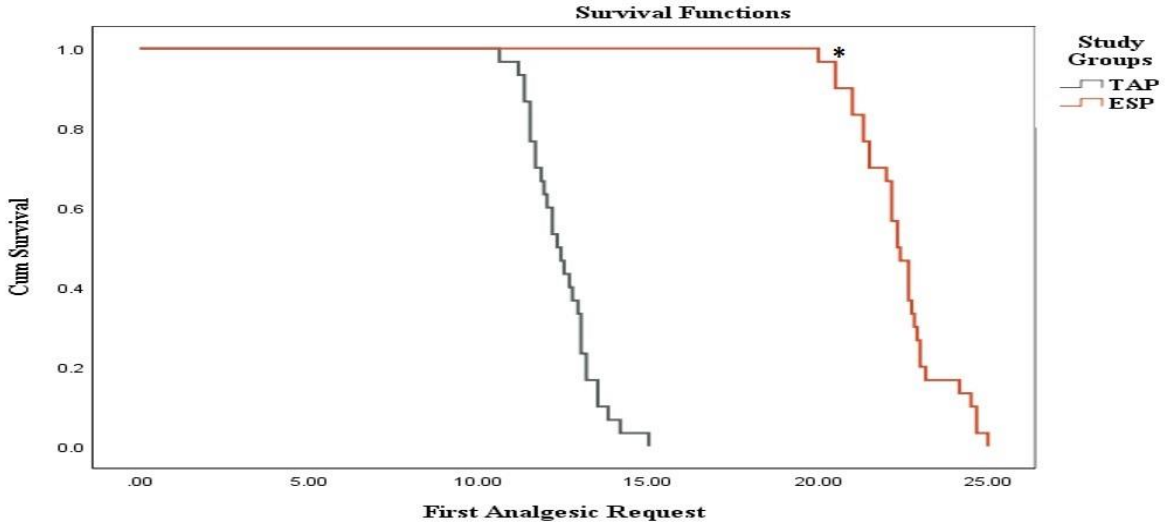

Figure (4): Time to first analgesic request over the time period. The figure shows that duration of analgesia was statistically longer in the ESP group than TAP group.

3.4 Frequency of analgesic doses and total analgesic consumption:

The 24hr postoperative analgesic consumption was significantly lower in the ESP group with ($p < .001$) as shown in Table 2. The frequency of analgesic doses of postoperative 24hr analgesic consumption was significantly higher in the TAP group with ($p < .001$) as shown in Table 2.

3.5 Patient satisfaction and complications:

The overall patient satisfaction 24hr after CS was significantly higher in the ESP group with ($p < .001$) (Table 2). No adverse effects or complications were observed in our study.

Table (2): Comparison between both groups regarding the total consumption of analgesia, frequency of analgesic doses and patient satisfaction.

	TAP (N=30)	**ESP (N=30)**	**p**
Total consumption of pethidine (mg) in 24h, median (IQR)	30 (40-30)	10 (20-10)	< .001*
	N (%)	**N (%)**	
Number of analgesic doses	**TAP (N=30)**	**ESP (N=30)**	**p**
0 dose	0 (0%)	5 (16.7%)	< .001*
1 dose	0 (0%)	15 (50%)	
2 doses	1 (3.3%)	10 (33.3%)	
3 doses	17 (56.7%)	0 (0%)	
4 doses	11 (36.7%)	0 (0%)	
5 doses	1 (3.3%)	0 (0%)	
	N (%)	**N (%)**	
Patient satisfaction	**TAP (N=30)**	**ESP (N=30)**	**p**
Poor	0 (0%)	0 (0%)	< .001*
Fair	5 (16.7%)	0 (0%)	
Good	16 (53.3%)	6 (20%)	
Excellent	9 (20%)	24 (80%)	

4. Discussion

ESP is a recent technique that was first described for post-thoracotomy pain management [10]. It is a simple, safe and effective technique that was found to have an efficient postoperative analgesic effect for various surgeries such as breast, [17] thoracic [18,19] cardiac [20,21] renal transplantation [22] cholecystectomy [23] inguinal hernia, [24] hip [25] and spine surgeries [26]. Its advantage over the TAP block is that in the ESP block, the spread of LA was observed to diffuse into the paravertebral space, thus, dorsal and ventral rami of spinal nerves were blocked and both somatic and visceral blockade were achieved. Moreover, a recent cadaveric study reported that craniocaudal spreading of LA was observed within the 3-6 vertebral levels from the injection site [27]. In this study, we included 60 patients classified into two groups comparing the postoperative analgesic efficacy and safety of US-guided ESP block with TAP block in women undergone elective CS receiving intrathecal anesthesia**.** Regarding the pain severity, the current study found that VAS score was not significant difference at 2h and 4h postoperatively that assessed at rest

and at movement, however, VAS score was highly significantly lower in the ESP at 8hr, 12hr, 24hr postoperatively which suggests that the ESP block has a superior analgesic effect than TAP block. Interestingly, this is supported by the observation of Boules et al [28] in which 60 patients had ASA II and were scheduled for elective CS under spinal anesthesia, 30 patients in each group of ESP and TAP, respectively and 20ml bupivacaine 0.25% was used. They agreed with our study that ESP has a significantly lower VAS score at 8hr and 12hr ($p < .0001$) compared to the TAP group. In addition, there was not statistically significant between both groups in the VAS score at other times; PACU, 2hr, 4hr ($p > .05$). In contrast to our result, there was not statistically significant between both groups in the VAS score at 24h postoperative **.**

Malawat et al, [29] at which they randomly enrolled 60 patients who had ASA I, II, or III and were scheduled for elective CS under spinal anesthesia, 30 patients in each group of ESP and TAP, respectively that received 0.2% ropivacaine 0.2ml/kg was injected. They agreed with our results that VAS was significantly lower in the ESP group than in the TAP group at 12h, and 24h postoperatively. In contrast to our result, VAS score was statistically significant lower in ESP group than TAP group 2h, and 4h postoperative. In addition, VAS score was statistically significant lower in ESP group than TAP group at 36h, and 48h postoperative. In parallel to the previous study, Hamed et al [26] found that the VAS score was significantly lower in the ESP group for the first 12hr postoperatively in women undergoing abdominal hysterectomy using 20ml bupivacaine 0.25% that was used bilaterally compared with a control group using 20ml saline **.**

In the current study, the time to first rescue analgesia was significantly longer in ESP group than TAP group with mean time (22.42hr vs 12.43hr). These results are consistent with Malawat et al, [25] as they found that the mean time to first rescue analgesia was much longer in the ESP group with a mean of (43.53hr vs 12.07hr) than in TAP group. Moreover, Boules et al [28] agreed with our results as they found that the mean time to first rescue analgesia was significantly longer in ESP group with mean time (12hr vs 8hr) than in TAP group**.** The current study is consistent with the result of Eslamian et al, [31] a meta-analysis of 17 studies reported that US-guided TAP was associated with significantly longer duration to first rescue analgesia compared with control groups (placebo or no block). In agreement with the current study, Hamed et al, [30] found that ESP block lasted for 12hr in women undergoing abdominal hysterectomy using 20ml bupivacaine 0.25% that was used bilaterally compared with a control group using 20ml saline**.**

In the current study, total analgesic consumption was highly significantly lower in the ESP group than in the TAP group. Malawat et al, [25] which agreed with our results, however, they used diclofenac 75mg as a bolus dose. The mean analgesic consumption in the first 48hr was (55mg vs 292.5mg) diclofenac in the ESP group compared to into the TAP group. The result is in agreement with Boules et al [28], who used tramadol with a 20mg dose, 10min lockout interval, and 1hr limit of 50mg, without a background dose. Total analgesic consumption was significantly lower in the ESP group with a median of 100mg pethidine than the TAP group with a median of 125mg pethidine, ($p < .001$). Hamed et al18, found that total fentanyl consumption in the first 24hr was significantly lower in the ESP block group with a mean of (445mcg vs 485mcg) compared with a control group. In contrast to McKeen et al,20 a study using TAP block with 20ml of 0.25% ropivacaine after CS reported that at the first 24h, no significant difference of opioid consumption was observed among groups with mean opioid (15.5mg, 13.4mg) in TAP and control group, respectively**.**

In our study, patient satisfaction was significantly higher in the ESP group than TAP group which is in contrast to Boules et al15 that reported no significant difference

in patient satisfaction between TAP and ESP groups. Regarding complication or adverse effects, neither were observed in the current study in the two groups which is in agreement with the previous studies [28, 29].

5. Limitation

The current study has some limitation as dermatomal level and spread of LA in ESP need more investigation. Also, more trials are warranted in order to compare the efficacy of both ESP and TAP block as postoperative CS analgesic management. The effect of various drugs additive to the LA are needed to be addressed in the future.

6. Conclusion

In conclusion, US-guided bilateral ESP block was associated with longer duration of analgesia, lower VAS pain score at rest and at movement, and lower consumption of pethidine during the first 24h when compared to US-guided bilateral TAP block.

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