

How to Cite:

Rasmy, I., Badr, E. M., Embaby, S. A., Zakaria, H., Wedad, M., & Fawzy, D. (2022). Unilateral erector spinae plane block versus intravenous morphine for postoperative analgesia after Percutaneous nephrolithotomy. A randomized controlled trial. *International Journal of Health Sciences*, 6(S4), 1551–1563. <https://doi.org/10.53730/ijhs.v6nS4.6282>

Unilateral erector spinae plane block versus intravenous morphine for postoperative analgesia after Percutaneous nephrolithotomy. A randomized controlled trial

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Abstract---Pain is an everyday challenge during all surgeries and it is a chief postoperative complication, so pain management is a corner stone in anesthetic practice. Percutaneous nephrolithotomy PCNL surgeries are usually associated with acute postoperative pain. Ultrasound guided nerve block is considered a recent technique for pain management. It provides better visualization of the nerves and reduces the risk for complications e.g. unintended injury to adjacent structures. Erector spinae plane (ESP) block is a novel method of delivering postoperative analgesia after PCNL surgery, technique involves injecting local anaesthetic into the interfascial plane between

the erector spinae muscle and the transverse processes, and is therefore devoid of major adverse effects like pneumothorax, spinal cord trauma, and hypotension that can occur with other types of blocks like thoracic paravertebral block (TPVB). The goal of this research was to determine the analgesic efficacy and safety of ultrasound-guided ESP block done at T8 transverse process level in patients undergoing PCNL surgeries for intraoperative and postoperative analgesia. After receiving ethics committee permission and signed patient agreement, the study was conducted at Kasr Al-Ainy Teaching Hospital from September 2019 to December 2020. A total of 44 adult ASA I-II patients, ranging in age from 18 to 65 years, were involved in the study. Patients were sorted into two equal groups, each with 22 patients, based on the following inclusion and exclusion criteria: Group E, ESP group (n=22): After induction of general anaesthesia, patients got an ultrasound guided ESP block prior to surgical incision. Group C, Control group (n=22): Patients were given general anaesthesia without ESP block before to surgical incision. The study's main conclusion was that an ultrasound-guided ESP block at the level of the T8 transverse process has a satisfactory analgesic effect in patients undergoing PCNL surgery, as follows: • In compared to the control group, the overall amount of postoperative morphine use was reduced. • The period between the initial request for analgesia was extended (duration of analgesia).

Keywords---ESP block, Intravenous morphine, Postoperative analgesia, Percutaneous nephrolithotomy, Ultrasound.

Introduction

The visceral pain from the kidneys and ureters, as well as the somatic pain from the incision site, are the main sources of acute pain following PCNL. Renal pain is passed on by the T10–L1 spinal neurons, ureter pain is transmitted via the T10–L2 spinal nerves, and the skin incision site is largely innervated by the T8–T12 spinal nerves (as the incision site and tract for PCNL is usually performed in the tenth to eleventh intercostal space, or in the subcostal area) (Liu et al., 2016)

In thoracic and abdominal surgery, the erector spinae plane block (ESPB) provides good postoperative analgesia. The ESPB is a basic fascial plane block that is guided by ultrasound. From T2–T4 to L1–L2, it can provide sensory blockage (Restrepo-Garces et al., 2017; Forero et al., 2016). Cadaver studies revealed that the dye travels to the thoracic paravertebral region, causing visceral analgesia (Forero et al., 2016).

So, assuming that Erector spinae plane block can cover somatic and visceral pain induced by PCNL, we'll look into how effective it is at reducing pain after surgery. This had already been done by Kim et al (2018), who demonstrated good pain control for 36 hours after surgery, but this was a case report for additional

assessment. The use of erector spinae plane block for postoperative analgesia in PCNL has yet to be thoroughly studied.

This study aimed to investigate Erector spinae plane block as an alternate method for pain control after PCNL with decreased need for the conventional opioids and analgesics.

Patients and methods

The study took place at Kasr Al-Ainy Teaching Hospital from September 2019 to December 2020, with the ethics committee's clearance and written consent from the patients. It included a total of 44 adult ASA I-II patients, aged 18-65 years. Scheduled for PCNL surgeries. Patients were randomly divided into 2 equal groups, 22 each, according to the inclusion and exclusion criteria:

Upon arrival to operating room, Electrocardiography, pulse oximetry, and a non-invasive blood pressure monitor were used. A General Electric (GE, Solar 8000i) monitor was used to assess arterial blood pressure. Anesthesia was induced with morphine 0.1 mg/kg, propofol 2 mg/kg, atracurium 0.5 mg/kg, a cuffed endotracheal tube was introduced, and isoflurane (1.2 MAC) and atracurium 0.1 mg/kg were used to maintain the anaesthesia.

Group E, Unilateral erector Spinae plane block group:

After induction of general anesthesia block has been performed as follow: The patient has been placed in a prone position. The eighth rib was located using ultrasonography (Siemens ACUSON X300 Ultrasound System) and marked on the skin using a counting down approach from the first rib. Chlorhexidine was used to sterilize the skin. After positioning a 5–12 MHz linear probe parallel to the vertebral axis at the level of the eighth rib, the probe was transversely moved from the lateral to medial side to identify any shape changes that occurred when the rib and transverse process (TP) were traversed. A 22 gauge spinal needle was placed into the trapezius and erector spinae, at the level of the TP of T8, using the inplane technique in a cephalad to caudal direction, when the circular shadow of the rib turned into the rectangular shape of the TP (Figure1).

By injecting 2 ml of saline into this fascial plane, we were able to demonstrate that it was well separated after the needle made contact with the TP. Then we injected the ready-to-use mixture of total of 20ml bupivacaine 0.25%, and 20 ml xylocaine 1%.

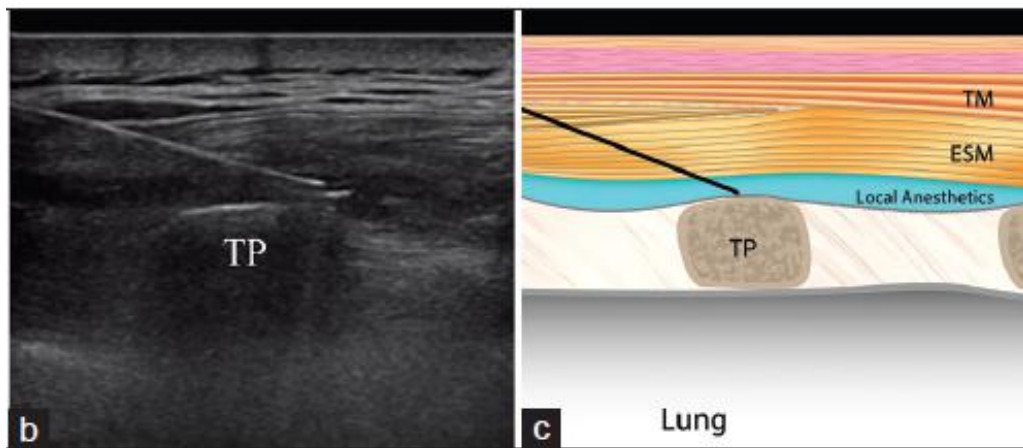


Figure 1. U/S guided erector spinae block

Group C, Controlled group:

After induction of general anesthesia, 0.1 mg/kg morphine has been given. Patients were subsequently transported to the post-anesthesia care unit (PACU) to be completely recovered and well monitored after the operation. Resting and dynamic ambulation pain scores have been assessed postoperatively at 30 and 60 minutes, then at 2, 6, 12, and 24 hours using the visual analog scale (VAS) score.

All patients took paracetamol 1gm IV every 8 h during first 24h after surgery. Reference analgesia in the form of morphine 0.05 mg/kg has been given when VAS is more than 4. Data collected including age, weight, sex, hemodynamic parameters (heart rate, and mean arterial blood pressure) have been recorded preoperative and every 15 minutes till the end of surgery. Then continued to be recorded postoperatively at 15, 30 & 60 minutes and 2, 6, 12, and 24 hours after surgery.

Another data recorded postoperatively including total morphine consumption in rescue boluses during 1st 24 hours postoperatively, VAS score at the following intervals: 15, 30 and 60 minutes. 2, 6, 12, and 24 hours after surgery, Duration of analgesia (defined as the time period between the end of local anaesthetic delivery and the first requirement for a rescue analgesic in the form of IV morphine), and the Incidence of complications, such as: Nerve injury; characterized by severe pain or parasthesia starting during injection, Hematoma formation; defined as local swelling at site of injection occurring during the first 24 hours and may cause ischemic nerve injury and LA toxicity; in the form of neurological manifestations (muscle twitching, convulsions, unconsciousness, and coma) or cardiovascular manifestations (chest pain, palpitations, hypotension, syncope, and cardiovascular collapse) .

Statistical analysis

Sample size:

In a previous study, the postoperative 24-hour morphine consumption in patients undergoing PCNL under general anesthesia the control group was 43.3±9.5 mg(

[Liu et al., 2016](#)). We determined a sample size using MedCalc Software version 14.10.2 (MedCalcSoftwarebvba, Ostend, Belgium) that could detect a 20% difference in morphine consumption (i.e. 8.64 mg) between the two study groups. A research power of 80% and an alpha error of 0.05 were computed using a minimum of 40 participants (20 patients each group). To account for probable drop-outs, the number of patients will be increased to 44 (22 per group).

Statistical methods:

The statistical package for the social sciences (SPSS) version 26 was used to code and enter the data (IBM Corporation, Armonk, New York, USA). Mean and standard deviation were used for normally distributed quantitative data; median and interquartile range was used for non-normally distributed quantitative variables. and for categorical variables, frequencies (number of cases) and relative frequencies (percentages) were used. For normally distributed quantitative variables, the unpaired t test was employed, whereas for non-normally distributed quantitative variables, the non-parametric Mann-Whitney test was utilised ([Chan, 2003](#)). The Chi square test was used to compare categorical data. When the anticipated frequency is less than 5, the exact test was utilised instead ([Chan, 2003](#)). Statistical significance was defined as a P-value of less than 0.05.

Results

Forty four adult patients scheduled for per-cutaneous nephro-lithotomy under general anesthesia-in Cairo university hospital - were enrolled in this study. The 44 patients were assigned to one of two study groups at random using a computer-generated table, with the randomization sequence hidden in sealed opaque envelopes.

Group E:

Erector spinea plane block (ESP group) (n=22): patients got an ultrasound-guided Erector spinea plane block (ESP block) prior to surgical incision. Group C: Control group (n=22): patients were given general anaesthesia without ESP block prior to surgical incision. The age of the participants in both groups ranged from 18 to 65 years old. The two groups included patients from both genders. The age, weight, and sex of the patients' demographic data did not exhibit statistical significance. (Table 1, 2)

Table 1
Gender of the patients in both groups represented as count and %

		ESP group		Controlled group		P value
		Count	%	Count	%	
Sex	female	11	50.0%	9	40.9%	0.454
	male	11	50.0%	13	59.1%	

Table 2

Age and weight of the patients in both groups. Data is represented as mean and standard deviation (SD)

	ESPgroup		Controlledgroup		P value
	Mean	Standard Deviation	Mean	Standard Deviation	
Age	40.86	10.01	40.64	11.33	0.944
Weight	72.50	10.44	77.00	12.15	0,195

Intra-operative data:

- 1) Intra operative heart rate was measured at baseline and every 15 minutes till the end of the operation. The mean of the intra-operative heart rate was lower in (ESP group) and there was statistically significant difference ($p=0.014$) between the two groups. (figure2).

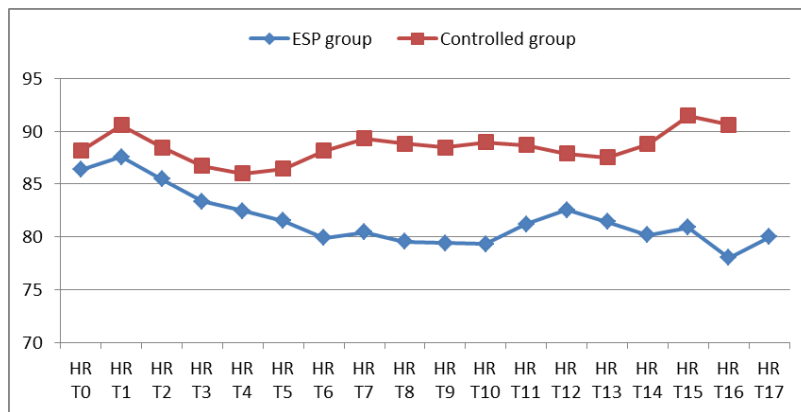


Figure 2. Intra operative heart rate

- 2) Intra operative Mean arterial blood pressure (MBP) was measured at base line, and every 15 minutes till the end of the operation.

There was no statistically significant difference between the two groups regarding the intra operative mean arterial blood pressure. ($p=0.063$). (Figure 3)

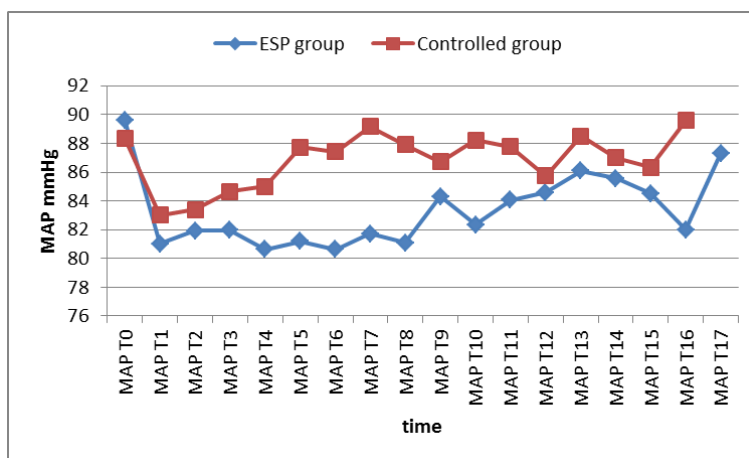


Figure 3. Intra operative mean arterial blood pressure, difference between two groups over time

Post-operative data

- 1) Heart Rate (HR) was assessed at 15, 30 and 60 minutes, 2, 6, 12 and 24 hours postoperatively. The difference between the ESP and control groups was statistically significant., ($p < 0.05$). (Figure 4).

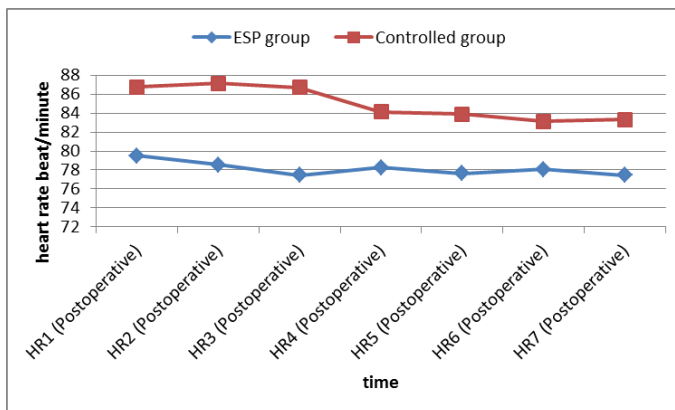


Figure 4. Post-operative heart rate (beats per minute) for the two groups. Data is presented as mean and standard deviation (SD)

- 2) Mean arterial blood pressure (MBP) was assessed at 15, 30 and 60 minutes, 2, 6, 12 and 24 hours postoperatively. The ESP and control groups had no statistically significant differences., ($p \text{ value} > 0.05$). (figure 5)

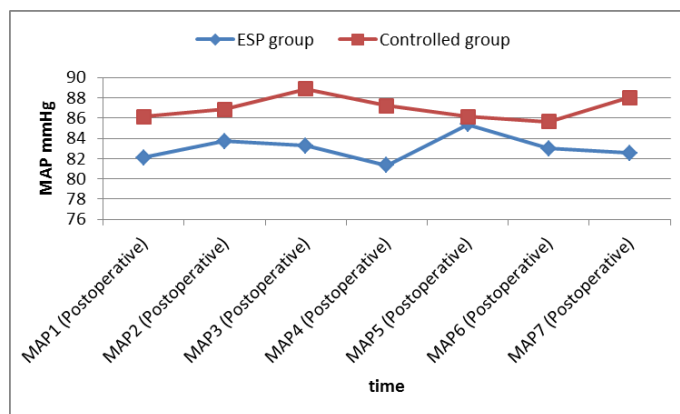


Figure 5. Post-operative means arterial blood pressure (in mmHg) for the two groups. Data is presented as mean and standard deviation (SD)

- 3) VAS score was assessed at 15, 30 and 60 minutes, 2, 6, 12 and 24 hours postoperatively. When compared to the control group, it was much lower in the ESP group. ($p < 0.05$). (Figure 6)

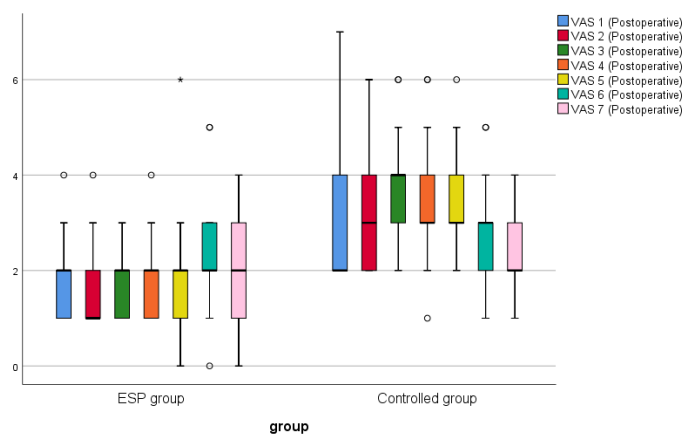


Figure 6. Postoperative VAS values for both groups

- 4) Morphine consumption in the first 24 hours after surgery was significantly lower in the ESP group. When compared with controlled group and duration of analgesia in hours was longer in ESP group when compared to controlled group ($p < 0.05$). (Figure 7,8)

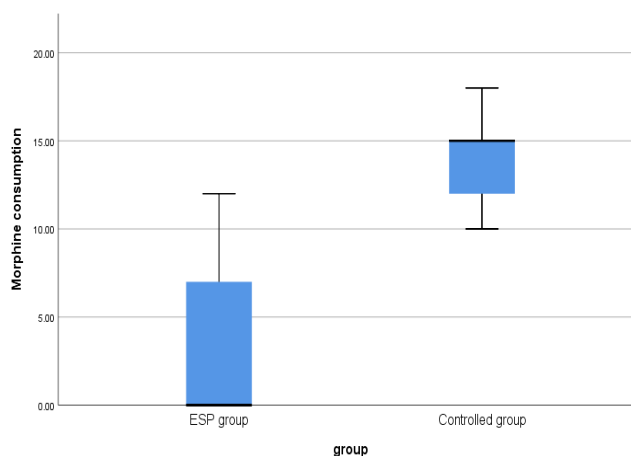


Figure 7. Morphine consumption in 1st 24 hours in both groups

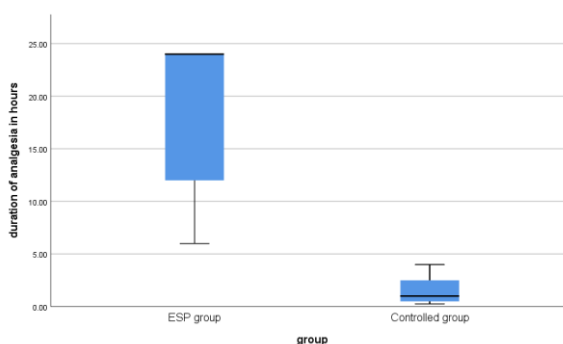


Figure 8. Duration of analgesia in both groups.

- 5) Incidence of complications: none of the patients had any complication in both ESP and controlled groups.

Discussion

Percutaneous nephrolithotomy (PCNL) is a frequent surgical procedure for the removal of kidney stones. Postoperative pain is a complication that necessitates a multimodal approach during PCNL, and effective pain management can reduce hospital stays, the risk of complications, and overall health costs. Because of its negative effects, traditional surgical pain management with opioids affects early recovery and discharge. As a result, the multimodal approach to postoperative pain management aids in the reduction of opioid-related side effects ([Mahmood, 2019](#)).

The majority of patients who receive PCNL have impaired renal function. In such cases, nonsteroidal anti-inflammatory medications (NSAIDs), which give great opioid-free analgesia, are generally contraindicated, thus any strategy or drug that may avoid opioid side effects and NSAID problems is preferable ([Begani et al., 2019](#)).

In abdominal and thoracic surgeries, the erector spinae plane block (ESPB), a relatively novel method of paraspinal fascial plane block introduced in 2016 by Forero for acute and chronic thoracic pain, is utilised to provide effective pain management. Local anaesthetic (LA) is injected in a plane between the transverse process and the erector spinae muscle to provide ESPB. The LA diffuses into the paravertebral region and spreads on both rami (dorsal and ventral) of spinal nerves. This is thought to be the ESPB's proposed mechanism. It provides significant analgesia with a single puncture and can be conducted at a level that is quite far away from the surgical site, avoiding any local difficulties that might otherwise make the puncture contraindicated (Kaushal et al., 2020). The ESP block is performed by injecting local anaesthetic into the space between the erector spinae muscle and the transverse process (Kline and Chin, 2019).

Local anesthetics injected in the ESP indirectly reaches the paravertebral space by spreading anteriorly through the connective tissue between transverse processes where it can block ventral and dorsal rami of the spinal nerves; so anesthetizing sympathetic nerve fibers causing relief of both types of pain; visceral, and somatic also spread of local anesthetics craniocaudally along the fascial plane beneath the ESM allows coverage of multiple dermatomes from single injection site (Chin et al., 2019).

US guided ESP block is considered a simple technique, with ultrasonographic landmarks that can be identified easily so considered safe to be done, also being a plain block with no risk of injury of great vessels or discrete nerves with clear end point of injection made it even of no great risk to be given under general anesthesia (Chin et al., 2019).

Being a novel block so volume and concentration of LA needed to be injected in the ESP to exert effective analgesia is still under investigation, it seems more safe to use high volume and low concentration but some authors used low volume high concentration with effective results. It's still also not clear how much local anesthetic is needed to achieve one dermatomal block, so we can decide how much local anesthetic need to be injected at certain level to achieve adequate analgesia to desired dermatome (Luo and Min, 2017).

In this study we found that the age of the participants in both groups ranged from 18 to 65 years old. The two groups included patients from both genders. The age, weight, and sex demographic characteristics of the patients are statistically insignificant.

In a study by Sobhy et al. (2020), sixty patients were assigned at random to one of two groups: ESP (study) or C (control). They discovered that there were no significant statistical differences between the two groups in terms of age, weight, BMI, height, sex, and ASA status of recruited patients, with a P value > 0.05 (12)

Prasad et al. (2020) found that there were insignificant difference between ESP group and control group as regards demographic data of patients regarding age, weight, and sex. In this study we demonstrated that the difference between the ESP and control groups was statistically significant, (p < 0.05) as regards Heart Rate (HR) which was assessed at 0.25, 0.5, 1, 2, 6, 12 and 24 hours

postoperatively. They also showed that in the postoperative period, the heart rate of ESP Group patients was consistently lower than that of control Group patients, and it was significantly lower during the 2nd and 3rd postoperative hours.

[Sobhy et al. \(2020\)](#) found that there was insignificant difference between both groups as regards heart rate in which They found bradycardia (heart rate less than 60 beats per minute) in two patients in the ESP group and five patients in group C, respectively ($p=0.22$). In study in our hands there was no statistically significant difference between the ESP and control groups, according to our findings, ($p \text{ value} > 0.05$) as regards postoperative Mean arterial blood pressure (MBP). [Prasad et al. \(2020\)](#) found that postoperative mean arterial blood pressure values were comparable in both groups.

[Sobhy et al. \(2020\)](#) stated that In terms of mean arterial blood pressure, there was no statistically significant difference between the two groups, with hypotension (systolic pressure 90 mmHg) occurring in two patients in the ESP group and five patients in group C, respectively., ($p=0.22$). In this study VAS score was assessed at 0.25, 0.5, 1, 2, 6, 12 and 24 hours postoperatively. We found that when compared to the control group, it was much lower in the ESP group. ($p < 0.05$). [Prasad et al. \(2020\)](#) stated that At 0, 1, 2, 3, 4, 6, 12, 18, and 24 hours after PCNL, the VAS score in the ESP Group was significantly lower ($P < 0.001$). [Sobhy et al. \(2020\)](#) VAS scores were found to be lower in the ESP group. At 0 time, 18, and 24 hours after surgery, the p value was 0.001. At the 6th hour, it was 0.001, and at the 12th hour, it was 0.006. In this thesis we illustrated that when compared to the control group, the ESP group consumed much less morphine in the first 24 hours after surgery.

[Prasad et al. \(2020\)](#) found the ESP Group's mean morphine usage was considerably lower 24 hours after surgery. [Sobhy et al. \(\(2020\)](#) found that The ESP group has a considerable reduction in overall morphine intake in the first 24 hours after surgery with p value < 0.001 . [Macaire et al. \(2019\)](#) have shown that the ESP block group administered a much lower dose of opioids both intraoperatively and 48 hours after surgery, resulting in a speedier postoperative recovery.

In this study we demonstrated that In the ESP group, the duration of analgesia in hours (1st call for rescue analgesia) was substantially longer with a median of 24 when compared to controlled group with a median of 1 ($p < 0.001$). [Krishna et al. \(2019\)](#) found that In comparison to the control group, patients in the ESP group had a considerably longer duration of analgesia.

[Prasad et al. \(2020\)](#) found that during the first 24 hours after surgery, In comparison to Group I the time required for the first rescue analgesia increased significantly. Only eight patients in Group II required rescue analgesia during the first 24 hours after surgery, while the remaining 23 patients did not.

[Sobhy et al. \(2020\)](#) found that following surgery, a single-shot ESP block guided by ultrasonography gave appropriate analgesia significantly compared to the control group. In this study we found that none of the patients had any complication in both ESP and controlled groups. They also [Sobhy et al.](#)

(2020) found that in the ESP group, there was a significant reduction in the occurrence of opioid-related side effects. Prasad et al. (2020) found that in control Group, two individuals experienced one episode of nausea and vomiting, whereas the ESP Group experienced no side effects.

Limitation

Limitation to our study is ESP block is a single shot injection and not continuous method to maintain analgesia so further studies needed to demonstrate the feasibility of inserting a catheter in the plain and either give multiple shots or continuous infusion to maintain analgesia. A larger sample size may be recommended to emphasise the findings of our study even more. We concluded that under ultrasound guidance, the ESP block is a simpler procedure that delivers greater postoperative analgesia in patients admitted for PCNL. It also offers improved hemodynamic stability and overall patient satisfaction, as well as a reduced complication rate.

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