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Intraoperative and Postoperative Opioid-Sparing Effect of Ultrasound Guided Quadratus lumborum Block versus Erector Spinae Plane Block in Renal Surgeries under General Anesthesia

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ABSTRACT

Background: Erector spinae plane block (ESPB) and Quadratus lumborum block (QLB) III are great interfacial plane blocks that have been providing a lot as regard perioperative pain relief in various surgeries.

Objective: To compare the effect of both block on opioid consumption.

Patients and methods: In a prospective randomized double blinded controlled trial, 102 (ASA 1 & II), aged 21- 64 y of both genders were scheduled to undergo open renal surgeries. They were separated into three groups at random (34 each). Control group where cases received general anesthesia alone, QLB group in which patients received unilateral QLB (III) before general anesthesia, with 20 ml of bupivacaine 0.25% and ESPB group in which patients received unilateral ESPB before general anesthesia, with 20 ml of bupivacaine 0.25%. Data collection included calculating amount of opioids given intra-operatively and 24h postoperatively, calculating time till end of block and evaluating patient satisfaction.

Results: The current results demonstrated a non-significant recording in the two block groups as regard amount of analgesics given (intra-operative fentanyl being 125.15 ± 17.17 and 121.18 ± 16.1 in QLB and ESPB respectively), (postoperative morphine being11.09 ± 2.53 and 10.85 ± 2.34 in QLB and ESPB respectively), satisfaction score (being 5.71 ± 0.87 and 6.06 ± 0.69 in QLB and ESPB respectively), hemodynamics and VAS score recordings, while being significant when comparing the block groups to the non-block ones.

Conclusion: ESPB and QLB provide relatively comparable analgesic effect with reduction of total intra-operative and post-operative opiate consumption in patients undergoing open renal surgery under general anesthesia.

Keywords: Postoperative opioid-sparing, Effect of ultrasound guided Quadratus lumborum block, Erector Spinae plane block, Renal surgeries under general anesthesia.

INTRODUCTION

Renal surgeries e.g., nephrectomy and pyeloplasty are common surgical procedures in urologic surgeries. The open approach provides a major tissue trauma to the patient, which results in a severe pain and discomfort in the convalescence period. Postoperative pain is a major clinical issue because it slows down patients' recoveries and can even cause long-term pain conditions [(1)].

In order to alleviate pain and reduce opioid-related side effects, multimodal analgesia is increasingly being used [(2)]. It represents combining of different mechanisms of analgesics, which helps to improve efficacy and decrease dose, which result in minimizing side effects of these drugs. It includes combining systemic drugs (e.g., acetaminophen, opioids, medication, such as NSAIDs or neuraxial analgesia e.g. combined spinal/epidural or epidural either spinal alone) for pain relief, interfascial plane block, local anesthetics infiltration as well as peripheral nerve block [(3)].

Both ESP block and QL block had emerged as a relatively novel interfacial plane blocks modalities for the management of post-surgical pain. Multiple publications prove its efficacy for managing acute, chronic, visceral and somatic pain that can add benefits to multimodal approach [(4)].

The aimed of this study was to compare the effect of both block on opioid consumption.

SUBJECTS AND METHODS

Population

At Zagazig University Hospitals we conducted a prospective randomized double-blind controlled trial.

Inclusion criteria: age between 21 and 64 years, had BMI ≤ 30 kg/m^2, from both genders, ASA I & II ready for general anesthesia and a planned open nephrectomy.

Exclusion criteria: Patients with history of allergy to the studied drugs, those with chronic use of analgesics or drug dependence, patients with mental health issues, those with anatomical abnormalities, neuropathic disease, abnormal bleeding profile and infection at site of injection or liver diseases.

Sample size calculation: Assuming the VAS at 2 hours postoperative was 4.2+2 vs 3.1+1.5 in control vs QL group [(5)]. The estimated sample was 102 cases, divided into 34 cases in each group. Taking into account a nonresponse rate of 10%, the sample size was computed using the open EPI program at a confidence level of 95% and a power of 80%.

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Randomization:

Using a computer-generated randomization table, the patients in this trial were randomly assigned to one of three groups (n=34): Group C (n = 34) patients received only general anesthesia for open renal surgeries, group QLB (n=34) in renal procedures, patients underwent general anaesthetic induction through ultrasound-guided anterior quadratus lumborum block (n = 34) and group ESPB where patients received ultrasound-guided erector spinae plane block before induction of general anesthesia for open renal surgeries (n = 34).

Preoperative assessment: Preoperatively, all patients were scheduled for a visit to inform them about the entire process and outcome of the study, to inform patients of the potential risks and benefits of the operation and to secure their written agreement for participation. Baseline vital signs were recorded, physical examination involving examining heart and lung symptoms and excluding contraindications. Investigations including CBC, coagulation profile, LFTs and KFTs. Visual analogue scale was explained to evaluate postoperative pain over a scale zero to ten, where 0 meant no pain and ten was the worst intolerable pain. Patients were instructed to fast for 6 hours prior to surgery, and to drink only clear liquids for the 2 hours before.

In the ESPB group: Everyone in the waiting area took a seat. Sonosite M Turbo ultrasonography (FUJIFILM Sonosite, Inc., Bothell, WA, USA) was used to find the first thoracic vertebra's transverse process after skin was sterilised. The superficial probe was positioned horizontally. Then we bend forward and downward to access the transverse process of the seventh thoracic vertebra. Near the transverse process, the erector spinae muscle can be seen. Underneath the probe, an 80 mm needle of 22 gauge (Stimuplex D; B-Braun; Germany) was introduced and aimed at the transverse process. After feeling the bony prominence of the needle's tip, we injected 20 ml of 0.25 percent bupivacaine, which rose and spread along the muscle's longitudinal extension [6] (Figure 1).

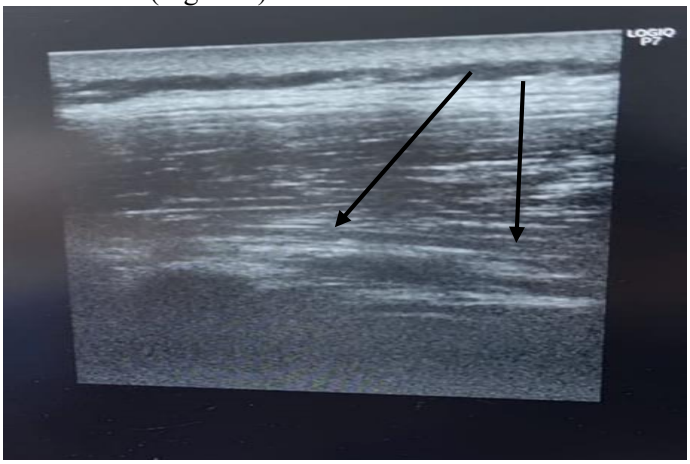

Figure (1): Sonogram of ESP block showing local anesthetic spread.

In the (QLB III) group:

A Sonosite M Turbo ultrasonography deep convex probe was placed horizontally over the abdomen in a lateral position, allowing all three abdominal muscles to be seen clearly: The external oblique, the internal oblique, and the transversus abdominis.

Then, by moving the probe backward along transversus aponeurosis and with the psoas major muscle in front and the erector spinae muscle in back, an ultrasonic image of the quadratus lumborum muscle was shown up as a semicircular hypoechoic formation on the tip of the transverse process of the L4 vertebra probe. This is known as the Shamrock sign.

After inserting the probe, an 80 mm, 22-gauge needle (Stimuplex D, B-Braun, Germany) was pushed through until it reached the fascia between the psoas major and the QL muscle. Once the two muscles were isolated, 20 ml of 0.25 percent bupivacaine was administered. [7] (Figure 2).

Figure (2): Sonogram of QL block showing local anesthetic spread

Intraoperative:

On entering the operation room, a large sized I.V. cannula was inserted. The patient was outfitted with the standard array of monitoring devices (including NIBP, ECG, and pulse oximetry) and their first values were documented. For three minutes, patients were exposed to 100 percent oxygen. Induction of general anesthesia was performed with fentanyl 1 µg/kg, propofol 2 mg/kg, rocuronium (0.6-1.2) mg/kg to facilitate insertion of a suitable endotracheal tube.

Maintenance of general anesthesia was performed using isoflurane volatile anesthetic, incremental doses of rocuronium and ventilation was maintained keeping (EtCO2) between 35 and 40 mmHg

through the regulation of tidal volume and respiratory rate (volume-controlled ventilation). If the patient's heart rate or blood pressure rose by more than 20% from their preoperative baseline, a bolus of fentanyl was administered intraoperatively.

After inhalation anaesthesia was withdrawn, neostigmine (0.05 mg/kg) and atropine sulphate (0.01 mg/kg) were administered to reverse neuromuscular blockade. A bolus dosage of acetaminophen (15 mg/ kg with a maximum of 4 g/day) was given to patients when they were moved to the after anaesthesia care unit (PACU) to recover from their anesthetics. Pain was assessed and reported both at static and during dynamic state using visual analogue scale (VAS)] as 0 meant there is no pain, 1 to 3 represents mild pain, 4 to 6 represents moderate pain, 7 to 10 represents severe intolerable pain] at 2, 4, 8, 12, 18 & 24 hours after surgery by an observer who was blinded to the technique used for each group. If pain was > 4 on VAS scale, the patient received morphine (0.1 mg/kg) as a rescue analgesia and time of this request was recorded [8].

Data collections:

1-Patient demographics: age (years), sex, ASA grade, BMI (kg/m^2) and duration of surgery.
2-Total intraoperative fentanyl consumption.
3-Hemodynamics (HR, MAP) as a baseline, then at the following times: every 10 minutes for the 1st 30 min, then every 15 min till the end of surgery and in PACU.
4- Pain score (VAS) at 2, 4, 8, 12, 18 and 24 hours post-operatively.
5- The time to 1st request of rescue analgesia.
6-Total doses of morphine given in post-operative 24 hours.
6-Complications of the technique or side effects of the drugs.
7-Satisfaction score of patients using a Likert-like verbal rating scale [9].

Ethical consent:

This study was ethically approved by the Institutional Review Board of the Faculty of Medicine, Zagazig University, Written informed consent was taken from all participants. The study was conducted according to the Declaration of Helsinki.

Statistical analysis

The significance of differences in mean scores between more than two research groups was determined using an analysis of variance (ANOVA) test. When comparing the means of more than two groups, we resort to a "Post Hoc" analysis. A Student t test was used to assess whether or not the groups actually did differ statistically. Chi-square and Fisher's exact tests were used to examine the relationship between two qualitative variables. $P \leq 0.05$ were considered significant.

RESULTS

Elective open nephrectomy was planned for 108 patients, all of whom would undergo the procedure while under general anaesthesia. Four patients did not match the study's inclusion requirements, while two others declined participation. As illustrated in the consort flow diagram, a total of 102 patients were randomly split into three groups of equal size, each consisting of 34 people **(**Figure 3).

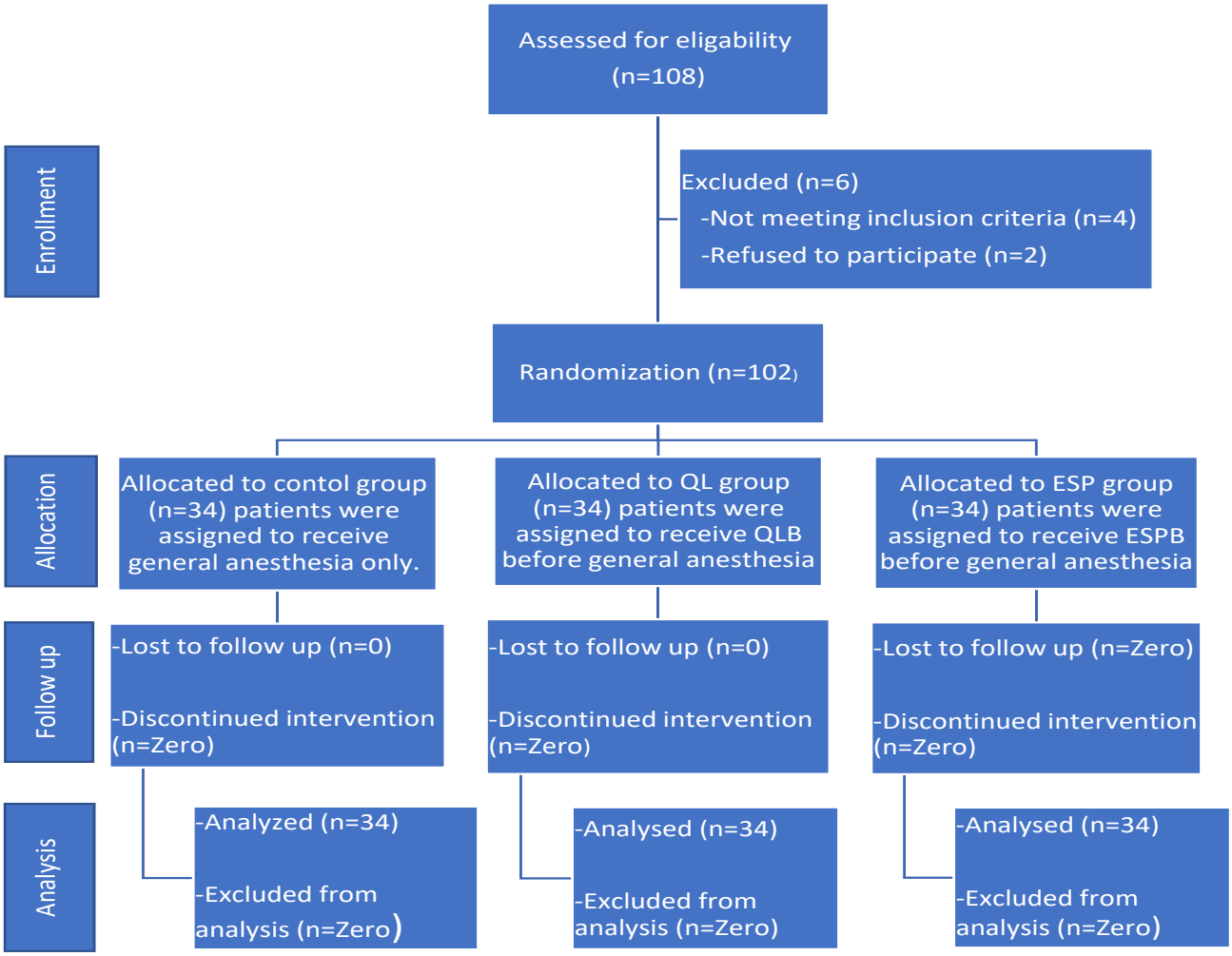

Figure (3): Consort flow diagram

The results revealed that age, sex, body mass index, and ASA physical status, as well as the length of time spent in surgery, showed non-statistical significant changes between 3 groups. (p=0.934) (Table 1).

Table (1): Demographics

Variable	Group				Test of significance	
	Control		QL	ESP		
	Mean ± SD N (%)		Mean ± SD N (%)	Mean ± SD N (%)	p-Value	Sig.
Age	51.03 ± 5.06		51.41 ± 5.12	51.12 ± 4.46	0.945[(A)]	NS
Gender	Male	18 (52.94%)	18 (52.94%)	18 (52.94%)	1.00[(C)]	NS
	Female	16 (47.06%)	16 (47.06%)	16 (47.06%)		
BMI	28.09 ± 1.09		28.04 ± 0.96	28.16 ± 0.75	0.863[(A)]	NS
ASA	I	29 (85.29%)	29 (85.29%)	29 (85.29%)	1.00[(C)]	NS
	II	5 (14.71%)	5 (14.71%)	5 (14.71%)		
Duration of surgery	147.5 ± 11.23		148.09 ± 8.62	147.21 ± 10.01	0.934	NS

[(A)] One Way ANOVA test. **ASA:** American society of anaesthesiologist. **BMI:** body mass index
[(C)] Chi-Square test. **QL:** quadratus lumborum. **ESP:** erector spinae plane. **SD:** standard deviation.

Until 20 minutes after induction, MAP didn't change significantly between groups. After that, compared to the control group's elevated readings, blood pressure was significantly lower in both block groups (p <0.001) at 30 min, 45 min, then at 1st, 2nd hours and till the patient was recovered and in postoperative period. Also, there was no significant difference as regards MAP between both block groups throughout the entire study (Figure 4).

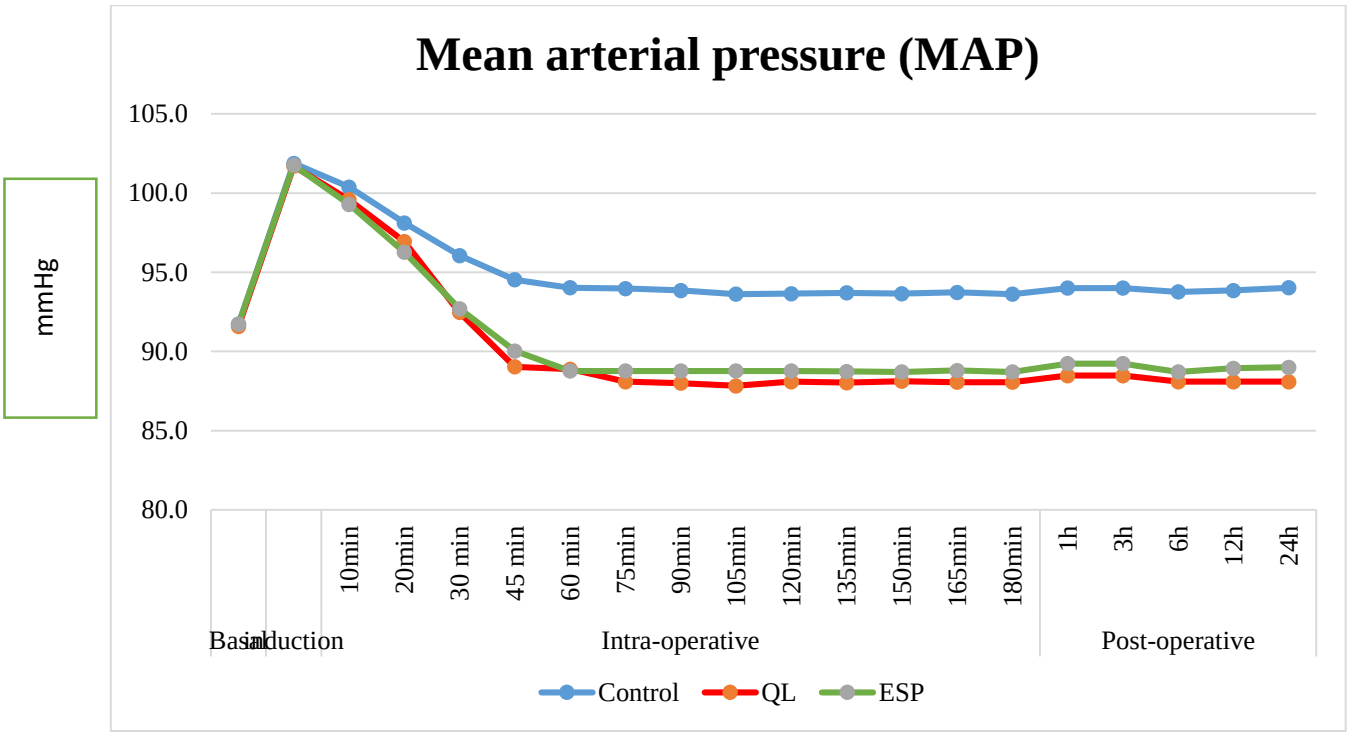

Figure (4): Mean arterial pressure in all studied groups**.**

As regards HR, it didn't show any significant differences among 3 groups until 20 min of induction, then HR was significantly deceased (p <0.001) in both block groups in comparison with the control group, which showed a significant higher readings at 30 minutes, 45 min, then at the 1st, 2nd and till the end of surgery and in postoperative period, with non-statistical significant differences in heart rate between the two block groups throughout the entire study (Figure 5).

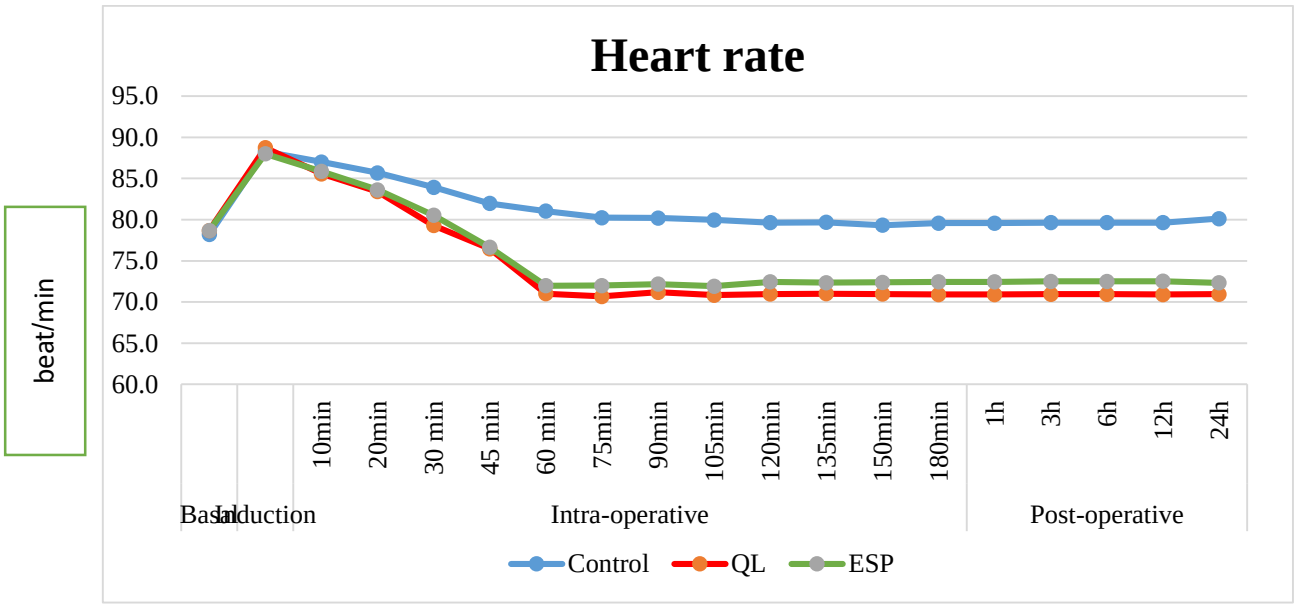

Figure (5): Heart rate in the 3 studied groups

As regards the total amount of intra-operative fentanyl, there was a statistically significant lower (p < 0.001) doses given to the ESPB (121.18 ± 16.1 mcg) and (125.15 ± 17.17 mcg) in QLB groups in comparison with the control group (199.56 ± 14.37 mcg). Both intervention groups showed similar results, with no discernible difference. It took significantly less time to provide rescue analgesia the first time (p < 0.001) in control group (68.97 ± 15.36 min) compared to (261.91 ± 32.31min) in ESPB group and (253.82 ± 29.59 min) in QLB group. The total amount of morphine administered after surgery was much significantly greater (p <0.001) in control group (20.03 ± 3.46 mg) compared to (10.85 ± 2.34 mg) in ESPB group and (11.09 ± 2.53 mg) in QLB group and between the two blocks, there was no discernible change (Table 2).

Table (2): Intraoperative and postoperative Analgesic consumption among the studied groups

Variable	Group			One Way ANOVA	
	Control	QL	ESP		
	Mean ± SD	Mean ± SD	Mean ± SD	p-Value	Sig.
Total intraoperative fentanyl (mcg)	199.56 ± 14.37	125.15 ± 17.17	121.18 ± 16.1	<0.001*	S
Time for 1st rescue analgesia (min)	68.97 ± 15.36	253.82 ± 29.59	261.91 ± 32.31	<0.001*	S
Total postoperative morphine consumption (mg)	20.03 ± 3.46	11.09 ± 2.53	10.85 ± 2.34	<0.001*	S

* Post-hoc Bonferroni test was significant between: (A1) Controls Vs. others. **QL:** quadratus lumborum. **ESP:** erector spinae plane.

As regards VAS both at static and during dynamic state there were a statistically significant lower scores in the two block groups when compared to control group. And over the course of the first 24 hours, we found no discernible variation between the block groups and the various recording times (Table 3).

Table (3): Visual analogue score assessment among studied groups

Postoperative VAS		Group			One Way ANOVA	
		Control	QL	ESP		
		Mean ± SD	Mean ± SD	Mean ± SD	p-Value	Sig.
Static	**2h**	3.06 ± 0.69	1.15 ± 0.36	1.09 ± 0.29	<0.001(A1)	S
	4h	3.59 ± 0.86	2 ± 0.74	2.09 ± 0.71	<0.001(A1)	S
	8h	4 ± 0.74	3.06 ± 0.65	3.12 ± 0.69	<0.001(A1)	S
	12h	4.06 ± 0.69	3.21 ± 0.69	3.18 ± 0.58	<0.001(A1)	S
	18h	3.68 ± 0.77	3.12 ± 0.73	3.15 ± 0.66	0.002(A1)	S
	24h	3.26 ± 0.71	2.91 ± 0.67	2.94 ± 0.65	0.062(A)	NS
Dynamic	**2h**	3.59 ± 0.7	2.06 ± 0.65	2.09 ± 0.62	<0.001(A1)	S
	4h	4.53 ± 0.66	2.44 ± 0.5	2.44 ± 0.56	<0.001(A1)	S
	8h	5.06 ± 0.65	3.85 ± 0.78	4.09 ± 0.75	<0.001(A1)	S
	12h	4.85 ± 0.7	4 ± 0.74	4.12 ± 0.77	<0.001(A1)	S
	18h	4.56 ± 0.66	3.91 ± 0.75	4 ± 0.74	0.001(A1)	S
	24h	4 ± 1.02	3.82 ± 0.76	3.82 ± 0.72	0.608(A)	NS

(A) One Way ANOVA test. Post-hoc Bonferroni test was significant between: (A1) Controls vs. others. **QL:** quadratus lumborum.
(B) ESP: erector spinae.

As regards side effects, the current study showed that the control group had a higher rate of nausea and vomiting than any of the block groups. But this difference wasn't statistically significant (32.35%, 14.71%, 14.71%) in CTRL, QLB & ESPB groups respectively (p=0.115) with no noticeable difference between both block groups. Also, the patient satisfaction showed higher degrees (p<0.001) of satisfaction in ESPB group (6.06 ± 0.69) and in QLB group (5.71 ± 0.87) compared to the control group (3.85 ± 0.86). And neither block group differed significantly from the other (Table 4).

Table (4): Adverse effect and patient satisfaction among studied groups

variable		Group			Test of significance	
		Control	QL	ESP		
		N (%) Mean ± SD	N (%) Mean ± SD	N (%) Mean ± SD	p-Value	Sig.
PONV	**No**	23 (67.65%)	29 (85.29%)	29 (85.29%)	0.115(C)	NS
	Yes	11 (32.35%)	5 (14.71%)	5 (14.71%)		
Patient satisfaction	**Dissatisfied**	2 (5.88%)	0 (0%)	0 (0%)	<0.001(F)	S
	Somewhat dissatisfied	9 (26.47%)	0 (0%)	0 (0%)		
	Undecided	15 (44.12%)	2 (5.88%)	0 (0%)		
	Somewhat satisfied	8 (23.53%)	13 (38.24%)	7 (20.59%)		
	Satisfied	0 (0%)	12 (35.29%)	18 (52.94%)		
	Extremely satisfied	0 (0%)	7 (20.59%)	9 (26.47%)		
Patient satisfaction		3.85 ± 0.86	5.71 ± 0.87	6.06 ± 0.69	<0.001(A1)	S

(C) Chi-Square test. (F) Fisher's Exact test. **QL:** quadratus lumborum. **ESP:** erector spinae plane.

DISCUSSION

Open renal surgeries are procedures that can add unpleasant experience to the patient if postoperative pain is not properly treated. The most common surgical technique for renal surgery is flank incision. Improper management of acute postsurgical pain may impair patient recovery and lead to development of chronic post-surgical pain syndromes [(1)]. Multimodal analgesia has been proved to be the best as regards overcome the severe postoperative pain, which include combination of low doses of multiple analgesics to increase efficacy and reduce harmful side effects of these drugs [(10)]. The flank incision mainly receives innervation mainly from T7-L1. So interfacial interfascial plane block as QLB and ESPB may be helpful for control of the pain.

In 2016, **Forero *et al.*** [(11)] described a novel regional technique called erector spinae plane block (ESPB). ESPB having been performed for several abdominal and thoracic operations [(4)]. Multiple studies have reported that it provided a lot as regards perioperative pain relief and decreased perioperative opioid given**.**

Anterior quadratus lumborum block is also considered an interfascial block, injecting local anesthetics in fascia between QL muscle and psoas major muscle. It has been used for multiple abdominal, orthopedic surgeries, obstetric and gynecologic surgery, and now it has been tested for its analgesic effect for nephrectomy surgeries [(12)]**.**

The current study showed that in the block groups (ESPB and QLB) there were a significant lower heart rate (HR) results and mean arterial pressure both intraoperatively and postoperatively in comparison with the control group. Also, the two block groups (ESPB and QLB) showed a significant reduction in opioid usage both intraoperative and postoperative as regards non block group. This led to lower incidence of PONV and much patient satisfaction postoperatively in the interventional groups.

Intraoperatively, the hemodynamic recordings including main arterial pressure and heart rate, were statistically significant lower in both block groups (ESPB and QLB) than the non-block group after twenty minutes of induction throughout the entire time of surgery and in postoperative period as well. There was also no noticeable difference between the two block groups (ESPB and QLB). That we believe results from analgesic effect of the ESPB and QLB on surgical incision and led to a noticeable decrease in total fentanyl doses given during surgery in ESPB and QLB groups as regards non-block group. This agrees with **Ali *et al.*** [(13)] stating that in ESPB there was lower hemodynamic recordings as regards heart rate and mean arterial pressure and there was a lot less intraoperative opioids consumption which had led to a more patient satisfaction in ESPB group in comparison with the non-block group in patient undergoing emergency laparotomy**.** Unlike what **Singh and Kumar** [(14)] stated, as those who had a modified radical mastectomy were investigated for ESPB. Hemodynamic recordings during surgery and afterward showed no significant difference between the ESPB and non-block groups.

Regarding QLB, current study was matched with **Lai *et al.*** [(15)] as they found reduction of the consumption of intraoperative remifentanil in quadratus lumborum group compared to non-block group in patients undergoing robot-assisted partial nephrectomy**.** Also, **He *et al.*** [(16)] found lower fentanyl doses given in the block group than those given in non-block group in arthroplasty surgeries**.**

Postoperatively, the current study showed that the duration for VAS to become > 4 and patient was given rescue analgesia was significantly shortest in control group compared to ESPB and QLB groups. While it was non-noticeably longer in ESPB compared to QLB group. The calculated dose of morphine given in 1st 24 h after surgery was not significant between the two block groups, despite being significantly higher in non-block group. In contrast to the two block groups, the non-block group recorded significantly higher VAS scores. With no significant changes between the two interventional groups in the 24 h postoperatively. This explains the significantly lower amount of opioids and longer duration until requesting for analgesics in block groups compared to the non-block group. Matching with the current study, **Onay *et al.*** [(17)] showed that no significance in total morphine consumption and total morphine demands in the two block groups**.** On comparison with the control group, **Şahin and Baran** [(18)]**,** had reported that with ESP block, there was a reduction of VAS score recordings and the amount of opioid given after surgery compared to those in non-block group in patients undergoing nephrectomy**.** Unlikely, **Tulgar *et al.*** [(19)] had shown that in the block group there was no significant pain relief in 6.5% of patients that underwent different abdominal surgeries compared to non-block group. As regards QLB, the current results are consistent with **Wang *et al.*** [(20)]**,** as they found reduced postoperative intravenous opioid given and pain results both during static and during dynamic state after nephrectomy compared to control group**.** They also stated that a single-shot QLB increased time for given analgesia after surgery, decrease time of recovery and lower complications including PONV.

As regards PONV, the current study recorded less patients who complained of nausea and vomiting in the two block groups, 5 patients in each group, compared to control group (11 patients). This resulted from the decreased doses of opioids given in the two interventional groups compared to the non-block group as side effect of opioids depend on the amount of drug given [(21)]**.** This is consistent with **Koo *et al.*** [(22)] who found that patients undergoing laparoscopic cholecystectomy who were assigned to the ESP group required fewer analgesics and had fewer complaints of nausea and vomiting than those assigned to the non-block group**.** Also, **He *et al.*** [(16)] reported a lower incidence of PONV in the QL group than in the control group of patients undergoing hip arthroplasty surgeries. However, these

results differ from what **Haskins *et al.* [23]** found, as patients in both groups reported an equal number of cases of nausea. As regards patient satisfaction, the current study showed a significant higher degree of patient satisfaction in ESPB group and QLB group compared to non-block one. This is matching with **Ali *et al.* [13]** who reported a better patient satisfaction in ESPB group than control group in patients undergoing emergency laparotomy**.** For QLB, **He *et al.* [16]** stated that there was higher degree of satisfaction in QLB compared to control group in arthroplasty surgeries**.**

CONCLUSION

The current study demonstrated that ESPB and QLB provide relatively comparable analgesic effect with reduction of total intraoperative and postoperative opiate consumption in patients undergoing open renal surgery under general anesthesia.

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Competing interests: Nil.

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