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www.commprac.com
ISSN 1462 2815

ULTRASOUND-GUIDED CONTINUOUS ERECTOR SPINAE PLANE BLOCK IN OPEN NEPHRECTOMY FOR RENAL MALIGNANCY

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DOI: 10.5281/zenodo.10065977

Abstract

Background: Erector spinae plane block (ESPB) block is a relatively novel truncal block that tries to place local anesthetic (LA) between the thoracic transverse process and erector spinae muscle. This study aimed to investigate the effect of ESPB on pain, analgesic consumption, hemodynamic parameters, and adverse effects. **Methods:** This pilot interventional study was conducted on 15 adult patients between 18-65 years, American Society of Anesthesiologists class II, body mass index between 20 and 40 kg/m^2 with malignant renal tumors scheduled for open nephrectomy under general anesthesia. Patients received continuous ESPB 20 ml of 0.25% bupivacaine was injected as a bolus dose in the epidural catheter 30 min before the induction of general anesthesia. Prior to making the skin incision, bupivacaine 0.125% was then continuously infused at a rate of 6 ml/h. After 24 hours, the dose was increased by 2 ml/h increments up to 10 ml/h. **Results:** Numerical rating scale (NRS) at rest was significantly lower at 2h (P value=0.035), higher at 12h (P value=0.026) and was insignificantly different at 1, 4, 6 and 24 h compared to post-anesthesia care unit (PACU). NRS at movement was significantly lower at 2, 4 and 24h (P value <0.05) and higher at 12h (P value=0.041) and was insignificantly different at 6h compared to PACU. Eight (53.33%) patients required morphine. The mean value (± SD) of time of first rescue analgesia was 4.27 (±4.46) h. The mean value (± SD) of total intra-operative fentanyl consumption was 64.67 (±26.96) µg/kg. The mean value (± SD) of total dose of bupivacaine consumption was 192.3 (±30.96) mg and of the number of total doses was 2 (±2.45). **Conclusions:** When treating postoperative pain after open nephrectomy for renal malignancy operations, ultrasound guided continuous ESPB has promise as an easy and effective approach.

Keywords: Erector Spinae Plane Block, Ultrasound, Open Nephrectomy, Pain

INTRODUCTION

Between 2% and 3% of all cancers are renal cell carcinomas (RCC), the third most prevalent genitourinary tract malignancy [1]. Open nephrectomy has long been the accepted curative technique for resectable kidney cancers. The pain that results from nephrectomy is known to be particularly intense, and research has shown that it can trigger intricate biochemical and physiological stress reactions that can impede pulmonary, immunological, and metabolic functioning as well as raise post-operative morbidity. Chronic post-surgical pain syndrome could emerge if perioperative pain is not effectively treated. Therefore, proper postoperative pain management is essential for both patient satisfaction and outcome [2].

Opioids are currently the treatment of choice for postoperative pain but taking them in high doses can have a number of negative side effects, some of which are serious, including nausea, vomiting, dizziness, lightheadedness, constipation, respiratory depression, hypoventilation, and breathing issues while you sleep. Alternatives to opioids are therefore suggested without sacrificing effective and safe analgesia [3].

A relatively new truncal block called the erector spinae plane block (ESPB) attempts to insert local anesthetic (LA) between the thoracic transverse process and the erector

spinae muscle. Forero et al. [4] initially announced it in 2016. It is said that LA, which is given in this erector spinae fascial plane and spreads to the thoracic paravertebral region, targets the dorsal and ventral rami of the spinal neurons [4, 5]. Because ESPBs have a reduced risk of pneumothorax than thoracic paravertebral blocks, they have earned a desirable place in the toolkit of the local anesthesiologist. They have worked there for the previous four years, providing postoperative analgesia for various surgical procedures, from spine [6] to thoracic [7] surgery.

In cadaveric studies using MRI, ESPB was utilized to evaluate the distribution of LA coupled with gadolinium dye. They demonstrated the 30 ml injection volume's dispersion at level T10 between levels T5 and T12 [8]. Another cadaveric investigation revealed that the dye had traveled to the thoracic paravertebral region, which may help to explain the block's ability to relieve visceral pain [9].

This study aimed to investigate the effect of ESPB on pain, analgesic consumption, hemodynamic parameters, and adverse effects.

Patients and Methods

This pilot interventional study was conducted on 15 adult patients between 18-65 years, American Society of Anesthesiologists class II, body mass index between 20 and 40 kg/m^2 with malignant renal tumors scheduled for open nephrectomy under general anesthesia. The study was done at National Cancer Institute after approval from the Ethical Committee. All patients gave their informed consent in writing and the ethical committee approved. The study procedure was fully and thoroughly explained to the patients, who were also told of both the possible advantages and drawbacks of developing a successful approach.

Exclusion criteria included patient resistance, local infection at the puncture site, coagulopathies with platelet counts below 50,000 or an INR >1.6, renal and hepatic insufficiency, unstable cardiovascular disease, a history of psychiatric and cognitive disorders, patients allergic to the drug being used, and abnormal anatomy of the thoracic region.

Prior to surgery, all patients underwent preoperative evaluations that included a physical examination, clinic history review, laboratory tests (such as complete blood count, coagulation profile, liver, and kidney functions), an electrocardiogram (ECG) for patients over 40, and any additional tests that may have been necessary for high-risk patients.

In the waiting area, the patients' pulse, blood pressure, and oxygen saturation were continuously checked. An intravenous (IV) 18-gauge cannula was placed into each subject. It was given 0.02 mg/kg of midazolam. Each patient received 7–10 ml/kg of intravenous (IV) ringer acetate if necessary to replace fluid lost 30 minutes before surgery. A portable US machine, and resuscitation tools and medications (such as epinephrine, lipid emulsion) must be accessible. The numerical rating scale (NRS), with 0 denoting "no pain" and 10 denoting "worst possible pain" was taught to the patients as a method of reporting pain.

Ultrasound guided continuous erector spinae plane block

The SonoSite M-Turbo ultrasound machine (Fujifilm Sonosite, Inc., Bothell, WA)'s high-frequency linear probe (6 to 13 MHz), was used to take the US measurements. The transducer was positioned in a longitudinal orientation 3 cm lateral to the T8

spinous process while the patient was in a sitting position in a completely aseptic environment. This should highlight the trapezius, rhomboid major, and erector spinae as the three muscles that are superficial to the hyperechoic transverse process shadow. To anesthetize the skin, 3ml of 2% lidocaine were used. On the deep (anterior) aspect of the ESM, an 18-G Tuohy needle with a 20-G catheter (Perifix, Braun, Germany) was placed in-plane in a cephalad-to-caudad manner, following confirming the right space with hydrodissection by 5mL of saline 0.9%, lifting ESM off the bony shadow of the transverse process, a catheter was inserted was inserted 3 cm beyond the needle tip and 20 ml of 0.25% bupivacaine was injected as a bolus dose in the epidural catheter in 5ml divided aliquots at 5min intervals, 30 min before the induction of general anesthesia and the patient was turned to the supine position. The lack of pinprick sensation in the midclavicular line was used to gauge sensory block on the side that had surgery. A further 5ml of bupivacaine was administered after 15 minutes if the sensory block level remained below T5. Prior to making the skin incision, bupivacaine 0.125% was then continuously infused at a rate of 6 ml/h. After 24 hours, the dose was increased by 2 ml/h increments up to 10 ml/h. Adapting rates according on pain level and adverse effects [9-11].

Patients with unsuccessful blocks were removed, and the absence of pinprick sensation below T5 confirmed the effectiveness of the aforementioned blocks.

Each patient received general anesthesia according to the same regimen. In order to induce anesthesia and facilitate endotracheal intubation, rocuronium 0.5 mg/kg, fentanyl 1 g/kg IV, and propofol 2 mg/kg were administered. MAC 1.2% isoflurane was employed to maintain anesthesia in a mixture of 50% oxygen and air. All patients were mechanically ventilated using volume-regulated positive pressure ventilation with tidal volumes of 6–8 mL/kg and a ratio of 1:2 in order to maintain end tidal carbon dioxide tension around 35 mmHg. All patients underwent end-tidal CO_2 measurement, a 5-lead electrocardiogram, pulse oximetry, and non-invasive blood pressure monitoring (NIBP).

The time of the first rescue analgesia, total intra-operative fentanyl intake, and pain using NRS, both at rest and during movement, were outcome criteria. In the PACU and for the following 24 hours (1, 2, 4, 6, 12 and 24h) postoperatively, pain scores were collected using NRS. Mean arterial pressure (MAP) and heart rate (HR) were recorded before the LA injection to serve as a baseline reading, and follow-up after injection was then recorded immediately before and after the surgical incision as well as at 30-minute intervals throughout the procedure. MAP and HR were also recorded immediately after surgery, at 1, 2, 4, 6, 12 and 24 h postoperatively. The total dose of bupivacaine consumed, as well as the incidence of different side effects like hemodynamic instability, nausea, vomiting, dural puncture with a needle or a catheter, post-dural puncture headache, failed block, unintentional intravascular injection of LA, LA toxicity, and respiratory depression (respiratory rate 10/minute) were all recorded.

Statistical Analysis

IBM Inc., Chicago, Illinois, USA, used SPSS v26 to conduct the statistical study. Histograms and the Shapiro-Wilks test were employed to assess the normality of the data distribution. The mean and standard deviation (SD) of quantitative parametric data were displayed, and repeated measures ANOVA was used to compare them. Interquartile range (IQR) and median were used to show quantitative non-parametric data, which were then compared using the Freidman test and Wilcoxon test. The Chi-

square test was used to compare qualitative variables that were reported as frequency and percentage (%). Statistical significance was defined as a two-tailed P value 0.05.

RESULTS

The mean value (± SD) of age of the studied patients was 55 (±6.07) years. There were 10 (66.67%) males and 5 (33.33%) females. The mean value (± SD) of weight was 78.7 (±14.17) kg. The mean value (± SD) of height was 78.7 (±14.17) m. The mean value (± SD) of BMI was 31.79 (±5.27) kg/m^2. The mean value (± SD) of duration of surgery was 174.73 (±16.45) min.

Table 1: Demographics and duration of surgery of the studied patients

		n = 15
Age (years)		55 ± 6.07
Sex	**Male**	10 (66.67%)
	Female	5 (33.33%)
Weight (kg)		78.7 ± 14.17
Height (m)		78.7 ± 14.17
BMI (kg/m^2)		31.8 ± 5.27
Duration of surgery (min)		174.7 ± 16.45

Data are presented as mean ± SD or frequency (%). BMI: Body mass index.

HR and MAP intraoperative were insignificantly different between baseline and other measurements. HR and MAP postoperative were significantly higher at 6h and 12h compared to baseline (P value <0.05) and were insignificantly different between (1h, 2h,4h and 24h postoperative) and baseline.

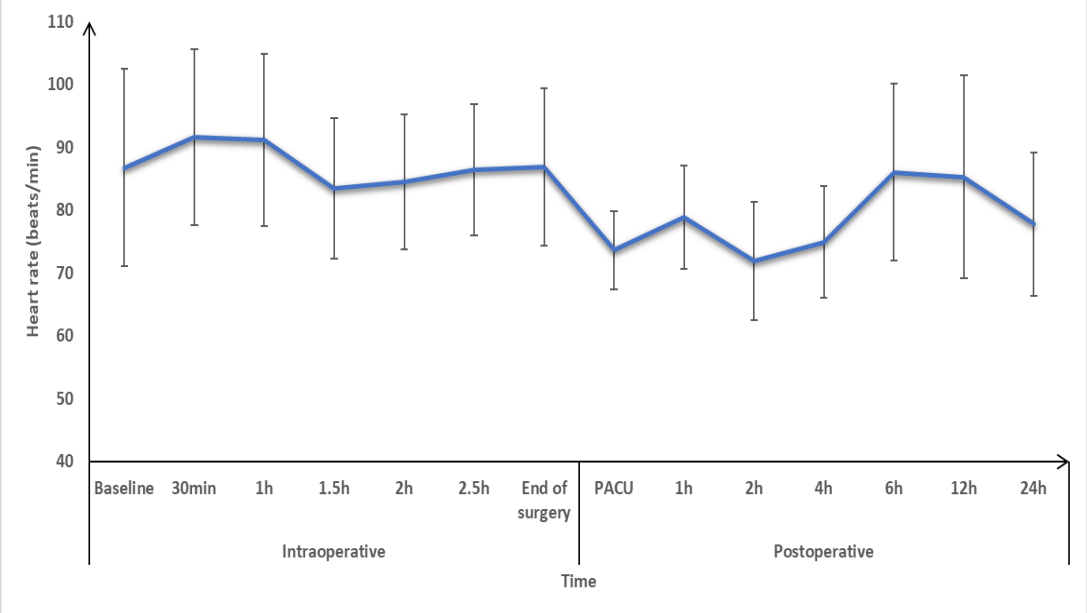

Figure 1: Heart rate intraoperative and postoperative of the studied patients

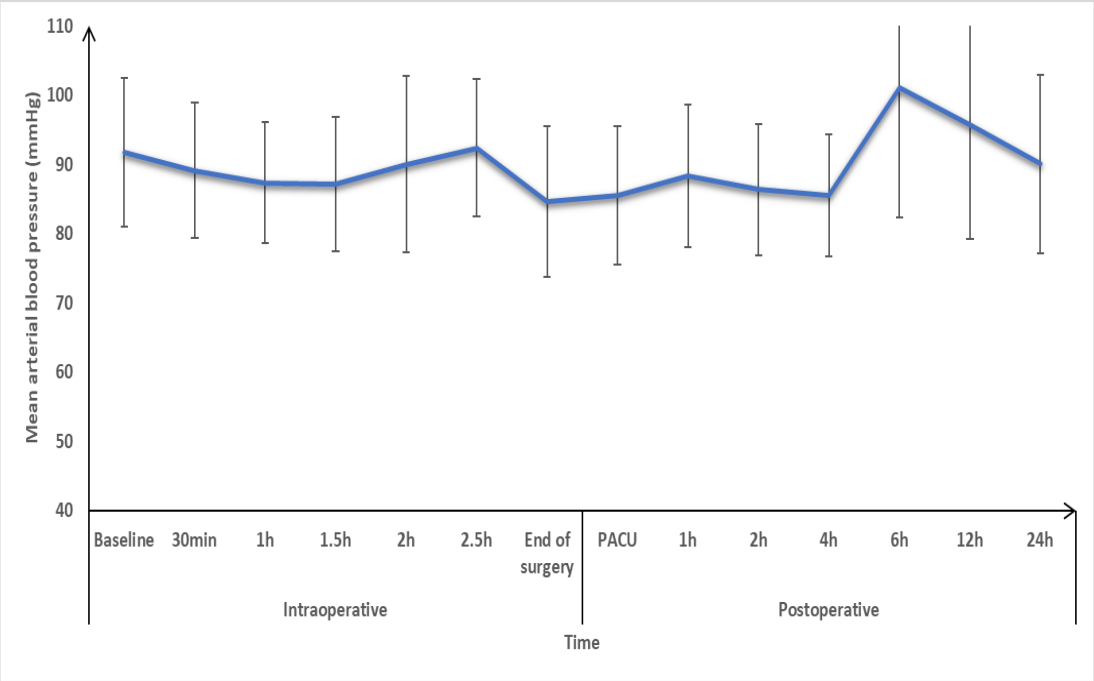

Figure 2: Mean arterial blood pressure intraoperative and postoperative of the studied patients

NRS at rest was significantly lower at 2h compared to baseline (P value=0.035), higher at 12h compared to PACU (P value=0.026) and was insignificantly different between PACU and (1h,4h, 6h and 24 h). NRS at movement was significantly lower at 2h, 4h and 24h compared to PACU (P value <0.05) and higher at 12hr compared to baseline (P value=0.041) while was insignificantly different between 6h and baseline.

Table 2: NRS at rest and movement of the studied patients

	(n=15)	P value
NRS at rest		
PACU	2 (2-3)	
1 h	2 (1-2.5)	0.100
2h	2 (1-2)	0.317
4h	2 (1-3)	0.477
6h	3 (2.5 - 3.5)	0.128
12h	3 (2.5 - 4)	**0.026***
24h	1 (0.5 - 3)	0.074
NRS at movement		
PACU	3 (3 - 3)	0.271
1h	3 (2 - 3)	
2h	2 (2 - 2)	0.655
4h	2 (2 - 2.5)	1.00
6h	3 (3 - 4.5)	0.064
12h	3 (3 - 6)	**0.041***
24h	2 (1 - 2)	0.565

Data are presented as median (IQR) *: Significantly different P value ≤ 0. 005. NRS: Numerical rating scale.

Eight (53.33%) patients required morphine. The mean value (± SD) of time of first rescue analgesia was 4.27 (±4.46) h. The mean value (± SD) of total intra-operative

fentanyl consumption was 64.67 (±26.96) µg/kg. The mean value (± SD) of total dose of bupivacaine consumption was 192.3 (±30.96) mg. The mean value (± SD) of the number of total doses was 2 (±2.45).

Table 3: Analgesic outcomes of the studied patients

	(n=15)
Time of first rescue analgesia (h)	4.3 ± 4.46
Number of patients required morphine	8 (53.33%)
Total intra-operative fentanyl consumption (µg/kg)	64.7 ± 26.96
Total dose of bupivacaine consumption (mg)	192.3 ± 30.96
Number of total doses	2 ± 2.45

Data are presented as mean ± SD.

PONV occurred in 6 (40%) patients. Hypotension occurred in 2 (13.33%) patients. No patients suffered from dural puncture with the needle, post dural puncture headache, unintentional intravascular injection, LA toxicity and respiratory depression.

Table 4: Side effects of the studied patients

	(n=15)
PONV	6 (40%)
Hypotension	2 (13.33%)
Dural puncture with the needle	0 (0%)
Post dural puncture headache	0 (0%)
Unintentional intravascular injection	0 (0%)
Local anesthetic toxicity	0 (0%)
Respiratory depression	0 (0%)

Data are presented as frequency (%). PONV: Postoperative nausea and vomiting.

DISCUSSION

Acute pain management is difficult during an open nephrectomy due to the extensive muscle cutting and wide subcostal flank incision required for a large operating field [12, 13]. For the first time, ESPB was identified as a potential treatment for thoracic neuropathic pain [4]. Later studies supported the effectiveness of ESPB delivered from the thoracic vertebral levels as an analgesic strategy for major abdominal surgery and bariatric surgery [4, 14, 15]. The mechanism that is responsible for ESPB is thought to entail sympathetic fiber blockage in the ventral and rami dorsal and local anaesthetic diffusion into the paravertebral area, which reduces somatic and visceral pain [16].

In line with our results, Zhang et al. [17] discovered that patients who got ESPB had considerably lower intraoperative and postoperative opioid use than patients who underwent GA alone, as well as decreased HR and MAP in patients undergoing open posterior lumbar surgery .

Additionally, Wahdan et al. [18] discovered that the ESPB group's pain scores in the first 12 hours following lumbar spine surgeries (with 20 mL levobupivacaine 0.25%) were significantly lower than those in the controls (20 mL normal saline).

In a case series, it was shown that continuous ESPB considerably reduced opioid consumption and pain scores over the first 48 hours after acute abdominal surgeries (such open nephrectomy) (20 mL Levo-bupivacaine 0.375% bolus and 10 mL/h 0.25% bupivacaine) [19].

Similar to our findings, Abd Ellatif et al. [20] found that after open nephrectomy, the ESPB group's initial rescue of analgesic request took a much longer than controls (without ESPB) (p 0.001). Both at rest and while moving, the VAS score in the ESPB group was considerably lower. There were also no signs of any LA or block placement problems.

Our results are in line with those of Aksu and Gurkan [21], who examined the efficacy of US-guided continuous ESB for postoperative pain control in two pediatric Wilms tumor patients undergoing nephrectomy. The findings of this investigation can also be compared to those of Piskin et al. [22], who discovered that US-guided continuous ESPB, used in conjunction with multimodal analgesia, produced acceptable analgesia following video assisted thoracoscopies (VATS). When compared to the control group, continuous ESPB considerably reduced narcotic-analgesic intake and the negative consequences that go along with it.

In agreement with our findings, Abdelgalil et al. [23] showed that there was no statistically significant difference between ESPB and patient controlled analgesia regarding complications.

Limitations of our study included small sample size, short follow-up period, and absence of control group. Being a single-center study is considered among the limitations. We recommend further randomized controlled trials with multi-center cooperation and large sample size. Follow-up period should be extended to determine the pain, hemodynamic parameters and possible complications.

CONCLUSION

The use of ultrasound guided continuous ESPB to manage postoperative pain following open nephrectomy for renal malignancy surgeries shows promise as a simple and secure method.

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