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Ultrasound Guided Erector Spinae Plane Block Versus Quadratus Lumborum Block in Upper Abdominal Surgeries

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Abstract

Postoperative pain (POP) after abdominal surgeries has many causes which include a parietal component (from surgical incision) and a visceral component (from the peritoneum). Erector spinae plane block (ESPB) is an interfacial plane block (IFPB) was applied to treat thoracic neuropathic pain. Ultrasound (US)-guided quadratus lumborum (QL) block (QLB) is a facial plane block (FPB) where local anaesthetic (LA) is injected close to QL muscle (QLM) aiming to anesthetize the thoracolumbar nerves. To assess the analgesic efficacy of QLB versus ESPB bock in upper abdominal surgery. In this study, eighty-eight patients of both genders, aged from 18-60 years undergoing elective upper abdominal surgeries were comprised in our study. Patients were haphazardly categorized into two groups (n=44). Group (ESP) received US-guided ESPB with injection of 20ml of isobaric bupivacaine (0.25%) in each side. Group (QL) received US-guided QLB with injection of 20 ml bolus of isobaric bupivacaine (0.25%) in both sides 20 min prior to general anesthesia (GA) induction. Patients were assessed postoperatively by using (VAS) score, (HR), (MBP), (SPO2) at 1,6,12,18,24 hours. Also, total fentanyl consumption and time to first analgesia request were taken. Total fentanyl required postoperatively was statistically reduced in QL group in comparison to ESP. Duration to the 1st request of analgesia was statistically significant longer in QL group compared to ESP group. Postoperative VAS score was statistically significant lower in QL group during rest and movement at 1,6,12 hr compared to ESP group. No significant differences were documented between both groups concerning hemodynamics and complications. This study concluded that PQLB provides prolonged and more effective analgesia with less postoperative fentanyl consumption in comparison to ESBP.

Keywords: Regional Anesthesia, Erector Spinae Plane Block, Quadratus Lumborum Block.

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1. Introduction

Abdominal surgeries represent an essential ratio of general surgeries [1]. Postoperative pain (POP) from abdominal surgeries is owing to several causes which include a parietal component arising from the incision and a visceral component arising from the peritoneum and the manipulations of the abdominal organs [2, 3]. Acute POP has been considered as a major challenge in the postsurgical period and isn't frequently adjusted [4]. Improper treatment of POP could induce shallow breathing, atelectasis, and retaining of secretions. This increases the incidence of postsurgical morbidities which ultimately ends in delayed recovery [5]. Regional anaesthesia is occasionally combined with GA to decrease operative opioid requirement, surgical stress response and provide postoperative analgesia. By advancement of ultrasound (US) imaging, interfascial regional anaesthesia approaches have gained mush popularity [6]. ESPB is an IFPB utilized to treat thoracic neuropathic pain [7]. When local anesthetic (LA) is administrated deep to the erector spinae muscle (ESM), it spreads cranio-caudally to the paravertebral space (PVS) to reach spinal rami [8]. It is an easy, simple effective and safe approach which spread on multiple dermatomal areas [9]. In addition US-guided QLB is a FPB in which LA is injected close to QLM aiming to anesthetize the thoracolumbar nerves. Of note, QLB procedures take this name as the injection site is close to QLM [10]. Posterior QLB (PQLB) was described by Blanco and McDonnell by injection of LA at the posterior surface of the QLM [11]. In PQLB when LA is injected it spread between posterior aspect of QLM and the thoracolumbar fascia (TLF) which is close to PVS [12]. This block leads to dermatological coverage (T7-L2) required for abdominal and hip surgery [10]. These blocks are recorded to provide proper postoperative analgesia for abdominal surgery. However, studies comparing and evaluating QLB and ESPB efficacy for acute POP management in upper abdominal surgeries are limited. This randomized controlled trial (RCT) was designed to assess

efficiency of ESPB versus PQLB in upper abdominal surgeries.

2. Patients and methods

This RCT study was conducted in Mansoura University Hospitals. Eighty-eight patients of either sex with ASA physical status I or II, aged from 18-60 years undergoing elective upper abdominal surgeries were enrolled in our study from August 2020 to August 2022 after being approved by IRB of Mansoura faculty of medicine (code no. MD.20.04.313) and written informed consent was obtained from all patients. The study was registered at Pan African Clinical Trial Registry (www.pactr.org) with registry number (PACTR202204718711277). We excluded patients refused to participate in the study and those with contraindication to regional anesthesia (infection at site of injection, bleeding disorder), Patients with Body Mass Index (BMI) > 36kg/m², chronic opioids or NSAIDs treatment, cases with history of hypersensitivity to any drugs of the study, pregnant and uncooperative patients.

2.1. Preoperative anesthetic management

All patients were evaluated before surgery by medical and surgical history taking, clinical examination, electrocardiogram (ECG) & ECHO if needed and laboratory investigations (CBC, LFTs and KFTs, coagulation profile). Day before the surgery, all patients received detailed instructions for using 10 cm visual analogue scale (VAS) for pain evaluation where they could mark at the point which represent their pain [13]. Demographic characteristics as age, gender and weight was registered. Eligible 88 patients were haphazardly divided into 2 equal groups using sealed opaque envelopes. ESPB group (ESP) included 44 patients who received 20 ml bolus bupivacaine 0.25% in each side and QLB group (QL) included another 44 patients who received 20 ml bolus bupivacaine 0.25% in both sides.

2.2. Intraoperative anesthetic management

On arrival to the operating theater, IV line was inserted, and fluid infusion was started. All patients were premedicated with 2 mg midazolam IV and monitored by standard monitoring (ECG, oxygen saturation, noninvasive arterial blood pressure). Before induction of GA, patients allocated to ESP group received US-guided ESPB and patients allocated to QL group received US-guided QLB. Patients of each group received 20 ml of isobaric bupivacaine in both sides. After 15-20 min the block was assessed by Hollmen scale using pin prick as following; Grade I= full sensation, Grade II= weak sensation, Grade III=recognized as light touch, Grade IV = no sensation [14]. Patients with failed block were excluded. All cases were preoxygenated by 100% oxygen and anesthetized by the same GA protocol which include iv administration of fentanyl (1µg/kg), propofol (2mg/kg) and atracurium besylate(0.5mg/kg). All patients were intubated and connected to mechanical ventilator to keep end tidal Co_2 around 35mmHg. Maintenance of anesthesia was done by utilizing isoflurane 1.2% in air –O2 mixture and top up doses of atracurium. IV fluids were given per body weight and based on intraoperative loss. Intraoperative HR, MAP, and O2 saturation (spo_2) were recorded every 5 min for first 15 min then every 30 min till the termination of the operation. IV infusion of paracetamol (15mg/kg) and ketorolac 30mg was started then given postoperatively every 8 hours &12 hours respectively. Fentanyl boluses (0.5µg/kg) were given for any rise in MAP or HR more than 20% of baseline (after optimization of the depth of anaesthesia). Postoperative, and after discontinuation of isoflurane and reversal of neuromuscular blocker using neostigmine (0.04mg/kg) and atropine (0.02mg/kg) all the patients were extubated and transferred to PACU and followed up for 24hrs.

2.3. US Guided ESP Block Technique

According to **Luis-Navarro *et al.*,** the patient was put in a sitting position. Taking the C7 spinous process (SP) as a reference, the T7 SP was recognized by palpation. When reached, high frequency (6-14 MHz) linear us probe was positioned over the SP and slipped laterally about 3cm till the transverse process was recognized. At this point, under complete aseptic condition 3 ml of 2% lidocaine was administrated. The probe was rotated in a longitudinal manner, and the puncture was conducted in the cranio-caudal direction after the preceding LA infiltration. A 22-gauge 100mm spinal needle (Quincke needle) was inserted in-plane of the US ray and directed towards the transverse process. When it contacted the transverse process, 2 ml of NaCl 0.9% was injected. After hydrodissection, 20mL of isobaric bupivacaine 0.25% was injected and cranial and caudal distribution of LA in the fascial plane deep to the ESM was observed. The approach was conducted for another time on the contralateral side [15].

2.4. US Guided Posterior QL Block Technique (QLB2)

As described by **Okmen *et al.*,** The patient was positioned laterally. Under complete aseptic condition. Using high-frequency linear US probe (6-10 HZ) (Mindary L14-6NE, China) abdominal wall muscles were identified. The probe was introduced posteriorly and the fascia transversalis (TF), TLF and QLM were visualized. Following administration of 3 ml of 2% lidocaine, 22- G 100mm spinal needle (Quincke needle) was introduced in plane and its tip was placed at the posterior edge of the QLM. 20 ml of 0.25% isobaric bupivacaine was injected between QL and middle layer of TLF. The same technique was done in the opposite site [16].

2.5. Postoperative management

After patient transfer to PACU hemodynamic parameters (HR, MAP& SPO2) and pain intensity using VAS score were assessed at 1,6,12,18 and 24 hours during rest and movement. The time to first analgesic request was recorded. Rescue analgesia in the form of Fentanyl iv boluses of 0.5µg/kg were given if VAS score ≥4. It was repeated after 30 min till VAS score ≤4 with maximum dose 1-2µg/kg. The total amount of 24 hrs postoperative opioid consumption was recorded. Any concomitant adverse events as (postoperative nausea and vomiting (PONV), hypotension, bradycardia and shivering) were also documented.

2.6. Statistical Analysis

The collected data were analyaed by utilizing SPSS software (Version 24, Inc.,IL, USA). Data were expressed as a median or number. The normality of data distribution was

evaluated by utilizing Kolmogorov-Smirnov test. Unpaired student-t test was utilized to compare numerical variables between groups, in cases when its assumptions were fulfilled, otherwise for non-parametric; the Mann-whitney test was utilized. The description of data was evaluated as mean±SD for quantitative data and frequency for qualitative data. Chi-square test was used for qualitative data. With regard to all the previous tests, P is considered significant when its value is less than 0.05.

3. Results and discussion

Demographic data of the studied group and surgical data were comparable (**Table 1).** Considering Hemodynamic changes, there was no statistically significant difference between both groups concerning intraoperative and postoperative HR and MAP (**Table 2).** There was no statistically significant difference between both groups intra and post operatively regarding oxygen saturation (**Table 3).** Concerning pain assessment, QL group was superior to ESP group in respect of pain score. The median range of (VAS) score was statistically significant higher in ESP group when compared to QL group during rest and movement at 1,6,12 hours postoperatively (p value ≤0.001) (**Table 4).** With reference to analgesic outcomes, intraoperative fentanyl consumption was comparable in both groups (p=0.862) **(Table 5).** The primary outcome of total postoperative fentanyl consumption was statistically higher in ESP group (75.65±18.60) in comparison to QL group (62.65±16.84) with significant (p 0.003) (**Table 5).** On the same line, the mean duration of analgesia in ESP group was (10.23±3.95) while in QL group was (13.28±4.43) with significant p (p=0.003) (**Table 5).** Regarding postoperative complication, 4 patients in QL group (9.1%) versus 6 patients in ESP group (13.6%) complained of nausea, and 7 patients in QL group (15.9%) complained of vomiting versus 6 patients in ESP group (13.6%) (**Table 6).** Of note, these adverse events were minor with no significant differences between both groups regarding all adverse events. Additionally, conservative treat was conducted which control these adverse events. Optimal analgesia is valuable for proper recovery following abdominal surgeries. Various analgesic modalitites are available for postoperative pain control. As multimodal analgesia component, regional IFPB are used for pain control. Finding the best analgesic modality for abdominal surgeries has always been a matter of great concern to improve postoperative quality of recovery and patient satisfaction of POP management. The PQLB was described by Blanco and McDonnell by administration of the LA between QLM and ESM[17]. In QLB the key to analgesia lies in TLF. Of note LA action could be clarified by the anatomic- histologic features of TLF in which there are high and minimal threshold mechanoreceptors and also pain receptors sensitive to LA action. Such receptors have main roles as regards pain development. The QLB could be conducted LA block of such receptors [18]. Another mechanism is LA spread to sympathetic fibers associated with abdominal divisions of lumbar arteries where it lies on the back of QLM innervating TLF. So their blockade could participate in analgesic efficiency of PQLB [10]. Also, TLF is attached medially to thoracolumbar vertebra, cranially with endothoracic fascia (ETF) and caudally with fascia illiaca confirming distribution of LA in cranio-caudal manner. As a result, LA spread along TLF and ETF into PVS is responsible patially for analgesia [19]. Also contrast dye was found to spread in a cranial manner to thoracic PVS and intercostal spaces (ICS) covering somatic nerves as well as the thoracic sympathetic trunk up to T4 level after cadaveric injection for QLB. In a caudal manner, contrast could reach lumbar nerve roots [18]. Chin *et al.,* 1st defined ESPB in terms of abdominal surgeries [20]. Many case reports and some clinical trials encouraging its use to provide regional analgesia for variable surgical procedures (rib fractures, thoracotomy, sternotomy, open and laparoscopic abdominal surgeries) [21]. As mechanism of analgesic action of ESPB is caused by penetration of LA into PVS and ICSs of many levels with block of both rami with sympathetic fibers with subsequent pain alleviation [20]. This current prospective comparative study was conducted to assess the safety and analgesic efficacy of ESPB vs QL II block in patients scheduled for upper abdominal surgeries, in terms of 24 hr total postoperative fentanyl consumption, time to first analgesia request, postsurgical VAS at rest and movement, the effect on hemodynamics, in addition to any postoperative adverse effects. Our study demonstrated that the average amount of postoperative fentanyl need was significantly decreased in QL group and time to 1st analgesic request was prolonged in QL group in comparison with ESP group. These outcomes were in concordance with those recorded by Taman *et al.,* who did a study involved 85 patients comparing between ESPB and QLB in terms of pediatric POP control following laparoscopic abdominal surgeries. They concluded that QLB is accompanied by longer and more efficient postsurgical analgesia in children after laparoscopic abdominal surgeries compared to ESPB [21]. Another study conducted by Liu *et al.,* on 84 patients to study the efficiency of US-guided QLB on quality of recovery following abdominal surgeries and found that single injection QLB with ropivacaine improved the quality of recovery at 48h postoperative and enhanced analgesia throughout the initial postsurgical period in patients undergoing abdominal surgeries in comparison to control group [22]. On the other hand, the current results were in disagreement with Aygun *et al.,* who reported that the effect of US-guided bilateral PQLB and ESPB in cases undergoing lap cholecystectomy were similar in regards to POP and opioid requirement [23].This may be owing to the use of higher volume of LA mixture (30ml) applied in this study. Also Kang *et al.,* who compared the analgesic efficiency of ESPB and PQLB in terms of laparoscopic hepatic resection and found that ESP and QLB provided comparable postsurgical analgesia in patients undergoing hepatic excision laparoscopically [24]. This may be related to performing of the block after induction of GA so dermatomal block was not confirmed. Also, concentration of LA was 0.375% , while in the current study we used 20 ml of 0.25% bupivacaine. As demonstrated by tulgar *et al.,* volume and concentration of LA is essential factor for ESPB. As dermatomal coverage increases with increased volume [25]. In the current study, there was no evident effect on haemodynamics which include HR and MAP. Also, operative fentanyl consumption was similar in the two groups. We believed that this was related to the analgesia provided by these blocks. This was supported by a study that showed that more hemodynamic stability in patient received QLB and ESPB in comparison to control group in patients undergoing open nephrectomy [17].

Table 1: Demographic data in the studied groups.

Variable	QL group (n=44)	ESP group (n=44)	P value
Age (Years)	42.59±12.52	38.77±10.81	0.130
Sex			0.089
Male	5 (11.4 %)	15 (34.1%)	
Female	39 (88.6%)	29 (65.9%)	
ASA			0.14
I	30 (68.2%)	36 (81.8%)	
II	14 (31.8%)	8 (18.2%)	
BMI (kg/m^2)	28.95± 4.08	30.56± 5.28	0.113
Diagnosis			
Achalesia	9 (20.5%)	11 (25.0%)	0.987
GERD	14 (31.8%)	12(27.3%)	
Diaphragmatic cyst	1 (2.3%)	1 (2.3%)	
Cancer stomach	4 (9.1%)	3 (6.8%)	
GERD& Hiatus hernia	6 (13.6%)	7 (15.9%)	
Cancer antrum	2 (4.5%)	3(6.8%)	
Hiatus hernia	8(18.2%)	7(15.9%)	

Table 2: Heart rate and Mean blood pressure in the studied groups.

Time	**Heart rate (bpm)**			**Mean blood pressure** (mmHg)		
	QL group (n=44)	ESP group (n=44)	P value	QL group (n=44)	ESP group (n=44)	P value
Intraoperative						
Basal	81.34±12.49	82.59±8.47	0.584	91.90±10.69	92.40±12.43	0.840
5 min	74.70±10.75	78.79±12.47	0.103	85.06±11.04	86.61±13.82	0.564
10 min	78.75±9.64	83.70±15.00	0.069	85.68±15.35	88.70±12.03	0.307
15 min	75.97±9.06	83.32±12.77	0.161	87.37±11.58	89.59±11.25	0.367
30 min	80.0±10.72	82.88±12.26	0.249	85.84±9.32	89.16±10.40	0.122
1 hr	80.74±10.45	85.92±12.80	0.07	86.62±9.35	89.88±10.51	0.172
1.5 hr	80.70±8.26	85.37±10.13	0.07	83.36±12.86	89.88±9.19	0.039
2 hr	79.93±8.98	86.50±10.57	0.103	88.37±11.72	85.60±7.27	0.510
2.5 hr	83.42±8.81	86.80±7.59	0.466	81.50±14.93	88.40±8.64	0.354
3 hr	77.62±12.69	88.00±6.92	0.221	89.71±9.37	96.33±2.08	0.275
Postoperative						
1 hr	78.86±8.78	80.15±9.03	0.497	84.22±6.89	85.36±7.96	0.476
6 hr	82.75±6.11	85.15±8.81	0.140	88.82±6.22	90.43±6.19	**0.226**
12 hr	85.14±7.67	88.09±6.81	0.06	91.16±7.61	93.75±6.48	**0.09**
18 hr	87.18±5.33	87.68±5.61	0.669	90.23±6.80	92.31±6.59	**0.147**
24 hr	84.18±5.33	84.75±4.97	0.607	86.86±6.74	89.13±5.84	0.095

Table 3: Oxygen saturation (%) in the studied groups.

Time	Oxygen saturation (%)		
	QL group (n=44)	ESP group (n=44)	P value
Intraoperative			
Basal	98.97±1.33	99.22±1.05	0.333
5 min	98.79±1.32	99.04±1.01	0.322
10 min	98.88±1.08	99.04±0.96	0.469
15 min	98.84±1.11	99.00±0.94	0.472
30 min	98.93±1.18	99.14±0.95	0.368
1 hr	98.91±1.17	99.11±1.03	0.456
1.5 hr	99.03±0.95	99.07±1.23	0.900
2 hr	99.25±0.93	99.00±1.24	0.564
2.5 hr	99.45±0.68	99.00±1.22	0.352
3 hr	99.57±0.53	98.33±1.52	0.079
Postoperative			
1 hr	98.09±1.00	98.11±1.01	0.916
6 hr	98.34±0.96	98.52±0.90	0.363
12 hr	98.77±0.77	98.86±0.82	0.595
18 hr	99.06±0.81	99.11±0.78	0.791
24 hr	99.27±0.54	99.25±0.65	0.859

Table 4: Postoperative visual analogue scale (VAS) score for pain assessment (0-10) at rest and movement in the studied groups.

	VAS score at rest			**VAS score at movement**		
Postoperative time	QL group (n=44)	ESP group (n=44)	P value	QL group (n=44)	ESP group (n=44)	P value
1 hr	0(0-2)*	1(1-2)	**≤0.001**	0(0-2)*	2(1-3)	**≤0.001**
6 hr	1(0-3)*	2(1-6)	**≤0.001**	1(0-3)*	2(1-7)	**≤0.001**
12 hr	2(0-4)*	3(1-6)	**≤0.001**	2(0-4)*	3(2-6)	**≤0.001**
18 hr	2(1-4)	2(2-5)	0.887	2(1-4)	3(2-6)	0.262
24 hr	2(1-2)	2(1-3)	0.084	2(1-3)	2(1-3)	0.143

Table 5: Intraoperative fentanyl consumption (µg), time to first request for analgesia (hr) and total post-operative fentanyl consumption (µg) in the studied group.

Variables	QL group (n=44)	ESP group (n=44)	P value
Intraoperative fentanyl(µg)	40.50±4.97	40.0±6.32	**0.862**
Time to first request for analgesia(hr)	13.28±4.43*	10.23±3.95	**0.003**
Total postoperative fentanyl consumption(µg)	62.65±16.84*	75.65±18.60	**0.003**

Table 6: Postoperative complications in the studied groups.

Variables	QL group (n=44)	ESP group (n=44)	P value
Nausea	4 (9.1%)	6 (13.6%)	0.502
Vomiting	7 (15.9%)	6 (13.6%)	0.764
Bradycardia	0 (0 %)	0 (0 %)	1
Hypotension	0 (0 %)	0 (0 %)	1
Shivering	0 (0 %)	0 (0%)	1

In the current study, there were few patients complained of PONV without clinical significance, this may be explained by reduction of the POP together with the opioid sparing effect of regional blocks. This came in correlation with what reported by Fu *et al.,* that analgesic consumption and incidence of PONV in group of patients received ESPB were significantly less when compared to control group while studying effect of ESPB on POP and recovery after hepatectomy [26]. Another meta-analysis study conducted by Huda and Minhas showed that QLB improved POP control and opioid consumption and subsequently diminished the incidence of PONV compared to controls in total hip arthroplasty [27].

3.1. Limitations

The main limitations of our study included that; no single surgeon conducted all surgeries in both groups and we have rule out the patients with BMI>36 kg/m^2 so the efficacy and feasibility of these blocks are needed to be assessed in this category of patients, we didn't have control group with systemic analgesia only and we didn't use catheter as we wanted to evaluate the duration of single shot block.

4. Conclusions

This study concluded that QLB was accompanied by prolonged and more effective analgesia with less fentanyl consumption in comparison to ESPB when conducted with general anesthesia for upper abdominal surgeries.

Conflict of interest

None.

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