Post-operative Analgesic Efficacy of Ultrasound Guided Ipsilateral Erector Spinae Plane Block versus Caudal Block Using Bupivacaine in Inguinal Herniotomy in Pediatrics

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Abstract

***Background*: Alleviation of postoperative pain is one of the goals of perioperative anesthesia care. The most frequently used regional anesthesia technique in children is caudal block. The erector spinae plane block (ESPB) has emerged as a valuable regional anesthesia technique for a range of thoracic, abdominal, & other procedures. *Aim*: To decrease the postoperative analgesic consumption in inguinal herniotomy in pediatrics. *Subjects & Methods*: Forty children planned for unilateral inguinal herniotomy, were randomly allocated into two equal groups to receive either ultrasound-guided erector spinae plane (ESP) or caudal blocks (CB) using bupivacaine. *Results:* The means of the first request of analgesia were statistically significant difference between ESP & caudal group (582 ± 91.8 minutes versus 342 ± 96 minutes respectively). Moreover, total postoperative paracetamol consumption was significantly different between both groups with higher consumption among the caudal group. *Conclusion*: ESPB and CB provided good postoperative analgesia with superior outcomes for ESPB.**

Keywords: Herniotomy, ESP, caudal, pediatrics.

Introduction

Inadequate analgesia can cause postoperative pain a widespread issue, up to one-third of patients suffer from moderate to severe pain[(1)]. Patient comfort, early mobilization, less cardiac & pulmonary problems, a lower risk of deep vein thrombosis, and a quicker recovery were all benefits of efficient postoperative pain management[(2)]. Perioperatively, pharmacological & interventional methods can be used to control postoperative pain[(3)]. Assessing pain in children is more difficult than in adults; it could be difficult for the pain therapist to distinguish between discomfort & pain[(4)]. A combination of analgesics, such as acetaminophen, non-steroidal anti-inflammatory medications, opioids, and/or local/regional anesthesia, can typically be used to effectively control postoperative pain in children[(5)]. The most often utilized method of regional anesthetics in pediatrics is the caudal approach epidural block. Since its initial description in 1933, it has grown to be one of the most widely used methods of regional anesthetics[(6)]. Typically,it is used in

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conjunction with general anesthesia to provide pediatric patients having lower extremities, perineal, lower abdominal, hypospadias, inguinal hernia, orchidopexy surgeries & other procedures effective postoperative analgesia. It lessens the need for intraoperative inhalational or opioid agents when paired with general anesthesia[7]. For a variety of thoracic, abdominal, and other operations, the erector spinae plane block (ESPB) has proven to be an effective regional anesthetic approach. Local anesthetics were injected into the fascial plane deep to the erector spinae muscle at the transverse process of the spine at the desired level. The injectate is then disseminated craniocaudally[8]. Additionally, local anesthetics pierce anteriorly to enter the thoracic paravertebral region, where they block the rami communicants that transmit sympathetic fibers as well as the ventral & dorsal rami of spinal nerves. If the injection was performed at a lower thoracic level, the erector spinae plane block is thought to provide visceral & somatic abdominal analgesia due to the extension down to the lumbar spine. Lumbar ESPB is relatively novel & opens new possibilities for regional anesthesia & pain management[9]. It allows a multi-dermatomal coverage with single injection. These features make the ESP block a potentially safer & more straightforward alternative to thoracic epidural or paravertebral block. Additionally, the sonographic target is easily visualized, & the injection site is remote from the neuroaxis, pleura & major vascular structures[10]. There are limited reports about the use of ESP block in children. To date, few studies are comparing postoperative pain control in children undergoing lower abdominal surgery receiving caudal block versus those receiving ESP block using bupivacaine. In this study, we compared the postoperative analgesic efficacy of ultrasound-guided ipsilateral ESP block versus caudal block using bupivacaine for unilateral inguinal herniotomy in children for whom the operation was performed under general anesthesia.

Patients & methods

After approval of the Research and Ethics Committee of the Faculty of Medicine, Suez Canal University, and written informed consent from the patient's parents with an explanation regarding the purpose, methods, effects, and complications of the study. We studied 40 children, American Society of Anesthesiologists (ASA) I and II planned for elective unilateral inguinal herniotomy at Suez Canal University Hospital, in a prospective, comparative, randomized, double-blinded, clinical trial carried out during the period from June 2022 to July 2023. Patients were randomly allocated by computer-generated random numbers into two equal groups and received either ipsilateral ultrasound-guided ESP block (*n*=20) or ultrasound-guided caudal block (*n*=20) using bupivacaine. The randomization sequence was concealed in opaque closed envelopes that were sequentially numbered, which were opened on the day of surgery after patient assignment to study.

ESP group: received 0.5 ml/kg of 0.25 % bupivacaine (limited to a maximum dose of 20 ml), (prepared by diluting bupivacaine 0.5% with normal saline in ratio of 1:1).

Caudal group: received 1 ml/kg of 0.25% bupivacaine. Patients aged from 1-7 years old, both male & female, ASA physical status I & II & scheduled to undergo elective unilateral inguinal herniotomy were included in the study. Patients who had an infection or skin lesion (angioma, hair tuft, or nevus) at the site of puncture for local

anesthetic injection, bleeding disorders or received preoperative analgesics were excluded from the study. A preoperative anesthetic assessment and investigations including [CBC, bleeding profile as prothrombin time (PT), partial thromboplastin time (PTT), International Normalized Ratio (INR)]were done. Intraoperatively, patient was reassured, then non-invasive blood pressure,3- leads ECG and pulse oximetry were attached. No routine pre-medication was given. A 22-G intravenous cannula was inserted. All patients were given general anesthesia with endotracheal intubation using sevoflurane inhalation with 8% in 100% O_2, then maintained on 2% in 50% O_2: 50% air. Ventilation using PC-VG mode with tidal volume 8 ml /kg, respiratory rate 16-25 depending on the age of the child. After giving the block, we waited 15 minutes before the start of skin incision. An increase in heart rate and/or arterial blood pressure more than 20% of baseline values in response to surgical stimulus or thereafter throughout the whole operation was considered as inadequate or incomplete block so, fentanyl (0.5-1 µg/kg) was given. After extubation, the child transferred to PACU for further assessment of vital signs & FLACC pain score.

ESP block:

With ultrasound guided technique using, Sonosite M-turbo, linear transducer [6-13 MHz] with sterile probe cover & gel. Patient was placed in lateral position (with the surgical side on the top). Following skin preparation with disinfectant, the ultrasound transducer was used to define the level of block at L1 transverse process. Ultrasound probe was placed transversely in parasagittal plane 1-2 cm lateral to the midline to visualize the lateral tip of the L1 transverse process. The erector spinae muscles were visualized superficial to the acoustic shadow of the transverse process. A 22 gauge, 50 mm, echogenic short beveled block needle was inserted deep into the erector spinae muscles, utilizing the 'in-plane' technique in a cranio-caudal direction. Confirming correct placement of needle was done by injecting (0.5-0.1) ml sterilized normal saline, the needle was attached with flexible tubing to a syringe filled with the study solution deep to the erector spinae muscle.

Caudal block:

Using ultrasound guided technique, linear transducer [6-13 MHz] was used. Patient was placed in left lateral position with both hips flexed 90°.Back exposure & sterilization of site of block with disinfectant. Preprocedural scanning of the sacral & coccyx was done. The probe was placed transversely over coccyx & moved cranially to identify sacral cornu which appears as "frog eye sign" & hyperechoic sacrococcygeal ligament as "the hump." At this point, the probe was rotated 90° to obtain longitudinal view of the caudal space, then placed between the two cornu. A 5-cm short beveled needle was advanced at a 45 ° degree angle cephalad in longitudinal plane. After locating the caudal space, aspiration for blood or CSF was performed & if negative, a calculated dose of study solution was injected.

Postoperative assessment:

Vital signs & FLACC pain score were recorded at the PACU then at 6^{th} ,12^{th} ,18^{th} & 24^{th} hours. Time of first request of analgesia and total analgesic consumption of paracetamol in the first 24 hours were recorded in both groups. Any adverse effects associated with both blocks also were recorded.

Pain assessment:

One of the most often used observational pain assessment scores in clinical practice,

the Faces, Legs, Activity, Cry, & Consolability score (FLACC score)was used to measure pain. It is intended & validated to measure pain following surgery [11]. This score is to be interpreted as follows:(1–3 = mild discomfort or pain, 4-6 = moderate pain, 7–10 = severe pain)

All patients who requested analgesia were given intravenous paracetamol (15 mg/kg/dose) every 8 hours if their FLACC score was ≥4, or every 6 hours in some cases based on their pain assessment (maximum daily dose: 75 mg/kg/day).

Statistical analysis:

The statistical analysis was performed using IBM SPSS Statistics® 22 for Windows 10 operating system. Descriptive data was expressed as median & interquartile range (-) for continuous nonparametric variables, and as mean & SD for continuous parametric variables, & count/total & percentages (%) for categorical & dichotomous variables.

One-way analysis of variance (ANOVA) was used to analyze the continuous variables between the two studied groups (e.g., heart rate, blood pressure, time of first request & paracetamol consumption) & Chi-test for categorical & dichotomous variables. The level of statistical significance was considered to be P-value < 0.05.

Presentation of the statistical outcomes in the form of tables & graphs was performed using the "Microsoft Office Excel® 2013" program.

Results

Forty children with ASA I & II, ages 1-7 years of either sex, who were scheduled for unilateral inguinal herniotomy, this prospective, randomized, double blinded study was conducted. The concert flow-chart illustrates how patients were randomized into two equal groups & given either ipsilateral ultrasound guided ESP block (n=20) or caudal block (n=20) using bupivacaine(figure1).

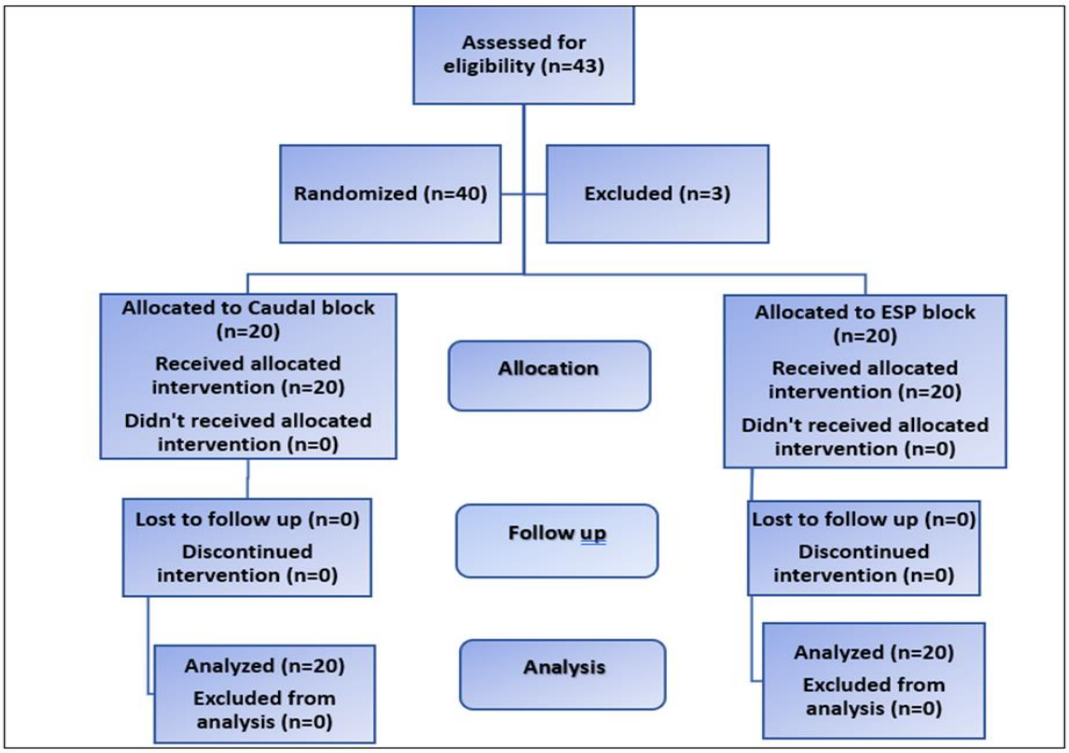

Figure (1): The concert flow-chart of the study

Regarding the demographic data, age, sex, ASA class, weight and mean duration of surgery, there were no statistically significant differences among groups (table1).

Table 1: demographic characteristics of study group & duration of the surgery(n=40)

Variables		ESPB group (n=20)	CB group (n=20)	P-value
Age (years)		4.25 ± 1.37	4.4 ± 1.57	0.375[1]
Sex	**Male n,(%)**	15(75%)	14(70%)	0.723[2]
	Female n,(%)	5(25%)	6(30%)	
Weight (kg)		16.5 ± 3.46	16.45 ± 5.52	0.432[1]
ASA class **I** **II**		 20(100%) 0(0%)	 20(100%) 0(0%)	1.00[3]
Duration of surgery (minutes)		30.25 ± 6.17	31.85 ± 7.04	0.225[1]

1. Student t test used 2. Chi square test used 3. Fisher exact test , ASA; American Society of Anesthesiologists

Concerning the first time request of analgesia postoperatively, ESP group had delayed onset than caudal group (582 ± 91.8 minutes versus 342 ± 96 minutes respectively) with statistical significant difference (P<0.001) (table2).

Table (2): Time of first request of analgesia in minutes among study groups(n=40)			
	ESP group (n=20)	Caudal group (n=20)	P- value
Time of first request of analgesia (minutes)	582 ± 91.8	342 ± 96	<0.001*[1]
1. Student t-test used	*Statistically significant as p<0.05		

Measurements of FLACC score showed statistical insignificant differences between both groups at PACU, while at 6 & 12 hours post-operatively FLACC scores were significantly lower among ESP group than caudal group. Also at 18 & 24 hours post-operatively FLACC scores were lower among ESP group than caudal group, but with statistical insignificant differences(p>0.05) (figure2).

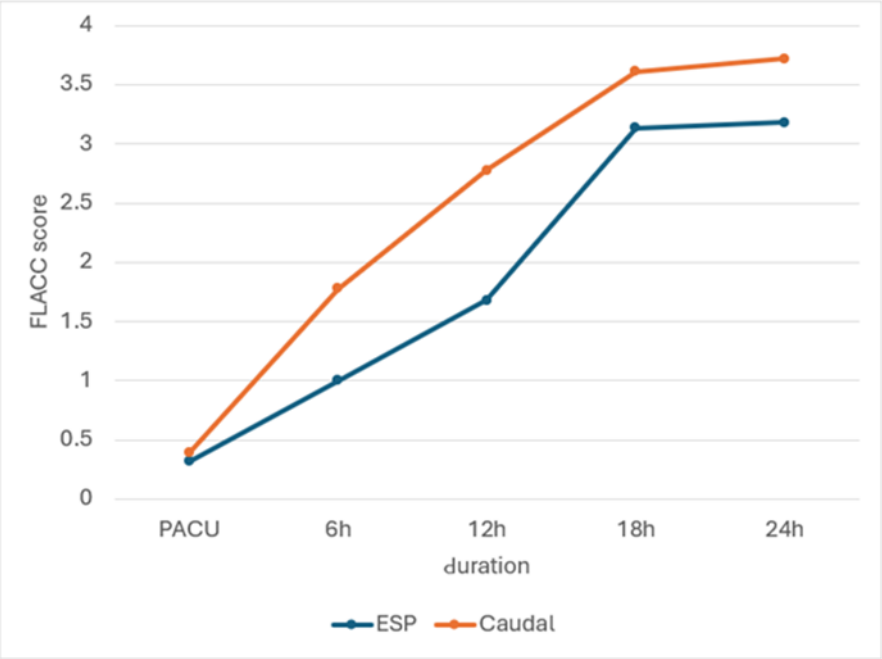

Figure (2): FLACC scale among study groups

Total amount of paracetamol consumption was significantly higher among caudal group than ESP group (p=0.027),the results were [270-990mg/24 hours (IQR:630) versus 250-750 mg/24 hours (IQR:525) respectively] (figure3).

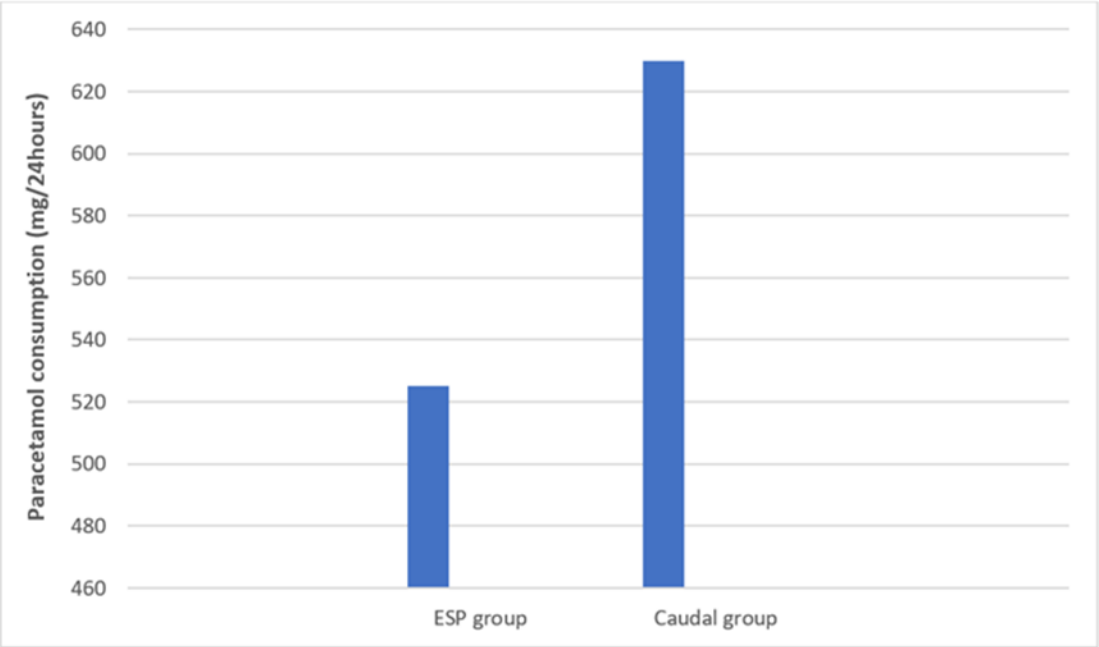

Figure (3): Total amount of paracetamol consumption postoperatively among study groups

Measurements of MAC of sevoflurane showed statistical significant differences between both groups as group ESP had higher mean of MAC than caudal group ($p<0.05$) (figure4).

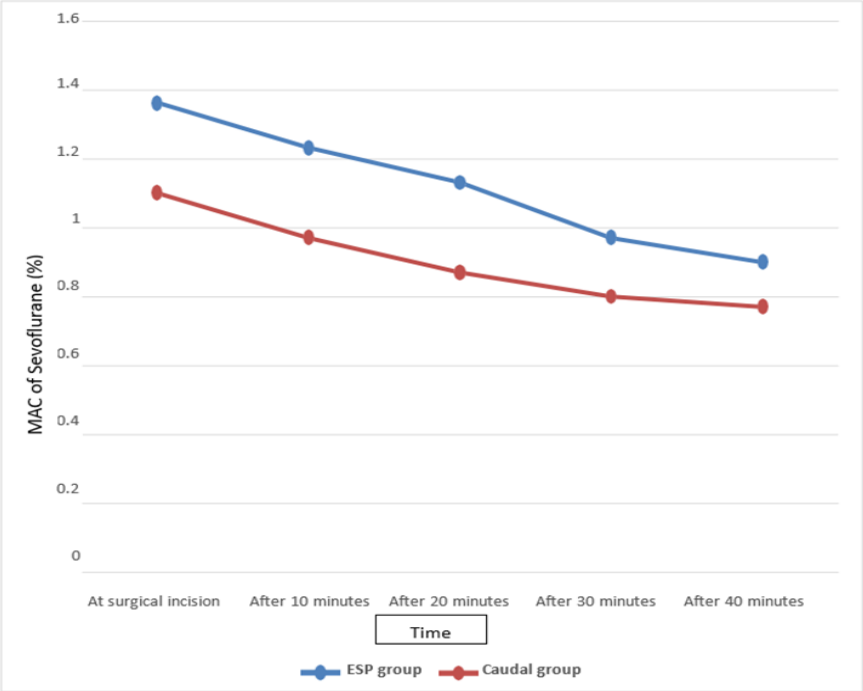

Figure (4): Measurements of MAC of sevoflurane among study groups

Systolic & diastolic blood pressure readings between the two groups revealed statistically insignificant differences. Additionally, heart rate measures revealed statistically insignificant changes between the two groups; however, intraoperatively, it was observed that the caudal group had a smaller reduction than the ESP group. Postoperative complications among study groups, were minimal with statistical insignificant differences (p=0.784) as follow; ESP group had one patient(5%) that complained from vomiting & was managed by IV antiemetics, while in caudal group two patients (10%), one patient complained from vomiting after 4 hours from surgery & was managed by IV antiemetics & the other complained from urine retention that resolved early.

Discussion

Inguinal hernia repair in pediatrics, being among the most prevalent surgeries done on daily basis, so it is important to maintain appropriate analgesia to facilitate early mobilization as part of perioperative care[12]. The goal of this study was to reduce children's use of post-operative analgesia with the best pain control & the fewest adverse effects. It compared the postoperative analgesic efficacy of caudal block and ESP block ultrasound guided using bupivacaine.This prospective, randomized, double blinded study was carried out on 40 patients with ASA class I&II, aged 1 to 7 years old of either sex & who were scheduled for unilateral inguinal hernia surgeries. Patients were divided into two groups: group I included 20 patients received (ESPB) with dose (0.5 ml/kg) of 0.25% bupivacaine & group II included 20 patients received (CB) with dose (1ml/kg) of 0.25% bupivacaine.The results showed that both ESPB & CB succeeded in decreasing post-operative pain & the total analgesic consumption with a superior outcome for ESPB. It was found that both groups were matched regarding age, sex, weight, and ASA class. Perioperative hemodynamics were comparable between the two groups. In this study, group I (ESPB) had significantly lower FLACC scores at 6 & 12 hours post-operatively compared to Group II (CB). Additionally, FLACC scores were lower in group I than group II at 18 & 24 hours after surgery, with statistically insignificant differences. This may be explained by the fact that local anesthetics injected into the fascial plane of the erector spinae were intended to travel cranially & caudally to reach distant dermatomes in addition to the paravertebral & epidural spaces.Visceral pain is relieved as a result of blocking the transmission of nociceptive stimuli through the dorsal/ventral rami of the spinal nerve roots, preventing the transmission of afferent stimuli, & inhibiting the efferent activation of the sympathetic nervous system [8].

This is consistent with a study conducted in 2022 by Abdelrazik et al., on 63 pediatric patients undergoing lower abdominal surgeries. The patients were divided into three groups: ESP group, Caudal group, & control group. The researchers found that the ESPB group had a lower early post-operative FLACC score than the Caudal group, & both groups had a FLACC score that was significantly lower than the control group[12]. In this study, ESPB group required a longer time to request analgesia (582 ± 91.8 minutes versus 342 ± 96 minutes, respectively) than CB group, with a statistically significant difference (p<0.001).

El-Emam and Abd El Motlb, conducted a randomized controlled trial to compare ilioinguinal/iliohypogastric blocks with ESPB for the treatment of inguinal hernias. Since the same nerves were used to anesthetize both blocks, they were able to demonstrate the superior analgesic efficacy of ESPB. This suggests that the more proximal ESPB that has spread into the paravertebral space may have a longer duration of action, as evidenced by the fact that patients undergoing unilateral inguinal hernia repair had a lower FLACC score & a longer first analgesic request in the ESPB group than in the group that received an ilioinguinal/iliohypogastric nerve (IIN) block[13]. Also, consistent with a study conducted in 2022 by Abdelrazik et al., which discovered that group ESB required less overall analgesia than group CB. Additionally, the ESPB group experienced pain relief for a longer period of time for an average of 8 (8–12) hours as opposed to the CB group's 6 (6–8) hours median[12].

In keeping with Mandour et al., 50 children were randomly divided into two equal groups for unilateral open kidney operations. In terms of the initial request for rescue analgesia during the 12-hour postoperative period, Group ESPB & Group Caudal differed in that none of the ESPB group's patients needed rescue analgesia during the same period (P-value < 0.001), while 20 out of 25 patients (80%) in the Caudal group required it, with a median (1st, 3rd quartiles) time to analgesia of 300 (240, 420) min & a total opioid consumption of 1.05 (0.90, 1.20) mg [14].

In a prospective randomized double-blind trial conducted by Öksüz et al., 53 patients undergoing orchiopexy & inguinal hernia surgery under general anesthesia were randomly assigned to receive either caudal block or quadratus lumborum block (QLB). In the first 24 hours, the QLB group had a considerably less number of patients who needed analgesics (p=0.001). The QLB group had significantly reduced postoperative 4,6,&12hours FLACC scores (p<0.001, p=0.001, & p<0.001, respectively)[15].

In terms of total analgesic consumption, in this study, it was found that total amount of paracetamol consumption was significantly higher among caudal group than ESP group (p=0.027),the results were [270-990mg/24 hours (IQR:630) versus 250-750 mg/24 hours (IQR:525) respectively]

Mostafa et al., in 2019, 13 out of 30 patients in the ESPB group & 28 out of 30 patients in the control group needed postoperative acetaminophen. The control group consumed more acetaminophen overall than the ESB group did[16].Aksu & Gürkan, in 2018,when used ESPB,it was reported no pain & no need for analgesics more than 24hours after surgery[17].

This study found that there were statistically significant variations in the Minimum Alveolar Concentration (MAC) of sevoflurane between the two groups. Specifically, (ESPB) had a greater mean MAC than (CB) (p<0.05). This could be explained by the fact that there is a delay in the action of ESPB and so caudal block is a better option in short-time surgeries than ESPB.

Similarly, Elshazly et al., study sought to determine if (CB) or (ESPB) had a better analgesic effect for juvenile patients undergoing hip or proximal femoral operations. According to the study, the ESPB group consumed more fentanyl overall during surgery than the caudal group, however the difference was not statistically significant [18].

The study found that postoperative complications among the study groups

were minimal, with statistically insignificant differences (p=0.784) as follows: one patient (5% in the ESP group) complained of vomiting & was treated with IV antiemetics, while two patients (10%) in the caudal group complained of vomiting after four hours of surgery & were treated with IV antiemetics.

With Aksu & Gürkan, in group CB, two patients reported urine retention, no other block-related side events, such as hematoma, infection, respiratory depression, or motor weakness, were reported [19].According to a study by El-Emam and Abd El Motlb, there was no statistically significant difference in the incidence of postoperative vomiting for the IIN (ilioinguinal block) & ESP (erector spinae block) groups, respectively, (9 [30%] & 12 [40%])[13].

Öksüz et al., reported in 2019 that their patients did not have any lower limb muscular weakening or other complications[17]. Hernandez et al., reported no complications[20]. Abdellatif, in 2012 reported two patients in the ilioinguinal/iliohypogastric nerve block group & just one patient in their CB group had vomiting. None of the patients of either group had any motor weakness at 3 hours postoperatively[21].

Conclusion:

Perioperatively, both blocks stabilized hemodynamic parameters. Both the ESPB & CB groups achieved good pain control with a better outcome for ESPB. For patients who cannot receive caudal block, ESPB may be a useful alternative for managing pain postoperatively.

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