Original Article

The analgesic effect of bilateral ultrasound-guided erector spinae plane block in paediatric lower abdominal surgeries: A randomised, prospective trial

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ABSTRACT

Background and Aims: This study aims to evaluate the analgesic effect of ultrasound-guided erector spinae plane block (ESPB) in paediatric lower abdominal surgeries. **Methods:** Randomised, prospective trial. Forty patients, aged 2–10 years with the American Society of Anesthesiologists Score of I and II scheduled for elective lower abdominal surgery were included in the study. **Interventions:** Patients were randomised into two groups as control group and ESPB group. Ultrasound-guided erector spinae plane block at L1 vertebral level was performed preoperatively using 0.5 ml/kg 0.25% bupivacaine (max 20 ml) for the patients in ESPB group. Analgesic requirements and time to first analgesic requirement were recorded and Face, Legs, Activity, Cry and Consolability (FLACC) scores for pain were recorded at 0, 1, 2, 3, 6, 12 and 24 h postoperatively. **Results:** Forty patients were included in the final analyses. Significant difference was determined between the groups on post-operative morphine requirement and FLACC scores at 3 h and 6 h postoperatively ($P < 0.05$). Significant difference was also determined in time to first dose of rescue analgesia between the groups ($P < 0.05$). **Conclusions:** This study shows that the ESPB provides adequate post-operative analgesia in paediatric patients undergoing lower abdominal surgery.

Key words: Paediatric, post-operative pain, regional block, ultrasound

INTRODUCTION

Lower abdominal surgery in paediatric patients is the most common group of surgery done in this age group.[1] These surgeries are mostly done on day care basis and an adequate opioid-free analgesia is much required. Many fascial blocks have been used for post-operative analgesia in lower abdominal surgery – caudal block, transversus abdominis plane (TAP) block and Quadratus lumborum block (QLB) to name some.[2-6] A new block in the armamentarium is ultrasound-guided erector spinae plane (US-ESP) block described by Forero *et al*. in 2016.[7] This block has generated huge interest because of its safety and simplicity. Although US-ESP block has mostly been described for thoracic surgery in paediatrics,[8] it can also be used for abdominal surgery like in adults.[9,10] There are very few clinical studies, that also mostly case reports to assess the benefit of this block for lower abdominal surgery in paediatric patients. Thus, we planned this study to see the effect of US-guided-ESP block for post-operative analgesia in lower abdominal surgery in paediatric patients.

The primary aim of this study was to see efficacy of US-guided-ESP block based on total post-operative rescue analgesia requirement for the next 24 h. The secondary aims were to assess pain (Face, Legs, Activity, Cry and Consolability [FLACC]) scores both

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in the post-operative recovery room and on the ward, time for first rescue analgesia and parents' satisfaction score.

METHODS

The study was registered with clinicaltrials.gov (CTRI/2018/11/016305) prior to patient enrolment on November 12, 2018 and was conducted between November 2018 and December 2019. Approval was obtained from the institutional ethics committee and the patient's parent, before the start of the study. The Consolidated Standards of Reporting Trials flow diagram was used for patient enrolment and allocation [Figure 1]. We evaluated 54 patients but only 40 patients, aged 2–10 years with the American Society of Anesthesiologists (ASA) physical status scores of I and II were included in the study. The surgery which was included was ureteric reimplantation surgery, appendectomy and intussusception. Patients were divided into two groups, control and erector spinae plane block (ESPB). The control group did not received ESPB after giving general anaesthesia, ESPB group received the studied block.

We performed randomisation using computer-generated random number tables and concealment of allocation was carried out using the sealed opaque envelope technique. The exclusion criteria were ASA Scores of III or IV, allergies to bupivacaine, undergoing bilateral surgery or with infection of the skin at the needle puncture site. All the children were given premedication of oral midazolam (0.5 mg/kg) 30 min prior to probable shifting time to operating room.

In the operating room, patients were secured with standard monitors-pulse oximetry, electrocardiography and non-invasive blood pressure measurement, anaesthesia was induced with 8% sevoflurane and 50% air in oxygen. A 24/22 gauge intravenous (IV) cannula was then inserted and fentanyl 1 μg/kg was administered for anaesthesia induction. Airway was secured with ProSeal laryngeal mask airway (Intravent-Orthofix, Maidenhead, United Kingdom). Anaesthesia maintenance was performed with sevoflurane 2% in 50% nitrous oxide and oxygen. No additional opioid or drug was used during surgeries. An anaesthetist blinded to the study was responsible

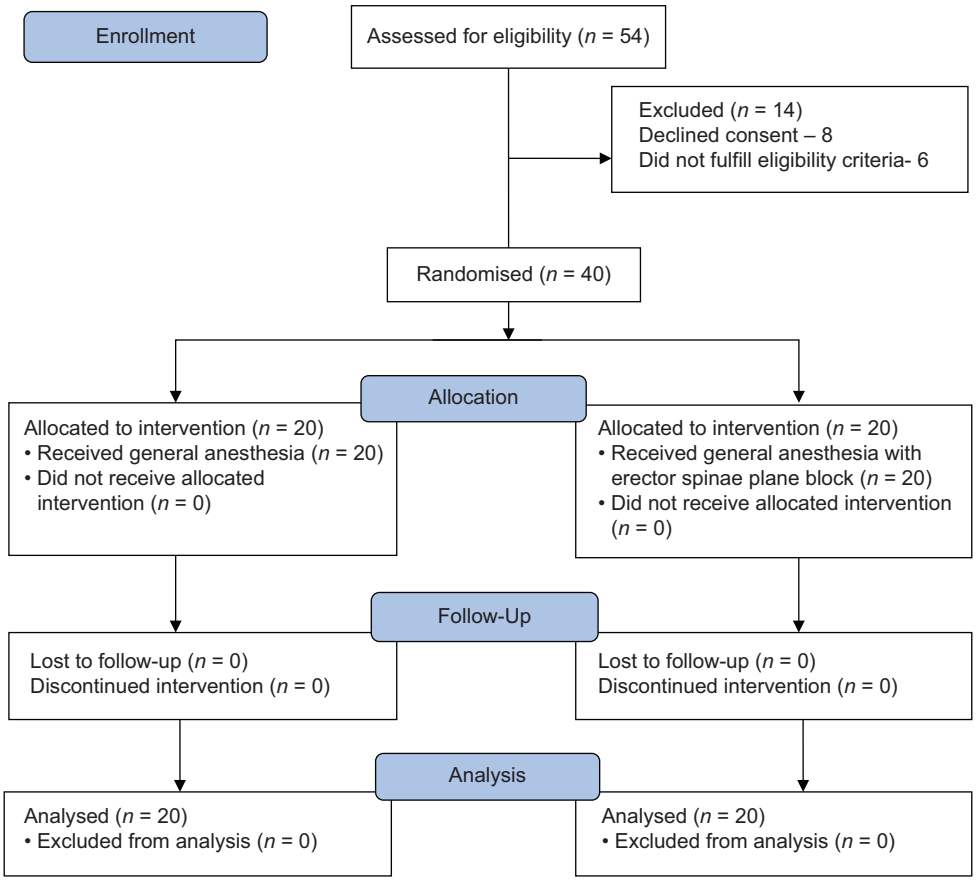

Figure 1: CONSORT diagram

for perioperative anaesthesia management in line with the departmental guideline. At the end of the surgery all patients received acetaminophen 15 mg/kg IV for post-operative analgesia. All blocks were performed after securing the airway before the start of surgery. The same anaesthesiologists, who were blinded to the data collection until the completion of study, performed all the blocks using an ultrasound machine (Sonosite, Bothell, USA) equipped with a multi-frequency linear probe (6–19 MHz) and a 22G, 50 mm, insulated facet type needle (B-Braun Sonoplex, Melsungen, Germany). Patients were put in the lateral position for performing the block. The skin preparation was done with 10% povidone iodine; ultrasound probe was placed 1–2 cm lateral to the midline with transverse orientation. The L1 level was identified by counting upwards from the sacrum. Following identification of the erector spinae muscle (ESM) and transverse process, a needle was inserted deep into the ESM in a lateral-medial direction, using an in-plane technique [Figure 2]. The correct needle position was confirmed with the administration of 0.5–1 ml local anaesthetic. A pre-calculated dose (0.5 ml/kg) of 0.25% bupivacaine (limited to a maximum dose of 20 ml) was injected deep to the ESM for block performance. The same thing was repeated for the other side.

A recovery room resident (blinded to the study) performed pain evaluation using FLACC scores both in the post-operative recovery room and on the ward. FLACC scores were recorded at post-operative 0, 1, 2, 3, 6, 12 and 24 h. Rescue analgesia was planned based on the patients FLACC scores. Morphine 0.05 mg/kg IV as rescue analgesia in case of FLACC scores ≥4. Analgesic requirements in the first 24 h postoperatively, time to first analgesic and parental satisfaction with the analgesia provided were recorded at post-operative follow-up visits. Parental satisfaction

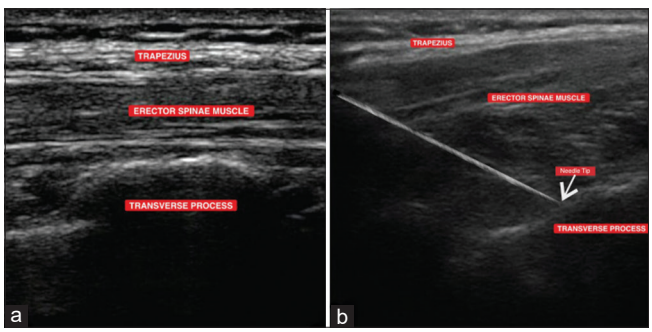

Figure 2: (a) Identification of the transverse process of the spine, (b) localisation of the tip of needle

levels were recorded a numerical scale from 1 to 10, with 1 representing the lowest possible level of satisfaction and 10 the highest.

The sample size calculation was performed using G*Power version 3.1.9.2 (Kiel University, Kiel, Germany) software. A pilot study was conducted in 6 patients (3 controls and 3 ESPB groups). The total morphine requirement was 0.84 ± 0.08 mg in control group. No patient in ESP group required any rescue analgesia. To make this difference significant at a power of 95% and a significance level of 5% the analysis showed that 17 patients would be required for each group. Twenty patients for each group were included to the study against the possibility of patient dropouts.

All statistical analyses were performed using International Business Machine Statistical Package for Social Sciences (IBM SPSS) for Windows version 20.0 software (IBM Corp., Armonk, NY, USA). The Kolmogorov–Smirnov test was used to test the normality of data distribution. Continuous variables were expressed as mean ± standard deviation and categorical variables were expressed as counts (percentages). The two groups were compared for significance by Student's *t*-test. Categorical variables were compared between the groups using Fisher's exact and Chi-square test. Two-sided $P < 0.05$ was considered statistically significant.

RESULTS

Out of 54 patients assessed, only 40 patients were included in the final analysis [Figure 1]. The demographic data, operation types and duration of the surgery was comparable between both the groups [Table 1]. Total morphine requirement in the post-operative period in control group was 1.28 ± 0.087 mg compared to 0.645 ± 0.49 mg in ESP group. The difference was extremely significant ($P = 0.0001$) [Table 2]. Comparison of FLACC score amongst two groups showed statistically non-significant variation at 1 h and 2 h postoperatively. At 3 h and 6 h, the FLACC score was significantly higher in control group [Table 3]. The requirement of first dose of rescue analgesia was 160 ± 25 min in control group and 360 ± 30 min in ESP groups ($P = 0.00$, highly significant) [Table 2]. Parents of the children in group 2 who received US-guided ESP block were more satisfied than control group (ESPB group – 8.25 ± 0.698 and control group –5.6 ± 0.583, $P < 0.0001$). No complications (hypotension, arrhythmia or allergic reaction) were

observed during the intra- or post-operative periods in any patient. There were no complications related to the block in post-operative period.

DISCUSSION

This randomised prospective trial on ESPB in paediatric patients showed that it provided an adequate post-operative analgesia in lower abdominal surgery, as indicated by highly significant difference from control group in the requirement of post-operative rescue analgesia. The FLACC score in ESPB group remained significantly low at 3 h and 6 h time period giving a longer duration for the analgesia. The mean time for FLACC score becoming ≥ 4 in ESPB group was 360 ± 30 min and 160 ± 25 min in control group which is nearly showing more than double time period for ESPB group. Thus, this significant difference indicates longer duration of analgesia provided by the US-guided-ESP block. There are very few published randomised controlled trials on ESPB in paediatric patients for lower abdominal surgery.[11]

There have been various other regional anaesthesia techniques practised in paediatric age groups for lower abdominal surgery – caudal block, TAP block, QLB block and isolated ilioinguinal nerve block.[12] There are limitations and benefits of every technique. Caudal block being most established among all but is difficult to perform in older children. Although a simple technique in infants and young children, the development of sacral fat pad in older children makes palpation of sacral cornua difficult.[13,14]

Table 1: Demographic data

Group	Group 1 (*n*=20) Control group	Group 2 (*n*=20) ESPB group
Age (months)	27.1±2.86	28.7±2.95
Gender (male/female)	17/3	19/1
Weight (kg)	12.65±0.96	12.75±1.1
Height (cm)	82.4±8.4	82.4±8.11
Duration of surgery (min)	49±5.11	50±8.53
Type of surgery		
Unilateral ureterotomy	5	4
Appendectomy	4	4
Intussesception	11	12

Data are expressed as mean±SD or number. ESPB: Erector spinae plane block, SD: Standard deviation

The TAP block has become popular because of its ease of application.[15] It has shown very impressive results in upper abdominal surgery but for lower abdominal surgery the result is not very favourable.[16-18] The analgesic outcome of QLB block for lower abdominal surgery has better result than TAP block. The reported demerit of the QLB block is the complications such as muscle weakness.[19] Ueshima and Hiroshi also observed muscle weakness with QLB block which might emerge as a natural result of close proximity between the block site and the lumbar plexus.[20]

ESPB is a new block being tried for lower abdominal surgery. This is an inter-fascial plane block where a local anaesthetic is injected in a plane between the ESM and transverse process. It is supposed to work at the origin of spinal nerves based on cadaveric and contrast study.[21,22] The ESP block is performed under ultrasonographic guidance. The target is the transverse process, which is easily identifiable and is relatively distant from neural or major vascular structures and the pleura. An advantage is that it provides extensive analgesia with a single puncture. Thus, it is possible to perform the block at upper or lower levels relatively distant from the surgical zone, thereby avoiding local problems that could contraindicate the puncture at a specific point. As already mentioned above, ESP is relatively avascular so this block can be given even in patients with coagulation disorders.[23] It can be used for selective multi-dermatomal sensory blockade according to surgery or site of pain. For lower abdominal surgery we used the landmark, L1 spine expecting a dermatomal spread of the block from T10 to L4 based on other studies.[24] We got a favourable result.

The literature points to a wide spectrum of indications for ESPB when considering abdominal procedures in an adult. A perceived key benefit of the ESP block over other interfascial blocks for abdominal procedures is the anterior spread of injectate into the paravertebral and epidural space. This would block not only spinal nerve roots but also rami communicantes transmitting sympathetic fibres, thus leading to relief from visceral pain. This was highlighted in the small case series by Chin *et al*., with significant relief of visceral pain after ESP

Table 2: Post-operative analgesia

Group	Group 1 (*n*=20) Control group	Group 2 (*n*=20) ESPB group	*P*
Total morphine requirement in 24 h (mg)	1.28±0.087	0.645±0.0497	<0.001
Time for first analgesia (min)	160±25	360±30	<0.001

Data are expressed as mean±SD. ESPB: Erector spinae plane block, SD: Standard deviation

Table 3: The Face, Legs, Activity, Cry and Consolability Score at rest in median and range (95% confidence interval) for the two study groups

Time period (h)	Group 1 (*n*=20) Control group	Group 2 (*n*=20) ESPB group	*P*
0	4 (3-4)	2 (1-4)	0.001
1	2 (1-3)	2 (1-3)	0.925
2	2 (1-3)	2 (1-4)	0.429
3	5 (3-6)	4 (1-3)	0.002
6	3 (2-4)	2 (1-3)	0.000
12	2 (1-3)	2 (1-3)	0.602
24	2 (1-3)	2 (1-3)	0.718

Data is presented as median (range). Independent samples Mann-Whitney U-test applied. ESPB: Erector spinae plane block, FLACC: Face, Legs, Activity, Cry, Consolability scale

blocks seen in three bariatric patients undergoing laparoscopic abdominal surgery.[25]

The position of the patient for realisation of this block includes: sitting, lateral or prone. The most common position for giving ESPB is sitting position but it is difficult to make this position under general anaesthesia. We used lateral position for giving this block in our study. This is an approach which was used earlier for performing this block when used in a paediatric patient under general anaesthesia.[26] This position is also useful when this block is being used for lower limb surgery, hip surgery, spine surgery, etc., when sitting position is difficult to attain. The most common orientation of probe is longitudinal to the spine but we found that in lateral position probe should be held in transverse orientation to the spine and needle should be approached in-plane from lateral to medial. This approach is ergonomically more acceptable in lateral position of the patient.[27]

The limitations of this study are that block was given under general anaesthesia, so success of block was not checked by dermatomal spread.

CONCLUSIONS

We conclude that the ESPB is an effective interfascial block for providing post-operative analgesia in paediatric patients for lower abdominal surgery. It decreases the requirement of postoperative rescue medication by prolonging the time period of the analgesia.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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