Perioperative Analgesia With Ultrasound Guided Erector Spinae Plane Block Versus Ultrasound Guided Caudal Block In Children

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The study was conducted at El Shatby Pediatric Hospital, a university hospital affiliated with Alexandria University.

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INTRODUCTION

Postoperative pain management in pediatric patients is a critical aspect of healthcare, demanding specialized attention due to the unique considerations of this vulnerable population. The challenge lies in addressing and recognizing pain effectively while minimizing potential side effects. [1-3]

Moderate to severe unmanaged pain may lead to physiological or psychological distress. Physiologically, this unmanaged pain may trigger a cascade of stress responses that may affect a child's overall health. Elevated stress hormones may lead to increased heart rate, blood pressure, and respiratory rate. Prolonged exposure may compromise the immune system, eventually delaying the healing process and increasing susceptibility to infections. [4]

Psychologically, the effect of pain on paediatric patients is multifaceted and may contribute to emotional distress, anxiety, and fear, even leading to long-term behavioural changes. Negative association with healthcare settings, future surgeries or even simple medical procedures may be formed. Additionally, unmanaged pain may affect a child's ability to concentrate, learn and engage in age-appropriate activities. [5-7]

The evolving understanding of pain physiology in children has led to advancements in multimodal analgesic techniques. Pain management plans encompass a spectrum of interventions ranging from medications, psychological support, and regional anaesthesia. Caudal anaesthesia is one of the most commonly performed regional anaesthesia techniques in paediatrics. A single dose of bupivacaine in the epidural space when accessed through the sacral hiatus provides analgesia for

almost the entirety of the surgical procedure time, but unfortunately, its action is time limited in the postoperative period. [8]

An ultrasound guided technique has been proven to provide better accuracy and success rate along with decreased puncture rates and increased first puncture success rates compared to a blind caudal block. Transverse and longitudinal views using ultrasound illustrate the sacrococcygeal ligament, the two sacral cornua and the dura mater with epidural space. [9, 10]

Erector spinae block is a relatively new technique first described by Forero et al in 2016. Since then, it has been described as an effective block in the paediatric population. It effectively blocks somatic and visceral pain when administered correctly in thoracic or abdominal surgeries, unilaterally or bilaterally. [11, 12]

Its analgesic effect appears to be due to injecting local anaesthetic into the interfacial plane between the transversus process and erector spinae accompanied by diffusion into paravertebral and intercostal spaces, where it affects the ventral and dorsal rami of spinal nerves. [13, 14]

As the field continues to progress, ongoing research and clinical innovations aim to provide an effective approach to the well-being of young surgical recipients with the most amount of pain control. In this study, we hypothesize that, erector spinae block may be an alternative technique for caudal block for perioperative analgesia in children undergoing lower abdominal surgeries. Our aim will be to compare between erector spinae block and the caudal block to determine which one will provide better postoperative analgesia for a longer duration with fewer side effects.

AIM OF THE WORK

Primary aim: is to evaluate the efficacy of postoperative pain management using the Face, Legs, Activity, Cry, Conceal ability (FLACC) Pain Scale.

Secondary aim:

- Intraoperative haemodynamic changes.
- The time to first rescue analgesic.
- Total postoperative analgesic requirements.
- Parent satisfaction with a 5-point Likert scale questionnaire. [15]
- Number of patients required rescue analgesic postoperatively.
- Time to Modified Aldrete score ≥9. [16]
- PACU stay (min).
- Incidence of any adverse effects.

PATIENTS

After approval of the Medical Ethics Committee of the Faculty of Medicine, Alexandria University. An informed written consent from every patient from parent/caregiver will be done in this study, the current study will be performed in El Shatby University Hospital for children on 60 patients who will be scheduled for elective lower abdominal surgeries under general anaesthesia.

The minimum total hypothesized sample size of 60 eligible study participants will be needed to evaluate the efficacy of postoperative pain management using the Face, Legs, Activity, Cry, Consolabilitly (FLACC) Pain Scale. Taking into consideration an effect size of 20%, significance level of 5% and power of 8-% using Chi Square Test.

This study will be a prospective randomized study. Randomization was done using a computer-generated random numbering of each study patient where even numbers will be group (ESB) and odd numbers will be group (CB). Opaque sealed envelopes will be used and will be opened in the operative theatre by an investigator who will be blinded to the study groups. The parents, children, surgeon, and the investigators who will collect the data after the block will be blinded to the study group. Patients will be randomized into two equal groups:

Group (ESPB): patients will receive bilateral ultrasound guided erector spinae block of dilute solution at dose 0.4 ml/kg of 0.25% bupivacaine between the 10^{th} transversus process and erector spinae muscle on each side, provided that it does not exceed toxic dose of bupivacaine 2.5 mg/kg. [17]

Group (CB): patients will receive ultrasound guided caudal epidural block of dilute solution bupivacaine 0.25% at dose 1ml/kg, provided that it does not exceed toxic dose of bupivacaine 2.5 mg/kg. [18]

Inclusion criteria:

- Age between 2-7 years old.
- ASA I-II.
- Elective surgery under general anaesthesia.
- Lower abdominal surgery.

Exclusion criteria:

- Parent/caregiver refusal.
- Allergy to one of the study medications.
- Renal or cardiac disease.
- Infection or redness at the site of injection.
- Clinically significant coagulopathy.
- Spinal anomalies.
- Altered mental status.
- Developmental delay.
- Additional surgery at different surgical sites.
- Block failure.

METHODS

Preoperative evaluation

1. All patients will be evaluated the day before surgery through proper history taking and clinical examination to exclude cardiovascular, respiratory, neurological, and metabolic diseases.
2. Routine laboratory investigations including:
    - Complete blood count (CBC).
    - Bleeding time.
    - Clotting time.
    - Prothrombin activity & INR.
    - Random blood sugar.
3. All parents will be informed about the techniques of both erector spinae and caudal blocks, and a written consent will be obtained from every parent.
4. All children will not take any solid food for 6 hours preoperatively, but each will be allowed to drink clear fluids up to 2 hours before induction of anaesthesia.

Anaesthetic Technique:

- On arrival to operating theatre, all patients will be attached to a multichannel monitor to display continuous ECG monitoring, non-invasive BP monitoring and peripheral oxygen saturation (SpO2), nasopharyngeal temperature monitor using Draeger Monitor model Vista 120, Germany.

- Inhalational induction will be conducted using incremental concentrations of sevoflurane up to 8% with 100% O2 (4 L/min) via face mask (Jackson-Rees modification of Ayer's T-piece).
- After loss of consciousness, a 24G cannula will be inserted into a peripheral vein.
- Laryngeal mask airway (LMA) that is appropriate size to age will be inserted, and anaesthesia will be maintained with oxygen and Isoflurane at double MAC delivered via Jackson-Rees circuit with pressure supported spontaneous ventilation (Trigger Sensitivity 0.7 L/min, PEEP 3, PS 10) using Penlon Ventilator (AV-S Model, Made in UK).
- A diclofenac sodium suppository will be administrated in a dose of 1 mg/kg.
- Bolus intravenous lactated ringers' will be given at the dose of 10 ml/kg.
- No intraoperative muscle relaxants, sedatives, or IV opioids will be administered.

Block Procedure:

All blocks will be given under ultrasound guidance (Philips ClearVue 350 made in USA) using a longitudinal parasagittal transducer probe (6–12 MHz) by the same experienced anaesthesiologist who will not participate in data collection, another anaesthetist will be called to the operating room after preparing the patient and block procedure so that, he will be blinded to group allocation.

Group ESPB:

Patients will be placed in lateral decubitus position. The area at the level of and 1-2 cm lateral to T10 over both sides of spine will be sterilized with 10% povidone-iodine and the probe will be placed in sterile gloves. After visualization of the erector spinae

muscle, the needle will be inserted proximally. After hydro dissection, the needle tip will be confirmed to be between the fascia of the erector spinae muscle group and the transverse process, the dilute solution of bupivacaine 0.25% at dose 0.4 ml/kg will be injected on each side. [16] After the block patients will be placed in supine position and surgery will take place 10 minutes after injection.

Group CB:

After induction of general anaesthesia, the patient will be placed in left lateral decubitus position with the upper hip flexed at 90-degree angle. The needle insertion site will be sterilized using 10% povidone-iodine and the probe will be covered with sterile gloves. The sacral hiatus will be visualized using the ultrasound as two hyperechoic band like lines, the superior line being the sacrococcygeal ligament and the inferior line the dorsum of the pelvic surface of the sacrum. A “pop” or “give” is usually felt when the sacrococcygeal ligament is penetrated. A 22G needle will be introduced at a 45° angle. Cautious aspiration will be performed to rule out an inadvertent systemic or spinal needle location then patients will receive dilute solution of bupivacaine 0.25% at dose 1 ml/kg between the two sacral cornua while observing caudal epidural space dilation or turbulent flow with Doppler. Then, we will wait 10 minutes before the first surgical incision. [18]

Haemodynamic will be closely monitored. Failure of block will be defined as increase in heart rate and or mean arterial blood pressure (MAP) above 10% than baseline values at the beginning of surgery, intravenous fentanyl will be given at dose 0.5 ug/kg and patient will be excluded from the study and replaced by another patient. Methods to keep normothermia will be done via warmed iv fluids and forced air-warming blankets.

At the end of surgery, O2 100% > 5 L/min will be continued after the discontinuation of sevoflurane. Once the patient shows adequate recovery from anaesthesia, oropharyngeal suction will be performed, and the LMA will be removed. Patients will be transferred to the post anaesthesia care unit (PACU) for monitoring of vital signs. Children will be considered ready for discharge from the PACU when being fully awake, stable vital signs for 30 min, no pain, no nausea or vomiting and the Modified Aldrete post-anesthesia score was ≥9.

MEASUREMENTS

The following parameters will be measured:

1. **Demographic data:**
   - Age.
   - Sex.
   - Weight.
   - **Duration of surgery:** (time from the start of induction till discontinuation of the inhaled anaesthetics in minutes).
   - **Duration of anaesthesia:** (from skin incision to final skin sutures in minutes).
   - **Type of surgical procedure.**
2. **Haemodynamic measurements:**
   - Heart rate (beats/min) using lead II electrocardiogram (ECG) waves.
   - Mean arterial blood pressure: (MABP) in mmHg.
   - Oxygen saturation.

They will be monitored and recorded at the following times:

- Pre-induction.
- Post-induction.
- Immediately after performing the block.
- At the start of surgical manipulation.
- Intraoperative every 10 minutes.
- At the end of the operation.

3. **Time to Modified Aldrete score ≥ 9.**
4. **PACU stay (min).**
5. **Postoperative pain: It will be assessed 15, 30 minutes in recovery room then every 2 hours the next 8 hours using FLACC Behavioural Pain Assessment Scale.** Postoperative pain score will be assessed by a nurse blinded to the patient's anaesthetic management.[19]

FLACC Behavioural Pain Assessment Scale 5 parameters: Table (1)

1. Face.
2. Legs.
3. Activity.
4. Cry.
5. Consolability.

Table (1): FLACC Behavioural Pain Assessment Scale

Category	0 score	1 score	2 score
Face	No Particular expression or smile	Occasional grimace or frown; withdrawn, disinterested	Frequent to constant frown, clenched jaw, quivering chin
Legs	Normal position or relaxed	Uneasy, restless, tense	Kicking or legs drawn up
Activity	Lying quietly, normal position, moves easily	Squirming, shifting back and forth, tense	Arched, rigid, or jerking
Cry	No cry (awake or asleep)	Moans or whimpers, occasional complaint	Crying steadily, screams or sobs; frequent complaints
Consolability	Content, relaxed	Reassured by occasional touching, hugging, or being talked to; distractible	Difficult to console or comfort

Interpreting the Behavioural Score: Table (2)

Each category is scored on the 0–2 scale, which results in a total score of 0–10.

Table (2): Interpreting the FLACC Behavioural Score

0	Relaxed and comfortable
1–3	Mild Pain
4–6	Moderate pain
7–10	Severe Pain

6. Time to first postoperative analgesic request

The time elapsed between end of surgery and first administration of an analgesic.

A postoperative pain score of **≥ 4** will be managed with paracetamol 10 mg/kg intravenous then will be repeated every 6 hours as required.

If pain persists after dose of paracetamol or score >4, nalbuphine will be given at dose 0.1 mg/kg intravenously.

7. Total postoperative analgesics requirement will be recorded.

8. Number of patients who will require postoperative rescue analgesia.

9. Parent satisfaction:

Parent satisfaction with a 5-point Likert scale questionnaire.

10. Side effects:

A) Side effects related to bupivacaine:

- **CNS:** Nausea, vomiting, circumoral numbness, facial tingling, vertigo, tinnitus, restlessness, anxiety, dizziness, seizure, coma.
- **Cardiovascular:** hypotension, arrhythmia, bradycardia, heart block, cardiac arrest.
- **Allergic reactions**

B) Side effects related to the erector spinae technique:

In addition to the common complications associated with any peripheral nerve block (local anaesthetic toxicity, intravascular injection, nerve injury, bleeding, and infection), vascular puncture, pleural puncture, pneumothorax, and failed block are the primary complications.

C) Side effects related to the caudal block technique:

Epidural abscess, meningitis, post dural puncture headache, subdural injection, pneumocephalus, air embolism and back pain.

ETHICS OF RESEARCH

Research on human or human products:

- [√] Prospective study: Informed consent will be taken from patients. In case of incompetent patients, the informed consent will be taken from the guardians.
- [ ] Retrospective study: Confidentiality of records will be considered.
- [ ] DNA / genomic material: Informed consent for DNA / genomic test and for research will be taken from patients. No further tests will be carried out except with further approval of committee and patients. If the samples will travel outside Egypt the researcher will be responsible for transportation and security approval.
- [ ] All drugs used in the research are approved by the Egyptian Ministry of Health.

Research on animal:

- [ ] The animal species are appropriate for the test.
- [ ] After test, if the animal will suffer, it will be euthanized and properly disposed.
- [ ] After operation, it will have a proper postoperative care.

RESULTS

All results obtained will be assessed, tabulated, and statistically analysed according to established statistical methods.

DISCUSSION

The results obtained from this study will be discussed in view of achievement of the aim and compared with any available published data in the same field of research.

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