Original Research Article

Comparison of Analgesic Efficacy of Caudal Block and Ultrasound Guided TAP Block In Pediatric Patients Undergoing Lower Abdominal Surgeries

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Abstract

Background: Caudal block is the most frequently used regional anesthetic for pediatric analgesia, technique with the disadvantage of limited duration of action associated with an undesired motor blockade and other complications. Recently, the transversus abdominis plane (TAP) block has been described as an effective technique to reduce postoperative pain intensity and morphine consumption after lower abdominal surgery. **Materials & Methods:** This prospective, randomized, controlled study included 40 children aged between 1 to 10 years, scheduled for elective lower abdominal surgery and divided into two groups in a double-blinded randomized manner. Group A (n=20): received single caudal dose with isobaric bupivacaine 0.25% (1.25ml/kg) and Group B (n=20): received an ultrasound guided TAB block with isobaric bupivacaine 0.25% (0.3ml/kg). The primary outcomes were the time to first analgesia in minutes and the analgesic doses (intravenous acetaminophen and rectal diclofenac) required during the first 24 h postoperatively. The secondary outcome measures included FLACC pain scale score and intraoperative hemodynamic variables. **Results:** No significant difference between two groups regarding demographic data and intraoperative hemodynamic values. Group B (TAP block) had a significantly longer time to first analgesia (638.50 ± 63.8 vs 268.53 ± 58.15 min) and required significantly lower doses of acetaminophen (320.5 ± 151.05 vs 653.05 ± 105.52 mg) and rectal diclofenac (0, 0, 0 vs. 0, 0, 25 mg) than group A (Caudal block). FLACC pain scale score was significantly lower in group B than in group A ($P < 0.05$) at 2, 4, 6, 8, 10, 12, 16, 18, 20, and 24 h postoperatively. **Conclusion:** TAP block provided superior analgesia compared with single dose caudal block injection with isobaric bupivacaine 0.25% in the first 24hours after surgery.

Key words: Transversus abdominis plane block, Caudal block, Lower abdominal surgery, bupivacaine, pediatric, postoperative analgesia, ultrasound

Introduction

Although general anesthesia is the commonly used technique in children, regional anesthesia is used as an adjuvant for intraoperative and postoperative pain relief, decrease parenteral opioids requirements and improve patient-parent satisfaction.[1]

Caudal epidural anesthesia is considered the gold standard regional technique for pain management after pediatric pelvic and lower abdominal procedures because it blocks both somatic and visceral pain. The main disadvantage of caudal analgesia is the limited duration of action after a single injection.[2] Complication from neuroaxial block is rare but serious as cauda equine or total spinal so trends are shifted toward peripheral nerve blocks or infiltration block.

An increased understanding of abdominal wall anatomy has led to the introduction of the transversus abdominis plane block (TAP block) for managing pain after lower abdominal surgery.[3–5] In the adult population, TAP block provides reliable unilateral sensory block in the T10-L1 distribution with a single injection,[6–9] and resulted in a significant decrease in postoperative pain scores and opioid requirements after major abdominal surgeries.[3, 6, 10, 11] Similar outcomes have been observed in pediatric studies,[12–15] and analgesia after TAP block in pediatric patients is thought to last 15 to 24 hours.[13] Complications associated with TAPB are rare, especially when performed under direct ultrasound visualization, lack long-term consequences, and do not require additional interventions.[14, 16]

The aim of the study was to compare the effectiveness of analgesia by using ultrasound guided TAP block and caudal block in children undergoing lower abdominal surgery.

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Materials & Methods

After approval from institutional ethical committee and obtaining an informed written consent from the child parents / guardians this prospective, randomized, controlled clinical study included 40 children from both genders, aged between 1 to 10 years, with an ASA physical status of I and II, who were scheduled for elective lower abdominal surgery.

Group A (n= 20): Caudal block group, received single dose caudal block with isobaric bupivacaine 0.25% (1.25ml/kg).

Group B (n =20): TAP block group, received ultrasound-guided transversus abdominis plane (TAP) block with isobaric bupivacaine 0.25% (0.3ml/kg).

Children with history of bleeding diathesis, hypersensitivity to any local anesthetics, any signs of infection at the puncture site, history of developmental delay or mental retardation, which could make observational pain intensity assessment difficult, parent's refusal, children belonging to ASA status III and IV, children with contraindications for caudal anaesthesia such as major sacral malformations, those with meningitis, with raised intracranial hypertension were excluded from the study.

After arrival to operation theatre intravenous access was secured using a 22 or 24 gauge intravenous cannula on the dorsum of the hand. Baseline vital signs were recorded following application of standard monitoring (ECG, HR, NIBP, and SpO2). NPO status confirmed and consent checked.

Premedication given with injection glycopyrolate 5 µg/kg and injection dexamethasone 0.1 mg/kg. Pre-oxygenation done for 3 min using a facemask with 100%oxygen. General anesthesia was induced using fentanyl 2µg/kg, propofol 2 –2.5 mg/kg over 20– 30 seconds as tolerated and atracurium 0.5 mg/kg to facilitate endotracheal

intubation. The patients were intubated by appropriate size (age/4+4 formula) of an endotracheal tube, fixed to mouth opening at an adequate length (age/2+12 formula) after ensuring bilateral chest equality of air entry and steadiness of capnography waves. Anesthesia was maintained with 1.5- 2% sevoflurane and 50: 50 % nitrous oxide-oxygen mixture, atracurium maintenance dose 0.1 mg/kg, and controlled mechanical ventilation was used to maintain end-tidal carbon dioxide at 35 mmHg. Intraoperative fluid therapy using lactated ringer's solution according to child weight (4- 2-1 formula) with care for replacement of losses (blood loss and third space).

Following induction Group A (caudal) patients were placed in the lateral decubitus position, and after careful negative aspiration for blood or CSF, 1.25ml/kg of 0.25% bupivacaine was injected into the caudal space with a maximum volume of 20 ml was performed under sterile conditions using a 22 G angiocath using a standard loss of resistance technique.

Group B (TAP block) patients were placed in the supine position and TAP block was performed under ultrasound guidance.The linear high frequency ultrasound probe (7–12 MHz) was placed in the mid-axillary plane midway between the lower costal margin and the highest point of iliac crest. A 50 mm insulated locoplex block needle attached with tubing system to a syringe filled with the local anesthetic solution as inserted in plane with the ultrasound probe and advanced until it reached the plane between the internal oblique and transversus abdominis muscles after careful aspiration to exclude vascular puncture; the local anesthetic solution of isobaric bupivacaine 0.25% (0.3 ml/kg) was injected, leading to separation between the internal oblique and the transversus abdominis muscles, which appeared as a hypoechoic space in ultasound.[17]

Skin incision was made 15 min after administration of caudal or TAP block. An increase in heart rate and mean arterial blood pressure (>20%) with skin incision compared with baseline values 15 min after administration of caudal or TAP block analgesia was defined as failed blockade. Patients with failed caudal blockade were given fentanyl 1 mcg/kg intravenously and were excluded from the study. Intraoperative hemodynamics were monitored and maintained accordingly.

After completion of the surgical procedure, patients were awakened and extubated after reversal of muscle relaxant using injection neostigmine 60 mcg/kg and injection glycopyrolate 10 mcg/kg and transferred to the post anesthesia care unit (PACU) for further monitoring.

Using the pediatric observational FLACC pain scale with its 0–10 score range [Table 1][18], postoperative FLACC pain scale score was assessed by an anesthesia resident who was blinded from study, upon arrival in and at the time of discharge from the post anesthesia care unit, and then every 2 h for the first 24 h after operation. If two observations separated by a 5 min waiting period yielded FLACC pain scale score at any time to be more than 3, intravenous acetaminophen 15 mg/kg/ dose was administered as rescue analgesia with maximum oral daily dose of 75 mg/kg/day to achieve FLACC scale score of 3 or less. Patients were observed for 20 min after intravenous acetaminophen; if FLACC pain scale score remained more than 3, rectal diclofenac 1 mg/kg/dose was given with maximum daily dose of 120 mg/day.

The primary outcome measures were the time to first analgesia in minutes (from the time of caudal or TAP block injection to the first registration of FLACC pain scale score >3) and the analgesic doses (intravenous acetaminophen and rectal diclofenac) required during the first 24 h postoperatively. The secondary outcome measures included FLACC scale score and intraoperative hemodynamic variables.

Table 1 FLACC behavioral pain assessment scale score[18]

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

Statistical Analysis:

The recorded data was compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Statistical software SPSS (version 20.0) and Microsoft Excel were used to carry out the statistical analysis of data. Continuous variables were expressed as Mean ± SD and categorical variables were summarized as frequencies and percentages. Graphically the data was presented by bar and line diagrams. Student's independent t –test was employed for comparing continuous variables Chi-square test or Fisher's exact test, which ever appropriate, was applied for comparing categorical variables. A p-value of <0.05 was considered statistically significant.

Results

In our study we included 40 children between 1- 10 year age scheduled for ellective lower abdominal surgeries either to receive caudal block or ultrasound guided TAP block. No significant differences existed between both groups with respect to patient demographic characteristics and intraoperative clinical data [Table 2 & Table 3].

Table 2 Patient characteristics

Characteristic	Group A (Caudal block) (n= 20) (mean ± SD)	Group B (TAP block) (n= 20) (mean ± SD)	P value
Age (years)	4.53± 1.50	4.40± 1.8	0.801
Sex (male: female)	12:8	15:5	0.540
Weight (kg)	12.50± 4.04	13.73± 3.667	0.741
Duration of surgery (min)	150.68 ± 8.15	155.9 ± 5.06	0.615

Table 3 Intraoperative clinical data

Intraoperative clinical data	Group A (Caudal block) (mean ± SD)	Group B (TAP block) (mean ± SD)	P value
Heart rate (beats/min)			
Before induction of anesthesia	112.05 ± 6.16	110.1 ± 7.65	0.753
Maximum intraoperative HR	99.95 ± 6.84	99.05 ± 7.31	0.61
Postoperative	104.3 ± 8.97	103.35 ± 8.89	0.734
MAP (mmHg)			
Before induction of anesthesia	69.16 ± 3.33	69.55 ± 4.33	0.718
Maximum intraoperative MAP	66.15 ± 3.73	65.85 ± 3.33	0.312
Postoperative	66.52 ± 3.03	67.55 ± 3.14	0.553

Using the pediatric observational FLACC pain scale score at different time intervals between both groups, FLACC pain scale score was significantly lower in group B than in group A at 2 h (P = 0.000), 4 h (P = 0.000), 6 h (P = 0.000), 8 h (P = 0.000), 10 h (P = 0.000), 12 h (P = 0.036), 16 h (P = 0.003), 18 h (P = 0.00), 20 h (P = 0.003), and 24 h (P = 0.000) postoperatively. However, both groups were comparable with respect to FLACC pain scale score upon arrival in post anesthesia care unit (P = 0.799), at the time of discharge from the post anesthesia care unit (P = 0.854), 14 h (P = 0.671) and 22 h (P = 0.782) postoperatively [Table 4].

Time to first analgesic requirement was significantly longer (P = 0.00) in group B than in group A (638.50 ± 63.8 vs 268.53 ± 58.15 min), with a significant decrease in the total dose of postoperative intravenous acetaminophen (320.5 ± 151.05 vs 653.05 ± 105.52 mg) (P = 0.00) and rectal diclofenac rescue analgesia (0, 0, 0 vs. 0, 0, 25.0 mg) (P = 0.039)[Table 5].

Table 4 FLACC pain scale score

1st quartile, median, 3rd quartile	**Group A** (Caudal block)	**Group B** (TAP block)	P- value
FLACC at arrival to PACU	0, 0.5, 1	0, 0.5, 1	0.799
FLACC at discharge from PACU	0, 1, 1	0, 1, 1	0.854
FLACC 2h after discharge	1, 2, 4	0, 0, 0	0.000
FLACC 4h after discharge	2, 2, 5	0, 0, 0	0.000
FLACC 6h after discharge	1, 0.5, 2	0, 0, 0	0.000
FLACC 8h after discharge	1, 2, 3	0, 0, 0	0.000
FLACC 10h after discharge	4, 6, 7	0, 0,2.5	0.000
FLACC 12h after discharge	1.5, 2, 3	0, 1, 3	0.036
FLACC 14h after discharge	1, 2, 3	1, 1, 4	0.671
FLACC 16h after discharge	1, 1, 2	1.2, 2, 2	0.003
FLACC 18h after discharge	4, 5, 6	1, 3, 3.5	0.00
FLACC 20h after discharge	1, 2, 2	1, 1, 2	0.003
FLACC 22h after discharge	1, 1,1	1, 1, 2	0.782
FLACC 24h after discharge	1.5, 3, 4	1, 1, 1.5	0.000

Table 5 Analgesic requirement

Parameters	**Group A** (Caudal block) (n= 20) (mean ± SD)	**Group B** (TAP block) (n= 20) (mean ± SD)	P value
Time to first analgesic requirement (min)	268.53 ± 58.15	638.50 ± 63.8	0.00
Total dose of intravenous acetaminophen rescue analgesia (mg)	653.05 ± 105.52	320.5 ± 151.05	0.00
Total dose of rectal diclofenac rescue analgesia (mg)	0, 0, 25.0	0, 0, 0	0.039

Discussion

Regional anesthesia and analgesia techniques are commonly used to facilitate pain control during pediatric surgical procedures, decrease parenteral opioids requirements and improve the quality of post-operative pain control and patient-parent satisfaction. The most commonly used technique is caudal anesthesia, which is generally indicated for urologic surgery, inguinal hernia repair and lower extremity surgery.[19] Complication from neuroaxial block is rare but serious as cauda equine or total spinal so trends are shifted toward peripheral nerve blocks or infiltration block.

The skin, muscles and parietal peritoneum of the anterior abdominal wall are innervated by the lower six thoracic nerves and the first lumbar nerve. They pierce the musculature of the lateral abdominal wall to course through a neuro-fascial plane between the internal oblique and the transversus abdominis muscles. The transversus abdominis plane thus provides a space into which local anesthetic can be deposited to achieve myo-cutaneous sensory blockade through transversus abdominis plane (TAP) block.[20,21]

This study demonstrated that TAP block and caudal block provide additional benefits to multimodal analgesia in children undergoing lower abdominal surgery with TAP block superiority as evidenced by decreased rescue postoperative analgesia and lower pain scores. Our study results were consistent with Carney et al.[13] who concluded that the use of unilateral TAP block as a part of multimodal analgesia regimen is superior to placebo in the first 48 h postoperatively.

In our study, the duration of adequate postoperative analgesia (FLACC pain scale score <4) was significantly higher during the first 24 h after an ultrasound-guided TAP block compared with caudal block. The difference in pain scores was observed on the first postoperative day and this could be explained by the duration of the TAP block that extend up to 24 h. A more cephalad extension of sensory block with the ultrasound-guided TAP block also probably accounted for the lower postoperative FLACC scores at 2, 4, 6, 8, 10, 12, 16, 18, 20, and 24 h and lower analgesic requirements. [Table 4 & 5]

Our study results were consistent with McDonnell et al.[6] who reported that postoperative visual analog scale pain scores and

morphine consumption was significantly reduced in patients who received TAP block.

Tanaka et al.[22] demonstrated the effectiveness of TAP block in 64 pediatric patients aged 5–12 years receiving bone graft from the ilium to the alveolar cleft. In these patients, analgesia was effective with a significant reduction in postoperative analgesic rescue drugs ($P<0.05$).

Conclusion

TAP block and caudal block provided adequate relief from postoperative pain in lower abdominal surgeries in children. However, patients who received TAP block required less postoperative rescue analgesia with a better impact on pain scores than a caudal block.

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