Comparative study between different ultrasound-guided techniques for postoperative analgesia in children undergoing lower abdominal surgeries

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Background and aim Ultrasound (US)-guided transversus abdominis plane (TAP) block, caudal block, and US-guided ilioinguinal/iliohypogastric (II/IH) nerve block are safe and effective methods in children. The aim of the study was to compare the effectiveness and occurrence of complications.

Patients and methods A total of 100 patients undergoing lower abdominal operations (infraumbilical incision) between 5 and 10 years were included in the study. The patients scheduled for elective operation were randomized into four groups: group A (*n*=25) received US-guided TAP block; group B (*n*=25) received US-guided caudal block; group C (*n*=25) received US-guided II/IH nerve; and group D (*n*=25) received Ketorolac 0.5 mg/kg intravenously to be considered as the control group. The Objective pain score, postoperative complication, satisfaction of the parents, and postoperative analgesic requirements were recorded.

Results Postoperative analgesia requirements were significantly higher in group D compared with group A, B, and C; meanwhile, it was significantly highest in group D compared with both groups A and group B. There was significant difference between group A and group D in pain score assessment, but no significant difference between group A and group B. Patient and parent satisfaction was markedly observed in groups A and B more than in group D (the control group) and more satisfaction in group A than group B.

Conclusion TAP block, caudal block, and US-guided II/IH nerve blockade under US guidance proved to be safe with no recorded postoperative complications. Patient and parent satisfaction was markedly observed in case of TAP block.
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Introduction

The abdominal wall is a significant source of pain after abdominal surgery. Even a relatively small operation such as inguinal herniorrhaphy may be followed by a risk of a chronic pain state in about 12% of patients, with clinically significant effects on daily activities if postoperative pain is not taken care of the regional analgesic techniques that have gained widespread popularity as an important component of postoperative analgesia regimens [1].

Postoperative pain control from pediatric surgical procedures is a great challenge to overcome due to family and children anxiety. That is why proper pain control will be a very comfortable condition and less emotionally disturbing experience for the patient and family, and it reduces unnecessary hospital admissions [2].

In pediatric patients, ultrasound (US)-guided blocks have been associated with a higher success rate and a lower volume of local anesthetic needed, compared with the conventional landmark-based techniques [3].

The abdominal wall has three muscle layers: external and internal obliques, and transversus abdominis. They are innervated by mixed somatic nerves that course between the transversus abdominis and the internal oblique muscles. 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 [4].

Caudal analgesia with local analgesics alone is effective but is often short-lived and associated with undesired motor blockade and other complications [5].

Ilioinguinal/iliohypogastric (II/IH) nerve blockade is one of the most common peripheral nerve block techniques in pediatric anesthesia and has been shown to be equally effective compared with caudal blockade for inguinal hernia repair [6]. An US-guided technique for II/IH has been described with significantly better block qualities compared with the landmark?based technique [7].

Aim

The primary outcome of the study was to compare the effectiveness of these techniques as postoperative analgesic and secondary outcomes as occurrence of complications such as hematoma, injury to viscus, dural puncture satisfaction of the parents and secondary postoperative analgesic requirements of those three methods.

Patients and methods

Patients

This prospective, randomized comparative double-blinded clinical study was performed in Al-Azhar University Hospitals (Al-Hussein and Sayed Galal), after obtaining approval by the Hospital Ethics Committee, and a written informed consent from the parents.

A total of 100 children undergoing lower abdominal operations were enrolled in this randomized controlled study.

Inclusion criteria were: children from 5 to 10 years, both genders, American Society of Anesthesiologists I and II scheduled to undergo operations with infraumbilical incision.

Exclusion criteria were: those who refused regional block or patients requiring emergency procedures, bleeding disorders, skin lesions, or wounds at the site of the proposed needle insertion, evidence of peritonitis or septicemia and cutaneous anomalies (angioma, hair tuft, nevus, or a dimple) near the puncture point requiring radiological examination (US, computed tomography, or MRI), in order to rule out the underlying spinal cord malformation and progressive neurological disorders.

The participants were randomly allocated by a computer-generated table into one of the four study groups; the randomization sequence was concealed in sealed envelopes. The four study groups were as follows:

(1) Group A: TAP block group (n=25) underwent US-guided TAP block.
(2) Group B: caudal block group (n=25) underwent US-guided caudal block.
(3) Group C: (n=25) underwent US-guided II/IH nerve block.
(4) Group D: (n=25) received Ketorolac 0.5 mg/kg intravenously.

Methods

Procedure

(1) EMLA cream was applied to the site of venous puncture. After insertion of venous access, all children received premedication in the form of atropine at a dose of 0.01–0.02 mg/kg.
(2) Perioperative monitoring included continuous ECG, pulse oximetry, noninvasive arterial blood pressure, and temperature monitoring.
(3) General anesthesia was induced using propofol 1.5–2.5 mg/kg over 20–30 s as tolerated, atracurium 0.5 mg/kg to facilitate endotracheal intubation, and fentanyl 2 μg/kg. Anesthesia was maintained using isoflurane (1.2%) and atracurium infusion at a rate of 0.5 mg/kg/h. The patients were intubated by an appropriately sized endotracheal tube. In groups A and C, the patients were supine while performing the block and sterilization of the site of the US and needle entry was performed.

The ultrasound-guided transversus abdominis plane block group (group A) (n=25)

The TAP block under US (Sonosite M turbo; fujifilm cleveland, USA) was performed laterally behind the midaxillary line between the iliac crest and the most inferior extent of the ribs. The plane between the internal oblique and transversus was located around the midaxillary line with the probe transverse to the abdomen. From anteriorly the needle passed to come perpendicularly into the US beam and placed between transversus and internal oblique posterior to the midaxillary line; then the local anesthetic was injected (Epicone TM short-length caudal needle Crawford type bevel 25 G 5 mm length by B Braun) as a bolus of 0.5 ml/kg levobupivacaine 0.25% using Stimuplex D needle (35–50 mm).

The ultrasound-guided caudal block group (group B) (n=25)

After the end of the study, a left lateral position is obtained with the upper hip flexed 90° and the lower one only 45°. With the probe placed in the transverse plane at the level of the coccyx just cephalic to the point of injection, the sacral hiatus is visible between two hyperechoic lines: the superior line represents the sacrococcygeal ligament while the inferior represents the dorsum of the pelvic surface of the sacrum. When the probe is placed in a longitudinal plane between the sacral cornua, the dorsal surface of the sacrum, dorsal aspect of the pelvic surface of the sacrum, as well as the sacrococcygeal ligament are viewed; then the local anesthetic was injected as a bolus of 1.0 ml/kg

levobupivacaine 0.25% using a 25 G graduated special caudal needle.

The ultrasound-guided ilioinguinal/iliohypogastric nerve block (*n*=25)

Linear probe (Sonosite M turbo) was used to identify the targeted nerves and the surrounding anatomical structures. After aseptic preparation of both the puncture site and the US probe, the block was then performed using the 'in-plane technique' and an insulated 22 G 40 mm needle with a faceted tip and an injection line, under direct visualization of the tip of the needle which was placed lateral to the nerve structures between the internal oblique and transverse abdominis muscles. The distribution of illioinguinal and illiohypogastric nerve (LA) (0.1 ml/kg levobupivacaine 0.25%) was monitored under real-time ultrasonography, and in case of a misdistribution of the LA, the needle would have been repositioned.

(1) After completion of the surgical procedure and emergence from anesthesia, the patient will be referred to the postanesthesia care unit after complete recovery.
(2) Quality of analgesia will be assessed by using the objective pain score (OPS) immediately postoperatively and then at 2, 4, 6, 8, and 12 h postoperatively. Paracetamol (acetaminophen) suppository (120 mg) will be given as rescue analgesia for patients in all the study groups if OPS is more than 5.

Measured parameters

(1) Pain assessment by OPS which is based on five criteria: arterial blood pressure, crying, movement, agitation, and verbal evaluation (localization of pain).
    (a) Blood pressure (10% preoperative=0, >20%=1, >30%=2).
    (b) Crying (not crying=0, crying but respond to tender loving care=1, crying but does not respond to tender loving care=2).
    (c) Movement (none=0, restless=1, thrashing=2).
    (d) Agitation (patient asleep or calm=0, mild=1, hysterical=2).
    (e) Complains of pain (asleep, state no pain=0, cannot localize=1, can localize=2).

    Each criterion is given a score of 0–2, with 2 being the worst, making the total worst possible score of 10 (Voepel-Lewis *et al.*, [8]). A total score of 5 is regarded as an indication of adequate analgesia. Paracetamol (acetaminophen) suppository (120 mg) was given as rescue analgesia if OPS is greater than 5.
(2) Occurrence of complications in the form of injury to the underlying structures (injury to the liver or a viscous), puncture of the dura, hematoma formation, postoperative nausea and vomiting, and satisfaction of the children and parents, and postoperative analgesic requirements was recorded.
(3) The number of patients in each group who needed increase in analgesic requirements postoperatively was measured:
    (a) The frequency of extra analgesic need in the form of paracetamol suppository (120 mg).
    (b) Number of doses for each patient.
(4) Incidence of postoperative complications in the form of postoperative nausea and vomiting, infection, or hematoma formation.
(5) The general satisfaction of the parents was also considered and recorded. Measures of satisfaction were noted on a four-point scale of 'completely dissatisfied' to 'completely satisfied' as follows: completely dissatisfied, dissatisfied, satisfied, or completely satisfied.

Statistical analysis

Data were summarized and analyzed and the results were reported as mean±SD. Comparison of the means of the four study groups was done using the repeated measures analysis of variance. Nonparametric variables were compared using the Kruskal–Wallis test when comparing between the four groups while Mann–Whitney test was used to compare between groups A and B. For all statistical tests done, the level of significance was fixed at the 5% level. A *P* value greater than 0.05 indicates no significant difference. A *P* value less than 0.05 indicates significant difference. The smaller the *P* value obtained, the more significant was the difference. Power analysis post-study was done by the post-hoc power test.

Results

In this study, 100 pediatric patients were recruited to undergo lower abdominal surgeries, and these patients were divided into four groups randomly using the closed-envelope method of randomization.

Regarding demographic data, we found that the demographic data of the patients did not show statistical significance nor the type of operation showed statistical significance between the three groups as shown in Tables 1 and 2.

Table 1 Comparison between groups according to the demographic data

	Group A: TAP (*N*=25) [*n* (%)]	Group B: Caudal (*N*=25) [*n* (%)]	Group C: II/IH (*N*=25) [*n* (%)]	Group D: control (*N*=25) [*n* (%)]	*P* value
Sex					
Male	16 (64.0)	15 (60.0)	18 (72.0)	19 (76.0)	0.607
Female	9 (36.0)	10 (40.0)	7 (28.0)	6 (24.0)	
Age (years)					
Mean±SD	7.22±1.41	6.77±1.30	6.84±1.24	7.09±1.27	0.586
ASA					
I	22 (88.0)	19 (76.0)	20 (80.0)	20 (80.0)	0.745
II	3 (12.0)	6 (24.0)	5 (20.0)	5 (20.0)	
Weight (kg)					
Mean±SD	22.43±2.81	21.54±2.60	21.67±2.47	22.18±2.53	0.586

ASA, American Society of Anesthesiologists; II/IH, ilioinguinal/iliohypogastric; TAP, transversus abdominis plane.

Table 2 Comparison between groups according to the type of surgery

	Group A: TAP (*N*=25) [*n* (%)]	Group B: caudal (*N*=25) [*n* (%)]	Group C: II/IH (*N*=25) [*n* (%)]	Group D: control (*N*=25) [*n* (%)]	*P* value
Type of surgery					
Inguinal hernia	14 (56.0)	11 (44.0)	18 (72.0)	17 (68.0)	0.482
Ureterovesical implantation	5 (20.0)	6 (24.0)	1 (4.0)	4 (16.0)	
Closure of colostomy	3 (12.0)	5 (20.0)	5 (20.0)	2 (8.0)	
Hydrocele operation	3 (12.0)	3 (12.0)	1 (4.0)	2 (8.0)	

II/IH, ilioinguinal/iliohypogastric; TAP, transversus abdominis plane.

As regards the primary outcome the OPS follow-up period showed the following:

(1) Highly significant increase in OPS score in group D, compared with other groups of patients at arrival to the postanesthesia care unit ($P<0.05$).
(2) Highly significant increase in OPS score in group C, compared with other groups of patients, at 2 h postoperatively ($P<0.05$).
(3) Highly significant increase in OPS score in groups B and D, compared with other groups of patients, at 4 h postoperatively ($P<0.05$).
(4) Highly significant increase in OPS score in group C, compared with other groups of patients, at 6 h postoperatively ($P<0$).
(5) Highly significant increase in OPS score in group D, compared with other groups of patients, at 8 h postoperatively ($P<0.05$).
(6) Highly significant increase in OPS score in groups C and D, compared with other groups of patients, at 12 h postoperatively ($P<0.05$) (Table 3).

As regards secondary outcomes, the follow-up period showed the following:

(1) The mean time for first requirement of rescue analgesia showed a statistically significant difference between the four groups, the earliest need for rescue analgesia being in the control group which was 0.56±1.08 h, while the last need for rescue analgesia being in the TAP group which was 4.80±1.10 h ($P<0.001$) as shown in Table 4.
(2) The need for postoperative rescue analgesia was in the form of paracetamol 120 mg suppository in group A (TAP block group); 20 patients did not require analgesia and only five patients needed rescue analgesia, in group B (Caudal block group) three patients did not need analgesia and 22 patients needed rescue analgesia which was significantly more than those in group A ($P<0.001$), and in group C (II/IH) one patient did not need analgesia and 24 patients received rescue analgesia which was significantly more than those in group A and group B ($P<0.001$), while in group D (control group) all patients have received rescue analgesia as shown in Table 5.
(3) The mean total analgesic requirement was least in group A (TAP) compared with the other three groups; there was a statistically significant difference between all groups ($P<0.001$) as shown in Table 5.

As regards satisfaction data, comparative studies regarding satisfaction data during our follow-up period showed the following:

(1) Parent satisfaction was markedly observed in groups A and B (the TAP and caudal block groups) more than group C (II/IH group) and

Table 3 Comparison between groups according to objective pain score

	Group A: TAP (*N*=25)	Group B: caudal (*N*=25)	Group C: II/IH (*N*=25)	Group D: control (*N*=25)	*P* value
T1, arrival to PACU					
Median (IQR)	3 (1.5)	3 (1)	3 (1.5)	6 (1.5)**	<0.001
Range	2–4	2–4	2–4	3–7	
T2, 2 h postoperative					
Median (IQR)	3 (1.5)	3 (1)	5 (2)**	4 (1)	<0.001
Range	2–4	2–5	3–6	3–7	
T3, 4 h postoperative					
Median (IQR)	3 (2)	5 (2)**	4 (3)	5 (3)**	<0.001
Range	2–6	2–6	3–6	3–6	
T4, 6 h postoperative					
Median (IQR)	3 (1.5)	4 (3)	6 (3.5)**	4 (2)	0.004
Range	2–6	3–6	2–7	3–6	
T5, 8 h postoperative					
Median (IQR)	3 (1)	3 (1)	3 (1)	4 (1.5)**	0.038
Range	2–4	2–6	2–4	3–6	
T6, 12 h postoperative					
Median (IQR)	4 (1)	4 (1)	4 (1)**	4 (2)**	0.029
Range	2–6	2–4	2–6	3–6	

II/IH, ilioinguinal/iliohypogastric; IQR, interquartile range; TAP, transversus abdominis plane. **Significant difference between this or these groups and other groups.

Table 4 Comparison between groups according to time to first rescue analgesia

	Group A: TAP (*N*=25)	Group B: caudal (*N*=25)	Group C: II/IH (*N*=25)	Group D: control (*N*=25)	*P* value
Time to first rescue analgesia (h)					
Mean±SD	4.80±1.10	4.35±1.43	2.83±1.01	0.56±1.08	<0.001

II/IH, ilioinguinal/iliohypogastric; TAP, transversus abdominis plane.

Table 5 Comparison between groups according to the number of patients who needed doses and their percentage and total dose of rescue analgesia

Number of rescue doses	Group A: TAP (*N*=25) [*n* (%)]	Group B: caudal (*N*=25) [*n* (%)]	Group C: II/IH (*N*=25) [*n* (%)]	Group D: control (*N*=25) [*n* (%)]	*P* value
No dose	20 (80.0)	3 (12.0)	1 (4.0)	0 (0.0)	<0.001
1 dose	3 (12.0)	18 (72.0)	9 (36.0)	2 (8.0)	
2 doses	2 (8.0)	4 (16.0)	11 (44.0)	13 (52.0)	
3 doses	0 (0.0)	0 (0.0)	4 (16.0)	10 (40.0)	
Total dose (mg)	72.24±163.83	240.24±131.33	414.12±224.14	569.28±193.36	<0.001

II/IH, ilioinguinal/iliohypogastric; TAP, transversus abdominis plane.

Table 6 Comparison between groups according to parent satisfaction

	Group A: TAP	Group B: caudal	Group C: II/IH	Group D: control	*P* value
Satisfaction					
Completely satisfied	18 (72.0)	6 (24.0)	1 (4.0)	0 (0.0)	<0.001
Satisfied	5 (20.0)	16 (64.0)	14 (56.0)	7 (28.0)	
Dissatisfied	2 (8.0)	2 (8.0)	7 (28.0)	10 (40.0)	
Completely dissatisfied	0 (0.0)	1 (4.0)	3 (12.0)	8 (32.0)	

II/IH, ilioinguinal/iliohypogastric; TAP, transversus abdominis plane.

group D (the control group) ($P<0.05$) as shown in Table 6.

There were no recorded occurrence of complications in all groups either intraoperatively or postoperatively in the form of injury to the underlying structures, hematoma formation, puncture of the dura, and postoperative nausea and vomiting.

Discussion

We conducted this prospective, randomized, controlled clinical study to compare the effectiveness of analgesia by using US guidance for TAP block, US guidance for caudal analgesia and US guidance II/IH nerve blockade on postoperative pain in children undergoing lower abdominal surgery.

This study demonstrated that TAP block, caudal block, and II/IH nerve blockade provide additional benefits to multimodal analgesia in children undergoing lower abdominal surgery, with TAP block superiority as evidenced by the decreased time to first dose and total dose of rescue postoperative analgesia, lower pain scores and better parent satisfaction.

As regards the time to first dose and total dose of rescue postoperative analgesia, our study found that the TAP block group was superior to others.

These results agreed with the results of Tobias, 2009 who demonstrated safe and effective use of US-guided TAP block in 10 pediatric patients in age ranging from 10 months to 8 years, undergoing umbilical and lower abdominal surgeries with 0.3 ml/kg of 0.25% bupivacaine and 1 : 200 000 epinephrine. In that study, the author reported effective postoperative analgesia in eight out of 10 patients with the first request for postoperative analgesia varying from 7 to 11 h [9].

In contrast to our results, Machotta *et al.* [10] compared the analgesic effects of splash blocks for 24 h using 0.5% bupivacaine 0.2 ml/kg to that of caudal blocks using 0.25% bupivacaine 1 ml/kg in 0–5-year-old children who were undergoing inguinal herniorrhaphy. They found that the two groups had no statistical differences for the total dose of rescue analgesics, the discharge time, and the postoperative pain scores. In the present study, the caudal block was performed after induction of anesthesia with 0.25% levobupivacaine 1 ml/kg and before surgery. For the local wound infiltration, 0.25% levobupivacaine 0.4 ml/kg was done before closing the incision site. In the study performed by Machotta *et al.* [10], the caudal block was performed after the surgery and after extubation, whereas the splash block was performed in a similar manner as that of the caudal block, but with twice the concentration of the local anesthetics.

TAP block patients in our study showed significant lower pain scores (CHEOPS and OPS) than the other three groups. These results were consistent with Alsadek *et al.* [11] who enrolled 60 children undergoing lower abdominal surgeries to receive either TAP block or caudal block or conventional analgesia; they reported that TAP, when compared with caudal, provided lower pain scores and his need for rescue analgesics is 6 to 12 h postoperative (need first postoperative analgesia after 6 h).

In line with our study, Jahromi [12] in his double-blinded, randomized, controlled clinical trial, 90 children aged between 3 months and 7 years, and scheduled for elective unilateral inguinal herniorrhaphy under general anesthesia were assigned to three equal groups. Patients in the first group received 20 mg/kg of suppository acetaminophen. In the second group, 2 mg/kg of 0.5% bupivacaine was infiltrated in the incisional site, and in the third group, a caudal block was performed with 0.75 ml/kg of 0.25% bupivacaine. The FLACC pain scale was applied 30 min after operation and during the next 6 h. If the FLACC score was 4 or more, intravenous meperidine was administered. The mean FLACC score of the acetaminophen group was significantly higher than 4 from the first hour while the caudal group and infiltration group was ~2 for the first 5 h only of the study which is also consistent with our results [12].

But, in contrast to our findings, in a study by Sandeman *et al.* [13] US-guided TAP blocks were used for laparoscopic hydrocele in children; the VAS in recovery was lower in the TAP group compared with the control group. However, at all other time periods, there were no differences in pain scores, similar time to the first morphine administration, approximately equal morphine consumption, and similar time to discharge from the recovery ward [13].

Also the randomized, controlled trial of Fredrickson *et al.* [14] compared TAP blocks (n=20) with II blocks (n=21), both performed under US guidance, in children undergoing elective inguinal surgery. A higher percentage of children in the TAP block group reported pain in the recovery unit (76 vs. 45%, P=0.04) and required ibuprofen (62 vs. 30%, P=0.037) when compared with the II block group, as the medial spread of local anesthetic to the genital branch of the genitofemoral nerve seems to occur more following II block [14].

As regards parent satisfaction, our study showed that parents of children who had undergone a TAP block were more satisfied when compared with those of caudal and local infiltration. Our results are consistent with those of Alsadek [11] who enrolled 60 children undergoing lower abdominal surgeries to receive either TAP block or caudal block or conventional analgesia. They concluded that better parent satisfaction was achieved with the TAP block [11].

Against our study, Ashrey and Bosat [15] reported a significant decrease in MAP and the HR in caudal group compared with the penile block group due to the inhibitory effect of bupivacaine on the sympathetic

nervous system. In a study conducted on 80 healthy boys aged 1–7 years, of American Society of Anesthesiologists I and II, scheduled for hypospadias repair, circumcision, and meatal stenosis under general anesthesia, the patients were randomly divided into two equal groups: group P (penile block, 0.25% bupivacaine, 0.5 mg/kg; n=40) and group C (caudal block, 0.25% bupivacaine, 0.5 mg/kg; n=40). Single-injection penile block was found superior to caudal epidural block for relief of postoperative pain with more satisfaction to the surgeon and the parents, without significant increase in the rate of adverse events [15].

Our results showed that there was no incidence of complications especially with the direct visualization of the site of injection which is the neurofascial plane in case of the TAP block (group A) and sacral canal in case of the caudal block (group B) and real-time injection of the local anesthetic under US guidance.

There were no recorded occurrence of complications in all groups either intraoperatively or postoperatively in the form of injury to the underlying structures, hematoma formation, puncture of the dura, and postoperative nausea and vomiting. Beyaz *et al.* [16] in their retrospective analysis of 2088 pediatric patients (5.6±2.8 years) who received a single-shot caudal block by the same two anesthetists without aid showed a low incidence of complications due to the caudal block as only 40 (1.91%) patients had vessel perforation, 31 (1.48%) patients had subcutaneous infiltration, four (0.19%) patients had dural puncture, and 26 (1.24%) patients had difficulty in determining sacral hiatus.In a meta-analysis comparing caudal block with noncaudal regional techniques for inguinal surgeries in children, Shanthanna *et al.* [2] found that the caudal block might be a better analgesic in early and late postoperative periods, but with a significant risk for motor block and urinary retention. Such complications may preclude early discharge for day-case surgeries.

In other multi-institutional study of Polaner *et al.* [17]: 6011 pediatric patients most of them 3 years old or younger received a single-shot caudal block with 183 (3%) adverse events. The most common adverse event was the inability to place the block or block failure. Single-shot caudal blocks were predominantly performed without any technical aid or imaging; US guidance was used in 3% of cases [17].

Conclusion

From the findings of our study we would like to state that US-guided TAP block is a good alternative for providing postoperative analgesia in children undergoing lower abdominal surgery. Also, we found that the US-guided technique was easier to perform and without any adverse effects.

Duration of analgesia was significantly longer in children who received TAP block as compared with the caudal block and US-guided II/IH nerve block. The quality of analgesia was superior for the TAP block than the others.

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Conflicts of interest

There are no conflicts of interest.

References

1 Kehlet H, Wilmore DW. Evidence-based surgical care and the evolution of fast-track surgery. *Ann Surg* 2008; **248**:189–198.

2 Shanthanna H, Singh B, Guyatt G. A systematic review and meta-analysis of caudal block as compared to noncaudal regional techniques for inguinal surgeries in children. *Biomed Res Int* 2014; **2014**:17.

3 Willschke H, Kettner S. Pediatric regional anesthesia: abdominal wall blocks. *Pediatr Anesth* 2012; **22**:88–92.

4 O'donnell BD. The transversus abdominis plane (TAP) block in open retropubic prostatectomy. *Reg Anesth Pain Med* 2006; **31**:91.

5 Abdellatif AA. Ultrasound-guided ilioinguinal/iliohypogastric nerve blocks versus caudal block for postoperative analgesia in children undergoing unilateral groin surgery. *Saudi J Anaesth* 2012; **6**:367.

6 Markham SJ, Tomlinson J, Hain WR. Ilioinguinal nerveblock in children: a comparison with caudal block for intra and postoperative analgesia. *Anesthesia* 1986; **41**:1098–1103.

7 Willschke H, Marshier P, Bosenberg A, Johnston S, Wanzel O, Cox SG, *et al.* Ultrasonography for ilioinguinal/iliohypogastric nerve blocks in children. *Br J Anesth* 2005; **95**:226–230.

8 Merkel SI, Voepel-Lewis T, Shayevitz J, Malviya S. 1997.

9 Tobias JD. Preliminary experience with transversus abdominis plane block for postoperative pain relief in infants and children. *Saudi J Anaesth* 2009; **3**:2.

10 Machotta A, Risse A, Bercker S, Streich R, Pappert D. Comparison between instillation of bupivacaine versus caudal analgesia for postoperative analgesia following inguinal herniotomy in children. *Pediatr Anesth* 2003; **13**:397–402.

11 Alsadek WM. Ultrasound guided TAP block versus ultrasound guided caudal block for pain relief in children undergoing lower abdominal surgeries. *Egypt J Anaesth* 2015; **31**:155–160.

12 Jahromi SAH. Effects of suppository acetaminophen, bupivacaine wound infiltration, and caudal block with bupivacaine on postoperative pain in pediatric inguinal herniorrhaphy. *Anesth Pain Med* 2012; **1**:243.

13 Sandeman DJ, Bennett M, Dilley AV, Perczuk A, Lim S, Kelly KJ. Ultrasound-guided transversus abdominis plane blocks for laparoscopic appendicectomy in children: a prospective randomized trial. *Br J Anaesth* 2011; **106**:882–886.

14 Fredrickson MJ, Paine C, Hamill J. Improved analgesia with the ilioinguinal block compared to the transversus abdominis plane block after pediatric inguinal surgery: a prospective randomized trial. *Pediatr Anesth* 2010; **20**:1022–1027.

15 Ashrey EM, Bosat BE. Single-injection penile block versus caudal block in penile pediatric surgery. *Ain-Shams J Anaesthesiol* 2014; **7**:428.

16 Beyaz SG, Tokgöz O, Tüfek A. Caudal epidural block in children and infants: retrospective analysis of 2088 cases. *Ann Saudi Med* 2011; **31**:494.

17 Polaner DM, Taenzer AH, Walker BJ, Bosenberg A, Krane EJ, Suresh S, *et al.* Pediatric Regional Anesthesia Network (PRAN): a multi-institutional study of the use and incidence of complications of pediatric regional anesthesia. *Anesth Analg* 2012; **115**:1353–1364