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Comparative study between ultrasound-guided pudendal nerve block and caudal epidural block anesthesia in children undergoing hypospadias surgery

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Abstract

Background: The aim of the study is to compare the effectiveness and safety of ultrasound-guided pudendal nerve block versus caudal epidural block as a part of multimodal analgesia in children undergoing hypospadias surgery. In this prospective, single-blinded study, 50 patients were randomized into 2 groups (25 each group) either receiving ultrasound-guided pudendal nerve block group A or caudal epidural block group B. In the pudendal nerve block group, patients were injected with 0.3 mL/kg 0.25% bupivacaine and 1 ug/kg fentanyl. In the caudal epidural group, patients were injected with 1 mL/kg 0.25% bupivacaine and 1 ug/kg fentanyl. Consumption of paracetamol was assessed during the first 24 h postoperatively. The "objective pain scale" done by Hannalah and Broadman was used to assess postoperative pain.

Results: This prospective randomized controlled single-blind clinical study was performed on total (50) ASA status I or II patients, of age 3 to 6 years scheduled for hypospadias surgery.
For the primary outcome, there was no statistically significant difference found between the two studied groups regarding objective pain score at arrival to PACU with p value = 1.000 while there was a statistically significant increase in pain score in group B than group A at 6 h and 12 h with p value = 0.017 and 0.003, respectively. Also, no statistically significant difference found between the two groups after 18 h with p value = 0.238 may be due to receiving acetaminophen dose in group B. Finally there was a statistically significant increase found in objective pain score in group B at 24 h than group A with p value = 0.015. And there was a statistically significant increase in time to first analgesia in group A than group B with p value < 0.001 while there was a statistically significant increase in total dose of acetaminophen in group B than group A with p value < 0.001.

Conclusion: Both ultrasound-guided pudendal block and caudal epidural block are effective and safe methods for postoperative analgesia for children undergoing hypospadias surgery but ultrasound-guided pudendal block gives more postoperative pain control.

Keywords: Pudendal nerve block, Bupivacaine, Caudal block, Hypospadias

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Background

Regional anesthesia methods are commonly used to facilitate pain control during pediatric surgeries, decrease parenteral opioids needs, and better post-operative pain. Caudal epidural block and pudendal nerve block are the most commonly used methods as a part of multimodal analgesia in children undergoing hypospadias surgery (Cyna & Middleton, 2008).

Although general anesthesia is the most commonly used technique in children, regional anesthesia is used as an adjuvant for intraoperative and postoperative pain control (Cyna & Middleton, 2008).

Caudal analgesia is one of the most commonly regional technique performed in children. It has been used for many years as an adjuvant to general anesthesia and to provide postoperative pain control for subumbilical procedures (Naja et al., 2013).

Recently, there is a trend toward the use of peripheral nerve block wherever applicable, with lower incidences of adverse effects when used with neuroaxial techniques. Furthermore, there may be specific anatomic variations or abnormalities which make the use of caudal blockade difficult (Naja et al., 2013).

Pudendal nerve block is a rapidly used peripheral nerve block technique providing effective pain control during the postoperative period following penile surgeries. Pudendal nerve block gives good analgesia intra- and postoperative that has been successfully described in adult patients undergoing penile surgeries and vaginal delivery in females (Kendigelen et al., 2016).

Some studies on children have been done by some anesthiologist who concluded that the use of pudendal nerve block is a good alternative block. That can be done by using a landmark technique through transcutaneous using peripheral nerve stimulator or with ultrasound (US) guidance (Kendigelen et al., 2016; Ecoffey, 2012).

The pudendal nerve arises from the second, third, and fourth sacral ventral rami. In the pudendal canal, it first gives off inferior rectal (anal) nerves, and then divides into its 2 terminal branches as follows: perineal nerve and dorsal nerve of the penis/clitoris (Kendigelen et al., 2016; Williams et al., 1989).

PNB provides perfect analgesic blockade to the skin, subcutaneous tissue, and musculature of the external genitalia of both sexes, skin around the anus, anal canal, and perineum. So, it can be a part of a multimodal approach in surgeries involving the hypospadias surgeries. Moreover, the use of US-guided PNB is an attractive method because of its simplicity and safety by targeting exactly the neural structures (Kendigelen et al., 2016; Bellingham et al., 2012).

The aim of the study is to compare the effectiveness and safety of US-guided pudendal nerve block versus caudal epidural block as a part of multimodal analgesia in children undergoing hypospadias surgery.

Methods

After ethical committee approval in faculty of medicine, we explained the procedures then we take a witnessed written informed consent from every patient's parents. This prospective randomized controlled single-blind clinical study was performed on total (50) ASA status I or II patients, of age 3 to 10 years scheduled for hypospadias surgery that needed hospital stay for at least 1 day in pediatric surgery department were included in the study.

Exclusion criteria

ASA III or IV patients

Patients with history of growth retardation or mental disorders affecting pain score assessment, patient's parents refuse to do the block, patients underneath or over the age, patients with bleeding and coagulation disorders, hypersensitivity to any drugs of the local anesthetics, patients with vertebral column abnormalities or any neurological disorders, and if the patient seems to have infection at the site of the block.

After the history was obtained from patient's parents, chest X-ray was done to all patients. The patients fasted for 4–6 h preoperatively, examination and assessment of airway and preoperative laboratories were taken from all patients as (complete blood picture, renal function tests, liver function tests, and coagulation profile).

All patients were attached to standard monitoring (blood pressure (non-invasive), heart rate, and pulse oximetry).

Inhaled induction of anesthesia by using facemask oxygen and 8% sevoflurane for 2 to 5 min followed by insertion of an IV cannula. Then, intubation by endotracheal tube with no muscle relaxant was used. An Ayres T-piece is the breathing system was used. After that injection of local anaesthetic was performed, we decreased the concentration of sevoflurane to 0.4 to 0.8% that was maintained until the end of the operation. Sedation was provided by low concentration of sevoflurane (0.4–0.8%). During surgery, if the heart rate increased to > 20% from baseline, the sevoflurane concentration was increased .

After induction of general anaesthesia, we divided the patients randomly using closed envelopes into 2 groups: group A (PNB) and group B (caudal block). In the pudendal nerve block group, patients were injected with 0.3 mL per kg 0.25% bupivacaine with 1 ug per kg fentanyl. In the caudal epidural group, patients were injected with 1 mL/kg 0.25% bupivacaine with 1 ug per kg fentanyl. Analgesic consumption of oral acetaminophen {15 mg/kg} given PRN was assessed during the first 24 h postoperatively. The "objective pain scale"

developed by Hannalah and Broadman was used to assess postoperative pain (Broadman et al., 1988) (Table 1).

We recorded patient's height, weight, and age. In addition, time needed to do the block and the time of the surgery were also recorded. The concentration of sevoflurane and its duration were observed during operation. Also, we record any complication that happened during surgery.

Fluid bolus was used for any Intraoperative hypotension and atropine for intraoperative bradycardia. For perioperative blood loss, crystalloids were used.

Pudendal nerve block ultrasound-guided technique:

We put the patients in lithotomy position then the assistant supported the patient's knees to keep the lithotomy position to make it easy to do the block. Two different injection points were pointed at 3 o'clock and 9 o'clock, about 2 cm to 2.5 cm bilaterally from the center of the anus. Firstly, we sterilized the skin. Ultrasound scanning in the transverse plane was used to visualize the ischium forming the lateral border of the sciatic notch. A curvilinear array 2- to ()MHz transducer was used. By moving the US probe caudally, the ischium became progressively straighter as it transitioned to become the ischial spine. At this level, visualization of the pudendal artery and nerve could be achieved, both lying medial to the spine.

Caudal block technique

We put the patients in the lateral position. Sterilization of the skin, needle 2.5 cm 22-gauge was inserted at a 90° position over the skin of the back above sacral hiatus (located at the distal part of the sacrum and its lateral margins are formed by the two sacral cornua) until it crosses the sacrococcygeal ligament, to reach the sacral canal the needle redirected at about 25° being introduced of about 2 to 3 mm.

All patients were admitted postoperative for 24 h in the hospital. Experienced nurses blinded to the two groups record during the study, motor block, and pain. The pain control was measured using the "objective pain scale" (OPS) done by Hannallah and Broadman. The scale consists 5 variables: position of the child, crying, agitation, movement, and mean arterial blood pressure. These variables were measured with three grades (0 = none, 1 = moderate, 2 = severe) to give a total score ranging from 0 to 10 points. The OPS score was evaluated and recorded during the first 24 h after the operation. Every 6 h, if the OPS pain score was recorded at any time, two to three, acetaminophen syrup (15 mg/kg) were prescribed according to the child weight.

Statistical analysis

Information were gathered, amended, coded, and recorded at the Statistical Package for Social Science (IBM SPSS) rendition 23. The quantitative information were introduced as mean, standard deviations, and reaches when their distribution discovered parametric and middle with inter-quartile range (IQR) when non-parametric. Also, qualitative variables were introduced as number and percentages.

Table 1 Objective pain/discomfort scale (OPS)(Naja et al., 2013)

	Criteria	Points
Blood pressure	±10% preoperative value	0
	>20% preoperative value	1
	>30% preoperative value	2
Crying	Not crying	0
	Crying but responds to loving care	1
	Crying and does not respond to loving care	2
Movement	None	0
	Restless	1
	Thrashing	2
Agitation	Asleep or calm	0
	Mild	1
	Hysterical	2
Posture	No special posture	0
	Flexing legs and thighs	1
	Holding hands to the neck	2

The correlation between groups in regard to subjective information was finished by utilizing chi-square test. So, the examination between two autonomous gatherings with quantitative information and parametric distribution was finished by utilizing independent *t* test while with non-parametric distribution was finished by utilizing Mann-Whitney test, and the correlation between in excess of two combined groups with quantitative information and parametric circulation were finished by utilizing Repeated estimates ANOVA.

The certainty span was set to 95% and the border of error accepted was set to 5%. In this way, the *p* value was viewed as huge as the following: $P > 0.05$: non-significant, $P < 0.01$: highly significant, $P < 0.05$: significant.

Sample size

Utilizing PASS program, setting alpha mistake at 5% and power at 80%, results from previous study (Naja et al. 2013) showed that 70% of caudal epidural block children got analgesics 24 h postoperatively contrasted with 20% just among ultrasound-guided pudendal nerve block. Based on this, the needed sample is 25 cases per group with total cases of 50 patients. A generally expected huge impact size (0.8) utilizing 2 free *t* test for means and an importance level of 0.05 and force of 0.8 at least 25 cases per group is needed. Mathematical data was investigated utilizing Student's *t* test and non-parametric data was investigated utilizing chi-squared test.

Results

This study was performed on 50 patients divided into two groups (25 patients in each group). Group A (PNB) and group B (caudal block).

Apparently, we found no statistically huge difference between the two studied groups in age, height, weight, and duration of surgery (min) but we found statistically significant difference between the two studied groups regarding time needed to do the block with *p* value < 0.001 as shown in Table 2.

Apparently, we found no statistically huge difference between the two studied groups regarding objective pain score at arrival to PACU with *p* value = 1.000 but we found statistically huge increase in pain score in group B than group A at 6 h and 12 h with *p* value = 0.017 and 0.003, respectively. Also, no statistically huge difference was found between the two groups after 18 h with *p* value = 0.238. Finally, we found statistically huge increase in objective pain score in group B at 24 h than group A with *p* value = 0.015 as shown in Table 3.

Apparently, we found no statistically huge difference between the two studied groups regarding heart rate preoperative, intraoperative, and postoperative with *p* value = 0.688, 0.669, and 0.819, respectively as shown in Table 4 and also no statistically huge difference was found between the two studied groups regarding mean arterial blood pressure preoperative, intraoperative, and postoperative with *p* value = 0.794, 0.373, and 0.405, respectively, as shown in Table 4.

Apparently, we found no statistically huge difference between the two studied groups regarding respiratory rate preoperative, intraoperative, and postoperative with *p* value = 0.500, 0.160, and 0.425, respectively, as shown in Table 4 and also no statistically huge difference was found between the two studied groups regarding oxygen saturation preoperative, intraoperative, and postoperative with *p* value = 0.509, 0.560, and 0.456, respectively, as shown in Table 4.

Also, we found a statistically huge increase in the time to first analgesia in group A than group B with *p* value <

Table 2 Comparison between group A and group B regarding characteristics of the studied patients, duration of surgery, and time needed to do the block

		Group A PNB	Group B Caudal block	Test value	*P* value	Sig.
		No. = 25	No. = 25			
Age (years)	Mean ± SD	5.07 ± 1.88	5.15 ± 1.89	− 0.150•	0.881	NS
	Range	3–10	3–10.2			
Height (cm)	Mean ± SD	105.2 ± 9.51	105.24 ± 9.52	− 0.015•	0.988	NS
	Range	95–130	95–130			
Weight (kg)	Mean ± SD	18.12 ± 3.79	18.32 ± 3.87	0.185•	0.854	NS
	Range	14–28	14–28			
Duration of surgery (min)	Mean ± SD	97.6 ± 9.7	97.92 ± 9.50	0.118•	0.907	NS
	Range	90–120	90–120			
Time needed to perform the block (min)	Mean ± SD	8.16 ± 0.9	6.24 ± 1.01	7.097•	0.000	HS
	Range	6–10	4–8			

P value > 0.05 non-significant, *P value < 0.05* significant, *P value < 0.01* highly significant
•Independent *t* test

Table 3 Comparison between group A and group B regarding objective pain and discomfort scale (OPS) at different time of measurement

OPS objective pain and discomfort scale		Group A PNB	Group B Caudal block	Test value	*P* value	Sig.
		No. = 25	No. = 25			
At arrival to PACU	Mean ± SD	0.00 ± 0.00	0.00 ± 0.00	0.000≠	1.000	NS
	Median (IQR)	0 (0–0)	0 (0–0)			
	Range	0–0	0–0			
At 6 h postoperative	Mean ± SD	0.80 ± 0.41	1.48±1.16	− 2.395≠	0.017	S
	Median (IQR)	1 (1–1)	1 (1–2)			
	Range	0–1	0–4			
At12 h postoperative	Mean ± SD	1.08 ± 0.49	2.60 ± 2.24	− 3.003≠	0.003	HS
	Median (IQR)	1 (1–1)	2 (1–4)			
	Range	0–2	0–8			
At 18 h postoperative	Mean ± SD	1.64 ± 0.57	2.44 ± 1.53	− 1.181≠	0.238	NS
	Median (IQR)	2 (1–2)	2 (1–4)			
	Range	0–2	1–5			
At 24 h postoperative	Mean ± SD	2.00 ± 1.47	3.12 ± 1.51	− 2.436≠	0.015	S
	Median (IQR)	2 (1–3)	4 (2–4)			
	Range	0–5	0–5			

P value > 0.05 non-significant (*NS*), *P value < 0.05* significant (*S*), *P value< 0.01* highly significant (*HS*)
≠Mann-Whitney test

0.001 while there was a statistically huge increase in the total dose of acetaminophen in group B than group A with p value < 0.001 as shown in Table 5.

Discussion

An optimal analgesic regimen should provide safe, effective analgesia reducing postoperative stress response and accelerating recovery from surgery. A multimodal analgesic technique is most likely used to achieve these goals (ElFawy & ElGendy, 2017).

Although the caudal block is one of the most commonly used regional anesthesia technique for pediatric surgeries; there are some contraindications, such as spinal deformities and coagulopathy. Considering these contraindications, the use of US-guided PNB should be a valuable alternative regional technique to caudal block (Naja et al., 2013).

In hypospadias operations, a lot of analgesic techniques are used such as penile block, performed by the surgeon, or epidural (mostly caudal block) performed by the anesthesiologist. The caudal block is the most commonly applied neuraxial block on children who undergo surgeries However, variations in sacral anatomy, the potential for coagulopathy, and the possible infection risks contribute to the complexity of application and success of the block. Caudal block may also lead to some complications (motor block, urinary retention, block failure, and intravascular injection) (Suresh et al., 2015).

Penile block is an easy method, but may cause hematoma, edema, or provide inconsistent pain control results due to the proficiency of the administrator or the specific technique used. The perineal nerve, second division of the pudendal, responsible for the innervation of the ventral part of the penis, is blocked with the pudendal but not with the penile block. Therefore, the pudendal block is a more accurate and appropriate peripheral block for hypospadias surgery (Sandeman & Dilley, 2007; Williams et al., 1989).

This randomized trial aimed to compare between US-guided PNB and caudal block for hypospadias surgery to show which of them is better as regard pain control and less complications. In the present study, 50 patients were included and were divided into two groups (n = 25; each); group A and group B.

Naja et al. (2013) provided the first report regarding pudendal blocks in children in hypospadias and circumcision surgeries. Pudendal nerve block has been, at first, traditionally applied via blind injection but has also been guided via nerve stimulator, fluoroscopy, and computed tomography scan. But in our study, and some other authors have reported, pudendal block application via ultrasound guidance (Naja et al., 2013; Bellingham et al., 2012; Akkaya et al., 2014).

Our pudendal block technique differs from that described by Naja et al. (2013) and Kendigelen et al. (2016) in several aspects. Both used nerve stimulator technique. Unlike Naja et al., (2013) who took the distance to the

Table 4 Perioperative comparison between the studied groups regarding heart rate, mean arterial blood pressure, respiratory rate, and oxygen saturation

		Group A PNB No. = 25	Group B Caudal block No. = 25	Test value	*P* value	Sig.
HR (beat/min)						
Preoperative	Mean ± SD	105.60 ± 10.34	104.40 ± 10.64	0.404	0.688	NS
	Range	85–125	85–125			
Intraoperative	Mean ± SD	93.00 ± 7.77	92.00 ± 8.66	0.430	0.669	NS
	Range	80–105	80–105			
Postoperative	Mean ± SD	100.60 ± 8.58	100.00 ± 9.79	0.230	0.819	NS
	Range	80–115	80–120			
MBP (mmHg)						
Preoperative	Mean ± SD	78.20 ± 5.38	77.80 ± 5.42	0.262	0.794	NS
	Range	70–90	70–90			
Intraoperative	Mean ± SD	71.20 ± 4.40	72.40 ± 5.02	− 0.899	0.373	NS
	Range	65–80	65–80			
Postoperative	Mean ± SD	77.52 ± 5.85	76.20 ± 5.26	0.839	0.405	NS
	Range	70–90	70–90			
RR(breath/min)						
Preoperative	Mean ± SD	18.04 ± 1.90	17.68 ± 1.84	0.680•	0.500	NS
	Range	15–22	15–22			
Intraoperative	Mean ± SD	20.60 ± 1.50	20.00 ± 1.47	1.427•	0.160	NS
	Range	18 –24	18–24			
Postoperative	Mean ± SD	18.60 ± 1.73	18.20 ± 1.78	0.805•	0.425	NS
	Range	15–22	15–22			
SPO2(%)						
Preoperative	Mean ± SD	97.64 ± 0.49	97.72 ± 0.61	0.509•	0.613	NS
	Range	97–98	97–99			
Intraoperative	Mean ± SD	99.52 ± 0.51	99.60 ± 0.50	0.560•	0.578	NS
	Range	99–100	99–100			
Postoperative	Mean ± SD	98.32 ± 0.9	98.44 ± 0.96	0.456•	0.651	NS
	Range	97–100	97–100			

P value > 0.05 non-significant (*NS*), *P value < 0.05* significant (*S*), *P value< 0.01* highly significant (*HS*)
*Chi-square test
•Independent *t* test

Table 5 Comparison between group A and group B regarding time to first analgesia given and total dose of analgesia acetaminophen in the first 24 h

		Group A PNB No. = 25	Group B Caudal block No. = 25	Test value	*P* value	Sig.
Time to first analgesia(h)	Mean ± SD	18.5 ± 3.92	10.56 ± 4.67	6.428•	0.000	HS
	Range	12–24	6–18			
Total dose of acetaminophen (mg)	Mean ± SD	425.63 ± 175.03	698.4 ± 312.67	− 3.746•	0.000	HS
	Range	210–780	210–1680			

P value > 0.05 non-significant (*NS*), *P value < 0.05* significant (*S*), *P value < 0.01* highly significant (*HS*)
•Independent *t* test

anus as a point of reference for needle entry, and Kendigelen et al. (2016) use the ischial tuberosity as the main landmark. Ultrasound scanning in the transverse plane was used to visualize the ischium forming the lateral border of the sciatic notch. A curvilinear array 2- to ()MHz transducer was used. By moving the US probe caudally, the ischium became progressively straighter as it transitioned to become the ischial spine. At this level, visualization of the pudendal artery and nerve could be achieved, both lying medial to the spine. It is important to note that taking the ischial tuberosity as a reference point gives consistent guidance across different age groups (Naja et al., 2013; Kendigelen et al., 2016).

Although we, like Naja et al. (2013) and Kendigelen et al. (2016), used bupivacaine, Naja et al. (2013) additionally used clonidine as an additive (pudendal block 0.3 mL/kg 0.25% bupivacaine and 1 μm/kg clonidine; caudal group 1 mL/kg 0.25% bupivacaine and 1 μm/kg clonidine) but we used 1 ug/kg fentanyl instead of clonidine and Kendigelen et al. (2016) used bupivacaine only. Naja et al. (2013) preferred to continue sedation with 0.4 to 0.8% sevoflurane via facemask. In the study of Naja et al. (2013), the sevoflurane concentration was increased by 2% in only 2 patients in the pudendal group; however, in the caudal group, the increase rate of sevoflurane concentration was 2%, 3%, and 4% for 5, 5, and 4 patients, respectively. Additionally, 4 patients in the caudal group required fentanyl during perioperative period. Similar to this, in our study, although patients in the pudendal group did not require any opioids, 3 patients in the caudal group required the usage of fentanyl. Our patients, on the other hand, were intubated and the sevoflurane concentration was kept at 2%. There were small differences in the initial intraoperative hemodynamics and initial postoperative pain scores. No significant difference in intraoperative hemodynamics was observed within the pudendal and caudal group between 10 min after block and the beginning of the incision (Naja et al., 2013; Kendigelen et al., 2016).

A similar study by Naja et al. (2013) reported similar pain scale score between PNB and caudal blocks in children undergoing hypospadias surgery upon arrival at the PACU, 6 h, 18 h, 12 h, and 24 h postoperatively. However, they found significantly lower pain scores in the PNB group compared with the caudal group at other time points postoperatively. The sample size in their study was 80 patients (Naja et al., 2013).

Although there was no statistical difference between both groups regarding hemodynamics, 3 patients in group B developed slight hypotension that was corrected by IV fluid bolus; this hypotension was due to prolonged fasting as shown from parents' history associated with vasodilatation attributed to sympathectomy resulted from caudal block. In group A, no hemodynamic changes were noted. This may make PNB more suitable for shocked patients but this needs further studies to be confirmed.

No cases of failed block were recorded as both types of blocks were given by expert senior staff.

Their current study showed that parents of children who had undergone a PNB were more satisfied when compared with those who had undergone caudal. Our results are consistent with those of Naja et al. (2013) (Naja et al., 2013).

In Naja et al., study of the pain score for caudal group rose after the sixth hour, and after postoperative hour 18 in the pudendal group. In Kendigelen et al. (2016) study, patients in the pudendal group needed extra analgesics until the 18th postoperative hour, and only 7.5% of the patients needed analgesia in the 24th postoperative hour. All caudal patients, however, required analgesics by 24 h postoperative. These results echo that of Naja et al. (2013) who stated that 70% of patients in the caudal group needed analgesia 24 h after the operation, whereas this rate was only 20% in the pudendal group for hypospadias surgery. In our study, PNB group with 4 cases (16%) started analgesia after 12 h and 13 cases (55%) started analgesia after 18 h but 17 cases (68%) started analgesia after 24 h; in caudal group, 10 cases (40%) started analgesia after 6 h and 8 cases (32%) started analgesia after 12 h, and 4 cases (16%) started analgesia after 18 h but 21 cases (84%) started analgesia after 24 h (Naja et al., 2013; Kendigelen et al., 2016).

This observation shows that the performance of the pudendal block provides long-lasting postoperative analgesia. Although the rate of patients requiring additional analgesics at 24 h in the pudendal group was 20% in the study of Naja et al. (2013) it was only 7.5% in Kendigelen et al. (2016) and in our study it was 68% (Naja et al., 2013; Kendigelen et al., 2016).

There are many important advantages of peripheral blocks including longer postoperative analgesic duration, less possible adverse effects, and fewer complications compared to neuraxial blocks. Cohort analyses support this view and suggest a higher benefit-to-risks ratio for peripheral blocks (Dadure et al., 2009).

There are some important adverse effects of both central and peripheral blocks as motor block and sphincteric dysfunction. No adverse effects or motor blocks were found in the caudal or pudendal groups postoperatively. Depending on the concentration of the local anesthetic and evaluation time, motor block may be observed after caudal block. None of our patients presented motor block when examined before transfer from PACU to the ward. None of the patients had defecation problems caused by the anal sphincter motor insufficiency after the pudendal nerve block.

Conclusion

The current study revealed that US-guided PNB provided significantly prolonged postoperative analgesia, reduced postoperative analgesic requirements, and better parents' satisfaction as compared with caudal block in pediatric patients undergoing hypospadias surgery. Both analgesic techniques are safe.

Abbreviations

ASA: American society of anaesthesiology; HR : Heart rate; HS: Highly significant; IQR : Inter-quartile range; IV: Intravenous; KG: Kilogram; LA : Local anesthetics; MBP : Mean blood pressure; MHz : Megahertz; NS : Non-significant; OPS: Objective pain score; PACU: Post anaesthesia care unit; PNB: Pudendal nerve block; RAS : Reticular activating system; RCTs : Randomized controlled trials; S: Significant; SD: Standard deviation; US: Ultrasound guided

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Authors' contributions

A.A.A.K. designed the study, revised literature, performed the analysis, followed the patients, measured objective pain score, and wrote the manuscript. M.H.E.H.S. designed the study, performed the analysis, and wrote and critically revised the manuscript. W.A.I.A. revised literature, performed the analysis, and critically reviewed the manuscript. M.H.AEA revised literature, followed the patients, measured and collected demographic data preoperative, intraoperative, and postoperative data, performed the block, and critically reviewed the manuscript. S.G.A.S. revised literature, followed the patients, measured and collected demographic data, preoperative, intraoperative, and postoperative data, performed the block, and critically reviewed the manuscript. All authors read and approved the final version of the manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Approval of research ethical committee of Faculty of Medicine, Ain-Shams University was obtained (code number: FMASU M D 222/2018) and informed written consent was obtained from patients' legal guardian(s) after description of the procedure and its potential complications.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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