Comparison of Postoperative Pain Relief Impact between Caudal Bupivacaine Alone and Caudal Bupivacaine-Dexamethasone Mixture Administration for Pediatric Local Tube Urethroplasty

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ABSTRACT

Objective: To compare the postoperative analgesic influence between caudal bupivacaine only and caudal bupivacaine-dexamethasone combination administration in children undergoing local tube urethroplasty.

Methods: This prospective, randomized and clinical trail investigation included 162 male pediatric patients, classed I by the American society of anesthesiologists, aged 11-14 years and assigned for local tube urethroplasty at Queen Rania Hospital, King Hussein Medical Center, Amman-Jordan, during the year of 2013. General anesthesia was induced using inhalational sevoflurane / oxygen anesthesia, after which a laryngeal mask airway was inserted and an intravenous line was secured. All subjects were repositioned to receive caudal sacral block using randomly either plain bupivacaine 0.25% mixed with normal saline 0.9% (Group I, n=80) or plain bupivacaine 0.25% mixed with dexamethasone 0.1mg/kg (Group II, n=82), not exceeding a total volume of 0.5ml/kg and not exceeding a maximum dose of 2mg/kg of bupivacaine in both groups, dividing the total volume in ¾ for bupivacaine and ¼ for dexamethasone, saline or both. Postoperatively, in the recovery room, rectal paracetamol 10 mg/kg was administered if the numerical rating scale was more or equal to four. Postoperative analgesia quality was assessed. Statistical discrepancies between the two groups were evaluated using Students t and Chi-square tests. Variance was used to assess inter-group differences in changes of pain scores. A value of $P<0.05$ was considered significant.

Results: Postoperative mean pain free period was significantly less in group I (186 min) than in group II (272 min) ($P<0.05$).The mean time to first rectal paracetamol dose was 192 min. in group II and 125 min. in group I ($P<0.05$).

Conclusions: The combination of caudal bupivacaine-dexamethasone significantly enhanced the postoperative analgesic profile compared to caudal bupivacaine-saline in children undergoing local tube urethroplasty under combined general-caudal anesthesia.

Key words: Anesthesia, Caudal, Bupivacaine, Dexamethasone, General, Pediatric.

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Introduction

As pain after surgery is unavoidable, good analgesia is mandatory after any surgery. The density of nociceptive nerve endings in the skin of children is similar to or greater than that in adults.[1] Under treatment of postoperative pain in children may trigger biochemical and physiologic stress response. A caudal (epidural or extradural) block defines the administration of local anesthetic into the epidural space via the sacral hiatus to achieve anesthesia of sacral and coccygeal nerve roots. Caudal anesthesia is commonly used in children for postoperative analgesia after circumcision, orchidopexy, inguinal hernia and hypospadias repairs. Caudal analgesia has the benefit of attaining an adequate nerve block in a limited area of the body by a relatively simple administration of local anesthetics. Caudal local analgesics have narrowed time duration. In addition to general anesthesia, caudal anesthesia may provide smooth surgical conditions and good postoperative analgesia. Caudal block is a common, dependable and safe (although serious complications may occur infrequently) method for child pain management after infraumbilical surgical interventions. In a proportion of patients and although good initial pain relief is achieved, moderate to intense pain develops as the block wears off.[2] It excludes the hazards of general anesthesia. Using bupivacaine is suitable for surgical techniques extending up to 90-120 min.[3]

Various adjuncts have been administered and added to local anesthetics to lengthen the duration of caudal analgesia, such as opioids, epinephrine, ketamine, clonidine or dexmedetomidine. Adjuncts to local anesthetics during caudal epidural block can enhance or lengthen caudal analgesia, but their regular administration has been restrained by some side effects in pediatrics undergoing day case surgery. The combination of epinephrine with local anesthesia leads to hypertension and tachycardia which are harmful for patients with compromised cardiovascular system.[4] Opioid administration has respiratory and central inhibition impacts.

Nowadays, few investigations showed the actions of glucocorticosteroids on sensory outcome in peripheral nerve blocks. Steroids may lengthen the pain relief actions of local analgesics in peripheral nerve blocks. Dexamethasone reduces pain by blocking transmission of nociceptive C-fibers and by inhibiting ectopic neural signaling. Vieira *et al*, demonstrated that the duration of postoperative pain relief was lengthened when dexamethasone is administered as an additive for peripheral nerve blockades.[5] Dexamethasone is a glucocorticosteroid with powerful anti-inflammatory actions, which can attain postoperative analgesia.

The aim of this study was to assess the potency of caudal dexamethasone to caudal bupivacaine on the postoperative sensory characteristics of caudal block in children undergoing local tube urethroplasty.

Methods

Our prospective, randomized and clinical trail study enrolled 162 male pediatric patients of class I of American Society of Anesthesiologists (ASA), aged 11-14 years old and allocated for local tube urethroplasy under combined general-caudal anesthesia, after obtaining local ethics committee review board approval and written informed consent from each participant's parent, preoperatively. Anesthesia and surgery lasted a mean of 110 min. Patients with history of spinal column surgery, using any agent that changes pain perception or with infection at the caudal puncture site were ruled out from the investigation.

In the operating theatre, peripheral oxygen saturation (spo2), ECG and non-invasive arterial blood pressure were recorded until the end of surgery. Inhalational induction of anesthesia was performed using sevoflurane MAC 8% with oxygen 4L/min after which an intraenous line was secured. A suitable laryngeal mask airway size (2.5 or 3) was placed through which a mixture of sevoflurane MAC 2% and oxygen 4L/min was delivered. Intravenous tracurium 0.5mg/kg was administered for muscle relaxation.

Caudal block was performed, after repositioning the patient in the lateral position, using a 5cm, 22-gauge cannula. Palpation down the sacral spine leads to the depression of the sacral hiatus at S5, flanked by the sacral cornua, via which the needle is advanced. The needle is passed via skin

and sacrococcygeal ligament in a cephalad direction at 45 D to the skin. When the membrane (sacral hiatus) is penetrated, administration may be achieved or the needle hub may be depressed toward the natal cleft and advanced a further 2-3mm along the sacral canal. The equilateral triangle is formed as the base is formed by a line joining the posterior iliac spines and the apex is formed by the sacral hiatus which is above the natal cleft in children.[3] Subjects were divided in a random manner into two groups. Patients in group I (Group I, n=80) were administered caudal plain bupivacaine 0.25% (Bucaine 0.25%, Hikma pharmaceuticals, Amman-Jordan) mixed with normal saline 0.9% and patients in group II (Group II, n=82) were administered caudal plain bupivacaine 0.25% mixed with dexamethasone sodium phosphate 0.1mg/kg (Dexamed, 8mg/2ml, Medochemie Ltd, Limassol, Cyprus). All patients in both groups received a total caudal sacral volume of 0.5ml/kg, of which the dose of 2mg/kg of bupivacaine was not exceeded. The total volume was divided in ¾ for bupivacaine and ¼ for dexamethasone or saline. The drug mixture was prepared and administered caudally by an anesthetist who was not engaged in the investigation. Surgery was permitted to start 10 min after performing the block. Rectal paracetamol 10 mg/kg was administered for postoperative analgesia if two consecutive recordings, five minutes apart concluded a pain score of numerical rating scale of more or equal to four.

The duration of postoperative pain relief was defined from time of caudal administration up to when patients feel pain in the area of surgical intervention (as general anesthesia is induced). Postoperative pain was evaluated at the end of surgery (0 min), 30 and 60 min intervals after surgery in the recovery room and at 24 hours interval in the ward using the numerical rating scale which is used by adults and children greater than nine years old who are capable to use numbers to rate the severity of their pain.

Patients are advised to choose a number from 0 to 10 that best describes their present pain, where 0 would mean no pain, 1-3 would mean mild pain, 4-6 would mean moderate pain,7-9 would mean severe pain and 10 would mean worst possible pain.[3] The time to first rectal paracetamol request (first paracetamol time) was defined as the time from the end of surgery to the first recording of a numerical rating scale (0-10) more or equal to five. A questionnaire was also prepared to evaluate the parents satisfaction on a four point Likert scale (1=excellent, 2=good, 3=fair, 4=poor). This scale has been recommended to score parents satisfaction with postoperative pain relief.[6]

Statistical analysis

Differences regarding data distribution between the groups were assessed using Students t and Chi-square tests. Variance was performed to test for inter-group differences in changes of pain scores recorded at the previous time intervals. Continuous variables such as age and weight were assessed using the Variance test. Duration of analgesia was evaluated using Students t test with a P value of <0.05 was considered significant.

Results

There were no significant statistical discrepancies regarding patients' demographic data in terms of age, gander, ASA class, weight and duration of anesthesia between the two groups (Table I). All 162 patients finished the investigation. The highest age incidence in our study for this type of surgery was 13 years as it was 48.8% in group I and 46.3% in group II, while the least age frequency was 14 years as it was 8.8% in group I and 8.5% in group II. The mean duration of anesthesia and surgery was 110 min. Regarding the caudal block, it appeared that the mean total volume was 18 and 18.25mls in groups I and II, respectively. The mean volume of bupivacaine 0.25% was 17.1 and 17.35mls in respective groups. The mean volume of dexamethasone was 0.9 ml in group II and 0.9ml of saline in group I.

Mean pain free period was more significantly in group II (272min) than in group I (186min) $p<0.05$. The time to first rectal paracetamol dose administration in group II (192min) was significantly longer than that in group I (125min) $P<0.05$, Table II. There was a mean frequency of 4 for rectal paracetamol administrations in the recovery room during the first postoperative hour in group II, while this was 7 in group I ($P<0.05$). Mean pain score was 2, 5, 6 and 7 during the 0,

Table I: Patients characteristics

		G I	G II	P
N		80	82	>0.05
Age(years)	11	9	11	>0.05
	12	25	26	
	13	39	38	
	14	7	7	
Sex	M	80	82	>0.05
Weight (kg)	33-42	30-42 (36)	33-40(36.5)	>0.05
ASA	I	80	82	>0.05
Surgery	Local tube urethroplasty	80	82	>0.05
Anesthesia	Bupivacaine (ml)	14.2-20 (17.1)	15.7-19 (17.35)	>0.05
(caudal)	Dexamethasone mg (ml)	----------	0.8(mg) - 4(1)(0.9)	
	Saline(ml)	0.8-1 (0.9)	----------	
	Total volume (ml)	15-21 (18)	16.5-20 (18.25)	
Duration of anesthesia (min)	100-120	110-120 (115)	100-110 (105)	>0.05

Table II: Postoperative caudal block characteristics

	G I	G II	P
Pain free period(min)	186	272	<0.05
Time to first rectal paracetamol dose(min)	125	192	<0.05
Incidence of rectal paracetamol doses at			<0.05
0 min	7	4	
30 min	10	2	
60 min	12	2	
24 h	14	2	
Pain scores at			<0.05
0 min	2	0	
30 min	5	2	
60 min	6	3	
24 h	7	5	
Satisfaction			
Excellent	8.8%	9.8%	<0.05
Good	60%	90.2%	
Fair	31.2%	0%	
Poor	0%	0%	
Caudal failure	0	0	
Dexamethasone side effects	0	0	

30, 60min and 24h postoperative intervals in group I. The mean pain score was 0, 2, 3 and 5 during the 0, 30, 60 min and 24h postoperative intervals. Pain scores were significantly lower in group II than in group I ($p<0.05$). Regarding postoperative parental satisfaction, it was 60% good in group I and 90.2% good in group II, in terms of postoperative pain management ($P<0.05$).

Discussion

Our investigation demonstrated that caudal bupivacaine 0.25% with 0.1 mg/kg of dexamethasone significantly lengthened postoperative analgesia compared with caudal bupivacaine alone in local tube urethroplasty of children. It also decreased postoperative pain scores and reduced analgesics needs significantly.

Kopacz *et al*. showed analgesic effects of steroids in neuraxial and peripheral blocks.[7] Dexamethasone induces a significant prolonged caudal block by vasoconstriction mechanism. The classic theory of steroid impact states that steroids bind to intracellular receptors and change nuclear transcription.[8] Thomas *et al*. reported that epidural dexamethasone (5mg) decreases

postoperative pain scores and morphine consumption following laparoscopic cholecystectomy.[9]

Release of glutamate and aspartate may induce sensitization of dorsal horn cells of spinal cord. These activate N-methyl-D-aspartate receptors causing calcium ion influx, stimulating phospholipas A2 which transforms membrane phospholipase to arachidonic acid. Steroids can reduce prostaglandin production by depression of phospholipase A2 via the production of Ca dependent phospholipid binding proteins called annexins and by the depression of cyclooxygenases.[10] The clinical effects of dexamethasone are related to changes in the transcription of DNA to proteins. The plasma elimination half life is six hours. An extradural administration of dexamethasone is correlated with temporary adrenal inhibition, explaining steroid blood absorption. It is well proved that epidural injection of steroids has systemic absorption which can affect many of body organs.[11]

Analgesic effects of corticosteroids are induced by their systemic actions.[12,13] The block lengthening impact may be due to its local effect on nerve fibers.[7] Prashant *et al*. showed that combination of dexamethasone with local anesthetics lengthened duration of blocks of peripheral nerves.[5]

We did not find any considerable complication after caudal dexamethasone administration. Meena *et al*. showed that after caudal bupivacaine 0.25% (0.5 ml/kg) in children undergoing subumbilical surgery, the mean duration of time interval between the caudal block and first dose of analgesic was 6.3 hours. Patients started having mild pain after three hours and the pain was significant after six hours. The pain score started to attain 3 after six hours. Pain scores were 0, 0 and 0 at postoperative 25, 30 and 60 min respectively and was 1 at postoperative 120 min. In the first postoperative 24 hours, mean doses of paracetamol were 1 of 2 doses, 6 of 3 doses and 8 of 4 doses.[14]

The epidural space in children has no fat. A higher dermatomal level may be achieved by increasing the volume of administered solution. The Armitage formula implies that analgesia over the sacral dermatomes is achieved by injecting 0.5ml/kg volume of solution. To reach the lower thoracic dermatomes, 1ml/kg must be injected and to reach the mid thoracic dermatomes, 1.25ml/kg must be administered.[3]

According to our study, we believe that administration of dexamethasone 0.1mg/kg in combination with bupivacaine 0.25% via the caudal route is easy, simple, safe and effective analgesic method for relieving pediatric postoperative pain. In addition, the cost of dexamethasone is low which makes routine use reasonable. The society of pediatric anesthesia on its 15th annual meeting at New Orleans (2001) defined the alleviation of pain as a basic human right, irrespective of age, medical condition, treatment, primary service response for the patient care or medical institution.

Conclusion

We conclude that the combination of dexamethasone with bupivacaine administered via the caudal route significantly lengthened the duration of postoperative pain relief and enhanced the analgesic profile. Further investigations are required to assess the optimal dose of dexamethasone to be administered in caudal anesthesia.

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