Original Article

A comparative study of caudal epidural bupivacaine with bupivacaine plus fentanyl and bupivacaine plus neostigmine for anaesthesia and postoperative analgesia in children undergoing sub-umbilical surgeries

Mizanur Rahman[1], Md. Habibur Rahmn[2], Md. Kamrujjaman[3], Md. Shafiqul Islam[4]

[1]Assistant registrar, Faridpur Medical College Hospital,[2]Associate Professor, Khulna Medical College Hospital,[3]Associate Professor, Sher-E-Bangla Medical College Hospital, Barisal, [4]Assistant Professor, Sher-E-Bangla Medical College Hospital, Barisal

Corresponding Author: Email: drmizan07@gmail.com

Abstract:

Background: *Single-shot caudal anaesthesia with local anaesthetic has a limited duration of action. Therefore, many children undergoing sub-umbilical surgery with caudal analgesia require further analgesia during the postoperative period. This study compared the effect of single-dose caudal epidural bupivacaine, bupivacaine plus fentanyl and bupivacaine plus neostigmine for anaesthesia and postoperative analgesia in children.*

Objective: *To evaluate effectiveness of bupivacaine with the addition of fentanyl or neostigmine for caudal anaesthesia and analgesia in children undergoing sub-umbilical surgeries.*

Methods: *Total ninety (90) paediatric patients, aged 2-8 years with ASA(American society of anesthesiologist) grades I & II who were scheduled for surgery in Sher-E-Bangla Medical college Hospital, Barisal were included in this study. Data were collected by using a pre-designed questionnaire. The patients were randomly allocated to one of the three groups. Group A was received caudal 1 ml/kg of bupivacaine 0.25%, Group B 1 ml/kg of bupivacaine 0.25% with fentanyl 1 µg/kg and Group C 1 ml/kg of bupivacaine 0.25% with neostigmine 2 µg/kg. Heart rate (HR), Blood pressure (BP), oxygen saturation (SpO2), Respiratory rate (RR) were recorded during operation and every five minutes thereafter. The duration of analgesia was defined as the time from caudal injection to first dose of rescue analgesia. Rescue analgesia was given for an objective pain scale (greater than or equal to) 4 in the form of oral paracetamol (15mg/kg).*

Results: *Assessment of anaesthesia was significantly longer in the two groups of children who received additives compared with local anaesthetics group alone ($p<0.01$). Mean time to first postoperative analgesic administration was 167.37±17.30 min, 280.57±14.40min, and 357.77±19.08 min in group A, Group B, and group C respectively. The difference was statistically significant ($p<0.01$) between the three groups. In these cases duration of analgesia was considered from the placement of caudal to first analgesia.*

Conclusion*: Addition of fentanyl or neostigmine to bupivacaine prolonged the duration of surgical anaesthesia and postoperative analgesia after a single shot caudal injection with minimal incidence of side effects in children undergoing sub-umbilical surgeries. This could be a safe and cheap alternative to extradural catheter placement for surgical procedures of intermediate duration.*

Key words: *Caudal epidural, bupivacaine, fentanyl, neostigmine, postoperative analgesia, sub-umbilical surgeries.*

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Introduction:

Caudal anaesthesia (CA) is a common paediatric regional technique that is quick to learn and easy to perform, with high success and low complication rates. CA provides high quality intraoperative and early postoperative analgesia for sub-umbilical surgery. In children, CA is most effectively used. Single-shot caudal anaesthesia with local anaesthetic has a limited duration of action.[2] Therefore, many children undergoing sub-umbilical surgery with caudal analgesia require further analgesia during the postoperative period.[4] Prolongation of anaesthesia can be achieved by adding various adjuvants, such as opioids and non-opioids like clonidine, ketamine, midazolam and neostigmine drug used to mimic the effects of stimulation of the parasympathetic nervous system. , with varying degrees of success. [1-5]

Opioids have been commonly used in caudal blocks with or without local anesthetic agents. The major disadvantage of opioid additives is the risk of respiratory depression. Another disadvantage of neuroaxial opioids is the increased incidence of postoperative pruritus, nausea, and vomiting. Although fentanyl 1 mcg/kg may prolong a caudal block, the incidence of pruritus and vomiting also increases.[6] Despite the pitfalls of using opioids as a component of central blockade, the practice continues because of the relative advantages these agents offer. Prolongation of analgesia in a study in which fentanyl 1 mcg/kg was added to a mixture of bupivacaine and lidocaine in children aged 6 to 108 months. The mean duration of analgesia in the fentanyl group was 253 ± 105 minutes compared with 174 ± 29 minutes in the control group without fentanyl. Vomiting occurred in 4 of 15 of the children who had extradural fentanyl and 0 of 14 in the children who had not received fentanyl.[6]

The use of neostigmine in the epidural space is a relatively new concept in children. Its action may be attributed to either direct action on the spinal cord via inhibition of the breakdown of acetylcholine in the dorsal horn or by peripheral antinociceptive effect.[7] A study in children compared three groups to determine the effectiveness of neostigmine 2 mcg/kg as a caudal analgesic for hypospadias repair, either alone or in combination with bupivacaine.[8]The groups received 1 ml/kg of either 0.25% bupivacaine plain, bupivacaine with neostigmine 2 mcg/kg, or neostigmine 2 mcg/kg plain. The neuroaxial administration of neostigmine is known to produce analgesia in animals, human volunteers and patients with acute postoperative and chronic pain.[9,10]

Methods

Ninety (90) paediatric patients, aged 2-8 years with ASA grades I & II who were scheduled for sub-umbilical surgeries. The study was approved by the ethics committee and written informed consent was obtained from legal guardian. Children with sacral bone abnormalities, spina bifida, Coagulopathy, infection at the site of caudal injection, hypovolaemia, body weight greater than 25 kg and failed caudal block.The patients were randomly allocated to one of the three groups. Patients was kept fasting for six hours before the procedure. Clear fluids were allowed up to two hours before the procedure. The patients received no premedication. An intravenous line was established with a 22G canula. After establishing the intravenous line a solution of 5% dextrose in 0.45% NaCl was started. All the procedures were performed under sedation combined caudal extradural block. Sedation was induced by Ketamine (2mg/kg), Atropine (0.02mg/kg) and diazepam (0.2mg/kg).Oxygen was administered through face mask. Now check for HR, BP and SpO2.When these parameters were within normal range, the patient was turned to lateral position with the knee drawn upto the chest. The caudal block was performed by an experienced anaesthetist using a 23 gauge short-bevel needle under aseptic conditions. After negative aspiration for blood or cerebrospinal fluid, the study solution was administered. The patients were randomly allocated to one of the three groups (n=30 in each group) by using a random number table. Group A received caudal 1 ml/kg of bupivacaine 0.25%; Group B 1 ml/kg of bupivacaine 0.25% with fentanyl 1 μg/kg and Group C 1 ml/kg of bupivacaine 0.25% with neostigmine 2 μg/kg.

HR, BP, SpO2, RR were recorded during operation and every five minutes thereafter. BP was measured by aneroid sphygmomanometer using child size cuff. HR and SpO_2 were monitored continuously by using standard pulse oximetry. During surgery, adequate intraoperative analgesia was defined by haemodynamic stability, as evidenced by the absence of an increase in the heart rate or a mean arterial blood pressure greater than 20% compared to the baseline values obtained before skin incision. An increase in the HR or BP within 15 minutes of skin incision indicated failure of caudal anaesthesia and excluded from the study. Maintenance fluid requirement was calculated by applying 4:2:1 rule. That was 4 ml for first 10kg/hr, 2 ml for second 10kg/hr, and 1 ml for remaining kg/hr.

Onset of analgesia was evaluated by pinching the skin. If the patient does not move with pinching surgery was started. After the operation, Duration of anaesthesia was recorded. Pain score was assessed using the OPS, which measures five variables: respiratory rate, heart rate, discomfort, cry and pain at the site of operation. Each variable score from zero to two to give a possible total score of zero to 10. A lower score was associated with less pain. The duration of analgesia was defined as the time from caudal injection to first dose of rescue analgesia. Rescue analgesia was given for an objective pain scale (greater than or equal to) 4 in the form of oral paracetamol (15mg/kg).

Results

Demographic data are given in table-I. There were no significant difference in age, weight, height and ASA grading of the patients. HR, Systolic blood pressure(SBP) and Diastolic blood pressure(DBP) recorded in preoperative, at induction, at skin incision, 15 min,30 min,1 hours,2 hours,4hours,6 hours, 8 hours and 12 hours of block. There were no significant differences between the three groups (Table-II,III,IV).

Duration of surgical anaesthesia was statistically significant ($p<0.01$) between the three group(table-I). Mean duration of analgesia among the three groups were compared using Compare mean with ANOVA. It was observed that mean time to first postoperative analgesic administration was 167.37±17.30 min, 280.57±14.40min, and 357.77±19.08 min in group A, Group B, and group C respectively. The difference was statistically significant ($p<0.01$) between the three groups(table-I). In these cases duration of analgesia was considered from the placement of caudal to first analgesia. The pain score was assessed using the OPS and the three groups were compared using Compare mean with ANOVA. It was found that there was a significant difference between the three groups from four hours to six hours post-operatively with a P value < 0.02, < 0.01 respectively (Table-V).

There were no instances of hypotension, bradycardia, residual paralysis or toxic reactions to local anaesthetics, fentanyl or neostigmine during or after administration of the caudal blocks. No postoperative urinary retention and motor weakness of the legs was observed when the children were discharged from the recovery room.

Table-I *Demography and operative data of the present study(n=90)*

Variables	Group A	Group B	Group C	P Value
Age in years	5.23±1.79	5.30±1.80	5.16±2.02	0.96(NS
Weight in kg	17.0±3.58	16.43±3.41	16.30±3.38	0.70(NS)
Height in cm	104.9±12.34	104.47±12.22	105.4±13.93	0.96(NS
ASA	**I-II**	**I-II**	**I-II**	
Duration of anaesthesia (min**)**	119.27± 9.85	145.17± 9.24	144.8± 8.93	<0.01(S)***
Duration of analgesia (min)	167.37±17.30	280.57±14.40	357.77±19.08	<0.01(S)***

NS = Non-Significant.S=Significant. Values are expressed as mean±SD. Analysis between group,time interaction was done by ANOVA.Values are significant when $p<0.05$ (CI-95%).

Table –II *Distribution of the study patients according to heart rate*

HR(beat/min)	Group-A (n=30)	Group-B n=30)	Group-C (n=30)	P-value
Preoperative	98.60±9.68	99.13±8.25	100.80±7.49	0.58(NS)
Induction	142.30±5.52	140.97±5.42	139.30±4.74	0.09(NS)
Skin incision	141.97±5.12	143.03±5.03	143.03±3.95	0.60(NS)
After 15mins	124.36±4.82	123.43±5.34	123.40±4.85	0.70(NS)
After 30mins	114.57±3.62	115.60±3.84	116.70±3.08	0.07(NS)
After 1 hr	107.53±5.65	110.57±5.77	110.47±4.27	0.05(NS)
After 2hrs	95.00± 7.73	93.77± 6.66	98.23± 7.01	0.05(NS)
After 4hrs	105.17±9.44	105.57±7.55	107.60±6.08	0.43(NS)
After 6hrs	101.93±8.85	102.73±6.43	105.73±5.30	0.09(NS)
After 8hrs	102.67±9.09	104.60±8.21	105.50±7.22	0.40(NS)
After 12hrs	103.93±8.86	105.00±6.88	106.83±6.47	0.32(NS)

NS = Non-Significant.S=Significant. Values are expressed as mean±SD. Analysis between group,time interaction was done by ANOVA.Values are significant when p<0.05 (CI-95%).

Table-III *Distribution of the study patients according to systolic blood pressure*

Systolic blood pressure(mmHg)	Group-A (n=30)	Group-B (n=30)	Group-C (n=30)	P value
Preoperative	103.17±7.93	103.67±8.42	102.93±9.01	0.94(NS)
Induction	110.70±6.27	111.43±8.25	109.77±8.42	0.70(NS)
Skin incision	113.07±5.91	113.90±6.94	112.17±7.33	0.61(NS)
After 15mins	108.50±6.72	109.97±6.72	109.00±8.14	0.73(NS)
After 30mins	106.13±6.87	107.33±6.26	107.37±7.55	0.73(NS)
After 1 hr	104.17±7.44	104.67±6.69	104.33±7.40	0.96(NS)
After 2hrs	100.70±7.49	101.17±7.62	100.33±7.65	0.91(NS)
After 4hrs	105.00±7.54	106.67±5.92	103.67±6.15	0.22(NS)
After 6hrs	108.00±6.24	109.47±5.50	106.33±6.56	0.15(NS)
After 8hrs	106.33±6.29	105.80±7.21	104.33±6.40	0.49(NS)
After 12hrs	107.50±5.98	106.80±6.59	105.83±6.11	0.43(NS)

NS = Non-Significant.S=Significant. Values are expressed as mean±SD. Analysis between group,time interaction was done by ANOVA.Values are significant when p<0.05 (CI-95%).

Table-IV *Distribution of the study patients according to diastolic blood pressure*

Diastolic blood pressure(mmHg)	Group-A (n=30)	Group-B (n=30)	Group-C (n=30)	P value
Preoperative	61.63±6.24	60.93±5.56	60.93±6.44	0.88(NS)
Induction	68.00±5.75	66.83±5.82	66.43±6.30	0.57(NS)
Skin incision	70.30±5.51	68.50±5.68	67.57±5.67	0.17(NS)
After 15mins	68.43±5.20	67.50±5.78	66.70±5.78	0.49(NS)
After 30mins	65.00±5.09	65.00±4.36	63.50±4.94	0.38(NS)
After 1 hr	59.67±5.56	58.73±5.70	58.83±5.36	0.77(NS)
After 2hrs	57.83±5.86	57.03±5.92	57.30±5.49	0.86(NS)
After 4hrs	61.13±5.34	62.60±5.53	63.63±5.18	0.20(NS)
After 6hrs	65.00±5.57	64.27±5.62	63.33±5.77	0.52(NS)
After 8hrs	63.47±6.26	63.10±6.59	63.27±6.20	0.98(NS)
After 12hrs	62.83±4.76	62.63±5.67	61.67±5.84	0.68(NS)

NS = Non-Significant, S=Significant. Values are expressed as mean±SD. Analysis between group, time interaction was done by ANOVA. Values are significant when p<0.05 (CI-95%).

Table-V *Distribution of the study patients according to pain score (n=90)*

Time interval of Pain Score	Group-A (n=30)	Group-B (n=30	Group-C (n=30)	P value
After 30mins	0.40±0.50	0.30±0.65	0.27±0.45	0.61(NS)
After 1 hr	0.50±0.68	0.43±0.77	0.43±0.68	0.91(NS)
After 2hrs	0.93±1.05	0.53±0.63	0.63±0.63	0.05(NS)
After 4hrs	1.50±1.10	0.87±0.92	0.83±0.95	0.02***
After 6hrs	3.40±1.19	1.83±1.23	1.63±1.35	0.01***
After 8hrs	2.43±1.63	2.17±1.37	1.87±1.43	0.34(NS)
After 12hrs	2.07±1.53	2.07±1.36	2.13±1.38	0.98(NS)

NS = Non-Significant.S=Significant. Values are expressed as mean±SD. Analysis between group,time interaction was done by ANOVA.Values are significant when p<0.05 (CI-95%).

Objective pain scale:

Parameter	Findings	Points
Systolic blood pressure	Increase <20% of preoperative blood pressure	0
	Increase 20-30% of preoperative blood pressure	1
	Increase >30% of preoperative blood pressure	2
Crying	Not crying	0
	Crying, responds to TLC	1
	Crying, not responds to TLC	2
Movements	None	0
	Restless	1
	Thrashing[moving wildly]	2
Agitation	Asleep or calm	0
	Mild	1
	Hysterical	2
Complains of pain	Asleep, state no pain	0
	Vague, cannot localize	1
	Localizes pain	2
Total		10

Discussion

Our study indicates that addition of fentanyl or neostigmine to bupivacaine 0.25% for caudal analgesia in children significantly prolongs the duration of analgesia, as compared with bupivacaine alone. Our findings are consistent with those reported by several other studies. To avoid extradural catheter placement, and yet prolong the duration of single shot caudal anaesthesia ,various additives such as opioids and non-opioids like clonidine, ketamine, midazolam and neostigmine neostigmine (nç'ôst-g'mçn, –m-n), drug used to mimic the effects of stimulation of the parasympathetic nervous system. to local anaesthetic solutions have been used with varying degrees of success. [1-5]

Fentanyl is added commonly to local anaesthetics administered in extradural space to improve analgesia in the postoperative period.[11] However; few studies have addressed the benefit of fentanyl for single shot procedures. The addition of fentanyl produced only a slight change in the quality and duration of analgesia after administration of 2% lidocaine with epinephrine for a short surgical procedure[13]or after administration of 0.125% bupivacaine[12] .Constant et al[12] found that single shot caudal block provided adequate surgical analgesia in only 57% 0f children in bupivacaine group compared with 93% in fentanyl group. Similar observations regarding surgical anaesthesia were also observed by Mostafa et al[14].Gainity et al[15] concluded their study that adding fentanyl 1 µg/kg to bupivacaine in the caudal epidural block in children does not influence plasma levels of E and NE, nor does it improve the analgesic intensity of the caudal block. However, Fentanyl was commonly added to local anaesthetics, and in a meta-analysis of 18 studies conducted in adults this combination was found to provide safe and effective intraoperaive pain relief[16].

Neostigmine potentiated the effect of caudal bupivacaine[17]. D Krushal et al[18] demonstrated that co-administration of neostigmine with bupivacaine prolonged the duration of surgical analgesia after a single shot caudal injection. This could be a safe and cheap alternative to extradural/ caudal catheter placement for surgical procedures of intermediate duration. Kumar Pet al[19] compared Midazolam, Ketamine and neostigmine administered with bupivacaine found all groups, increased the duration of caudal block. Majahan R et al[17]concluded that neostigmine potentiated the effect of caudal bupivacaine, but neostigmine alone in doses 2-10 µg/kg is not effective. Even though Memis D et al[20] tried low doses of neostigmine 1 µg/kg with bupivacaine for caudal block and found no significant advantage over bupivacaine alone. However, several paediatric studies have already demonstrated that neostigmine added to bupivacaine or lignocaine increase the duration and quality of postoperative analgesia provided by caudal anaesthesia. In children, doses of 2 µg/kg, 3 µg/kg have been used without adversed gastrointestinal, respiratory or haemodynamic effects, while an increase in postoperative nausea and vomiting was observed after a dose of 5 µg/kg.[5,18,21]

In our study, addition of fentanyl or neostigmine was effective in increasing the duration of surgical analgesia. Most children required supplementary analgesia in the postanaesthesia care unit. In the fentanyl or neostigmine group, mean time from caudal injection to first administration of analgesia was longer than control group. In these studies, no respiratory depression had been reported after caudal administration of fentanyl or neostigmine.

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