

Comparative Study between Intrathecal and Caudal Epidural Anesthesia in Children for Lower Abdominal Surgery

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ABSTRACT

Background: regional anaesthesia techniques are now established in the practice of pediatric anaesthesia. It is one of the most common techniques used for post-operative pain management in pediatric patients especially for urogenital, rectal, inguinal and lower extremity surgeries.

Objective: to compare caudal and spinal anaesthesia in paediatrics regarding haemodynamics, efficacy (sensory block characteristics, motor block characteristics) post-operative analgesia, surgeon's satisfaction, parents' satisfaction and complications incidence.

Material and Methods: the present study was carried on 100 patients, with age ranging from (6-12) and of ASA (American Society of Anaesthesia) I, II classes undergoing infraumbilical pediatric surgeries, patients in each group were randomly assigned to receive spinal or caudal epidural anaesthesia.

Results: the demographic data of patients as regard age, sex and ASA classification showed no statistical significant difference between the two groups, where the study was designed to compare between the effectiveness of spinal anaesthesia with bupivacaine 0.3mg/kg and caudal anaesthesia with bupivacaine 2mg/kg (1ml/kg vol.) as a sole anaesthetic technique adequate for infraumbilical pediatric surgeries below T10 as regard the sensory and motor block characteristics, perioperative haemodynamic effects, pain assessment, analgesic requirements, and both the surgeon and parents satisfaction was assessed. The results showed the superiority of subarachnoid on achieving rapid onset of sensory blockade, intense motor blockade, on the other hand the caudal epidural had the advantage of longer post-operative analgesic effect and lower post-operative analgesic consumption, furthermore both techniques gained good degree of parent and surgeon satisfaction.

Conclusion: if both techniques are correctly used and the anatomy of the patient is normal there is minimal risk of complications.

Key words: intrathecal, caudal epidural, infraumbilical, pediatric surgeries.

INTRODUCTION

The appearance of neuromuscular blocking agents and the development of volatile anesthetics in the forties shifted the techniques toward general anesthesia. However, regional pediatric anesthesia did not disappear⁽¹⁾.

Both spinal and caudal anaesthetic blocks can be given easily in combination with G.A (general anesthesia) or as the sole to provide anaesthesia and additional post-operative analgesia especially for infraumbilical lower abdominal pediatric surgeries (block below T10), furthermore both technique can replace G.A in circumstances where is shortage of anaesthetic drugs, supplies and monitoring equipment which are not available especially in the developing countries⁽²⁾.

There are advantages to use regional anaesthesia that are evident and continue to increase the popularity of its practice. One of the valuable goals during anaesthetic

management is to achieve safety and reliability⁽³⁾.

The common advantages of spinal anaesthesia are adequate anaesthesia without polypharmacy, endotracheal intubation and respiratory support, minimal biochemical and physiological differences, post-operative analgesia, absence of post-operative nausea and vomiting, rapid return of feeding, minimal postoperative apnoeic spells, low cost, reduction in post-operative hospital admissions in an outpatients population⁽³⁾.

Spinal anesthesia though gaining popularity in children, the misconceptions regarding its safety and feasibility can be better known with greater use and experience⁽⁴⁾.

Caudal anesthesia was first described at the turn of last century by two French physicians, Fernand Cathelin and Jean-Anthanase Sicard⁽⁴⁾. Today pediatric caudal

epidural anesthesia is a well-accepted technique, and considered one of the most used-popular regional blocks in children. This technique is a useful adjunct during general anesthesia and for providing postoperative analgesia after infraumbilical operations. The quality and level of the caudal blockade is dependent on the dose, volume, and concentration of the injected drug ⁽⁴⁾.

Caudal anesthesia can be easily modified to extend analgesia into the postoperative period by addition of opioids or insertion of caudal epidural catheter in the caudal canal for continuous techniques ⁽²⁾.

AIM OF THE WORK

Our aim is to compare caudal and spinal anaesthesia in pediatrics regarding haemodynamics, efficacy (sensory block characteristics, motor block characteristics) post-operative analgesia, surgeon's satisfaction, parents' satisfaction and complications incidence.

MATERIAL AND METHODS

After approval of Ethical Committee of Al-Azhar Faculty of Medicine, a prospective, randomized, double blinded study was conducted in the department of Anesthesia, Al- Azhar University (Al-Husien and Bab- Alshaeria) hospitals.

One hundred patients of both sex, aged 6-12 years, ASA grade I, II, weight (20-50 kg) scheduled for lower abdominal procedures requiring sensory block below T 10 which last for at least one hour were enrolled in our study.

Patients were divided randomly into two groups according to the type of regional anesthesia given spinal group or caudal group.

All patients were evaluated preoperatively by taking full medical history, physical examination including vital signs, cardiovascular, respiratory, abdomen, neurological, airway evaluation and laboratory investigations as full blood picture, bleeding and coagulation profiles.

Patients with any contraindication to regional anesthesia as those with known allergy to local anaesthetic drugs, weight > 50 kg, coagulopathy, infection at the site of block, spine deformity, history of developmental delay, were excluded from the study.

Before the operation the patient received instruction about the colour analogue scale (CAS). The colour analogue scale has been

shown to be a valid and reliable pain measurement tool for use in children aged above 6 years ⁽⁷⁾.

Parents were informed about anesthetic procedure and the informed consent was taken.

All the patients were kept NPO for 6 hours preoperatively.

Technique:

Upon arrival to the operating room the ambient temperature was kept warm. Child was monitored for ECG, HR, noninvasive blood pressure O₂% saturation with pulse oximetry (SPO₂%) and the base line values were recorded. After securing an intravenous line access with 22 G IV cannula, all patients were preloaded with lactate ringer solution 10 ml/kg. Atropine 0.01 mg/kg was given as premedication. In the operating room all the children were received I.V ketamine 2 mg/kg immediately before spinal or caudal block to achieve immobility of the patient during the block. Subsequently all the children were placed in left lateral position with the hips and knees flexed, painting and draping were done with full aseptic precaution. In all cases, sedation was maintained with propofol infusion (using syringe pump) at the rate of 50-75 mcg/kg/min. The spinal group (S) 50 patients were received spinal anaesthesia (Group S (n=50)), via midline approach lumbar puncture was done in the L4-5 interspace with 25 G spinal needle with stylette and the direction of the bevel was kept parallel to longitudinal fibres of the dura with spinal anesthesia using heavy bupivacaine 0.5% in the dose of (0.3 mg/kg) were injected in the subarachnoid space. The end of injection was considered as time zero for further data recording. The other 50 patients were received caudal epidural anaesthesia (Group C (n=50)), the caudal epidural space was entered using a short 23-gauge needle. The needle was inserted at a 60-degree angle and was advanced until a "pop" was felt, then was lowered to a 20-degree angle and was advanced an additional. 2-3 mm to make sure the bevel is in the caudal epidural space.

Caudal block was done using 0.25% bupivacaine dose (2 mg/kg) volume 0.7-1ml/kg which was injected slowly in the caudal epidural space. The parents and surgeon who had carried the surgery was blinded to the type of block given to the patient.

Surgical intervention was started after ensuring sensory block.

Adequate intraoperative analgesia was achieved by hemodynamic stability as indicated by absence of an increase heart rate or systolic blood pressure > 20 % compared with baseline values obtained preoperative.

An increase of blood pressure or heart rate more than 20 % was insufficient analgesia and was treated with opioid (fentanyl 1mic/kg) and the patient was excluded from the study and was transferred to GA and replaced by another patient according to the randomization list.

On the other hand decrease of heart rate more than 20% from preoperative values was defined as bradycardia. Bradycardia was treated with Atropine as necessary.

Preoperative blood loss was replaced using crystalloid solution and blood (when indicated) as appropriate.

At the begging of skin closure the duration of surgery was recorded.

After the operation the patients were taken to the recovery room for observation and

then transferred to the ward after achievement of criteria of discharge.

STATISTICAL ANALYSIS:

Statistical presentation and analysis of the present study will be conducted, using the mean, standered error,chi-square and analysis of variance(ANOVA)tests by SPSSV17.

Chi-square the hyposis that the row and column variables are independent, without indicating strength or direction of the relationship pearson chi-square and likelihood –ratio chi-square. Fisher's exact test and yate’s corrected chi-square are computed for 2x2 tables.

Analysis of variance (ANOVA) tests according to computer programs SPSS for windows. ANOVA test will be used for comparison among different times in the same group in quantitative data

P value>0.05 is considered non-significant

P value <0.05 is considered significant

P value<0.01 is considered highiy significant

RESULTS

Table (1): List of operative procedures in both groups

	Spinal	Caudal	P
Herniotomy	15	16	0.829
Circumcision	5	5	1.000
Orchidoplexy	10	9	0.799
Hypospadias	15	16	0.829
Cystolithotomy	5	4	1.000

Table (2): Comparison between the two groups as regard H.R

Heart Rate (beats/min.)	Spinal (S) (n=50)		Caudal (C) (n=50)		P
	Mean	p1	Mean.	p2	
Before block	72.5		73.3		0.169
5 Min.	75.55	<0.001*	77.2	<0.001*	0.101
10 Min.	79.72	<0.001*	81.4	<0.001*	0.090
15 Min.	82.9	<0.001*	85.6	<0.001*	0.014*
30 Min.	84	<0.001*	86.7	<0.001*	0.031*
45 Min.	81	<0.001*	83.9	<0.001*	0.035*
60 Min.	77.4	<0.001*	80.4	<0.001*	0.021*
90 Min.	75.2	<0.001*	76.6	<0.001*	0.166
120 Min.	73.1	0.518	74.2	0.235	0.315
150 Min.	72	0.500	73	0.594	0.247
180 Min.	71.8	0.081	72.6	0.178	0.094
4 hrs.	71.7	0.069	72.5	0.146	0.115
5 hrs.	71.9	0.147	72.7	0.221	0.166
6 hrs.	72	0.181	72.6	0.182	0.258
8 hrs.	73.5	0.094	73.8	0.445	0.732
10 hrs.	73.6	0.063	74.2	0.235	0.510
12 hrs.	72.5	0.964	73	0.594	0.405

p: for comparison between the two groups

p1: for comparison between before block with each other periods in Spinal (S) group

p2: comparison between before block with each other periods in Caudal (C)

*: Statistically significant at p ≤ 0.05

Table (3): Comparison between the two groups as regard systolic blood pressure

Systolic blood pressure (mmHg)	Spinal (S) (n=50)		Caudal (C) (n=50)		P
	Mean	p ₁	Mean.	p ₂	
Before block	118.4		115.6		0.060
5 Min.	110	<0.001*	106.6	<0.001*	0.100
10 Min.	103	<0.001*	99.8	<0.001*	0.062
15 Min.	100.4	<0.001*	98	<0.001*	0.256
30 Min.	100	<0.001*	100.8	<0.001*	0.626
45 Min.	106.6	<0.001*	108.4	<0.001*	0.162
60 Min.	112.2	<0.001*	112.2	0.012*	1.000
90 Min.	115.6	0.042*	112.2	0.023*	0.130
120 Min.	119	0.595	118	0.057	0.402
150 Min.	119.2	0.542	117.4	0.202	0.225
180 Min.	119.4	0.429	117.1	0.229	0.078
4 hrs.	117.4	0.417	115.6	1.000	0.107
5 hrs.	118.4	1.000	116	0.674	0.079
6 hrs.	116.8	0.159	114.8	0.438	0.136
8 hrs.	116.6	0.202	117.4	0.162	0.527
10 hrs.	119	0.595	118	0.057	0.402
12 hrs.	119.2	0.542	117.4	0.202	0.225

p: for comparison between the two groups

p₁: for comparison between before block with each other periods in Spinal (S) group

p₂: comparison between before block with each other period in Caudal (C)

*: Statistically significant at p ≤ 0.05

Table (4): Comparison between the two groups as regard diastolic blood pressure

Diastolic blood pressure (mmHg)	Spinal (S) (n=50)		Caudal (C) (n=50)		P
	Mean	p ₁	Mean ± SD.	p ₂	
Before block	78.2		77		0.445
5 Min.	67.4	<0.001*	66.2	<0.001*	0.369
10 Min.	62.2	<0.001*	61	<0.001*	0.563
15 Min.	58.4	<0.001*	60	<0.001*	0.194
30 Min.	60.4	<0.001*	61.8	<0.001*	0.272
45 Min.	66.8	<0.001*	68	<0.001*	0.367
60 Min.	71	<0.001*	72.2	<0.001*	0.332
90 Min.	72	<0.001*	73.6	0.036*	0.559
120 Min.	76	0.109	77	1.000	0.450
150 Min.	78	0.868	77	1.000	0.326
180 Min.	77	0.771	75.8	0.382	0.192
4 hrs.	79	0.252	76.4	0.705	0.136
5 hrs.	78	1.000	75.8	0.360	0.114
6 hrs.	76	0.197	75	0.105	0.291
8 hrs.	78	0.868	77	1.000	0.326
10 hrs.	77	0.771	75.8	0.382	0.192
12 hrs.	79.8	0.252	76.4	0.705	0.136

Table (5): Comparison between the two groups as regard Onset of sensory block, Duration of sensory block.

	Spinal (S) (n=50)	Caudal (C) (n=50)	P
Onset of sensory block (Min.)			
Mean ± SD.	3.14 ± 0.98	9.56 ± 1.63	<0.001*
Duration of sensory block (Min.)			
Mean ± SD.	91.88 ± 13.10	119.0 ± 10.83	<0.001*

Table (6): Comparison between the two groups as regard Onset, Duration of motor block.

	Spinal (S) (n=50)	Caudal (C) (n=50)	P
Onset of motor block (Min.)			
Mean ± SD.	6.80 ± 1.21	11.89 ± 1.90	<0.001*
Duration of motor block (Min.)			
Mean ± SD.	124.5 ± 10.7	143.6 ± 8	<0.001*

Table (7): Comparison between the two groups as regard the first analgesic rescue

	Spinal (S) (n=50)	Caudal (C) (n=50)	P
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First analgesic rescue			<0.001
Min. – Max.	82.0 – 120.0	101.0 – 174.0	

Table (8): Comparison between the two groups as regard Sedation score.

Sedation score	Spinal (S) (n=50)		Caudal (C) (n=50)		P
	Median	p1	Median	p2	
Before block	1		1		1.000
5 Min.	5	<0.001*	5	<0.001*	1.000
10 Min.	4	<0.001*	4	<0.001*	1.000
15 Min.	4	<0.001*	4	<0.001*	1.000
30 Min.	4	<0.001*	4	<0.001*	1.000
45 Min.	4	<0.001*	4	<0.001*	0.818
60 Min.	3	<0.001*	3	<0.001*	0.799
90 Min.	2	<0.001*	2	<0.001*	0.508
120 Min.	1	0.025*	1	0.001*	0.103
150 Min.	1	1.000	1	1.000	1.000
180 Min.	1	1.000	1	1.000	1.000
4 hrs.	1	1.000	1	1.000	1.000
5 hrs.	1	1.000	1	1.000	1.000
6 hrs.	1	1.000	1	1.000	1.000
8 hrs.	1	1.000	1	1.000	1.000
10 hrs.	1	1.000	1	1.000	1.000
12 hrs.	1	1.000	1	1.000	1.000

Table (9): Comparison between the two groups as regard Parents satisfaction and Surgeon satisfaction

	Spinal (S) (n=50)	Caudal (C) (n=50)	P
Parents satisfaction			
Poor	0(0.0%)	0(0.0%)	0.240
Fair	6(12.0%)	9(18.0%)	
Good	41(82.0%)	34(68.0%)	
Excellent	3(6.0%)	7(14.0%)	
Surgeon satisfaction			
Poor	0(0.0%)	0(0.0%)	0.863
Fair	3(6.0%)	5(10.0%)	
Good	41(82.0%)	40(80.0%)	
Excellent	6(12.0%)	5(10.0%)	

Table (10): Comparison between the two groups as regard color analogue scale(CAS)

CAS	Group S	Group c	P-value
30 min	0	0	0.001 *
60 min	0	0	0.001 *
90 min	2	0	0.010
120 min	2.5	2	0.010
150 min	2.5	2	0.010
180 min	3	2.5	0.39
4hours	3.5	3	0.39
5 hours	3	2.5	0.370
6hours	2.5	2	0.370
7 hours	3	2.5	0.193
8 hours	2.5	3	0.193
9 hours	3.5	3	0.205
10 hours	3	2.5	0.138
11 hours	4	3.5	0.138
hours12	4	3.5	0.138

Statistically significant at $p \leq 0.05$

Table (11): Comparison between the two groups as regard CAS

CAS	Group S	Group c	P-value
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30 min	0	0	0.001 *
60 min	0	0	0.001 *
90 min	2	0	0.010
120 min	2.5	2	0.010
150 min	2.5	2	0.010
180 min	3	2.5	0.39
4hours	3.5	3	0.39
5 hours	3	2.5	0.370
6hours	2.5	2	0.370
7 hours	3	2.5	0.193
8 hours	2.5	3	0.193
9 hours	3.5	3	0.205
10 hours	3	2.5	0.138
11 hours	4	3.5	0.138
hours12	4	3.5	0.138

Statistically significant at $p \leq 0.05$.

Table (12): Comparison between the two groups as regard Total iv. Paracetamol Consumption (mg/12)

	Group S (n = 50)	Group C (n = 50)	p-value
Comparison between the two groups as regard Total iv. Paracetamol Consumption (mg/12hr.)	398 ± 127	242 ± 125	<0.001*

Table (13): Comparison between the two groups as regard complications.

	Group S	Group C
Systemic toxicity	0	0
Neurotoxicity	0	0
Bradycardia	4	1
Nauea, vomiting	2	0
Hypotension	2	1
Failed block	2	2

DISCUSSION

In our developing countries there are a lot of challenges in anaesthetic drugs, supplies and monitoring equipments ⁽⁴⁾.

Some of these challenges can be overcome by choice of safe, reliable and effective sole anaesthetic technique which can provide both anaesthetic and analgesic satisfactory effects for performing the surgical procedure and capable of replacing the general anaesthesia in these situations. Nowadays regional anaesthesia techniques are well established in the practice of pediatric anaesthesia ⁽³⁾.

The present study was designed to compare between the spinal anaesthesia with bupivacaine 0.3mg/kg and caudal anaesthesia with bupivacaine 2mg/kg (0.7-1ml/kg vol.) as a sole anaesthetic technique adequate for infraumbilical paediatric surgeries below T10 as regard the sensory and motor block characteristics, perioperative haemodynamic effects, postoperative analgesia and both the surgeon and parents satisfaction were assessed.

The targeted level of sensory block was achieved below T8 in spinal group and below T10 in caudal group which provided both sensory, motor blockade allowing performing surgical procedure without facing any complications.

The present study was carried on 100 patients with age ranging from (6-12), and of ASA I, II classes undergoing infraumbilical paediatric surgeries.

Patients in each group were randomly assigned to receive spinal or caudal epidural anaesthesia.

The demographic profile of our patients and the mean duration of surgery were almost comparable in all groups with no significant statistical difference between the two groups ($p > .05$) however more male patients were selected in both groups as many surgeries were male specific, the result was quite similar with other research investigations ^(1,3).

Regarding the hemodynamics in the present study, the H.R was kept around normal

range this is because regional anaesthesia abolishes the bradycardiac response to spermatic cord or mesenteric manipulations during lower abdominal surgeries ⁽⁵⁾.

This result was agreed with the study done by Patel and Thacher ⁽⁴⁾ and Saikia *et al.* ⁽⁶⁾.

While the bl.p was significantly decreased at 5 minutes up to 90 minutes but still within normal accepted range, this is explained by that sympathetic vascular tone in children at rest is less than in adults. Similar results were observed by **Pandya *et al.*** ⁽¹⁾.

As regard the onset of sensory blockade, it was longer in caudal (9.5 ± 1.6) than spinal (3.1 ± 0.9), furthermore duration of sensory blockade was longer in caudal group (119 ± 10.8 min.) than spinal group (91.8 ± 13 min), however as age and weight of the patient decreases duration of both the blocks tends to decrease, this is explained by that myelination of nerve is not complete until 12 years of age, the unmyelinated nerve fibre are capable of relaying information slower than the myelinated fibres, also incomplete myelination allows for better penetration of L.A into nerve fibres, reduced milligram doses of local anaesthetic solutions can provide a complete block in children, in addition to loose fascial attachment around nerve facilitate the spread of L.A consequently regional block in children may spread further than the provider intends, additionally because L.A spreads easily in children the duration of block may be shortened compared to an adult ⁽⁴⁾.

This was explained by that subarachnoid anaesthesia has the advantage that the block is effective within the first 2 minutes compared to caudal which wait for about 10 minutes.

These results were coincided with the results of **Pandya and colleagues** ⁽¹⁾ and with the results reported by **Ebrahim *et al.*** ⁽⁷⁾ reported longer duration of sensory block in caudal group (186.3 min) than revealed in our study (119 ± 1.8).

This difference may be attributed to the difference in the dose of bupivacaine (15 ml of 5% bupivacaine) that he used in his study.

Regarding the motor blockade characteristics, onset of motor blockade was longer in caudal group (11.8 ± 1.9) than spinal group (6.8 ± 1.2), furthermore the duration of

motor blockade in caudal results were coincided with the results of **Pandya *et al.*** ⁽¹⁾. Similar results were obtained by **Patel and Thacher** ⁽⁴⁾.

Ebrahim *et al.* ⁽⁷⁾ reported longer duration of onset of motor blockade in caudal group (26min). This difference with the results of the current study may be attributed to the difference in the dose of bupivacaine that used in both studies.

Regarding the complications, the spinal group reported 4/50 (8%) had bradycardia, 2/50 (4%) cases had hypotension, 2/50 (4%) cases had nausea and vomiting, 2/50 (4%) cases had failed block, the caudal group reported 1/50 (2%) case hypotension, 1/50 (2%) cases had failed block. No systemic toxicity, neurotoxicity were reported in both techniques, No local infection was reported most probably because of aseptic cleaning before the puncture. Complications Were treated symptomatically: bradycardia were treated by atropine 0.01mg/kg, nausea and vomiting were treated by antiemetics (metoclopramide 0.2mg/kg), hypotension was treated by crystalloid solutions and ephedrine as appropriate, cases of post spinal headache were treated by bed rest, caffeine and analgesia as need, while cases of failed block were transferred to GA and were excluded from the study. Similar results were reported by **Patel and Thacher** ⁽⁴⁾ in their study.

CONCLUSION

Both techniques are safe effective and satisfactory as a sole anesthetic technique under sedation and have the capability of replacing the G.A especially in infraumbilical pediatric surgeries below T10 level with the superiority of subarachnoid on achieving rapid onset of sensory blockade, intense motor blockade, on the other hand the caudal epidural had the advantage of longer post-operative analgesic effect and lower post-operative analgesic consumption, furthermore both techniques gained good degree of parent and surgeon satisfaction.

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