DOI: 10.7860/JCDR/2022/51831.16095

Original Article

Anaesthesia Section

Lumbar Epidural Anaesthesia versus Caudal Epidural Anaesthesia- Intraoperative and Postoperative Profile in Paediatric Surgical Patients

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ABSTRACT

Introduction: Caudal and lumbar epidural are established techniques of central neuraxial blocks in paediatric anaesthesia. Learning them by landmark guidance is extremely important given the fact that they have a short learning curve and all centres may not be equipped with modern equipment like fluoroscopy and ultrasound.

Aim: To compare lumbar epidural anaesthesia with caudal epidural anaesthesia in terms of the ease of needle and catheter insertion, efficacy in providing intraoperative and postoperative analgesia, haemodynamics, patient satisfaction and complications.

Materials and Methods: This prospective observational study was done in the Department of Anaesthesiology, Sher-I-Kashmir Institute of Medical Sciences, Srinagar, Jammu and Kashmir, India between September 2016 and June 2018. Study included 60 patients, aged 2-15 years, of American Society of Anaesthesiology (ASA) grade I and II, undergoing elective infraumbilical surgeries. Patients were either administered General Anaesthesia (GA) and 0.2% ropivacaine 0.3 mL/kg through lumbar epidural catheter (Group L), or GA and 0.2% ropivacaine 1 mL/kg through caudal epidural catheter (Group C). Pain was measured postoperatively using Face, Legs, Activity, Cry, Consolability (FLACC) score and number of rescue top ups in the form of tramadol 1.5 mg/kg epidurally were noted. Student's independent-test was employed for intergroup and, paired t-test and Fisher's-exact test was used for intragroup analysis.

Results: Out of 60 patients, the mean age±Standard devation (SD) in lumbar technique group and caudal technique group was 8±3.42 years and 6.56±2.93 years, respectively. The age, gender distribution, intraoperative and postoperative vitals (heart rate, mean arterial pressure and oxygen saturation), number of rescue top ups, patient satisfaction were comparable between the two groups. On statistical comparison, needle insertion was easy in 21 patients in caudal epidural group (vs 13 in lumbar epidural group) and catheter insertion was difficult in 18 (vs 8 in lumbar epidural group) in caudal epidural block compared with lumbar epidural block (p-value=0.037 and 0.010 respectively). No complications were observed in any patient of either group except one patient in group C who had catheter occlusion in the postoperative period.

Conclusion: Needle insertion was easy and catheter insertion was difficult in caudal epidural block compared with lumbar epidural block in paediatrics. Both the techniques provided comparable quality of analgesia, stable haemodynamics with minimum complications.

Keywords: Endotracheal tube, Infraumbilical surgery, Regional anaesthesia, Tuohy needle

INTRODUCTION

The history of paediatric anaesthesia and analgesia is fascinating, in terms of the enormous advancement that has taken place, from the days when block techniques and equipment for adults were adapted for use in children. Since then, significant developments have occurred regarding General Anaesthesia (GA), Regional Anaesthesia (RA) and perioperative pain management in the paediatric population.

The RA and analgesia techniques provide a combination of excellent anaesthesia and pain relief, minimal side-effects and high patient satisfaction. Caudal block and epidural block were first described in paediatrics by Campbell MF in 1933 and Roderie Sievers in 1936 respectively for cystoscopies. These techniques have now become the most commonly used RA techniques in paediatric practice [1,2]. They have a short learning curve, with an extensive safety record. The use of neuraxial catheters has circumvented the disadvantage of short duration of action after single injection [3].

While the landmark guided approach to central neuraxial blocks is time tested, simple, and easy to perform, it is prone to block failure due to anatomical variations [4-6]. The advent of fluoroscopy and ultrasound has markedly improved the first attempt success rates of these techniques with less complications, although few studies reported a longer block time with ultrasound compared to the conventional technique [7,8]. However, learning the central neuraxial blocks with landmark guided technique is extremely important given the fact that all centres may not be equipped with modern equipment like fluoroscopy and ultrasound.

Although there are studies comparing lumbar and thoracic epidural analgesia in paediatrics [9-12], an extensive literature search revealed no study comparing the ease of needle and catheter insertion in lumbar and caudal epidural space in paediatric patients undergoing infraumbilical surgeries. Hence, the aim of the present study was to compare lumbar epidural anaesthesia with caudal epidural anaesthesia, in terms of the ease of needle and catheter insertion, efficacy in providing intraoperative and postoperative analgesia in terms of number of rescue analgesic requirements, haemodynamics, patient satisfaction and complications.

MATERIALS AND METHODS

The present prospective observational study was conducted in the Department of Anaesthesiology, Sher-I-Kashmir Institute of Medical Sciences, Srinagar, Jammu and Kashmir, India. Sixty patients posted for elective infraumbilical surgeries were included between September 2016 and June 2018. Institutional Human Ethics Committee approval was taken (SIMS1131/IEC-SKIMS/ 2018-315). Patient information sheet was provided and written informed

consent was obtained from the parents of all patients. Assent of the patient was taken if he was seven years or more in age.

Sample size calculation: Using G*Power software (Version 3.0.10; Franz Faul, Kiel University, Kiel, Germany), it was estimated that the least number of patients required in each group with 80% power, effect size of 0.65 and 5% significance level was 30. Therefore a total of 60 patients were included in the present study.

Inclusion criteria: Children between age group of 2-15 years, undergoing elective infraumbilical surgeries with ASA I and II status were included in the study.

Exclusion criteria: Patient/guardian who did not give consent for study, patients with neurological deficits or psychiatric disorders, bleeding disorders or who were on antiplatelet and anticoagulant drugs were excluded from the study. Patients who had infection at local site, spine deformities, raised intracranial tension, hypersensitivity to local anaesthesia drugs and patients with chronic pain syndrome or who were on pain modifying drugs were excluded from the study.

All patients underwent routine preanaesthetic evaluation a day before surgery and were fasted as per the institutional preoperative fasting guidelines. In the preoperative holding area, premedication (oral midazolam 0.4 mg/kg given 40 min before the procedure) was administered. In the Operating Theatre (OT), monitors were attached and patients were induced by inhalational agent sevoflurane 8% to start with, and titrated down to 3-4%. An intravenous (i.v.) line was established with 22/24 G i.v. cannula and Ringer's lactate solution was started according to Holiday Segar formula and the losses calculated and replaced intraoperatively. Fentanyl 1 micrograms (mcg)/kg i.v., Propofol 2 mg/kg i.v. and atracurium 0.6 mg/kg i.v. were administered. The patients were ventilated using Jackson Rees circuit and appropriate size Endotracheal Tube (ETT) was placed. Anaesthesia was maintained with nitrous oxide (50%) in oxygen and isoflurane with a target Minimum Alveolar Concentration (MAC) of 1-1.5. Ventilation was controlled with a tidal volume of 6-8 mL/kg and respiratory rate adjusted to maintain End-tidal Carbondioxide ($EtCO_2$) between 30-35 mmHg.

Procedure

Drugs were prepared by the anaesthesiologist and equipment necessary for procedure and resuscitation were kept available. Under all aseptic precautions, all blocks were performed in lateral decubitus position with one or both hips flexed, using midline approach. All those blocks were included in the study which were performed by a single anaesthesiologist with >5 years of experience in paediatric anaesthesia. For performing these blocks, 18 G Touhy needles with 20 gauge catheters were used.

For lumbar epidural anaesthesia (Group L): Tuohy needle was introduced at L3-L4 or L4-L5 space, epidural space identified by loss of resistance to air technique and catheter threaded upto 3-5 cm in the cephalad direction. Aspiration for the absence of cerebrospinal fluid and blood was done.

For caudal epidural anaesthesia (Group C): The sacral hiatus was palpated and Tuohy needle advanced at a 70° angle cephalad, until a pop was felt as the needle pierced the sacrococcygeal ligament. The angle of the needle was then flattened to 20°-30° and advanced. Loss of resistance to air was checked and epidural catheter was left 3-5 cm into the space. Aspiration for blood and cerebrospinal fluid was performed.

The catheters were labelled for the purpose of identification. Proper placement in both the groups was confirmed by a negative test dose (2% lignocaine with adrenaline 5 µg/mL in a dose of 0.1 mL/kg, maximum 3 mL) before administration of the drugs.

Group L (n=30): Received GA and 0.2% ropivacaine 0.3 mL/kg through lumbar epidural catheter.

Group C (n=30): Received GA and 0.2% ropivacaine 1 mL/kg through caudal epidural catheter at the sacral hiatus.

The drug doses were based on the desired dermatome blockade as T10 for infraumbilical surgeries and were inferred from a previous study [13]. In order to differentiate between difficult and unsuccessful needle/catheter insertion, all those patients were excluded in whom the block administration was unsuccessful. Successful block injection was defined as no blood or cerebrospinal fluid on aspiration, injection into the caudal canal without any resistance, no dural tap and no subcutaneous swelling. Such blocks were further classified as easy and difficult. A difficult caudal/epidural block was defined as a procedure that lasted >100 seconds or required >10 needle passes [14].

Vital parameters were recorded at induction (baseline), then for every 20 minutes till the end of surgery. After 20 minutes of block administration, any increase in Heart Rate (HR) or Mean Arterial blood Pressure (MAP) >20% from baseline inspite of a MAC value of 1-1.5, was considered as pain, and hence block failure. Patients with unsuccessful/failed blocks were supplemented with injection fentanyl 1 mcg/kg i.v. and paracetamol 15 mg/kg i.v. as analgesia.

Hypotension and bradycardia, defined as 20% decrease from baseline levels, were treated with rapid infusion of i.v. fluids and atropine 0.02 mg/kg i.v., respectively. Hypotension persisting inspite of fluid administration was treated with ephedrine 0.1-0.2 mg/kg i.v. Desaturation was defined as SpO_2 <94% in the perioperative period. After the completion of the surgical procedure, the patients were extubated and shifted to the Post Anaesthesia Care Unit (PACU). In the postoperative period the following parameters were evaluated for 24 hours of the study duration:

- Postoperative vitals were noted at the time of being shifted to PACU, then at 6 hours, 12 hours and 24 hours.
- Patient satisfaction score was inferred from Face, Legs, Activity, Cry, Consolability (FLACC) [15] score in PACU, at 6 hours, 12 hours and 24 hours postoperatively where,

  0: meant a relaxed and comfortable patient, represented by "best"

  1-3: meant mild discomfort, represented by "good"

  4-6: meant moderate pain, represented by "satisfactory"

  7-10: meant severe pain or discomfort or both, represented by "poor"
- Total number of top ups received- At a FLACC Score of ≥4 in the postoperative period, rescue analgesia of tramadol 1.5 mg/kg epidurally was given.
- Complications related to the procedure or the drugs, were noted in the intraoperative and postoperative period like Local Anaesthesia Systemic Toxicity (LAST), haemodynamic instability, pericatheter leak (identified by mild soakage of dressing applied at the site of insertion), catheter migration/blockage and catheter breakage during removal. Complications like dural puncture and subcutaneous swelling during epidural and caudal block respectively, were noted but not analysed.

After 24 hours, epidural catheter was removed by confirming the blue tip in all patients under aseptic precautions and antiseptic dressing was applied. If case of block failure, catheter malposition, catheter occlusion, postoperative analgesia/rescue analgesia would be maintained by injection paracetamol i.v.

STATISTICAL ANALYSIS

Statistical Package for the Social Sciences (SPSS) version 20.0 was used to obtain the statistics of the data including the mean and standard deviation for numerical variables and the percentages for categorical variables. Student's independent t-test was employed for intergroup analysis of the data. Intragroup analysis was carried out with the help of paired t-test and Fisher's-exact test. Paired t-test or Fischer's-exact test, whichever appropriate, was used for comparison of categorical variables. Graphically the data was

presented by bar and line diagrams. A p-value of less than 0.05 was considered statistically significant. All p-values were two tailed.

RESULTS

The two groups were similar in terms of demographic characteristics like age (p-value of 0.087) and gender [Table/Fig-1]. All patients in both the groups were ASA grade I.

Variables	Group L	Group C	p-value
Age (years)			
Mean±SD	8±3.42	6.56±2.93	0.087
Gender			
Male n (%)	18 (60%)	17 (56.7%)	0.793
Female n (%)	12 (40%)	13 (43.3%)	

[Table/Fig-1]: Comparison of patient demographics between the two groups.

On statistical comparison, needle insertion was easy and catheter insertion was difficult in caudal epidural block compared with lumbar epidural block with a p-value of 0.037 and 0.010, respectively [Table/Fig-2].

Variables	Group L N (%)	Group C N (%)	p-value
Ease of needle insertion			0.037
Easy	13 (43.3%)	21 (70%)	
Difficult	17 (56.66%)	09 (30%)	
Ease of epidural catheter placement			0.010
Easy	22 (73.33%)	12 (40%)	
Difficult	08 (26.66%)	18 (60%)	

[Table/Fig-2]: Comparison of ease of needle and catheter insertion between the two groups.

There were no statistically significant differences in baseline HR (p-value=0.252), MAP (p-value=0.091) and oxygen saturation (p-value=0.165), between the two groups before performing the epidural block, intraoperatively and in the postoperative period [Table/Fig-3,4]. Patient satisfaction based on the FLACC scores and the rescue analgesic requirements were comparable at all time intervals in both the groups (p-value >0.05) [Table/Fig-5,6]. None of the patients reported bradycardia in the intraoperative or postoperative period.

Heart rate	Group L		Group C		p-value
	Mean	Standard deviation	Mean	Standard deviation	
Baseline	98.13	9.584	100.07	11.991	0.252
20 min	90.73	12.259	91.20	10.740	0.517
40 min	87.80	10.097	92.50	9.843	0.436
60 min	92.13	7.847	93.90	8.495	0.890
80 min	87.13	8.456	92.53	9.947	0.766
100 min	87.47	10.579	91.50	8.195	0.124
120 min	87.70	9.018	88.40	8.295	0.867

[Table/Fig-3]: Comparison of heart rate distribution of patients in Group L and Group C at different time intervals.
Fisher's-exact test was used

MAP	Group L		Group C		p-value
	Mean	Standard deviation	Mean	Standard deviation	
Baseline	73.87	3.598	71.10	2.833	0.091
20 min	71.70	3.905	69.47	3.501	0.197
40 min	71.43	4.006	69.77	3.401	0.193
60 min	71.60	3.793	69.53	2.886	0.149
80 min	71.93	3.290	69.87	2.837	0.398
100 min	72.53	3.441	69.87	2.623	0.163
120 min	72.60	3.936	70.67	2.721	0.058

[Table/Fig-4]: Comparison of mean arterial pressure (MAP) between Group L and Group C at different time intervals.
Fisher's-exact test was used

Patient satisfaction		Group L N (%)	Group C N (%)	p-value
PACU	Poor	0	0	0.1808
	Satisfactory	12 (57.9%)	8 (42.1%)	
	Good	17 (50.0%)	17 (50.0%)	
	Best	1 (16.7%)	5 (83.3%)	
6 hours	Poor	0	0	1.00
	Satisfactory	10 (50.0%)	10 (50.0%)	
	Good	4 (44.4%)	5 (55.6%)	
	Best	16 (51.6%)	15 (48.8%)	
12 hours	Poor	0	0	0.3737
	Satisfactory	3 (30.0%)	7 (70.0%)	
	Good	1 (33.3%)	2 (66.7%)	
	Best	26 (55.3%)	21 (44.7%)	
24 hours	Poor	0	0	0.7741
	Satisfactory	14 (46.7%)	16 (53.3%)	
	Good	4 (44.4%)	5 (55.6%)	
	Best	12 (57.1%)	9 (42.9%)	

[Table/Fig-5]: Comparison of patient satisfaction between Group L and Group C.
PACU: Post anaesthesia care unit

Number of top ups	Lumbar N (%)	Caudal N (%)	p-value
One top up	10 (38.5%)	16 (61.5%)	0.15
Two top ups	14 (66.7%)	7 (33.3%)	
Three top ups	6 (46.2%)	7 (53.8%)	
Mean±SD	10±2.309	10±0.703	

[Table/Fig-6]: Number of top ups received in Group L and Group C.
Fisher's-exact test was used

DISCUSSION

Caudal and lumbar epidural anaesthesia techniques are the gold standard for postoperative analgesia in children. Epidurals avoid the side effects associated with administration of i.v. opioids, with studies demonstrating fewer episodes of hypoxemia or respiratory depression and a reduced need for postoperative ventilation and intensive care [16]. There is also better haemodynamic stability, improved gastrointestinal function, less nausea and vomiting and a reduced neurohumoral stress response [17]. The epidural and caudal anaesthesia and analgesia has been used either as a single shot technique or a continuous catheter technique for infants and young children undergoing abdominal, urologic or orthopaedic surgeries.

A total of 65 patients were enrolled in the present study. The demographic characteristics of patients in both the groups were comparable. There was inability to insert catheter in the epidural space in one patient of Group C. This was considered as block failure and the patient was excluded from the study. Dural puncture was observed in one patient from Group L during needle insertion. Although excluded from the present study, this patient was followed-up in the postoperative period. The child did not develop postdural puncture headache. Three patients were excluded from Group C due to subcutaneous swelling. Thus, 60 patients were analysed.

In the present study, the ease of epidural needle insertion in Group C was easier than in Group L [Table/Fig-2]. In accordance with these findings, Ponde VC discussed the recent developments in paediatric neuraxial blocks and stated that, the caudal epidural was technically much easier and safer to practice in intra-abdominal surgeries for intra and postoperative analgesia [18]. However, Price CM et al.,

found that 93% of lumbar and 64% of caudal epidural injections were correctly placed (p-value <0.001), indicating the accuracy of needle placement by the two approaches [11]. Auler Jr JO et al., delineated the ease of localising sacral hiatus in children younger than eight years of age or weight lower than 30 kg and observed that above this age, there is a relative difficulty in administering caudal epidural anaesthesia. This difficulty was attributed to progressive sacral ossification and obliteration of sacrococcygeal angle with age, leading to difficulty in identification of the sacral hiatus [19]. This explains the finding of subcutaneous swelling in three patients in the present study. This difficulty can be mitigated by using ultrasound to locate the sacral hiatus and visualise the local anaesthesia deposition in the space.

In the present study, the ease of epidural catheter placement was easier in Group L in comparison to Group C (p-value=0.010). Valairucha S et al., recommended that caudal catheters should be limited to patients younger than one year of age because development of the lumbar curve during infancy can prevent easy threading of the catheter and may cause catheter kinking [20]. This explains the block failure due to inability to insert caudal catheter in the present study. Polaner DM et al., also reported that the main problems with epidural blocks were block failure and inability to place needle correctly in caudal space [4]. The most common adverse effects in a study by Walker BJ et al., were catheter occlusion, dislodgement and disconnection that occurred in 4% of the patients [21]. However, with the introduction of new equipment and techniques, caudal catheter advancement is even possible in older children using epidural stimulation. According to Gunter J malpositionings are known in caudal epidural catheters and they can be reduced by the use of large bore catheters (18 G) and catheters with a stylet (the stimulating catheters) [22].

In the present study, incidence of catheter occlusion postoperatively was 3.33% in each group (one patient each in Group C and Group L). The incidence of block failure, catheter occlusion and dural puncture observed in the present study was in accordance with those reported by previous studies [23,24]. In a review article by Patel D on epidural analgesia in children, serious or catastrophic complications after caudal block were described as rare (incidence of inadvertent IV injection as 1:10 000, incidence of epidural haematoma/abscess as 1:80 000). The reported failure rate was 2-10% in caudal block (attributed to abnormal anatomy, inexperienced operator or inappropriate choice of block) and 5% in lumbar epidural block. The incidence of catheter leakage/occlusion and dural tap after lumbar epidural were reported as 11-17% and 0.1–0.5%, respectively. Similarly, the incidence of serious or major complications after lumbar epidural (<1:100 000) in children was described as less than that in adults [16]. Walker BJ et al., reported the risk of transient neurologic deficit was 2.4:10000 and did not report any permanent neurologic damage in any patient. They calculated the risk of severe (LAST) as 0.76:10000 and reported no haematomas due to neuraxial catheters. This study demonstrated a comparable efficacy of paediatric and adult RA techniques and confirmed the safety of performing the neuraxial blocks under GA [21].

In the present study, HR and MAP decreased from the baseline values after 20 minutes of block administration, indicating effective analgesia achieved by theropivacaine injections in both the groups. But when they were compared with the other group, the result was not significant (p-value >0.05) [Table/Fig-3,4]. Therefore, indicating that both the techniques were comparable in providing effective analgesia and none was superior to the other. Also, both the techniques had insignificant effect on the haemodynamics of the patient. There was no incidence of hypotension, bradycardia and respiratory depression postoperatively in either group. Various studies support the present study findings [10,25-28]. Comparison of the number of top ups in each group revealed statistically insignificant results [Table/Fig-6]. These findings were in accordance with the findings of numerous studies [10,29-31]. Patient satisfaction inferred from FLACC scores was also comparable between the two groups [Table/Fig-5] at all the time intervals. This finding was similar to that observed by Schnabel A et al., [32].

After the surgery all children were calm and showed no signs of discomfort. This suggests effective immediate postoperative analgesia, similar in both lumbar and caudal epidural techniques. No patient in either group who received epidural tramadol had any complications like nausea, vomiting, sedation, respiratory depression and pruritus.

Although the literature finds caudal and epidural catheters to be extremely valuable for managing postoperative analgesia when administered as a continuous infusion [9,33], authors in the present study, inserted them to observe the ease of catheter insertion and used it for intraoperative analgesia and postoperative rescue analgesia. We did not administer continuous analgesic infusions through them in the postoperative period.

Limitation(s)

Firstly, unsuccessful/failed block was defined separately from difficult block, hence not analysed for incidence. Secondly, the present study included a broad range of age i.e., 2-15 years, which makes reliable pain assessment a challenge in different age groups. Authors therefore suggest more prospective studies with larger sample sizes and with multicentre patient enrollments, to find out the incidence of complications associated with these procedures.

CONCLUSION(S)

Needle insertion was easy and catheter insertion was difficult in caudal epidural block compared with lumbar epidural block in paediatrics. Both the techniques provided comparable quality of analgesia, stable haemodynamics with minimum complications. In settings where ultrasound is available, the safety of needle and catheter insertion under anaesthesia may be further improved.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Aug 18, 2021
- Manual Googling: Dec 01, 2021
- iThenticate Software: Jan 03, 2022 (12%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? NA
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Aug 17, 2021**
Date of Peer Review: **Nov 02, 2021**
Date of Acceptance: **Dec 02, 2021**
Date of Publishing: **Mar 01, 2022**