An Observational Study to Compare the Confirmation of Correct Needle Placement During Caudal Epidural Blockade by Classic Give Way Technique and Heart Rate Variation.

Sandhya Babu[1], Lipika A Baliarsingh[2], Sneha Bipin Miniyar[3]

ABSTRACT

Caudal block is one of the most commonly performed regional anaesthesia procedures in children. The presenting study was aimed to study changes in heart rate during local anaesthetic injection in caudal blockade in paediatric patients. This was a prospective observational study carried out among 6 months to 12 years pediatric patients who underwent infraumbilical surgery. Total 125 patients were enrolled in study who fulfilled inclusion criteria by convenient sampling. About 76.8% aged ≤5 years. Mean age of study subject was 3.9±2.4 years & mean weight was 14.5±6.21 kg. About 77.60% were male. In majority (90.40%) of study subjects, tachycardia was absent and end tidal Sevoflurane required for maintenance was < 1 % each. The significant reduction in heart rate during 5 minutes of drug injection verify that, heart rate variation can be taken as a reliable predictor for a successful caudal block. Based on our study results, we conclude that a fall in heart rate during or within 1 to 5 minutes of caudal drug injection is a simple, reliable and objective test of successful caudal block.

Keywords: Epidural Blockade, Caudal Block, IV Glycopyrrolate, Fentanyl, IV Ketamine

INTRODUCTION

Caudal block is one of the most commonly performed regional anaesthesia procedures in children. The most widely used technique is landmark based approach where the sacrococcygeal hiatus is identified by landmarks and palpation. Though this technique yields convincing success rates, complete block failure and inadequate anaesthesia are well known.[1]

Many other methods have been used to find out the correct needle placement. Tests such as Whoosh [5,6] and Swoosh [7] are subjective and vary from person to person. Ultrasound imaging for correct needle placement is dependent on skill of an operator and availability.

Considerable variability occurs in sacral hiatus anatomy. With child's advancing age, the overlying ligaments and the cornua thicken, consequently, identification of the sacral hiatal margins become challenging [2]. Although relatively simple to perform, the classic give-way technique relies on the ability to locate sacral cornua and an endpoint of successful insertion in the form of 'pop' on piercing the sacrococcygeal ligament.[3] Camps et al suggested a decrease in heart rate following an injection of a test dose of bupivacaine-epinephrine as an indicator of correct needle placement[4].

The caudal space is the sacral portion of the epidural space. Procedure involves needle or catheter penetration of the sacrococcygeal ligament covering the sacral hiatus that is created by the unfused S4 and S5 laminae. The sacral foramina form together the sacral canal and the lower opening of sacral canal is called sacral hiatus. It is surrounded on either side by sacral cornua, that are of great importance for identification of sacral hiatus on the body surface. Sacral canal contains dural sac, sacral nerves and coccygeal nerves, venous plexus, areolar and fat tissue. Sacral hiatus is wider in children. So palpating sacral hiatus in children is easier. In infants the sacral canal is filled with fluid fat and loose areolar connective tissue which allows easy spread of anaesthetic solutions up to age of 6 or 7 years, and also this fluidity of epidural fat allows catheter insertion easier.

Landmarks

The skinfolds of the buttocks are useful guides in locating the underlying sacral hiatus. Alternatively, a triangle may be marked on the skin over the sacrum, using the posterior superior iliac spines (PSISs) as the base, with the apex pointing inferiorly (caudally). Normally, this apex sits over or immediately adjacent to the sacral hiatus. However, a recent study indicated that identification of the sacral hiatus using this method may be inaccurate because the actual triangle formed by the sacral hiatus and PSIS is not equiangular. Once the hiatus is marked, the tip of the index finger is placed on the tip of the coccyx in the intergluteal cleft while the thumb of the same hand palpates the two sacral cornua located 3–4 cm more rostrally at the upper end of the intergluteal cleft. The sacral cornua may be identified by gently moving the palpating index finger from side to side. The palpating thumb should sink into

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the hollow between the two cornua, as if between two knuckles of a fist. Sterile skin preparation and draping of the entire region are performed in the usual fashion.[8] The presenting study was aimed to study changes in heart rate during local anaesthetic injection in caudal blockade in paediatric patients.

METHODOLOGY

This study was approved by the institutional review board & written informed consent was obtained from the guardians of paediatric patients aged 6 months to 12 years, and the procedures was conducted in accordance with the Helsinki Declaration-2013. Pre- operative evaluation was done one day prior to the surgery. The patient details like name, age, gender, indoor number, diagnosis and the proposed operation was noted along with proper examination of the child including vitals, general condition, systemic examination, airway assessment and lower back examination to rule out any local infection or deformity. The procedure was explained to the patient's legal guardian. On the day of surgery, patient was pre medicated with IV glycopyrrolate 0.004mg/kg, IV fentanyl 2mcg/kg, IV ketamine 0.25mg/kg prior to anaesthesia induction. After pre-medicating, patient was taken to OT table, monitors including electrocardiogram, non invasive blood pressure monitor, pulse oximeter was attached and baseline values was noted. Patient was induced with inj IV Thiopentone 5-7mg/kg + inj Atracurium 0.5-1 mg/kg iv followed by inhalation anaesthesia with oxygen + air + sevoflurane. Direct laryngoscopy was done, airway was secured with endo-tracheal tube of size appropriate for age after 3 minutes of ventilation with oxygen + air + sevoflurane. Intra operative monitoring includes ECG with ST and T wave analysis, pulse oximeter, end tidal CO2 and sevoflurane concentration, non-invasive blood pressure and temperature. After achieving an end tidal sevoflurane concentration of 0.7-0.8 % in 50% air for 3 minutes, patient was positioned to lateral decubitus, lower back was cleaned and draped with all aseptic precautions. Heart rate was recorded from the ECG reading, which was taken as the baseline. A 22G /23 G needle was placed under full asepsis and 0.75 – 1 ml/kg of 0.25% bupivacaine is injected. Drug was injected at the rate of 1ml/3-4 sec. In children weighing 5-6kg drug was injected over 5-6 seconds. Accidental dural puncture or intravascular placement was ruled out by excluding blood in the hub of the needle and negative CSF aspiration, initially and after 1ml of injection. An Anaesthesiologist was recording the lowest heart rate until 1 minute, 3 minutes, and 5 minutes after the total administration of drug. This person was directed to inform the operator in case of any dysrhythmia or T- wave changes with injection (increase in amplitude by 25% for 10 seconds compared with base line) of drug. Heart rate was recorded at the time of incision and 1 min after incision. The operator's clinical impression of successful needle placement was based on four predictors i.e. ability to locate sacral hiatus, 'pop' on piercing the ligament, lack of resistance to injection and lack of subcutaneous swelling. Change in heart rate after 1 min of caudal block and change in heart rate at incision was compared with operator's pop on piercing the ligament. Another investigator observing the heart rate would define the successful caudal block based on following criteria:

1. Absence of tachycardia (HR > 20% of baseline) on surgical stimulation
2. End tidal sevoflurane required for maintenance

In case of failed block, analgesia is provided with tramadol iv 1mg/kg.

Sample size was calculated with reference to study by Polaner DM et al, reported that the proportion of HR as a successful caudal block was 90% [1]. About 125 patients who admitted in the department of paediatric Surgery, Nair hospital & infra umbilical surgeries underwent during the period of one and half years were enrolled by convenient sampling technique.

STATISTICAL ANALYSIS

The data were analysed using the Statistical Package for Social Sciences (SPSS), version 16.0 (SPSS, Chicago, Illinois) software. For comparison of parametric data, Student's independent sample *t* test was used; for comparison of proportions, Chi-square test was used.

RESULTS

During the study period total 125 paediatric patients were enrolled in the study, 76.8% aged ≤5 years. Mean age of study subject was 3.9±2.4 years & mean weight was 14.5±6.21 kg. About 77.60% were male and 22.4% were female. Majority of patients (73.6%) with ASA grade I. (Table 1)

Table 2 shows the mean HR & table 3 shows the reduction in HR in peri-operative period. In majority of study subjects (90.40%), HR reduced after 1 min of induction & at 5 min of induction, 91.20% study subjects showed reduction in HR. (Table 4)

In majority (90.40%) of study subjects, tachycardia was absent and end tidal Sevoflurane required for maintenance was < 1 % each. All patients had negative aspiration of blood during drug administration followed by able to detect sacral hiatus (98.40%), pop on piercing ligament (92.00%) and resistance to injection of LA (4.00%). Subcutaneous swelling after injection of LA was seen in none of the patient. (Table 5)

No significant association was seen in heart rate (per minute) at pre-operative (p=0.279), at 0 minute(p=0.341), at 1 minute(p=0.151), at 3 minutes(p=0.143), at 5 minutes(p=0.133) with able to detect sacral hiatus. Significant association was seen in heart rate (per minute) during incision, 1 minute after incision with ablility to detect sacral hiatus. (p <0.05) (Fig 1)

No significant association was seen in percentage reduction in heart rate at 1 minute (p=0.072), at 3 minutes(p=0.35), at 5 minutes(p=0.219) with able to detect sacral hiatus. Significant association was seen in percentage reduction

Socio-demographic Parameter		Frequency	Percentage
Gender	Male	97	77.6
	Female	28	22.4
Age Group	≤5	96	76.8
	>5	29	23.2
ASA Grade	I	92	73.6
	II	33	26.4

Table 1: Distribution of study subjects according to sociodemographic profile

Heart rate (per minute)	Mean ± SD	Median	Range
Pre-operative	110.67± 18.8	106	86-148
At 0 min	116.43± 18.74	112	92-154
At 1 min	115.16± 19.18	110	89-158
At 5 min	113.47± 19.47	109	87-159
At 3 min	113.88± 19.53	110	85-160
During incision	106.15± 19.17	101	79-146
1 minute after incision	107.62± 19.86	103	78-154

Table 2: Descriptive statistics of heart rate of study subjects.

Percentage reduction in heart rate	Mean ± SD	Median	Range
At 1 minute	1.16 ± 2.15	1.64	-10.71-3.26
At 3 minutes	2.66 ± 2.93	3.33	-11.61-5.43
At 5 minutes	2.3 ± 3.47	2.73	-14.29-7.61
During incision	9.04 ± 4.19	9.43	-15.69-15
1 minute after incision	7.77 ± 5.84	8.82	-21.57-17

Table-3: Descriptive statistics of percentage reduction in heart rate of study subjects.

Patients with reduction in heart rate	Frequency	Percentage
At 1 min	113	90.4
At 5 min	112	89.6
At 3 min	114	91.2

Table-4: Distribution of patients with reduction in heart rate.

Confirmation of classic give way technique	Frequency	Percentage
Able to detect sacral hiatus	123	98.4
Pop on piercing ligament	115	92.0
Resistance to injection of LA	5	4.0
Negative aspiration of blood during drug administration	125	100.00
Subcutaneous swelling after injection of LA	0	0.00

Table-5: Distribution of confirmation of classic give way technique of study subjects.

in heart rate during incision, 1 minute after incision with able to detect sacral hiatus. (p <0.05) (Fig 2)

Distribution of patients with reduction in heart rate was comparable with and without able to detect sacral hiatus. At 1 min p =0.183, At 3 minutes (p value=0.198), At 5 minutes (p =0.169)). (Fig 3)

No significant association was seen in heart rate at pre-operative (p=0.055), at 0 minute(p=0.068) with pop on piercing ligament. Significant association was seen in heart rate (per minute) at 1 minute, at 3 minutes, at 5 minutes, during incision, 1 minute after incision with pop on piercing ligament. (p value <.05). (Fig 4)

Significant association was seen in percentage reduction in heart rate at 1 minute, at 3 minutes, at 5 minutes, during incision, 1 minute after incision with pop on piercing ligament. (p value <.05) (Fig 5)

Proportion of patients with reduction in heart rate: - at 1 minute, at 3 minutes, at 5 minutes was significantly lower in not pop on piercing ligament as compared to pop on piercing ligament. (p value <0.0001)). (Fig 6)

Significant association was seen in heart rate (per minute) at pre-operative, at 0 minute, at 1 minute, at 3 minutes, at 5 minutes, during incision, 1 minute after incision with resistance to injection of LA. (p value <.05) (Fig 7)

Significant association was seen in percentage reduction in heart rate at 1 minute, at 3 minutes, at 5 minutes, 1 minute after incision with resistance to injection of LA. (p value <0.05). No significant association was seen

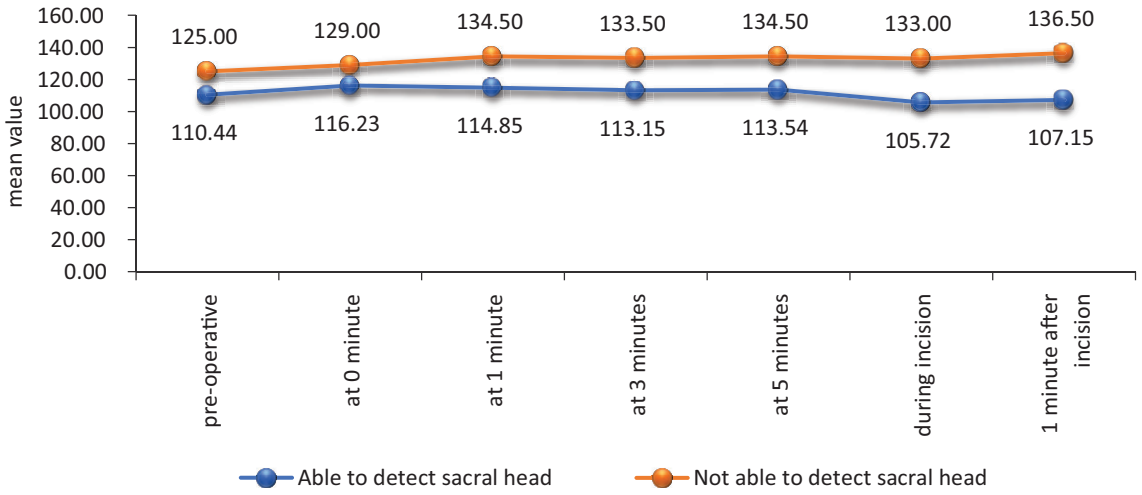

Figure-1: Association of trend of heart rate (per minute) at different time intervals with able to detect sacral hiatus

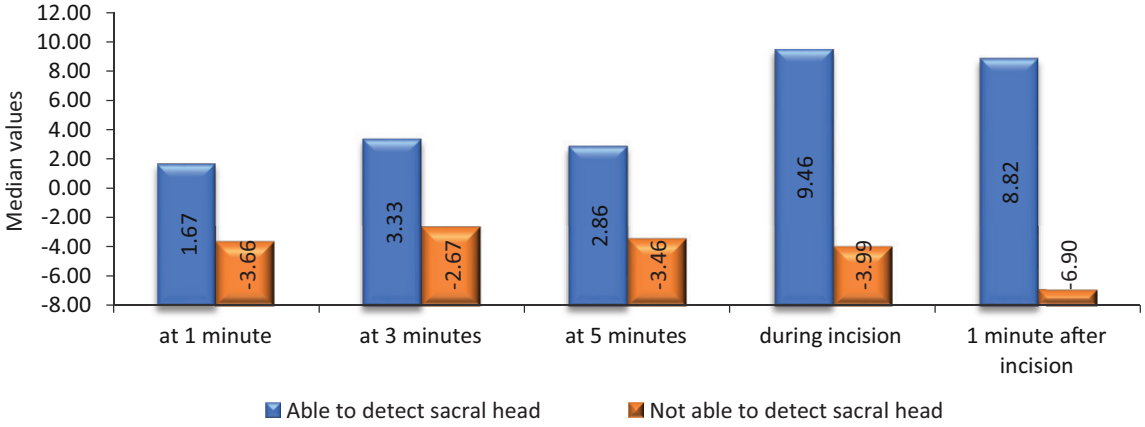

Figure-2: Association of percentage reduction in heart rate with able to detect sacral hiatus. (non-parametric variables)

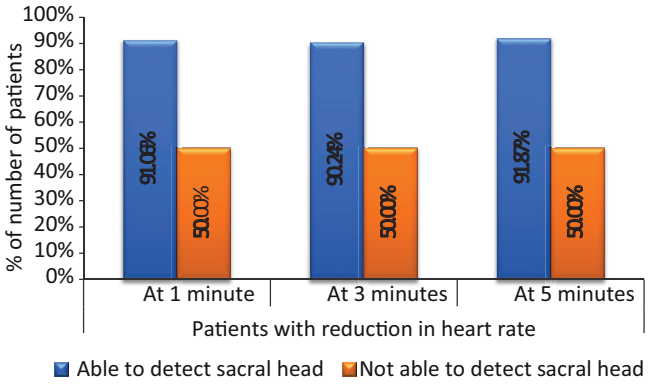

Figure-3: Association of patients with reduction in heart rate with able to detect sacral hiatus.

in percentage reduction in heart rate during incision (p value=0.147) with resistance to injection of LA. (Fig 8)

Proportion of patients with reduction in heart rate: - at 1 minute, at 3 minutes, at 5 minutes was significantly higher in not resistant to injection of LA as compared to resistant to injection of LA. (p value <0.0001)). (Fig 9)

No significant association was seen in heart rate (per minute) at pre-operative (p=0.107), at 0 minute (p =0.117) with absence of tachycardia. Significant association was seen in heart rate (per minute) at 1 minute, at 3 minutes, at 5 minutes, during incision, 1 minute after incision with absence of tachycardia. (p <0.05) (Fig 10)

Significant association was seen in percentage reduction in heart rate at 1 minute, at 3 minutes, at 5 minutes, during incision, 1 minute after incision with absence of tachycardia. (p value <.05) (Fig 11)

Proportion of patients with reduction in heart rate: - at 1 minute, at 3 minutes, at 5 minutes was significantly higher in without tachycardia as compared to with tachycardia. (p value <0.0001)). (Fig 12)

No significant association was seen in heart rate (per minute) at pre-operative (p value=0.107), at 0 minute (p value=0.117) with end tidal Sevoflurane required for maintenance <1 %. Significant association was seen in heart rate (per minute) at 1 minute, at 3 minutes, at 5 minutes, during incision, 1 minute after incision with end tidal Sevoflurane required for maintenance < 1 %. (p value <.05) (Fig 13)

Significant association was seen in percentage reduction in heart rate at 1 minute, at 3 minutes, at 5 minutes, during incision, 1 minute after incision with end tidal Sevoflurane required for maintenance < 1 %. (p value <.05) (Fig 14)

Proportion of patients with reduction in heart rate: - at 1 minute, at 3 minutes, at 5 minutes was significantly lower in end tidal Sevoflurane not required for Maintenance <

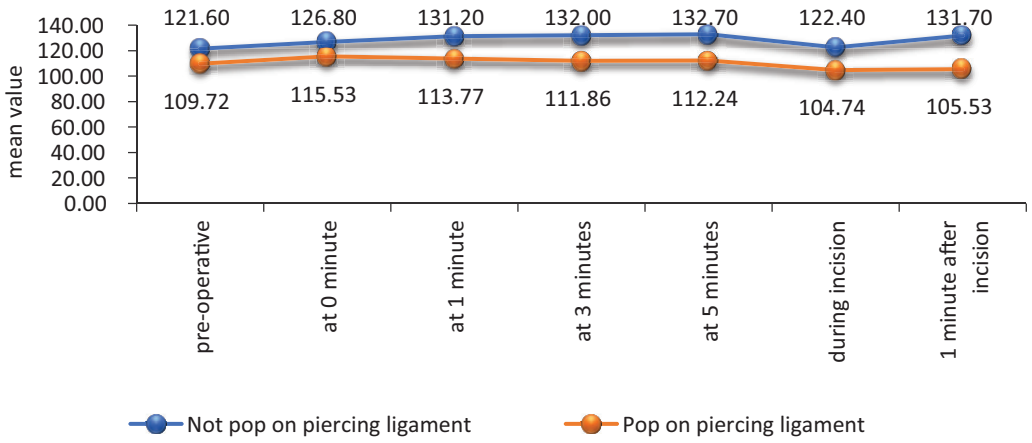

Figure-4: Association of trend of heart rate (per minute) at different time intervals with pop on piercing ligament.

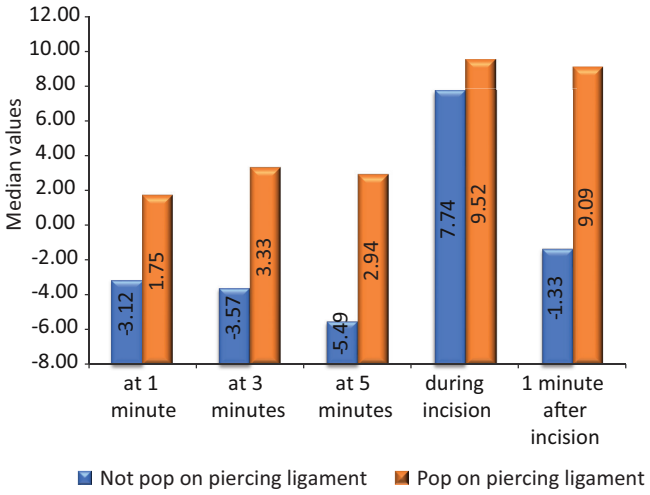

Figure-5: Association of percentage reduction in heart rate with pop on piercing ligament. (non-parametric variables)

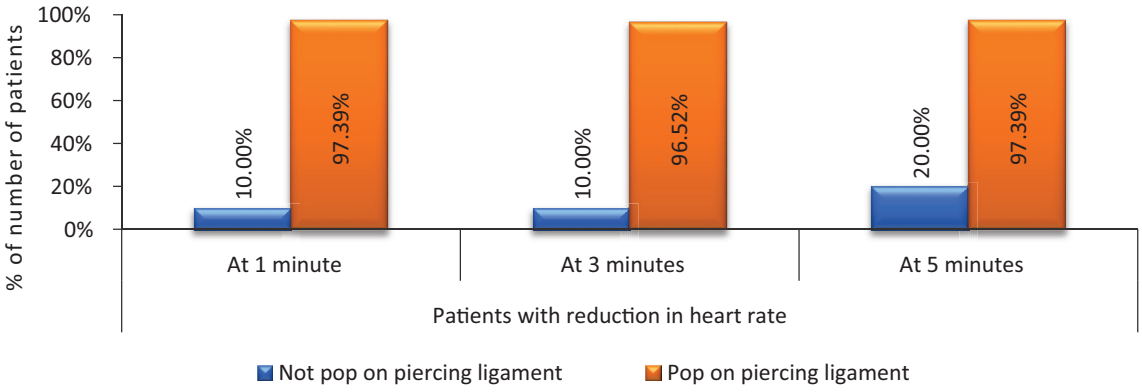

Figure-6: Association of patients with reduction in heart rate with pop on piercing ligament.

1 % as compared to end tidal Sevoflurane required for Maintenance < 1 %.
(p <0.0001)). (Fig 15)

DISCUSSIONS

Caudal epidural blockade is a commonly performed procedure in paediatric age group. It is widely used in anaesthesia practice for providing intraoperative and postoperative analgesia. Success rate as high as 96% has been demonstrated in various studies. Traditionally, the operator relies on the subjective sensation of "give" and "pop" of the sacrococcygeal ligament as the advancing needle pierces it. The decrease in HR might be from stimulation of pressure receptors as described by McGown [10] for stimulation of respiration produced by sacral epidural injection in a sleeping child. The pressure

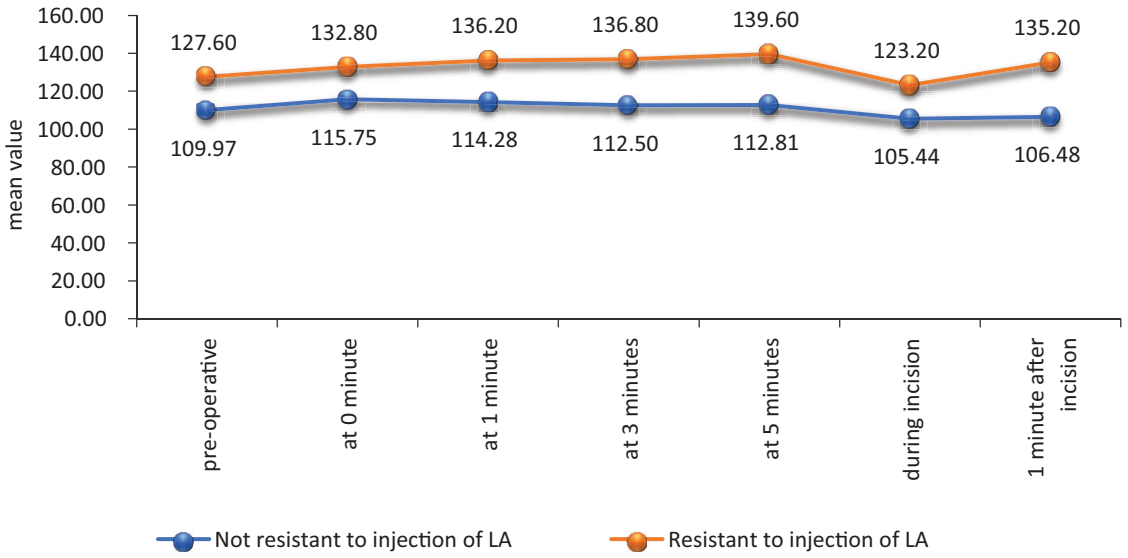

Figure-7: Association of trend of heart rate (per minute) at different time intervals with resistance to injection of LA.

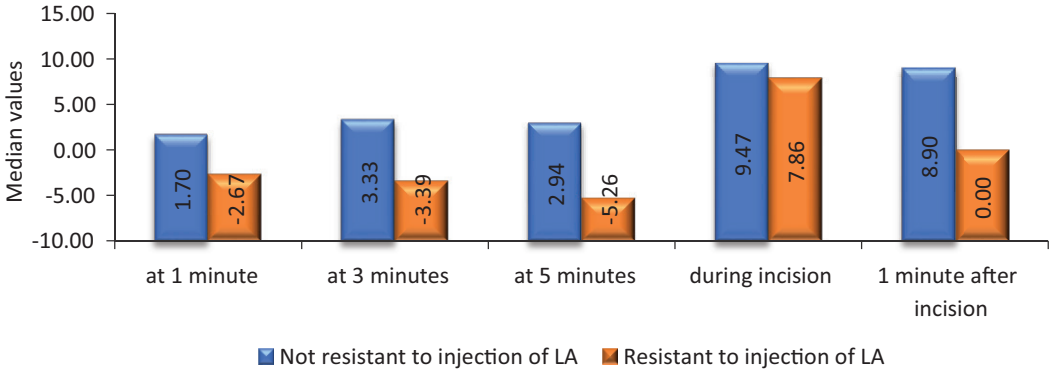

Figure-8: Association of percentage reduction in heart rate with resistance to injection of LA. (non-parametric variables)

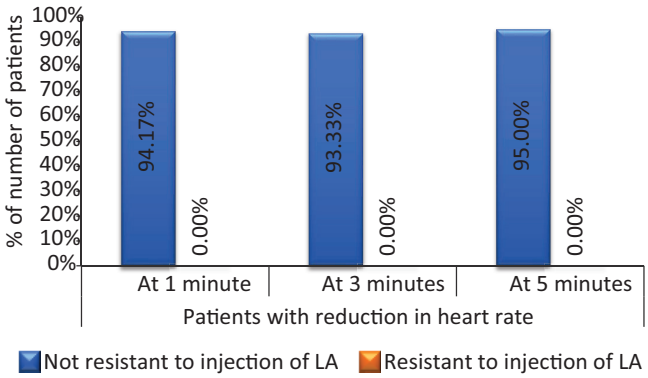

Figure-9: Association of patients with reduction in heart rate with resistance to injection of LA.

receptors within or outside the sacral nerve roots in caudal space or in adjoining CSF in the dural cuff at S2, are probably stimulated with ascent of drug.

In this study, mean age of study subject was 3.9 ± 2.4 years & 6.80% study subject belonged to age group ≤ 5 years of age. The mean weight was 14.5±6.21 kg. About 77.60% were male and 22.4% were female. Majority of patients (73.6%) with ASA grade I. Study done by Babita et al (11) showed that median age of study participants was 3 years with range from 6 months to 12 years and median weight of 12 kg with range from 5 to 40kg showing male predominance (11). *In-kyung song et al* (12) studied 27 patients which were all males with a mean age of 2.24 ± 0.93, mean weight of 14.49 ± 4.15. The study conducted by *Nandini Dave et al* (13) to compare the predictors of successful caudal blockade, out of 223 patients aged between 2 to 12 years of age with a mean of 48.5 months, 74% were < 5 years of age, and the weight ranged from 4 and 35kg with a mean of 15.35kg similar to our study result with a male predominance.

In our study the variation in heart rate was studied which showed mean value, pre operatively 110 ±18.8, at 1 min 116.43 ±18.74, 3 min 115.16 ±19.18, 5 min 113.47 ±19.47 of drug injection, during incision 113.88 ±19.53, and 1 min after incision 106 .15±19.17. The maximum heart rate went up to 154/minute which was within acceptable range with in paediatric population. Increase in heart rate more than 20% above baseline was considered as tachycardia. Detection of tachycardia during incision and 1 minute after incision was considered as failed caudal blockade.

Majority of the patients had reduction in heart rate at 5 minutes followed by at 1 minute of drug injection. The significant reduction in heart rate during 5 minutes of drug injection verify that, heart rate variation can be taken as a reliable predictor for a successful caudal block. The

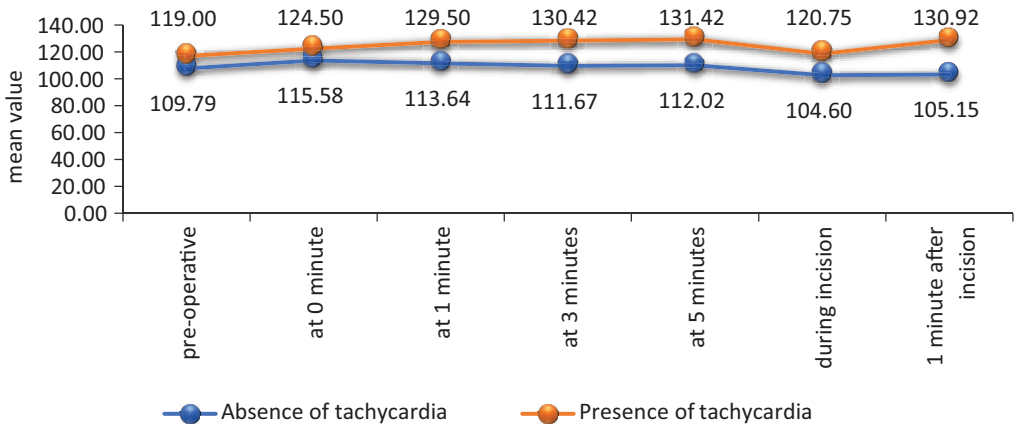

Figure-10: Association of trend of heart rate (per minute) at different time intervals with absence of tachycardia.

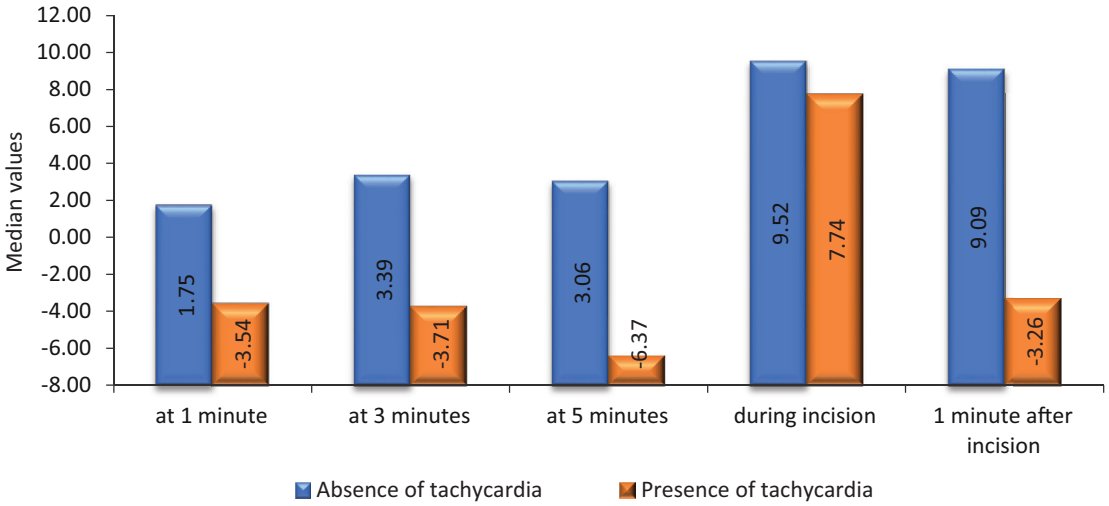

Figure-11: Association of percentage reduction in heart rate with absence of tachycardia. (non-parametric variables)

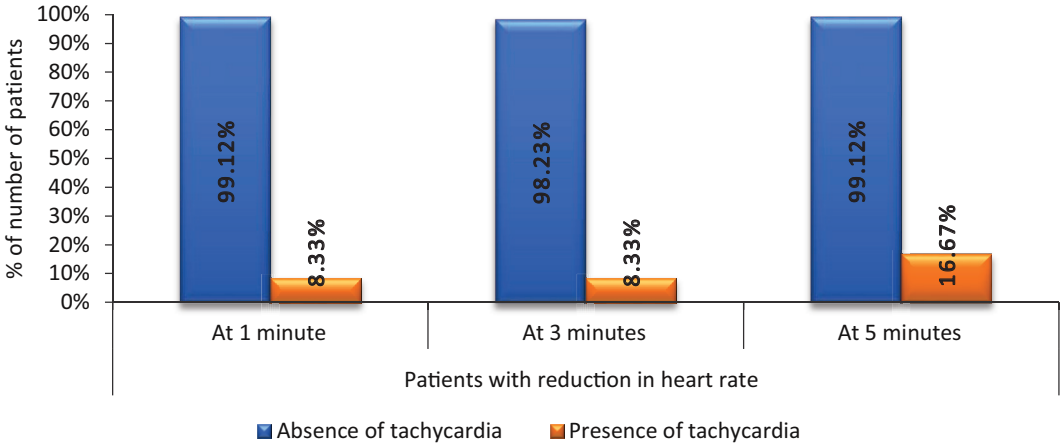

Figure-12: Association of patients with reduction in heart rate with absence of tachycardia.

decrease in HR might be from stimulation of pressure receptors as described by McGown [10] for stimulation of respiration produced by sacral epidural injection in a sleeping child. The pressure receptors within or outside the sacral nerve roots in caudal space or in adjoining CSF in the dural cuff at S2, are probably stimulated with ascent of drug. Another mechanism could be the pressure transmitted to the CSF space [12]. Temperature difference between the solution and the caudal space could be yet another mechanism.

All the patients had negative aspiration of blood during drug administration. 98.40% it was possible to detect sacral hiatus, pop on piercing ligament 92.00% and resistance to injection of LA 4.00%. Subcutaneous swelling after injection of drug was seen in none of the patient. It confirms that no patient has received caudal

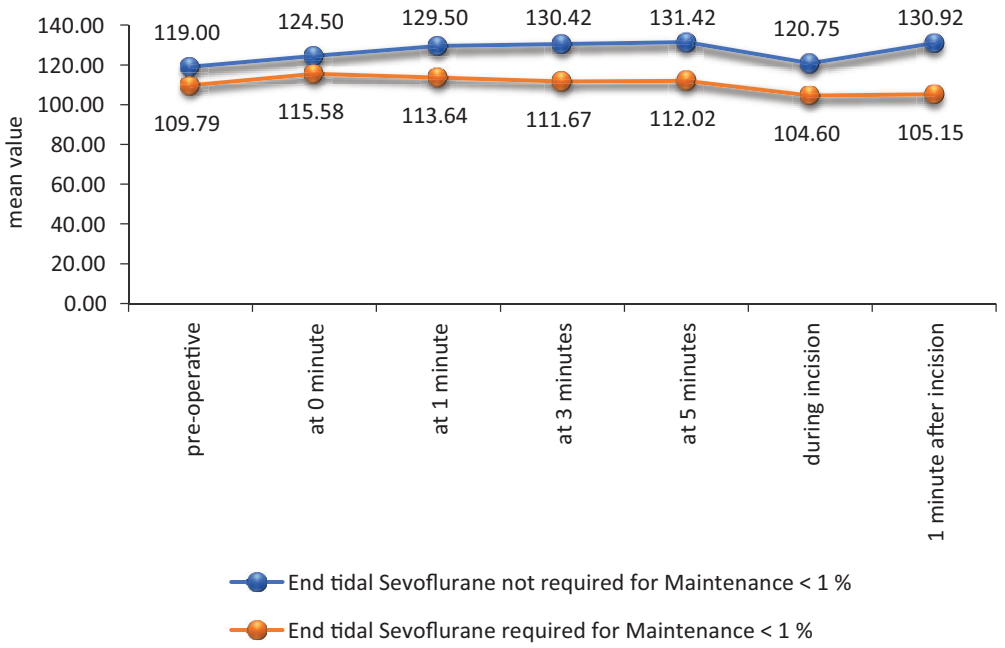

Figure-13: Association of trend of heart rate (per minute) at different time intervals with end tidal Sevoflurane required for maintenance < 1 %

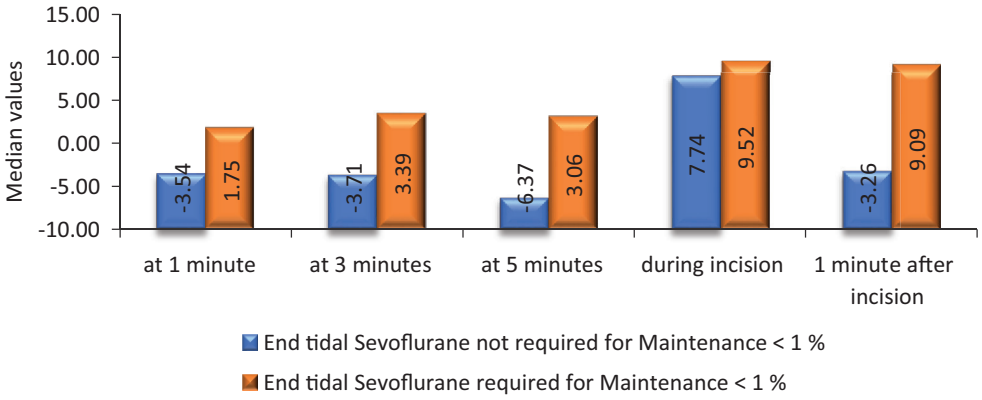

Figure-14: Association of percentage reduction in heart rate with end tidal Sevoflurane required for maintenance < 1 %. (non-parametric variables)

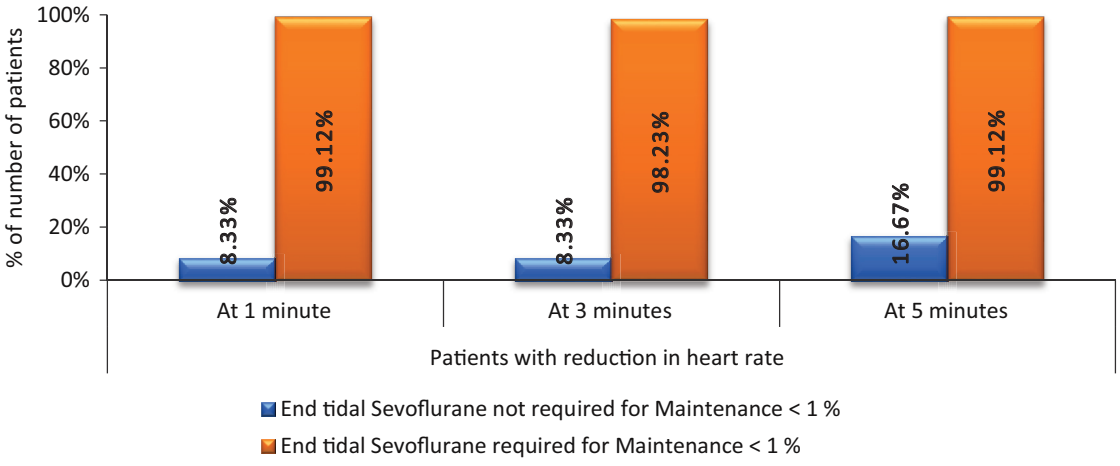

Figure-15: Association of patients with reduction in heart rate with end tidal Sevoflurane required for maintenance < 1 %.

block without confirming proper needle placement, needle was removed and manipulated until no visible swelling was present. Schuepfer et al [14] reported a pooled mean success rate of CEB of the staff anaesthesiologists to be 0.73 with a standard deviation of 0.45. Some investigators have reported a higher success rate of approximately 96%. Irrespective of the high success rate, certain anatomical factors contribute to failure; ill-developed sacral cornu, thick subcutaneous fat in sacral region, obliteration of hiatus due to fusion of lamina, ossified sacro-coccygeal ligament, dural sac puncture are some of the important factors contributing to procedure failure as demonstrated in a study done by Dalens B et al [15].

There was no significant association seen in percentage reduction in heart rate at 1 min, at 3 minutes, at 5 minutes with ability to detect sacral hiatus. Distribution of patients with reduction in heart rate was comparable with and without able to detect sacral hiatus, no significant association was seen in heart rate (per minute) at pre operative, at 0 minute with pop on piercing ligament. Significant association was seen in heart rate (per minute) at 1 minute, at 3 minutes, at 5 minutes, during incision, 1 minute after incision with pop on piercing ligament (p value <.05). There is no much literature available comparing each step in classic give way method with HR variation separately. Proportion of patients with reduction in heart rate: - at 1 minute, at 3 minutes, at 5 minutes was significantly lower in patients with no 'pop on piercing ligament' as compared to 'pop on piercing ligament (p value <0.0001)).

The Bupivacaine which is used as the caudal drug produces a concentration related depression of intra – atrial, AV nodal, intra ventricular conduction and myocardial contractility owing to a fast sodium channel blocking in both nerve and cardiac tissue. A fall in heart rate has been observed with intravascular injection of a test dose while caudal epidural blocks which was reported by Fischer et a (14). In our study none of the patients received intravascular injection of caudal drug which was confirmed by negative aspiration of blood during drug injection. The decrease in HR might be from stimulation of pressure receptors as described by McGown [10] for stimulation of respiration produced by sacral epidural injection in a sleeping child. The pressure receptors with in or outside the sacral nerve roots in caudal space or in adjoining CSF in the dural cuff at S2, are probably stimulated with ascent of drug. Another mechanism could be the pressure transmitted to the CSF space [12].

Significant association was seen in percentage reduction in heart rate at 1 minute, at 3 minutes, at 5 minutes, 1 minute after incision with resistance to injection of LA. (p value <.05). Proportion of patients with reduction in heart rate: - at 1 minute, at 3 minutes, at 5 minutes was significantly higher in patients with 'no resistance to injection of LA' as compared to 'resistance to injection of LA (p value <0.0001)). Resistance to injection means that we are not in the caudal space. This confirms that the LA injection was not given in any patients where resistance was felt and the needle is repositioned until no resistance to LA injection is confirmed. Such patients were not included in the study separately. The decrease in HR might be from stimulation of pressure receptors as described by McGown [10] for stimulation of respiration produced by sacral epidural injection in a sleeping child. The pressure receptors with in or outside the sacral nerve roots in caudal space or in adjoining CSF in the dural cuff at S2, are probably stimulated with ascent of drug. Another mechanism could be the pressure transmitted to the CSF space. Temperature difference between the solution and the caudal space could be yet another mechanism.

In our study successful caudal blockade was confirmed by absence of tachycardia and requirement of end tidal sevoflurane< 1% for maintenance of anaesthesia**.** No significant association was seen in heart rate (per minute) at pre-operative, at 0 minute with absence of tachycardia. There was significant association seen in heart rate (per minute) at 1 minute, at 3 minutes, at 5 minutes, during incision, 1 minute after incision with absence of tachycardia (p value <.05) Significant association was seen in percentage reduction in heart rate at 1 minute, at 3 minutes, at 5 minutes, during incision, 1 minute after incision with end tidal Sevoflurane required for maintenance < 1 %. Reduction in end tidal sevoflurane for maintenance <1% suggest that patient have received adequate analgesia which was provided with caudal blockade. Intraoperative haemodynamic stability is of prime importance in paediatric age group. So, with adequate analgesia intraoperative hemodynamic stability can be achieved. With this we could come to conclusion that the reduction in heart rate during caudal drug administration can be taken as reliable predictor for confirmation of successful caudal block.

CONCLUSION

Based on our study results, we conclude that a fall in heart rate during or within 1 to 5 minutes of caudal drug injection is a simple, reliable and objective test of successful caudal block**.**

REFERENCES

1. Polaner DM, Taenzer AH, Walker BJ, Bosenberg A, Krane EJ, Suresh S, Wolf C, Martin LD. Pediatric Regional Anesthesia Network (PRAN): a multiinstitutional study of the use andincidence ofcomplications of pediatric regional anesthesia. Anesth Analg. 2012 Dec;115(6):1353-64. doi: 10.1213/ANE.0b013e31825d9f4b. Epub 2012 Jun 13. PMID: 22696610.
2. Igarashi T, Hirabayashi Y, Shimizu R, Saitoh K, Fukuda H, Mitsuhata H. The lumbar extradural structure changes with increasing age. Br J Anaesth. 1997 Feb;78(2):149-52. doi: 10.1093/bja/78.2.149. PMID: 9068330.
3. B.Ghai et al.Pediatrics anaesthesia 200717:552-556
4. Camps MA, Ririe DG, O'Brien JJ et al. Is there a positive test dose for caudal epidural injection?Anesth

Analg 2000; 90: S523. (abstract).
5. Lewis MP, Thomas P, Wilson LF, Mulholland RC. The 'whoosh' test. A clinical test to confirm correct needle placement in caudal epidural injections. Anaesthesia. 1992 Jan;47(1):57-8. doi: 10.1111/j.1365-2044.1992.tb01957.x. PMID: 1536408
6. Eastwood D, Williams C, Buchan I. Caudal epidurals: the whoosh test. Anaesthesia. 1998Mar;53(3):305-7. doi: 10.1046/j.1365-2044.1998.00327.x. PMID: 9613279
7. Orme RML'E Berg SJ The 'swoosh' test'an evaluation of a modified 'whoosh' test in children.Br JAnaesth. 2002; 90: 62-65
8. Kenneth D. Candido, Anthony R. Tharian, and Alon P. Winnie https://www.nysora.com/techniques/neuraxial-and-perineuraxial techniques/caudal- anesthesia.
9. Orme RM, Berg SJ. The 'swoosh' test-an evaluation of a modified 'whoosh' test in children. Br J Anaesth. 2003;90:62–5.
10. McGown RG. Caudal analgesia in children. Five hundrend cases for procedures below the diaphragm. Anaesthesia 1982;37:806-818
11. Ghai B, Makkar JK, Behra BK, Rao KP. Is a fall in baseline heart rate a reliable predictor of a successful single shot caudal epidural in children? Paediatr Anaesth. 2007 Jun;17(6):552-6. doi: 10.1111/j.1460-9592.2006.02179.x. PMID: 17498017.
12. Song, In-Kyung, et al. "Heart rate variability may be more useful than pulse transit time for confirming successful caudal block under general anesthesia in children." Anesthesia and Pain Medicine 12.2 (2017): 140-146.
13. Dave NM, Garasia M. A comparison of the effectiveness of predictors of caudal block in children-swoosh test, anal sphincter tone, and heart rate response. J Anaesthesiol Clin Pharmacol. 2012 Jan;28(1):17-20. doi: 10.4103/0970-9185.92428. PMID: 22345939; PMCID: PMC3275964.
14. Schuepfer G, Konrad C, Schmeck J, Poortmans G, Staffelbach B, Jöhr M. Generating a learning curve for pediatric caudal epidural blocks: An empirical evaluation of technical skills in novice and experienced anesthetists. Reg Anesth Pain Med 2000;25:385-8.
15. Dalens B, Hasnaoui A. Caudal anesthesia in pediatric surgery: Success rate and adverse effects in 750 consecutive patients. Anesth Analg 1989;68:83-9

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