

Trends in Perfusion Index After Successful Caudal Block Under General Anaesthesia in Children- An Observational Study

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Conflict of interest: Nil

Abstract:

Background & Methods: Caudal anaesthesia is a very reliable technique used in pediatric age group for infraumbilical interventions. The aim of the study is to observe the trend of perfusion index which is the ratio of the pulsatile blood flow to non-pulsatile static blood flow in a patients' peripheral tissue such as fingertip, toe, ear lobe in pediatric population after administration of general anaesthesia followed by caudal block. This study involved 130 children between age group 2-7 years of either sex belonging to ASA grade I to II. Perfusion index was noted at 0,1,5,10, and then every 10 minutes interval upto 30 minutes following caudal block

Results: Perfusion index was noted at 0,1,5,10, and then every 10 minutes interval upto 30 minutes following caudal block. In our study, the baseline PI measurement was 1.87 ± 0.77 , which increased to 4.91 ± 1.63 at 5 minutes post-block, indicating a substantial 162.6% increase. The paired t-test results indicated statistical significance ($p < 0.05$) for all time points compared to baseline, highlighting the rise in PI after a successful caudal block.

Conclusion: There was a significant rise in the perfusion index following caudal block at all time intervals reflecting the block's ability to achieve the desired anaesthetic and perfusion outcomes, ensuring adequate regional anaesthesia and improved surgical conditions. A progressive improvement in perfusion indices following the administration of anaesthesia reflects its reliability as a promising non-invasive indicator of successful caudal block.

Keywords: Caudal block, regional anaesthesia, perfusion index (PI)

Study Design: Observational study

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Introduction

Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, demanding for its alleviation even before it manifests. Here's where regional anaesthesia provides us with a safe and effective option. Caudal anaesthesia is a very reliable technique used in pediatric age group for infraumbilical interventions.[1]

Perfusion index is the ratio of the pulsatile blood flow to non-pulsatile static blood flow in a patients' peripheral tissue such as fingertip, toe, and ear lobe. PI values range from 0.02% (weak pulse) to 20% (strong pulse). PI is a relative number and varies depending on patients' physiological conditions and monitoring sites, therefore, each patient's "normal" PI is unique. There is a significant increase in the

perfusion index following caudal block as it leads to sympathectomy which in turn causes vasodilation of the peripheral arterial bed.[2] PI has been used to determine proper management of pain, especially in patients unable to communicate their discomfort to the clinician.

The oximeter probe generates incident red and ultra-red light beams, whose transmitted intensities are transformed into an electrical current by a photo-detector, after penetrating a tissue.[3] The absorption is maximal during the systole, reflecting the dilatation of vessels under the systolic pressure, *i.e.*, the increase of arterial blood volume under the light source. The signal received by the photo-detector is then decomposed into pulsatile and non-pulsatile signals. Pulsatile variations in light

absorption, during systole, are commonly referred to as –alternating current (AC). Conversely, direct current (DC) is the term used to describe continuous absorption. Perfusion index (PI) represents the ratio of pulsatile light absorption on continuous light absorption, *i.e.*, the ratio AC/DC.[4]

Caudal Block

It is one of the most widely administered techniques of regional anaesthesia in children for procedures below the level of umbilicus. It was described at the turn of last century by two French physicians, Fernand Cathelin and Jean-Anthanase Sicard.[5] It is usually performed in sedated children in left lateral decubitus position by placing needle into sacral hiatus at an angle of 45 degrees, a pop or give is felt which marks the progression into sacrococcygeal ligament and entry into the epidural space, where drugs are injected thus providing with excellent hemodynamic stability and analgesia peri-operatively.

Material And Methods

Study Design: Observational study

Methodology:

- The present study comprises of patients between age group 2-7 years of either sex belonging to ASA grade I and II, scheduled for elective or emergency surgery requiring general anaesthesia with caudal block.
- Preoperative assessment of patient was done in the form of detailed history, allergy, comorbidities, general examination and systemic examination.
- Written and informed consent, before participation in study as well as pre-operatively before administration of general anaesthesia with caudal block, was taken from parents of all participants.
- Standard monitors were attached and baseline vital parameters of patients such as heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure, spo2 and perfusion index were noted down on shifting the patient to the operation theatre. Masimo's pulse oximeter was put on the toe of either foot of all patients.
- All patients were fasted as per the standard nil per oral (NPO) guidelines permitting clear fluids up to 2 hours prior and with intravenous IV access secured in the ward.

- Ringer lactate was administered as the intraoperative maintenance fluid at the rate of 5 mL/kg/h. All patients were administered intravenous midazolam (0.05 mg/kg), ondansetron (0.1mg/kg), glycopyrolate (0.01mg/kg) and fentanyl (1 mu/kg) as preoperative medication. Intravenous ketamine 2mg/kg and succinylcholine 2mg/kg was administered and after 1 min of preoxygenation with 100% oxygen, patients were intubated with appropriate sized endotracheal tube and maintenance of general anaesthesia was given to the patient with sevoflurane 2-4% along with oxygen at 4-6L/min and perfusion index was noted.
- Next, caudal block was given in left lateral decubitus position after skin sterilisation with knees flexed at 90 degrees with an appropriate size of needle. After loss of resistance, negative aspiration for blood and CSF was confirmed followed by local anaesthetic administration of Bupivacaine 0.25% according to patient's weight using Armitage measurement. Once the drug was administered the child was placed in supine position and perfusion index was noted at 0,1,5,10, and then every 10 minutes interval upto 30 minutes following caudal block.
- The general anaesthesia was reversed once the surgical procedure was over. Patients were extubated following extubation criteria and shifted to post anaesthesia care unit.

Inclusion Criteria:

- Age group 2-7 years of either sex.
- Pediatric patients undergoing elective or emergency surgery requiring general anaesthesia with caudal block.
- Patients of ASA grade - I, ASA grade II

Exclusion Criteria:

- Parents of patient refusal / consent not given.
- Patient with comorbidities like neuromuscular disease, bleeding disorders etc.
- Known allergy to any local anesthetic
- Contraindications to caudal block.

Sample Size:

Considering medium effect size of 0.5 and 95% confidence limits and 80% power of study using G power statistical software sample size calculated was 130.

Result

Table 1: Distribution of age in study population.

Age Group (years)	No. of Cases	Percentage
2-3 years	47	36.2%
4-5 years	40	30.8%
6-7 years	43	33.1%
Total	130	100.0%
Mean±SD	4.35 ± 1.755	

The above table shows the distribution of age among the study participants. The total sample consists of 130 children aged between 2 and 7 years. Among them, 47 children (36.2%) are in the 2-3 years age group, making it the largest subset of the population. The 4-5 years age group comprises 40 children, accounting for 30.8% of the sample. Lastly, the 6-7 years age group includes 43 children, representing 33.1% of the total participants.

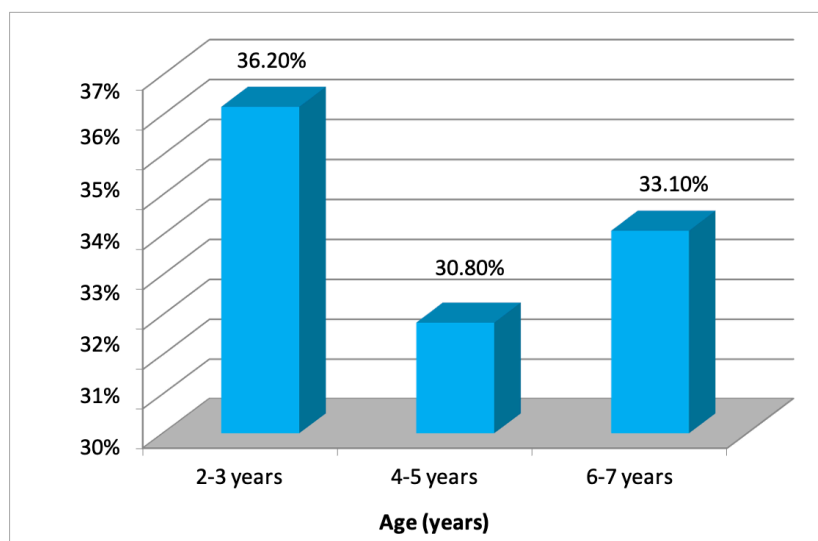


Figure 1: Distribution of age groups in study population

Table 2: Distribution of Gender in Study Population

Gender	No. of Cases	Percentage
Male	83	63.8%
Female	47	36.2%
Total	130	100.0%

The above table shows the gender distribution among the study population. Out of the total 130 participants, 83 (63.8%) are male and 47 (36.2%) are female. This indicates a higher representation of male children compared to female children in the study.

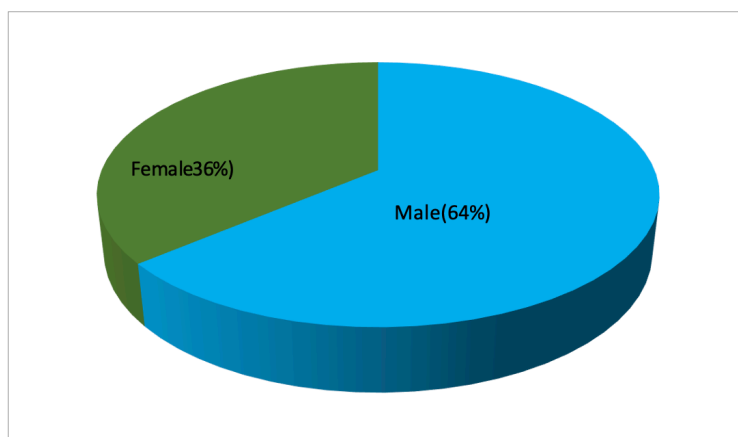


Fig. 2: Distribution of Gender in Study Population

Table 3: Perfusion Index (PI) at various time intervals compared to baseline

Time Intervals	Mean±SD	P value
Baseline time	1.87±0.77	-
Time after caudal block	1.95±0.73	<0.001
At 1 min post caudal epidural block	2.42±3.0	0.029
At 5 min post caudal epidural block	4.91±1.63	<0.001
At 10 min post caudal epidural block	5.63±1.75	<0.001
At 20 min post caudal epidural block	6.15±1.93	<0.001
At 30 min post caudal epidural block	6.6±2.16	<0.001

A paired 't' test was applied. P value <0.05 was considered statistically significant.

The above table shows the changes in the Perfusion Index (PI) at different intervals relative to baseline in children undergoing infraumbilical surgeries with general anaesthesia and caudal epidural block. An increase of 100% from baseline was considered to be statistically significant. At baseline, the mean PI was recorded at 1.87 ± 0.77 . Following the administration of the caudal block, there was a significant increase in PI to 1.95 ± 0.73 ($p < 0.001$),

indicating an initial response to the block procedure. Subsequently, at 1 minute post-caudal block, the PI increased significantly to 2.42 ± 0.73 ($p = 0.029$), demonstrating enhanced perfusion levels which further increased to 4.91 ± 1.63 at 5 minutes post-block, indicating a substantial 162.6% increase. As time progressed, the PI continued to rise significantly at 10 minutes (5.63 ± 1.75), 20 minutes (6.15 ± 1.93), and 30 minutes (6.6 ± 2.16) post-caudal block (all $p < 0.001$). These findings suggest a progressive improvement in perfusion indices following the administration of anaesthesia.

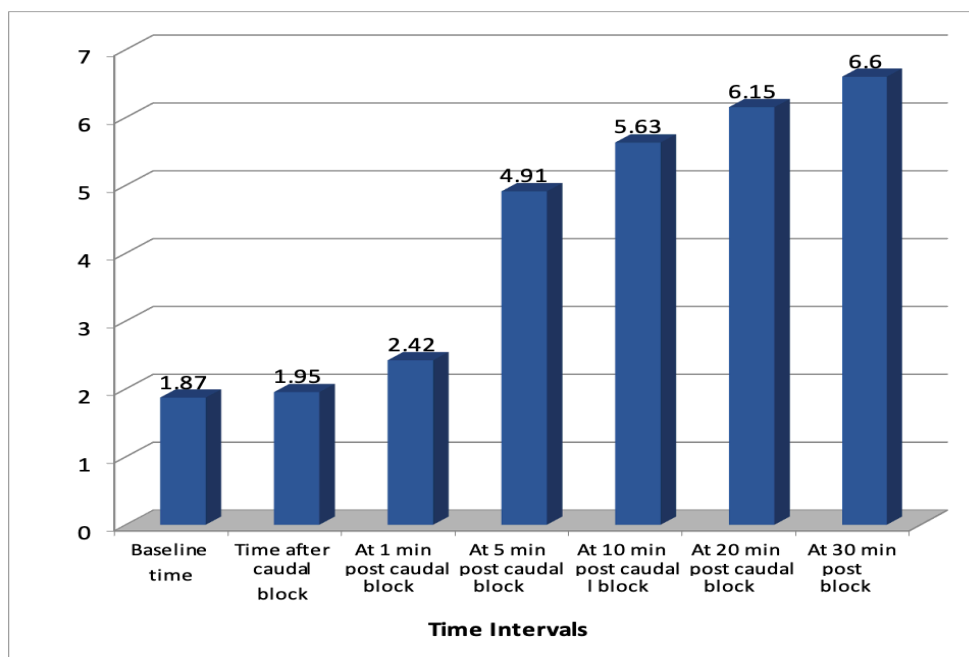


Figure 3: Distribution of mean PI at various time intervals.

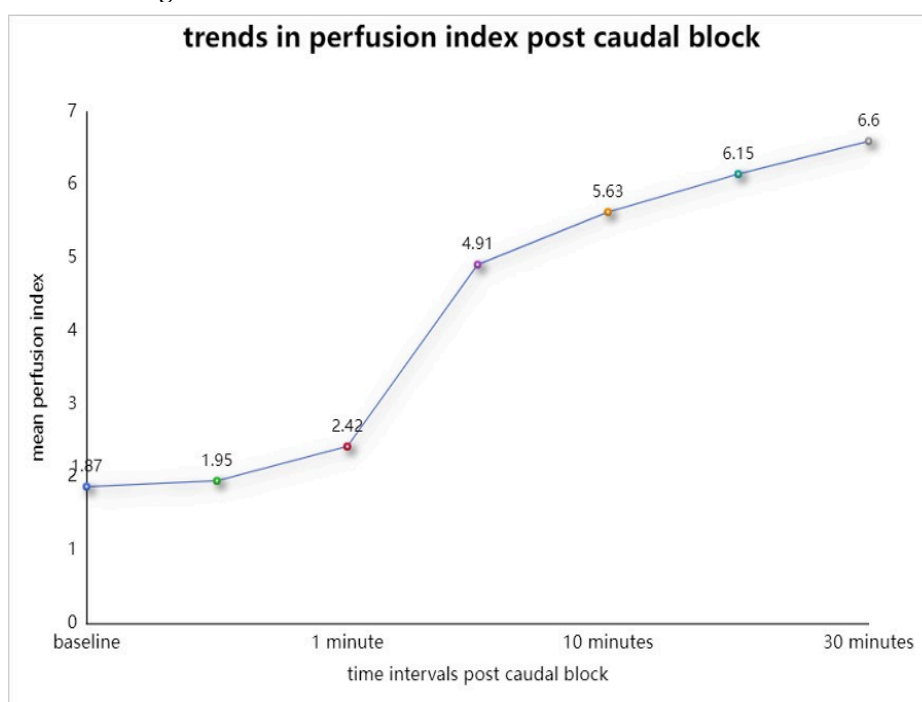


Figure 4 : Trends in Perfusion index post caudal block

Discussion

Among one of the most popular regional anesthetic techniques for pediatric patients is caudal block. A study conducted by Beyaz et al included 2088 cases of pediatric patients undergoing caudal block and found it to be simple and safe anesthetic technique that can be performed in sub-umbilical surgeries in children and infants, with a high success rate and a low incidence of complications or side effects.^[1] Benka et al studied 60 children who had inguinal hernia surgeries performed by administering solely under GA in 30 patients and by combining CEB with GA in 30 patients. The researchers came to the conclusion in this prospective study that combining CEB and GA led to a safer treatment that better maintained hemodynamic stability, less postoperative pain, and a reduced requirement for anesthesia^[6]. In our study, we preferred CEB application under general anesthesia because it is a reliable option in pediatric patients.

Due to the blocking of sympathetic fibers, successful regional anesthetic applications result in local vasodilation, increased local blood flow, a minor rise in skin temperature, and loss of sensation in the affected extremities. A study conducted by Nazir et al, including 96 patients who were given lumbar epidural block with 10 ml 0.5% bupivacaine for lower limb surgeries were assessed for changes in PI, MAP and toe temperature at various time intervals and found that after 20 minutes 100% patients achieved the criteria for PI (100% increases) whereas only 61.4 % and 46.8% of patients had reached target changes in MAP and toe temperature, respectively.^[7]

In one study carried out by R. Amutha rani et al on 100 participants, they assessed the caudal block by measuring the anal sphincter tone and perfusion index. In their study they concluded that both the measures were effective in assessing the success of block but the anal sphincter tone to become completely lax it took 20 minutes where as an increase in perfusion index was seen as early as 5 minutes.^[8] In our study also we found that changes in perfusion index relevant to the success of caudal block were seen as early as 5 minutes post block. After administering a regional anesthetic, sympathectomy can be identified by measuring the rise in pulsatile flow resulting from vasodilation in the block area. This is indicated by an increase in PI value.

Another study carried out by Kasthurba Bai et al assessed the success of caudal block in pediatric age group by hemodynamic parameters, swoosh test and anal sphincter tone. They found that perfusion Index significantly increased at 4 min (Mean 2.79+ - 0.46SD, p value <0.05).^[9] This literature is consistent with the increases in PI values that were

found in our investigation as early as 5 minutes post caudal block.

Ginosar et al found in their study that twenty-nine subjects out of forty had photoplethysmography signals that met a prior signal quality criteria for analysis. By 20 min, PI increased by 326%.^[10] Similar findings were observed in our study where we found an increase in PI values to 162.5% at 5 minutes, 201% at 10 minutes, 229% at 20 minutes and 253% at 30 minutes post caudal block. This clearly reflects early and persistent changes in PI following caudal block.

Conclusion

On the basis of observation and results of this study we conclude that perfusion index shows a persistently rising trend post caudal block administration. This reflects it's potential to be used as a non-invasive, reliable, efficient and highly sensitive indicator of successful caudal block in children under general anaesthesia.

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