

Original Article

## Prospective observational study to compare perfusion index and cremasteric reflex as indicators of onset of caudal block

Anish Kowstubb<sup>1</sup>, Kalyani Nilesh Patil<sup>1</sup>, Madhuri Sanjeev Madhekar<sup>1</sup>

<sup>1</sup>Department of Anaesthesiology, Bharati Vidyapeeth (Deemed University) Medical College, Pune, Maharashtra, India.



**\*Corresponding author:**

Kalyani Nilesh Patil,  
Professor, Department of  
Anaesthesiology, Bharati  
Vidyapeeth (Deemed  
University) Medical College,  
Pune, Maharashtra, India.

kalyanish19@gmail.com

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### ABSTRACT

**Objectives:** The aim of this study was to compare the efficacy of PI and cremasteric reflex (CR) in assessing the onset of caudal block.

**Material and Methods:** Using convenience sampling, eligible participants as per the inclusion and exclusion criteria were enrolled. Baseline and post-sedation readings of mean arterial pressure (MAP), PI, and CR were taken, standard general anesthesia protocol was followed, and a caudal block was given. MAP, CR, and PI values were monitored and documented at 1 min intervals for 10 min. The loss of CR and doubling time from baseline PI were considered as the onset of caudal block, and the time required was compared.

**Results:** The mean time to loss of CR and time required for PI to double were 7.17 min and 4.04 min, respectively. The average time of PI doubled post-caudal was significantly lower than the time to loss of CR ( $P < 0.05$ ).

**Conclusion:** PI is a more efficacious, non-invasive, objective, and a feasible parameter that gives an earlier indication of caudal block onset. Change in MAP is not proven to be a reliable indicator of the onset of caudal block.

**Keywords:** Caudal block, Cremasteric reflex, Perfusion index

### INTRODUCTION

Caudal anesthesia in pediatric infra-umbilical surgeries provides excellent analgesia in the intraoperative and post-operative period. Successful caudal block has a proven efficacy over a long time and is a safe technique as well, which guarantees an unparalleled pain control. The avoidance of endotracheal intubation, due to caudal block, along with a reduction in the requirement of inhalational agents intraoperatively and opioids perioperatively has important implications, especially in the pediatric population. It not only reduces the associated side effects but also is an important component of enhanced recovery.<sup>[1-4]</sup> A reliable assessment of successful caudal block is critical for optimizing management of anesthesia in pediatric patients. One practical limitation, considering the pediatric age group, however, is the assessment of the block with a reliable and objective method, the lack of which is a real challenge. The traditional methods used are subjective and usually do not provide a confirmation before at least 20–30 min until after the institution of the block. Perfusion index (PI) is a recently described parameter that can objectively assess the onset of caudal block.<sup>[5]</sup> However, there are very few studies comparing it with the traditional methods.

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Hence, we conducted this study with the aim of comparing the efficacy of PI and cremasteric reflex (CR) in assessing the onset of caudal block.

## MATERIAL AND METHODS

Following the approval from the Institutional Ethical Committee (BVDUMC/IEC/90), this observational study was conducted in a tertiary care medical center, in male children of age group 2–8 years, belonging to the American Society of Anesthesiologist I and II undergoing elective infra-umbilical surgeries. Parents or guardians were explained about the study and written informed consent was obtained. The criteria for exclusion were parental/guardian refusal to participate in the study, patients with anorectal defects, cardiac diseases, coagulopathies, local infection, and neural defects or deficits.

The sample size was calculated to be 100, on the basis of the standard deviation from the previous studies and considering alpha and beta errors and drop-outs.

In the pre-operative room, standard monitors were attached (electrocardiogram, non-invasive blood pressure, and SpO<sub>2</sub> with PI). PI was monitored by attaching the SpO<sub>2</sub> probe to the great toe and intravenous premedication was given with: Inj. Glycopyrrolate 40 mcg/kg, Inj. Ketamine 0.3–0.5 mg/kg, Inj. Midazolam 0.02 mg/kg.

Baseline readings for pulse, blood pressure, SpO<sub>2</sub>, and PI values were recorded in the pre-operative room after premedicating the child and once he calmed down.

Patient was then shifted to operational technology with ongoing monitoring and was induced with Inj. Fentanyl 1.5–2 mcg/kg and Inj. Propofol 2.5–3 mg/kg, titrated to effect. An appropriate size Igel was inserted, and the patient was maintained on oxygen: Air (50: 50) and sevoflurane on spontaneous respiration. The caudal block was instituted by making the child lateral. Inj. Bupivacaine 0.25% was injected after confirming negative aspiration, the volume was decided as per the Armitage rule for the planned procedure, taking care not to exceed the dose beyond 2.5 mg/kg.

The heart rate (HR), mean arterial pressure (MAP), CR, and PI were assessed by two different observers, every min, for 10 min after the completion of caudal injection.

Time points of loss of CR and doubling of PI from the baseline were defined as predictors of the onset of caudal block. Post-caudal drop in MAP of 15% or more from the baseline was considered significant.

Inj. Atracurium 0.5 mg/kg was administered after 10 min of completion of caudal injection.

Since ours is an observational study, we used Strobe's chart for recruitment [Figure 1].

## RESULTS

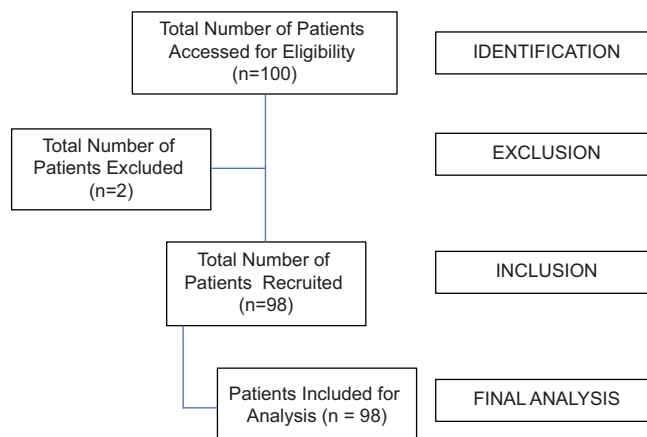
We enrolled 100 patients who fulfilled the inclusion criteria. All were administered a caudal block, as the circuit breaker (CB) failed in two cases only 98 cases (out of 100) were included for further analysis. In both these cases, the PI failed to double as well, and there was no loss of CR. Table 1 and Figure 2 show the distribution according to age and the surgical procedures, respectively.

Out of 98 patients included in the analysis, 24 of the cases lost CR in 6 min, 39 of them lost CR after 7 min, 30 of them lost CR after 8 min, 4 of them lost CR after 9 min, and 1 of them lost cremasteric reflex after 10 min [Figure 3].

For 44 of the cases, PI doubled within 4 min, for 19 of them, PI doubled in 5 min, for 27 of them, PI doubled within 3 min, for 7 of them, PI doubled within 6 min, and for one of them PI doubled within 2 min [Figure 4].

The time to loss of CR and that for doubling of PI post-caudal was  $7.17 \pm 0.89$  min and  $4.04 \pm 0.90$  min, respectively. The difference was statistically significant ( $P < 0.001$ ) [Table 2].

Average MAP did not show any significant change or specific



**Figure 1:** Strobe chart depicting the flow of study.

**Table 1:** Distribution of cases as per age.

Age (years)	No. of cases	Percentages
2	22	22
3	22	22
4	22	22
5	12	12
6	11	11
7	8	8
8	3	3

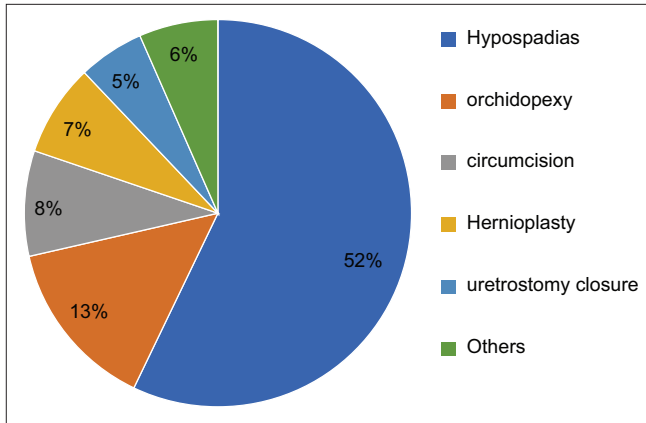


Figure 2: Distribution of cases as per surgery.

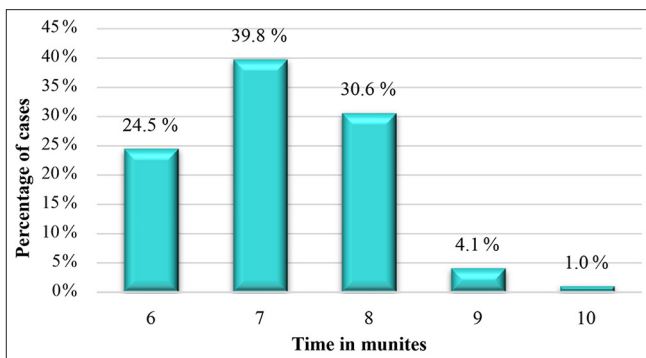


Figure 3: Time to loss of cremasteric reflex after caudal block.

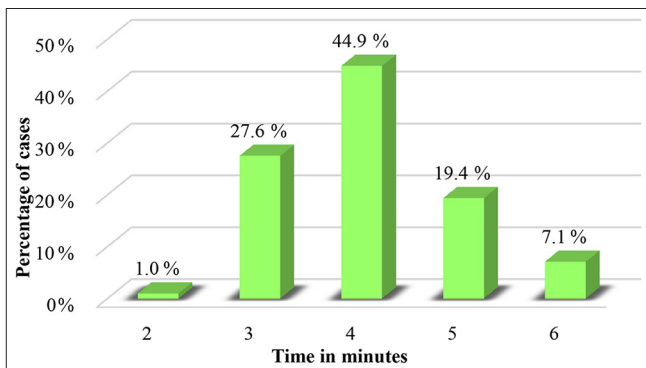


Figure 4: Time for the perfusion index to double after caudal block.

pattern post-caudal ( $P > 0.05$ ) [Table 3].

## DISCUSSION

Any analgesic plan for pediatric anorectal and infraumbilical abdominal surgeries cannot be complete in a true sense without a caudal anesthetic, as it forms a core element of multimodal analgesia.<sup>[1-3]</sup> Various adjuvants have been studied in caudal block.<sup>[6-8]</sup> However, studies have shown up to 4% failure of caudal block given by landmark guided

Table 2: Comparison of time to doubling of PI and to loss of CR post-caudal.

Time for loss of CR post caudal		Time for PI to double post caudal		P-value
Mean	SD	Mean	SD	
7.17	0.89	4.04	0.90	<0.001

Values are mean and SD, P-value by Wilcoxon signed-rank test.  
PI: Perfusion index, CR: Cremasteric reflex, SD: Standard deviation

Table 3: Values of MAP post-caudal.

Time (minutes)	MAP (mm of Hg)	P-value	dMAP	Percentage change in MAP
0	69.90±7.20	-	-	0.13
5	70.63±6.88	0.951	-0.69±4.11	1.04
8	70.20±7.00	0.679	-0.22±4.77	0.43
10	70.92±7.70	0.980	-1.04±5.02	1.46

MAP: Mean arterial pressure, dMAP: Difference in MAP from baseline

technique. Considering the pediatric age group and the fact that the block is instituted under general anesthesia, makes the assessment further challenging. Hence, there is a need for an objective method with high sensitivity and specificity that can predict the onset of CB. Lately, a novel technique of change in PI was proposed to demonstrate the success of caudal block.<sup>[5]</sup> However, the studies are very few; hence, we designed our study which compares this novel monitoring parameter with the traditional technique of loss of cremasteric reflex to assess the onset of caudal block.

Various parameters have been used in the past as predictors of the adequacy of caudal block. The search for an ideal parameter continues due to inherent challenges of each technique, most important being a lack of sensitivity and specificity. Dave and Garasia<sup>[9]</sup> compared the swoosh test, anal sphincter tone (AST), and HR response in regard to their efficacy in predicting a successful caudal block. They found that the AST had a sensitivity of 95.22%, and a specificity of 92.86. The HR response had a sensitivity of 92.82% and specificity of 78.57%. The swoosh test with a sensitivity of 66.51% and a specificity of 35.71%.

Cetgen *et al.*<sup>[10]</sup> studied PI value in determining the success of axillary block in 50 patients aged between 18 and 65 years. This study made us look into the change in PI as a marker of success, namely, caudal block.

Rajan *et al.*<sup>[11]</sup> conducted an observational study of PI as a predictor of successful pediatric caudal block under general anesthesia in 25 children between 1 and 6 years. They observed that, after 10 min, the PI doubled in patients in whom the caudal block was successful. Xu *et al.*<sup>[12]</sup> conducted a study which compared the increase in PI and loss of CR

after a caudal block in 108 patients using lidocaine. There was a significant rise in PI by  $2.01 \pm 1.19$  and  $4.38 \pm 1.86$  at 5 and 20 min, respectively.

Vashishth *et al.*<sup>[13]</sup> compared PI, AST at 5 min intervals in patients receiving caudal block with those without a caudal block, under general anesthesia. The PI, and AST were recorded at 5-, 10-, 15-, and 20-min following induction of anesthesia in both groups and these readings were compared to a baseline value. The PI was recorded at 5-, 10-, 15-, and 20-min following induction of anesthesia in both groups. The patients who received caudal block showed a significant and persistent rise in the value of PI, starting from 5 min till 20 min, as compared to those who did not receive caudal block. An expected 15% reduction in MAP was observed in only 14.5% of the patients of group 1 who had received CB after observation of 20 min.

Anitha and Bai<sup>[14]</sup> conducted a study with 60 pediatric patients scheduled for elective surgery and evaluated PI for assessing the success of caudal block and compared it with AST. They observed an intact tight AST preoperatively in all the cases (Score 1). The CB was given, and the AST was seen for loss at 0 min until it was lost for every 2 min interval that they observed that AST became lax (Score 3) at the 6<sup>th</sup> min in most cases. PI was seen at 0 min for every 2 min interval till the PI doubled; they observed that in children in whom caudal was successful, PI significantly increased at the 4<sup>th</sup> min.

Our study has the advantage of a large sample size and a wider age group range from 2 to 8 years, which improves its validity.

Xu *et al.*<sup>[12]</sup> compared caudal block with PI and CR in 108 patients using lidocaine. The caudal block was administered, and CR was checked in all cases from 0 to 20 min post-caudal at 5 min interval. They observed that in all patients, the CR was abolished after 20 min of administration of caudal anesthetic, whereas the PI significantly increased by  $2.01 \pm 1.19$  and  $4.38 \pm 1.86$  at 5 and 20 min, respectively, which significantly preceded the abolition of CR. In our study, we used bupivacaine instead of lignocaine so as to provide a longer duration of analgesia postoperatively.

Anitha and Bai<sup>[14]</sup> compared the efficacy and predictivity of PI against loss of AST for onset of caudal block. They observed an intact tight AST preoperatively in all the cases (Score 1). Loss of AST was assessed after institution of caudal block, at 0 min and every 2 min interval thereafter till it was lost. They observed that anal sphincter became lax (Score 3) at the 6<sup>th</sup> min in most cases. We used loss of CR as a reference standard to compare with PI doubling instead of AST loss which is used in most studies and has similar sensitivity and specificity as CR. Cremasteric reflex is relatively easier to perform, is less invasive, and hence safer even with lighter

planes of anesthesia as compared to assessment of AST.

Khalil *et al.*<sup>[15]</sup> compared ropivacaine with bupivacaine in caudal block injection, they found that analgesic concentrations (0.25%) of ropivacaine and bupivacaine provided comparable analgesia postoperatively with respect to duration, quality, sensorimotor characteristics, and had similar incidence of urinary retention. In our study, we used bupivacaine as it is more affordable and easily available than ropivacaine and demonstrated a negligible difference in onset and duration of action.

Rajan *et al.*<sup>[11]</sup> studied MAP as a predictor of successful pediatric caudal block under general anesthesia in 25 children measured. They recorded the MAP before and post-caudal block and at 5, 10, 15, and 20 min thereafter, and on skin incision. They observed a 15% decrease in MAP only in 8 patients (out of 25) with an accuracy of only 32% until the time of incision (which was later than 20 min in most cases). Xu *et al.*<sup>[12]</sup> observed the MAP at baseline before the injection of the caudal drug and at 5, 10, 15, and 20 min post-caudal injection. Their results showed that there were no significant differences in MAP following caudal block at any given time. Vashishth *et al.*<sup>[13]</sup> evaluated MAP at 5-, 10-, 15-, and 20-min following induction of anesthesia in both groups, and these readings were compared to a baseline value. It was observed that it was observed that the MAP reduced by 15% in only 14.5% of the patients of group 1 who had received caudal block after observation of 20 min. The above studies had results supporting our findings, that is, a change in MAP is not a reliable indicator to predict the onset of caudal block.

The strength of our study is that we have recorded the PI value far more frequently and also quantified and analyzed the readings for each minute after the administration of caudal drug, which helped us analyze the trend shown by PI change every minute and greatly improved the accuracy of our results. Most studies described have noted the readings at 5-min intervals, which can miss the exact time point of onset of the block as assessed by the parameters. The uniqueness of our study is that we used an I-gel instead of endotracheal tube so that we can avoid the muscle relaxant for first 10 min. Avoidance of muscle relaxant made the observations of CR more reliable.

Our study has the few limitations. Being an observational study, observer bias in the observation of the cremasteric reflex cannot be nullified. Furthermore, PI is a relatively new parameter and the monitor for measuring PI may not be available in all centers.

## CONCLUSION

We conclude that PI is a more efficacious, non-invasive, objective, and more feasible parameter that gives an earlier

indication of caudal block onset. Change in MAP is not a reliable indicator of onset of caudal block.

**Authors' contributions:** AK, KNP and MSM: Concept, design, intellectual content, literature search, clinical studies, data acquisition, data analysis, statistical analysis, manuscript preparation, manuscript editing, manuscript review.

**Ethical approval:** The research/study approved by the Institutional Review Board at Bharati Vidyapeeth, Pune, number BVDUMC/IEC/90, dated 12th August 2022.

**Declaration of patient consent:** The authors certify that they have obtained all appropriate patient consent.

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**Use of artificial intelligence (AI)-assisted technology for manuscript preparation:** The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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