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EFFECTIVENESS OF PERFUSION INDEX (PI)AS AN EARLY PREDICTOR OF SUCCESSFUL CAUDAL BLOCK IN CHILDREN UNDER GENERAL ANAESTHESIA- AN OBSERVATIONAL STUDY

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ABSTRACT **Background and objectives :** Caudal block is a regional anaesthetic procedure commonly performed in paediatric age group. But the success rate is still less in paediatric population. The clinical signs and objective assessments are not fast and reliable enough to provide a good feedback. Perfusion Index is a recent advancement of the pulse oximetry technology. Hence this study was conducted to assess the efficacy of Perfusion Index (PI) in assessing the success of caudal block over the other conventional methods.

Methods: 30 children with ASA physical status I and II who were scheduled for routine and emergency infra umbilical surgeries were included in the study. They were divided into two groups Group P and Group C by computer generated randomisation. The results of conventional methods of assessment were compared with the values of Perfusion index and evaluation of efficacy was done using statistics.

Results: In Group P it was found that the PI increased significantly and earlier , compared to changes in the other parameters from the baseline value. in Group C , the statistically significant changes in the hemodynamics were noted only 5-10 minutes after the block.

Conclusion: Hence from this study we have observed that PI is an efficient ,and highly sensitive indicator to assess the early onset of caudal block

KEYWORDS : Perfusion Index, Caudal, Paediatric.

INTRODUCTION

In all areas of anaesthesia, safety and efficacy are valued goals. Additional challenges are present when there is a shortage of anaesthetic drugs, monitoring equipment and other supplies.

Caudal block is a regional anaesthetic procedure commonly performed in the paediatric age group. It is useful as an adjunct to general anaesthesia and also for post operative pain control. It offers excellent analgesia without the side effects of intravenous opioid medication like nausea, vomiting and respiratory depression.[1]

Although it has its benefits, such as ease of performance , a rapid learning curve, its success rate is reported to be only 75% . Failure of caudal block is about 4% due to caudal canal anatomical and embryological abnormalities in pediatric population .[3] An appropriate evaluation of success of caudal block is important for optimising management of anesthesia. It usually takes around 15-30 minutes to confirm the efficacy of caudal block with the conventional methods such as-pin pricking, cold stimuli, cutaneous temperature changes, cremasteric reflex, laxity of the anal sphincter and , change in the hemodynamic parameters. These clinical signs and objective assessments are not fast and reliable enough to provide a good feedback as these children are already under deep sedation or general anaesthesia.

Recent advances in pulse oximeter technology have expanded the abilities to measure more parameters. Perfusion index (PI) is an assessment of the pulsatile strength at a monitoring site.It is a noninvasive numerical technique derived from a pulse oximeter signal, reflecting the real time changes in peripheral flow including pulsatile strength and the peripheral perfusion status. It is calculated by measuring the ratio of infrared light absorbed by pulsating arterial flow signal against non-pulsating signals in blood and tissue.

Not many studies have been done to assess the accuracy of Perfusion Index as an early indicator of successful caudal block in children. It has been shown in studies that PI can detect the onset of caudal block that induce sympathectomy so increasing the blood flow to the tissues. In the present study, we aimed to assess the efficacy of Perfusion Index in caudal block in children under general anaesthesia undergoing surgery.

MATERIAL AND METHODS

The study was conducted after obtaining approval from the Ethics committee and the scientific committee of our institute . The study was performed in 30 patients aged 1-10 years over a period of 6 months. Children with American Society of Anaesthesiologists (ASA) physical status I and II who were scheduled for elective or emergency infra umbilical and lower limb surgery, in whom caudal block was indicated were chosen to participate in the study.

Children were evaluated prior to surgery and written informed consent from the parents were obtained.

Exclusion criteria included children with history of drug allergy, infection at the insertion site, neuromuscular disease, cerebral palsy, or bleeding disorders.

Children were adequately fasted as per the NPO guidelines .Premedication was given if indicated. Routine monitoring was performed with electrocardiogram, pulse oximeter, non invasive arterial pressure monitor and the Masimo pulse oximetry monitor for perfusion index monitoring.

The induction and maintenance of GA was left to the choice of the attending anesthesiologist. After induction, children in both groups were placed in lateral decubitus position with knees flexed at 90 degrees. Appropriate size of needle was used for both groups of patients. After loss of resistance and negative aspiration for blood or CSF, 0.2% Ropivacaine (1mg/kg) with adjuvant clonidine (1mcg/kg) was slowly administered , and then the children were immediately placed in the supine position.

The sample size and the power of the study was determined using program G power. Each group may achieve a power of 80% and detect a difference of p-value less than 0.05.

In Group C (n=15) the hemodynamics were monitored at regular intervals after the administration of block.

In Group P(n=15) after positioning the child for caudal block ,the Masimo Radical T Set monitor probe was place on the right toe of the child and recorded at regular intervals following induction.

Primary outcome: The PI was monitored using the Masimo monitor and recorded at 0,5,10,15 and 20 minutes.(T0,T5,T10,T15,T20).

Secondary outcome: Heart rate and MAP were recorded by a standard anaesthesia monitor and was recorded at 0,5,10,15,20 minutes following induction.

Cremasteric reflex (CR) was performed in both the groups by stroking the upper inner side of the thigh and pulling up of scrotum and testis on the side was looked for. CR was recorded as Yes/No at 0,5,10,15,20 minutes after induction.

For assessing the onset of adequate caudal block, we looked at the following criteria as indicators of onset of success of caudal block

1) absence of CR
2) A 100% increase in the PI value from baseline
3) 15% decrease in the Heart rate from baseline
4) 15% decrease in MAP from baseline.

Data analysis was done by statistical package for SPSS version 16. Comparing the mean+/_ SD of 2 groups using unpaired students t-test where p value <0.005 is considered significant and p value <0.001 is considered highly significant.

RESULTS

This study included a total of 30 children, aged 1- 10 years, divided randomly into 2 groups and there was no significant difference among the two groups as regard to demographic data (age, height, weight) and the baseline value of PI, MAP, and HR at beginning of the block(Table 1).

Table (1): Demographic data and baseline value in both groups (Data are expressed as mean +/-SD).

Parameter	Group P	Group C	p value
Age (years)	5.6 +/- 1.9	5.3+/_ 1.8	0.231
Height(cm)	108+/_ 12	113+/_11	0.182
Weight(kg)	24.5 +/_ 10.0	27+/_ 9	0.534
Preinduction	Group P	Group C	p value
MAP(mmHg)	82.1+/_ 11.3	80.6 +/_ 13.0	0.693
HR(bpm)	98.7+/_ 16.5	100.2+/_ 16.3	0.779
PI(pre block)	2.3+/_ 0.8		

In group P, PI was found to be significantly increased from baseline values (p<0.01) at 2minutes after the administration of caudal block, before any changes in MAP or heart rate.

After 5 minutes of caudal block PI was found to be significantly increased(p <0.01) while MAP and Heart rate were not significantly decreased compared to baseline value(T0).

PI was significantly increased (p<0.01) but MAP was significantly decreased (p<0.05) at 10,15,20 minutes after caudal block when compared to the baseline (T0).

There was significant decrease in heart rate (p<0.01) from baseline at 15 and 20 minutes compared to baseline value (T0)

The changes in MAP and heart rate in Group C were insignificantly decreased from baseline at 5 and 10 minutes from baseline (T0). The MAP and heart rate were significantly decreased (p<0.05) at 15 and 20 minutes of caudal block administration.(Table 2&3).

Table 2: Indices for the onset of caudal block and changes over time after caudal block (Group P)

Time after administration of caudal(min)	PI	MAP(mmHg)	HR(bmp)
0	2.26+ 0.36	67.8+ 11.19	100.75 + 16.01
5	3.95+ 1.11(**)	64.3 + 10.2	100.5+ 15.01
10	3.97+ 1.12(**)	57.8+ 9.6 (*)	101.2+ 16.87
15	4.85+ 1.45 (**)	53.8+ 5.17 (**)	99.65+ 16.01
20	6.75+1.50 (**)	61.76+ 9.57 (**)	98.65+ 13.8

Table 3: Indices from the onset of caudal block and changes over time after caudal block(Group C)

Time after administration of caudal (in min)	MAP (mmHg)	HR(bpm)
0	65+/_11.19	102+/_16.01
5	66+/_10.8	100.82+/_12.90
10	64.29+/_9.89	104.09+/_11.9
15	63.3+/_10.4	101.75+/_9.91
20	61.7+/_9.46	100+/_15.01

{ *,** -indicates significance with p value of 0.05 - 0.01}

Cremasteric reflex (CR) was absent in both the groups 5 minutes after the caudal block .

Perfusion index increased significantly after caudal block in Group P much earlier and more significantly than other parameters (CR, MAP,HR). So PI is a good and reliable index for assessing the effects of caudal block.

Figure1

DISCUSSION

The key finding of this study was that the perfusion index significantly increased following caudal block .It was earlier and more reliable than the other parameters (Cremasteric reflex,MAP, Heart rate).

Therefore PI can serve as an effective ,continuous and reliable indicator in detecting early onset of caudal block in paediatric patients under general anaesthesia.

Perfusion index is a continuous non invasive and direct assessment of the peripheral perfusion,at a specific monitoring site (e.g. the hand, finger or foot). It is calculated by means of pulse oximetry by expressing the pulsatile signal (during arterial inflow) as a percentage of the nonpulsatile signal, both of which are derived from the amount of infrared light absorbed. [5]

Masimo signal extraction technology(SET) pulse oximetry yields continual and simultaneous absolute values and trends with arterial oxygen saturation(SaO2)and pulse rate using validated signal SET. Only the trend reveals the often subtle changes in perfusion, which is often missed by static displays. Hence, they give immediate clinical feedback of the efficacy of anesthesia,analgesia or therapeutic intervention. It delivers high precision sensitivity and specificity in the measurement of blood oxygen saturation and yields clinically useful information regarding the peripheral perfusion status of the patient.[12]

The PI value is relative to a particular monitoring site as physiological conditions vary between monitoring sites and individual patients. The changes in PI are dependent on some factors such as peripheral vascular resistance,blood volume and elasticity of the vascular wall. A site with a high pulse amplitude (high PI number) generally indicates an optimal monitoring site .The hand or foot (sometimes toe) is often used in neonates and children.

PI increase on the toe following caudal block is most likely due to sympathectomy related vasodilation of peripheral arterial blood and redistribution of blood volume. In our present study,caudal block not only caused significant increase in the PI but it also significantly increased from the pre-block PI value. This significant increase was seen at 2 minutes after caudal block, much earlier than the other conventional methods. In accordance with our study, Mohammed I.A. Sonabaty(2015) conducted a prospective study on 140 paediatric patients undergoing surgery under sevoflurane anaesthesia with one group receiving caudal block, aiming to assess the efficacy of PI during caudal block. They concluded that the pulse oximeter PI was significantly increased in the group that received caudal block, reflecting the peripheral perfusion changed by caudal block.

In a prospective study, 40 pediatric patients undergoing inguinal hernia repair received one shot lumbar epidural block (epidural space L2/3). These patients were monitored for PI in all four limbs. PI values in both lower limbs were significantly and statistically elevated from the preanesthesia baseline, and as compared with the upper limbs (lower PI compared to baseline) after 5 minutes [$p<0.05$] They concluded that pulse oximeter PI reflects the peripheral perfusion changed by epidural block and that PI value can be used as a prediction for the effect of epidural block.

In our study too, we found that the PI was markedly increased earlier than the other parameters.

When we compared the other studied indicators (CR,HR, MAP),we found that HR was not so significantly altered after caudal block. The MAP did significantly decrease after 10 minutes, but the change ratios were much smaller than PI suggesting that PI was an earlier and more reliable indicator in detecting the success of caudal block compared to the other parameters.

Conversely, failure to increase in PI might give the anaesthesiologist a warning sign of failure of adequate caudal block which may warn the anaesthesiologist to optimise the management of anaesthesia.

CONCLUSION

PI can serve as an effective ,continuous and reliable indicator in detecting early onset of caudal block in paediatric patients under general anaesthesia.

In the neonatal acute care setting, a low PI has been shown to be an objective and accurate measure of acute illness[10].

Additionally, PI measurement represents a more rapid and inexpensive method to assess peripheral perfusion and circulatory status in comparison to evaluating calf muscle perfusion and oxygen consumption by way of near-infrared spectroscopy.

PI monitoring warrants further exploration for other clinical applications where information on peripheral perfusion or circulatory status would be useful. Potential future applications include prediction of the success of reimplanted body parts, restoration of peripheral perfusion after cardiopulmonary bypass, and estimation of volume status in trauma patients[10]

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