Evaluation of Perfusion Index (PI) Efficiency in Pediatric Caudal Block: Is it the Time to Depend on PI?

MOHAMED I.A. EL-SONBATY, M.D. and AHMED I.A. EL-SONBATY, M.D.

The Department of Anesthesiology, Faculty of Medicine, Cairo University

Abstract

Objective: This study was conducted to evaluate the efficiency of Perfusion Index (PI) as an indicator of pediatric caudal block in comparison with Mean Arterial Pressure (MAP) and Heart Rate (HR).

Methods: 140 patient children (2-8 year old) were randomized into two groups: Group I (n=70) were anesthetized by 8% lidocaine followed by caudal block using 1mL-kg⁻¹ lidocaine (1%) under 3% sevoflurane with fentanyl and; group II (n=70) were anesthetized by 8% lidocaine sevoflurane anesthesia then decreased to 3% with fentanyl only. Cremasteric Reflex (CR) also was done to both groups after induction of the anesthesia.

Results: In group I, PI significantly increased (p<0.01) after 2min of caudal anesthesia and MAP significantly decreased after 5min of caudal anesthesia (p<0.05), while HR insignificant increased as compared to baseline (T0). In group II, no significant changes were detected in PI, HR and MAP as compared to the baseline. Also PI increased significantly before loss (CR).

Conclusion: This concludes that PI is efficient, highly sensitive indicator to assess the early onset of caudal block than other parameters (HR and MAP). PI is more earlier indicator than absence of CR.

Key Words: Pediatric – Caudal block – Sevoflurane – PI – HR – MAP.

Introduction

In pediatric surgery, the most common techniques of anesthesia are epidural blocks as (caudal & lumbar) and nerve blocks including (ilioinguinal, iliohypogastric and penile) [1]. Nowadays, caudal block approach is the most popular and frequently used regional anesthetic technique in pediatric lower abdominal and lower limbs surgery which was first described in 1933 [2]. The latter is better and efficient than general anesthesia with trachea intubation, fastens the recovery and provides an excellent postoperative pain control [3]. However, failure of caudal block is about 4% due to caudal canal anatomical and embryological abnormalities in pediatric [4]. In order to obtain efficient postoperative analgesia for pediatric patients, caudal block may be combined with general anesthesia [4] that reduces intraoperative inhalational or opioid agent consumption [5]. Also, efficiency of the combination between sevoflurane anesthesia and caudal block has been proved to reduce the postoperative pain and prevent emergence agitation [6].

An appropriate evaluation of successful caudal block is important for optimizing management of anesthesia in pediatric patients. Pinpricking, cold stimuli, cutaneous temperature changes, cremasteric reflex and perfusion index are indicators for the onset of caudal anesthesia [7].

PI 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 by calculating the ratio (AC X 100/DC%) of infrared light absorbed by pulsating arterial flow (AC) signal against non-pulsating signals in blood and tissue (DC) [2,8,9].

Recently, it was shown that PI is more sensitive than other indicators such as Mean Arterial Pressure (MAP) in assessment of epidural anesthesia and intravascular injection of epinephrine-containing epidural test dose in adults [10]. The hypothesis supposed by many studies is 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 study the role of PI in comparison with MAP and Heart Rate (HR) in early detection of pediatric caudal block.
Patients and Methods

After approval from ethic committee of Anesthetic Department and with parental written informed consent, this prospective single blind control randomized study was conducted in Abu El-Reesh Pediatrics Hospital from June 2014 to February 2015, to evaluate the efficiency of PI in early detection of pediatric caudal block. 140 children 2-8 year old children scheduled for circumcision surgery were randomly divided into two groups (70 per group) using closed envelope method. The sample size and the power of study was determined using program G power as 76 participants in each group may achieve a power of 80% and detect a difference of $p$-value less than 0.05. Exclusion criteria were any history of drug allergy, infection at the insertion site, neuromuscular disease, cerebral palsy, mental retardation and bleeding disorders. Anesthesia in both groups was induced by 8% sevoflurane and after loss of consciousness, i.v. catheter was inserted. Fentanyl 1 mic g/kg was injected slowly i.v. then laryngeal mask with appropriate size was inserted. Group I were received caudal block under inhalational sevoflurane 3% anesthesia 3min after induction of anesthesia; group II were under sevoflurane 3% anesthesia only. Caudal blocks were performed at left lateral decubitus position, after losing the resistance during introducing the needle and negative aspiration, slow injection (less than 10mL/30 seconds) of \[1 \text{mL\cdot kg}^{-1} 1\% \text{ lidocaine}, \] and then the patients were immediately placed at supine position.

Primary outcome:

The PI was monitored using Masimo Radical-7 SET (Masimo Corporation, Irvine, CA), and were recorded at 0, 2, 5, 10, 15, and 20min (T0, T2, T5, T10, T15, and T20) following induction of anesthesia.

Secondary outcome:

1- HR and MAP were recorded by an S/5 anesthesia monitor (Datex-Ohmeda, Finland) and were assessed at 0, 5, 10, 15 and 20min following induction.

2- Creamastric Reflex (CR) was done to both groups by stroking upper inner side of the thigh and notice the pulling up the scrotum and testis in the same side by the creamastric muscle. CR recorded by yes or no at 0, 5, 10, 15, 20min. after induction of anesthesia. Adequate caudal block was considered when absence of CR and increase PI 100% from baseline.

Data was analyzed by Microsoft Office 2003 (excel) and Statistical Package for Social Science (SPSS) version 16. Parametric data was expressed as mean ± SD, while non parameteric data was expressed as number and percentage. Comparing the mean ± SD of 2 groups was done using unpaired student’s $t$-test where $p$-value <0.05 is considered significant, and $p$-value <0.01 is considered highly significant.

Results

This study included 140 children, aged 2-8 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 preinduction (Table 1).

In group I, PI significantly increase at ($p<0.01$) at 2min after caudal block before any changes in MAP or in HR. After 5min of induction of anesthesia PI significantly increased ($p<0.01$) while MAP insignificantly decreased and HR insignificant increased as compared to baseline (T0) following caudal block (Table 2). PI significantly increased ($p<0.01$) Fig. (1) but MAP significantly decreased ($p<0.05$) at 10, 15, 20min after caudal block as compared to baseline (T0). There were no significant difference in HR following caudal lidocaine administration compared to its baseline value at T0 unless in T20 which was significant at ($p<0.01$). CR was absent in 10min after the induction of anesthesia in group I (8min after inhalational induction). PI increase significantly after caudal anesthesia in group I much earlier and more reliable than other parameters (CR, MAP, HR) so PI is good index for assessing the effects of caudal block.

The changes in group II of PI value on the toe PI, MAP, and HR following sevoflurane only were presented in (Table 3). HR and MAP were insignificantly increased after 5min. till 20min. but PI decreased insignificantly at 5min till 20min.

![Fig. (1): PI changes overtime in both group.](image)
Data are expressed as mean ± SD.

HR : Heart rate.
MAP: Mean arterial pressure.
PI : Perfusion index.

Table (1): Demographic data and baseline value in all patients.

<table>
<thead>
<tr>
<th></th>
<th>Group I</th>
<th>Group II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>6.12±1.09</td>
<td>5.9±2.1</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>110±11.98</td>
<td>103±12.03</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>24.53±10.1</td>
<td>26±11.6</td>
</tr>
</tbody>
</table>

Data are expressed as mean ± SD or numbers.

Table (2): Indices for the onset of caudal block under sevoflurane anesthesia: Changes over time following caudal lidocaine administration.

<table>
<thead>
<tr>
<th>Time after induction of anesthesia (min)</th>
<th>PI</th>
<th>MAP (mmHg)</th>
<th>HR (bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2.28±0.39</td>
<td>67.80±11.19</td>
<td>101.75±17.01</td>
</tr>
<tr>
<td>5</td>
<td>3.97±1.13**</td>
<td>66.30±10.4</td>
<td>100±15.01</td>
</tr>
<tr>
<td>10</td>
<td>3.99±1.14**</td>
<td>59.80±9.80**</td>
<td>108.10±17.87</td>
</tr>
<tr>
<td>15</td>
<td>4.87±1.47**</td>
<td>55.81±5.37**</td>
<td>107.10±18.11</td>
</tr>
<tr>
<td>20</td>
<td>2.73±1.71**</td>
<td>61.75±9.56*</td>
<td>108.05±22.80</td>
</tr>
</tbody>
</table>

PI : Perfusion index.
MAP: Mean arterial pressure.
HR : Heart rate.

Table (3): Changes in indices overtime in group II.

<table>
<thead>
<tr>
<th>Time after induction of anesthesia (min)</th>
<th>PI</th>
<th>MAP (mmHg)</th>
<th>HR (bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2.49±0.29</td>
<td>66.00±11.19</td>
<td>102.65±16.01</td>
</tr>
<tr>
<td>5</td>
<td>2.00±1.01</td>
<td>67.10±10.9</td>
<td>100.92±13.90</td>
</tr>
<tr>
<td>10</td>
<td>2.02±1.10</td>
<td>68.29±8.9</td>
<td>106.09±11.91</td>
</tr>
<tr>
<td>15</td>
<td>2.09±1.21</td>
<td>69.98±11.98</td>
<td>105.10±9.91</td>
</tr>
<tr>
<td>20</td>
<td>2.73±1.76</td>
<td>69.78±16.91</td>
<td>106.98±11.98</td>
</tr>
</tbody>
</table>

PI : Perfusion index.
MAP: Mean arterial pressure.
HR : Heart rate.

Discussion

The key finding of this study was that although sevoflurane alone can insignificantly increases PI, the latter showed significant increase following caudal block. Thus PI can provide an effective indicator in detecting the early onset of caudal block in pediatric patients undergoing caudal block anesthesia. PI is a sensitive indicator in detecting the early onset of caudal block, reducing the risk of postoperative complications.

Sevoflurane is non-pungent, causing minimal airway irritation, minimal cardiac adverse effects and reduced rate of postoperative restlessness, shivering, nausea and vomiting hence, it is the most inhalational anesthetic agent of choice for pediatrics.

A previous study had shown that HR decreased significantly whereas PI increased during induction and then decreased. Moreover, PI value vary greatly according to time after sevoflurane inhalation. In contrast, we found an insignificant increase in PI following sevoflurane inhalation (in group II). These controversial results could be attributed to different doses as they used sevoflurane 2% increased progressively to 6%. Similarly, Hagar H (2004) found a correlation between sevoflurane concentration and PI which supports the hypothesis that the PI provides an independent indicator of anesthesia efficiency.

PI increase on the toe following caudal block was most likely due to sympathectomy related vasoconstriction of peripheral arterial bed and redistribution of blood volume. In the present study, caudal block not only caused significant increase of PI in pediatric patients, but also increased PI far beyond the preinduction PI value. Moreover, the significant increases in PI had been shown at 2min after caudal anesthesia. In accordance with our results, Uemura et al., (2006) Conducted a prospective study on 40 pediatric patients undergoing inguinal hernia repair aiming to assess the value of monitoring PI during epidural block under general anesthesia. They concluded that the pulse oximeter PI was significantly increases reflecting the peripheral perfusion changed by epidural block.
differences in either demographic characteristics or MAP between patients, while PI gave a positive indication of epidural-induced sympathectomy earlier and more consistently than MAP [8].

Our data clearly demonstrated that an increase in PI is an early, reliable, and objective indicator of the successful onset of caudal anesthesia. Conversely, failure to increase in PI might give the anesthesiologist an early warning of failure of adequate caudal block, which may help the anesthesiologist to optimize the management of anesthesia and finally to avoid the side effects of ketamine or other adjunctive medicines overdose.

Conclusion:

PI provides an earlier, more objective, and more sensitive indicator to assess the early onset of caudal anesthesia under sevoflurane anesthesia than HR and MAP. PI is good index for assessing the efficiency, management and effects of caudal block so this may be the era for anesthesiologists to use PI instead of other old traditional indicators.

Conflict of interest statement: We declare that we have no conflict of interest.

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References

الملخص العربي

الهدف: أجريت هذه الدراسة لتقديم كفاءة مؤشر التروية (PI) كمؤشر كلمة النبيذية للأطفال بالمقارنة مع ضغط متوسط الشرياني (MAP) ونشاط القلب (HR) في فحص الوريد. وتم اختيار 140 طفلًا من المرضى (2-8 سنوات من العمر) إلى مجموعة طرق تم تخدير آ، (N=70) بنسبة 8/7 سيفوفلور، استنشاقpine الكيتين (8/7)، أقل من 3/7، استنشاق سيفوفلور، وتم تخدير المجموعة الثانية (N=70) عن طريق تخدير سيفوفلور، 8/7، استنشاق ثم انخفض إلى 2/7، مع الفنتانيل فقط لا إرادى كما تم القيام به كلا الفريقين Cremastric (CR) بعد تخدير التخدير.

النتائج: في المجموعة الأولى، PI انخفض بشكل ملحوظ بعد 2min تخدير النبلية وPI انخفض بشكل ملحوظ بعد 5 دقائق من التجوير. في المجموعة الثانية، HR ارتفعت بشكل ملحوظ مع خط الأساس (T0) في المجموعة الثانية، ثم انخفض عن أي تغييرات كبيرة في PI وCR. PI بالمقارنة مع خط الأساس، كما كانت بشكل ملحوظ قبل اختبار الخسائر والموارد البشرية وPI بالمقارنة مع خط الأساس، كما زاد بشكل ملحوظ PI قبل اختبار الخسائر.

الخلاص: هذه ينصح إلى أن PI، مؤشر حساس للغاية لتقييم وقت مبكر من بداية كلمة النبيذية من العوامل الأخرى (HR وMAP). هو أكثر المؤشرات في وقت سابق من غياب PI.