Comparison of the effect of sevoflurane and halothane anesthesia on the fall in heart rate as a predictor of successful single shot caudal epidural in children

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ABSTRACT

الأهداف: بحث تأثير مادة السيفوفلورين المخدرة على انخفاض معدل ضربات القلب (HR) بعد حقنه في التجويف الشوكي الذيلي العصعصي للتأكد من المكان الصحيح للحقنة.

الطريقة: بعد الحصول على موافقة المرضى، أجريت دراسة عشوائية مستقبلية في مستشفى يديتيب الجامعي – تركيا، خلال عام 2007م، حيث تم اختيار الأطفال الذين تتراوح أعمارهم مابين 12- 1 عاماً، المرشحين للخضوع لعمليات جراحية تحت السرة تحت تأثير مخدر كلي بالإضافة للتخدير النصفي الشوكي. في المجموعة S والمؤلفة من 85 مريضاً باستخدام السيفوفلورين عن طريق الاستنشاق لبدأ التخدير واستمراره، أما في المجموعة H والمؤلفة من 82 مريضاً فقد تم استخدام الهالوثين. تم تسجيل معدل ضربات القلب HR الأساسي قبل الشروع في حقن بوبيفاكين، كما تم تسجيل معدل ضربات القلب HR بعد الحقن، بعد مرور 5 و 10 دقائق من أتمام الحقن الشوكي.

النتائج: مائة وسبعة وستون طفلا تم تقسيمهم عشوائيا لمجموعتين، كانت نسبة نجاح الحقن ذيلي العصعصي 96.5% في المجموعة S و 97.6% في المجموعة H، أما متوسط معدل ضربات القلب HR بعد الجرعة المبدئية 110.9±10.9 في المجموعة S، 105.9±10.1 في المجموعة H، كان متوسط ضربات القلب HR بعد الجرعة الكاملة 109.8±10.9 في المجموعة S، و 102.9±9.9 في المجموعة H. كان الانخفاض المؤثر في معدل ضربات القلب HR في المجموعة S بعد مرور 10 دقائق من إتمام حقن المخدر.

خاتمة: إن الانخفاض في معدل ضربات القلب المصاحب لحقن مخدر السيفوفلورين في التجويف الشوكي الذيلي (العصعصي) لا يعتد به كمؤشر لنجاح هذا المخدر

Objectives: To investigate the effect of sevoflurane anesthesia on heart rate (HR) fall with the injection of the initial drug in caudal space to confirm the correct needle placement.

Methods: After the ethical approval was obtained from the hospital's ethics committee, a prospective, randomized, clinical study was designed in Yeditepe University Hospital, in 2007. Children aged 1-12 years, scheduled for infraumblical surgery under general anesthesia, and caudal block were included in the study. Anesthesia was induced, and maintained by sevoflurane in group S (n=85), and by halothane in group H (n=82). Baseline HR was recorded before the caudal block was performed. The HR changes during the initial dose, and total drug injection were recorded followed by 2 more HR recordings taken 5, and 10 minutes after caudal injection. The success of the block was recorded by a blind observer.

Results: There were 167 children included in the study. Caudal block success was 96.5% in group S, and 97.6% in group H. Basal HR was 110.9±10.9 in group S, and 105.9±10.1 in group H. Following the initial drug injection, mean HR was 109.8 ± 10.9 in group S, and 102.9 ± 9.9 in group H. It was significantly lower than the baseline in group H. The only significant decrease in the HR of the patients in group S was at the tenth minute following caudal injection.

Conclusion: The decrease in HR with drug injection has no value to predict the success of caudal block under sevoflurane anesthesia.

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Caudal epidural blockade with a local anesthetic solution is widely used to provide postoperative analgesia in infants and children undergoing infraumbilical surgical procedures.[1] It is a simple and effective method of postoperative pain management with a wide range of safety.[2-4] Schuepfer et al[5] published the success rate (80%) on caudal epidural injection after 32 procedures was performed in pediatric patients, and Dalens et al[6] published their overall success rate (96%) of caudal blockades in 750 consecutive pediatric patients. Several methods have been described for confirming the correct placement of the needle with variable success.[7-10] Investigation to find a method that is objective, while it does not require complicated technical equipment is still ongoing. Recently, Ghai et al[11] published that a fall in heart rate (HR) >3 beats/minute during, or within one minute of an initial caudal drug injection was a simple, reliable, and objective test of a successful caudal injection. However, it is better to study this test with other inhalational agents before mentioning its reliability, since halothane has a very well known cardiac depressant effect. On the other hand, sevoflurane is one of the most widely used anesthetic agents, both for induction and maintenance in pediatric anesthesia, and there is no information regarding this issue related with sevoflurane in the literature. Thus, this study was planned to compare the effect of sevoflurane and halothane anesthesia on HR decrease, with the injection of the initial drug in the caudal space to confirm correct needle placement.

Methods. This double-blind, prospective, randomized, clinical study was performed in Yeditepe University, School of Medicine, Department of Anesthesiology and Reanimation, Yeditepe, Turkey between January 2006 and October 2007. During the planning, practice, assessment, and publication of this research no contact has been made for any commercial, political, or individual reason, or with any financing foundation in order not to damage the ethical aspects of the study. After the Hospital Ethics Committee approval, and parents' informed consents were obtained, 167 ASA I children aged one-12 years, scheduled for infraumbilical surgery were included in the study. Patients were randomly allocated into one of the 2 groups. The patients in group S (n=85) received sevoflurane for anesthesia induction and maintenance, and the patients in group H (n=82) received halothane for induction and maintenance. Children with congenital abnormalities, hepatic, renal disease, and malnutrition, bleeding diathesis, history of any drug reaction to one of the drugs used in the study, and aspirin ingestion in the preceding week, preexisting neurological or spinal disease, and children on ß-blocker medication, children who received atropine, or needed to be intubated at any stage before the caudal injection were excluded from the study. All patients received premedication with 0.5 mg/kg oral midazolam approximately 30 minutes before the induction of anesthesia. Anesthesia was induced via a face mask with incremental doses of either sevoflurane in group S (n=85), or halothane in group H (n=82) in 50% oxygen-nitrogen (O_2-N_2O) mixture. In each group, inhalational anesthetic was increased, following every 3-5 breaths by 1% for sevoflurane to a maximum level of 7%, and by 0.5% for halothane to a maximum level of 3%. Intravenous cannulation was performed as soon as possible, and Lactated Ringer's solution was started thereafter, at a rate of 10 ml/kg for the first 20 minutes, to be arranged according to the patient's need later. Following airway management by a laryngeal mask airway, and delivery of the anesthetic agent equivalent to 1.5 minimum alveolar concentration in a mixture of 50% O_2-N_2O for 3 minutes for each patient, all were placed in the left lateral position, and basal HR was recorded. The patients were monitored throughout the surgery for HR, noninvasive blood pressure, saturation level of oxygen in hemoglobin, and end-tidal carbon dioxide pressure, inspiratory and end-tidal anesthetic agent concentrations, and body temperature. After positioning and basal HR recording, caudal block was performed with a total volume of one ml/kg of 0.25% bupivacaine solution (Marcaine 0.5%®, AstraZeneca, Istanbul, Türkey) with an appropriate sized caudal needle (Epican Paed® Braun, Germany). Caudal blockade was performed by the same anesthetist, in a position that she was unable to see, or hear the monitor, with an injection at a rate of 1 ml/3-4 seconds.[11] Accidental dural puncture, or intravascular placement was ruled out by negative aspiration, excluding blood in the hub of the needle initially, and after one ml of injection. An initial 0.2 ml/kg (1/5 of the total dose) 0.25% bupivacaine at a rate of one ml/3-4 seconds was injected, and after one minute of waiting, the total drug was injected at the same rate. An anesthetist not involved in the study recorded the lowest HR during the injection, and one minute after the completion of 1/5 of the total dose. This person was instructed to inform the operator in case of any dysrhythmia, or significant T-wave change (increase in amplitude by 25% for 10 seconds compared with the baseline) with the injection of the drug. The repositioning of the patient to supine position and surgical draping were followed by 2 more HR recordings, obtained 5 and 10 minutes after the completion of the total caudal drug injection, thereafter, incision was allowed. Another investigator blinded to HR changes defined the success of caudal block by the criteria such as: absence of tachycardia >20% of baseline on surgical stimulus, end-tidal halothane concentration <1%, or

sevoflurane concentration <2%, and postoperative pain score as assessed by objective pain score at arrival to recovery, and 30 minutes postoperatively being <3 of 12.[12] In the condition of these 3 criteria, all positive caudal blockades were assessed to be successful. Otherwise, blockade was accepted as unsuccessful, and 0.5-0.75 mg/kg meperidine was given in divided doses intravenously for postoperative analgesia.

Data are presented as mean + SD, or percentages. Demographic data was compared by student's t-test. Heart rate following initial and total drug administration, and consecutive recordings were compared by using repeated measures of ANOVA tests. The results were evaluated using statistical software package (SPSS version 9.01). A $p<0.05$ was considered statistically significant.

Results. The groups were comparable with respect to demographic characteristics, duration of surgery, and anesthesia in a study population of 167 children (124 male and 43 female) (**Table 1**). The groups were also comparable regarding the operation type (**Table 2**). None of the patients developed any complication related with either anesthesia, or surgery in the operating theater, and recovery unit. The mean age of the study population was 4.1 ± 1.9 years, and mean body weight was 18.4 ± 1.9 kg. The caudal block was defined to be successful in 82/85 (96.5%) patients in group S, and 80/82 (97.6%) patients in group H by an independent observer. Although it was not significant, mean HR recorded just before the performance of caudal injection in group H (105.9 ± 10.1 beats/minute) was lower than that in group S (110 ± 10.9 beats/minute (**Figure 1**). In group H, the mean of the lowest HR during initial injection ($p=0.02$), and after total drug administration ($p=0.03$) was significantly less than the baseline value. In group S, the mean of the lowest HR during initial injection (109.8 ± 10.9), and after total drug administration was comparable with the baseline (**Figure 1**). Five minutes after the caudal injection completion, both groups had a comparable mean HR that were 108.7 ± 10.9 in group S, and 101.5 ± 10.0 in group H with the previous recording at the end of the total dose of each group (**Figure 1**). Ten minutes after caudal injection, the mean HR was 106.6 ± 11.1 in group S, and 98.6 ± 10.1 in group H. Both were significantly lower than the previous recordings including baseline value (**Figure 1**).

Table 1 - Demographic data and duration of surgery according to the groups (mean ± SD).

Demographics	Group S (n=85)	Group H (n=82)	Total (n=167)
Age (years)	4.2±1.5	4.1±1.9	4.1±1.9
Gender (M/F)	61/24	59/23	124/43
Body weight (kg)	15 (10.7)	18.0 ± 3.3	18.4±1.9
Duration of operation (min)	118.8 ± 65	110.3 ± 6.8	114 ± 25.7

Between the 2 groups, $p>0.05$ was considered non-significant

Table 2 - Types of surgery performed in the groups.

Operation type	Group S n=85 (%)	Group H n=82 (%)	Total n=167 (%)
Circumcision	24 (28)	24 (29)	48 (29)
Inguinal hernia repair	15 (18)	14 (17)	29 (17)
Orchidopexy	17 (20)	17 (21)	34 (20)
Appendectomy	8 (9)	8 (9)	15 (9)
Orthopedic surgery	21 (25)	20 (24)	41 (25)

Between the 2 groups, $p>0.05$ was considered non-significant

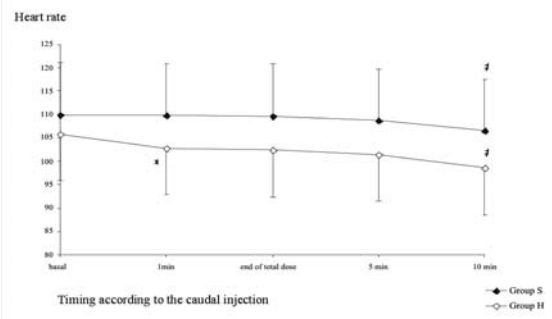

Figure 1 - Change of heart rate (HR) by time starting with the baseline value recorded just before caudal injection. Basal - basal level of HR before caudal injection was performed, 1 min: HR during or within 1 minute of an initial caudal drug injection, 5 min: 5 minutes after the total dose of the caudal drug injection, 10 min: 10 minutes after the total dose of the caudal drug injection.

Discussion. Caudal anesthesia is a safe, simple, and effective technique with a widespread use in pediatric patients of all ages.[1-6] Dalens et al[6] published their overall success rate (96%) of caudal blockades in 750 consecutive pediatric patients, which was also approximately 97% in the current study. Mostly, anesthetists depend on their clinical impressions to perform successful placement of the caudal needle, such as "pop" on piercing the sacrococcygeal ligament, ease of injection, and lack of subcutaneous swelling. However, it was published that these kind of subjective clinical impressions posses low specificity for detecting success of caudal block.[7,11]

There are a number of tests published to be effective, to ensure the correct placement of the needle, and successful caudal block. "Whoosh" and "swoosh" tests performed with air, and with local anesthetic[7,8,13]

confirmation of the needle placement, either by nerve stimulator,[9] or by ultrasonography[10] were used for confirmation of the successful caudal block. Recently, Ghai et al[11] published that a fall in HR of >3 beats/minute during, or within one minute of initial caudal drug injection was simple, reliable, and objective test with high specificity of successful caudal block.[11] They claimed that the highly desirable feature of this test was the absence of any false positive results.[11] This may be important for the safety of the caudal injection. Besides, this test with the requirement of no complicated equipment might be very advantageous, if reliability could be supported with other studies under different circumstances, such as with other inhalational agents, and with the use of atropine. The mentioned study was performed in patients under halothane anesthesia, that was very well known with its hypotensive and bradycardic effects.

One of the most important findings of this study was under halothane anesthesia, it still revealed the similar fall in HR during, or within one minute of the initial drug injection. Neither the current study, nor the above mentioned study had data related with the mechanism of this fall. The decrease in HR may be due to the stimulation of pressure receptors within, or outside the sacral nerve roots in the caudal space.[14] The pressure wave transmitted to the cerebrospinal fluid could be another reason to explain that fall in HR.[15] The drug introduced into the epidural space is in room temperature. Thus, the temperature difference could also be responsible for the decrease in HR. However, before taking any other step further to figure out the mechanism, it seems to be more reasonable to see, whether caudal drug injection posses the same effect on HR under sevoflurane anesthesia.

Sevoflurane is one of the most commonly used anesthetic drug, both for induction, and maintenance of anesthesia in children.[16] The other outcome of this study was the significant fall of HR at the tenth minute after the completion of caudal injection, while it did not reveal any statistical change during, or within one minute of initial drug injection, at the end of the total dose, and 5 minutes after the total dose (**Figure 1**). It is well accepted that sevoflurane has an increasing effect on HR.[17] That rapid decreasing response of the HR to the initial dose of caudal injection might be blunted by the positive chronotropic effect of sevoflurane. The hemodynamic effect of epidural anesthesia under general anesthesia in children is not a very well known field of anesthesia. In one of the recent studies, Monsel et al[18] published that following epidural anesthesia in infants under sevoflurane anesthesia, a negative chronotropic effect was observed. However, this mentioned study did not make it possible to have an objective evaluation of this fall in HR due to its design with sufentanil, and without a control group. It is important to take into consideration, the effect of time on the anesthesia's depth, and sufentanil's effect on the hemodynamics. Besides, Monsel et al[18] observed this negative chronotropic effect, 5 minutes after caudal block was performed. Regarding the test that Ghai et al[11] tried to develop, waiting for 5 minutes to see the decrease of HR does not seem to be very practical. Furthermore, the decrease that Monsel et al[18] observed was following total dose, and it is not clear that if this decrease can be detected following the initial dose. For all these reasons, it was decided not to be ethical to wait for 5 minutes after the initial dose, to see its predictive value for the patients under sevoflurane anesthesia. The other issue related with this test before accepting it into daily practice, is its reliability in patients who has to receive atropine before the caudal needle is placed. To be able to mention regarding this fall in HR as a reliable, and objective test of successful caudal block, it is required to conduct further studies with different designs to see its reliability, and predictive value under different circumstances.

Relative small sample size of this study may be encountered as a study limitation and further studies are needed to conclude that the decrease in HR with drug injection has no value to predict the success of caudal block in all occasions.

As a conclusion, the decrease in HR during, or within one minute of an initial caudal drug injection has no value, to predict the success of caudal block under sevoflurane anesthesia, since it does not cause a decrease in HR.

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Illustrations, Figures, Photographs

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