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Identification of optimal anesthetic depth with sevoflurane using different stimuli for a pain free intravenous cannulation in children

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ABSTRACT

The ideal time for intravenous cannulation following inhalational induction with sevoflurane in children is debatable. Loss of eyelash reflex or centralization of eyeballs has been recommended to assess adequate depth for painless cannulation but occasional patient may still respond to pain. Trapezius Squeeze Test (TST) elicits toe/body movement if the patient feels pain while being induced with sevoflurane. We tested the hypothesis that the loss of response to TST under sevoflurane anesthesia would give an accurate optimal time for pain-free intravenous cannulation.

37 patients between the age ranges of 1 to 8 years of either gender weighing 8-20 kg undergoing minor day care surgery were included in the study. Patients were randomly assigned to Group I (eyeball centralization), Group II (loss of eye lash reflex + 3.5 min), and Group III (Unresponsive to TST). All children were induced with a gradually increasing concentration of sevoflurane. After one minute of induction, the study indicators (eyeballs centralizing effect, loss of eye lash reflex + 3.5 min or negative response to TST) were checked every 15 s till the end point of the indicator had been reached. A person not associated with the study performed intravenous cannulation and noted movement, if any.

None of the TST group patients (Group III) showed any motor response to cannulation (0%). In contrast, 7.1% and 16.7% of Group I and II patients demonstrated some motor response respectively. Grade-3 response to the cannulation in the form of movement of the limb or head and neck accompanied with coughing and/or laryngospasm was not observed in any patient.

Key words: Induction of Anesthesia, Pediatric Anesthesia, Sevoflurane, Venous Cannulation

INTRODUCTION

Intravenous cannulation in children is generally done after induction with sevoflurane. However, an inadequate depth of anesthesia is at times accompanied by sudden withdrawal of hand or coughing and or laryngospasm when cannulation is attempted. It has been recommended that to achieve optimal depth of sevoflurane anesthesia for response free intravenous cannulation, either 3.5 min should elapse after the loss of eyelash reflex[1] or the eyeballs have centralized[2]. However, neither of these optimization methods takes into consideration the painful stimulus evoked during intravenous cannulation. Trapezius Squeeze Test (TST) is a non-invasive, simple test in

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which 1–2 inches of full thickness trapezius muscle is squeezed for 1–2 seconds and toe/body movement is recorded if the patient feels pain[3,4]. In this study we hypothesized that the loss of response to TST would give a more accurate optimization time for pain-free intravenous cannulation as compared to the other two tests methods stated above.

METHODOLOGY

Following approval by the Hospital Ethical Issues committee, this prospective, randomized pilot study was conducted on 37 children between 1 to 8 years of either gender weighing 8–20 kg of ASA grade I/II, undergoing minor day care surgery like circumcision, extra digit excision, tongue tie, cast application etc. Children with delayed development or any neurological pathology, recent URTI, were excluded from the study. The selected children were randomly allocated into three groups as per computer-generated numbers.

Group Division: The three groups were divided as per the end point of the indictor used:

Group I: Eyeball-centralization (n = 14).

Group II: Loss of eyelash reflex +3.5 minutes (n = 12).

Group III: Unresponsiveness to TST (n = 11).

After explaining the procedure, verbal informed consent was obtained from the parents.

All patients were premedicated with syrup midazolam (0.25 mg/kg) approximately one hour prior to induction of anesthesia. On arrival in the operation theatre, pulse oximetry and electrocardiographic monitoring was instituted. Induction of anesthesia was gradually commenced from 0.5 to 6 % sevoflurane in 100% oxygen over 60–90 seconds and thereafter maintained at 6% till intravenous cannulation had been achieved. After one minute of induction, the study indicators (eyeballs centralizing effect, loss of eye lash reflex +3.5 minutes or negative response to TST) was checked every 15 seconds till the end point of the indicator had been reached. Time needed to reach end point indicator in the three groups was recorded in seconds. The same anesthetist performed induction of anesthesia with sevoflurane and tested for the end point of indicators as per three groups. After reaching the end point of indicator, intravenous cannulation was performed by a person not associated with the study and noted the presence or absence of limb and/or head neck movement if any. Patient's response to intravenous cannulation was graded as: Grade-1: No response, Grade-2: Movement of the limbs ± head and neck, Grade-3: Movement of the limb ± head & neck accompanied with coughing and/or laryngospasm:

Parameters recorded: Besides the demographic variables, the following parameters were recorded and analyzed:

1. Time needed to reach the end point of the concerned indicator (eyeballs centralization, loss of eye lash reflex +3.5 minutes, and negative TST).

2. Success (Grade I response to cannulation) or failure (Grade II or III) in judging the optimal depth for intravenous cannulation by the end point indictor.

Primary Objectives

Success (Grade 1 response to cannulation) or failure (Grade 2 or 3) in judging the optimal depth for intravenous cannulation by the end point indictor of the group.

Secondary Objectives

1. Time needed to reach the end point of the concerned indicator (eyeballs centralization, loss of eye lash reflex +3.5 minutes, and negative TST).

2. Grade of response to IV cannulation.

Statistical analysis: Pearson Chi-Square test was used to analyze significance of results utilizing SPSS program.

RESULTS

The distribution of patients was nearly uniform in the all the three groups in terms of age and weight (Table 1).

Table 1: Showing demographic data of the patients in the three groups

Group	Age in yr ± SD	Weight in Kg ± SD
I: Eyeball Centralization	3.38 ± 2.113	13.251 ± 6.132
II: Loss of Eye lash reflex	4.03 ± 2.001	15.98 ± 5.182
III: TST	3.97 ± 1.954	15.053 ± 7.012
'p' value	**2.607**	**0.925**

Yr-year, Kg-Kilogram, SD-Standard Deviation, TST-Trapezius squeeze test

There was a statistically significant difference in the time needed for successful cannulation in the three groups (p = 0.007). Group III patients (TST) were noted to have the shortest induction time to reach for a painless intravenous cannulation (Table 2).

As seen in (Table 3), 1 patient of Group I and 2 patients of Group II demonstrated upper limb movement (grade 2) during intravenous cannulation when attempted at the end of induction time as per group protocol. None of these three patients demonstrated (grade 3) response to intravenous cannulation. In contrast, all patients belonging to Group III (TST) showed no response to intravenous cannulation (grade 1) response.

Table 2: Showing time needed to reach end point of initiating intravenous cannulation

Group	Time for endpoint in seconds ± SD
I: Eyeball centralization	164.29 ± 48.113
II: Loss of eye lash reflex	175.5 ± 150.181
III: TST	161.55 ± 100.744
'p' value	**0.007**

SD-Standard deviation

Table 3: Showing incidence of successful intravenous cannulation with movement

Group	Response				Total			'p' Value
	No response		Responded					
	Count	%	Count	%	Count	%		
I: Eyeball Centralization	13	92.8	1	7.1	14	37.8		
II: Loss of Eye lash reflex	10	83.3	2	16.7	12	32.4		
III: TST	11	100	0	0	11	29.7		0.246
Total	Count	34		3		37		
	%	100		100		100		

DISCUSSION

Induction with sevoflurane is the preferred method to initiate anesthesia in children. Intravenous cannulation is generally done after reaching adequate depth of anesthesia. However, difficulty still persists in occasional patients to correctly identify the optimal depth of sevoflurane anesthesia that would elicit no motor response from the child during cannulation. We believe that this is mainly because all previous methods to identify adequate depth of anesthesia for cannulation are dependent on non-painful stimuli as assessment tools[1,2,5,6]. The results of this study proved our hypothesis that absence of any response to non-invasive painful stimuli such as the TST following induction with sevoflurane in 100% oxygen would yield the most appropriate time for a movement free, painless intravenous cannulation. None of the patient in Group III (TST) of this series showed any motor response to intravenous cannulation in contrast to the other two groups where some motor response was noted though statistically there was no significant difference between the groups. This may be attributed to small sample size, as many parents were reluctant to give their consent for TST in their child.

To keep a uniform application of TST of 1–2 inch in all patients, the same person applied the force in all patients of group III in this study. Also, the observer for any motor response in all three groups remained constant to rule out inter-observer variability.

A previous study evaluated the time required to achieve optimum anesthetic depth for intravenous cannulation in relation to different age groups. They observed significant difference amongst various age groups[5]. We did not analyze the effect of age in this study, as our intention was to observe the efficacy of abolition of response to painful stimuli to judge adequate depth of anesthesia for cannulation for all age groups.

In this study we noted mean induction time of 161.55 ± 100.744 s in Group III patients that was the fastest amongst the three groups (p = 0.007). Recommended time for optimum IV cannulation based on the few previous data range between 54 s up to 200 s[1,2,4,5]. This variation may be attributed to several factors such as using a high concentration (8%) of sevoflurane[5] or use of additional nitrous oxide in oxygen[6] during induction. We desisted from using 8% sevoflurane in this series, as there are studies that suggest an association between 8% sevoflurane with epileptic form EEG in children[7,8].

This study had a few limitations. First, the sample size was not large due to recruitment difficulties. Second, we did not include patients less than one year old. Lastly, blinding of observer for recording patient's movement versus end point marker was not possible.

In conclusion, we recommend using the TST method for optimal timing of a painless, movement-free intravenous cannulation in patients between 1–8 years under sevoflurane in 100% oxygen via facemask in spontaneously breathing children.

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DISCLOSURE STATEMENT

No potential conflict of interest amongst the authors.

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