THE CHARACTERISTICS OF INDUCTION WITH AND RECOVERY FROM ENFLURANE AND ISOFLURANE ANAESTHESIA IN CHILDREN*

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SUMMARY
Enflurane or isoflurane were used to induce anaesthesia in children (4-12 ages) scheduled for outpatient surgical procedures. The characteristics of induction with and recovery from enflurane and isoflurane anaesthesia were evaluated. Enflurane and isoflurane were used in equipotent concentrations. There was no difference between the induction times of the agents. But isoflurane anaesthesia had a shorter recovery period compared to enflurane anaesthesia.

Key Words: Enflurane, isoflurane, induction period, reovery time.

INTRODUCTION
Recently, there is a significant increase in the number of paediatric minor surgical procedures, and it brings along the term "outpatient", in other words the paediatric patients, who have general anaesthesia go home the same day. Consequently, anaesthetists are looking forward to new anaesthetic agents with a fast recovery period and with minor side effects. Since the studies already performed were either started with different pharmacologic agents as premedicants or with an intravenous induction agent, the effects of the inhaled agents alone could not been shown, yet (1, 2, 3, 4, 5). Enflurane and isoflurane, recently used inert volatile inhalational anaesthetics, are relatively insoluble agents with minimal cardiac depressant properties and low potential for organ toxicity and would appear to be the agents of choice for short outpatient paediatric surgical procedures (6, 7, 8).

In the present study, we tried to determine and compare the characteristics of induction with and recovery from enflurane and isoflurane anaesthesia, both used in equipotent concentrations in children premedicated with the same pharmacologic agents.

MATERIALS AND METHODS
Our study was performed on 40 paediatric outpatients, between 4-12 years old, scheduled for minor surgical procedures. The patients were divided into two equal groups randomly, Enflurane (E) Group and Isoflurane (I) Group. The mean duration of the surgery and the mean ages of the patients in both groups were shown in table I, concerning both data there was no statistically significant difference between the two grups.

The patients following their applications to the hospital were visited and examined systematically, their files were looked through and they were informed about the operating room, anaesthetic and surgical procedures in detail. They were all premedicated i.m. with 1 mg/kg pethidine HC1 and 0.015 mg/kg atropine sulfate 30 minutes prior to surgery. On arrival in the operating theatre, induction of anaesthesia was obtained through a mask with 70 % N_2O, 30% O_2 and 3 % enflurane for E Group or 2 % isoflurane for I Group, accepted to be the equipotent concentrations (5 MAC). The loss of eyelid reflex was our criterion in determining the time of induction. Their heart rates were monitorized as well as their systolic and diastolic blood pressures via an intraarterial catheter, which was put into the left arteria radialis percutaneously. Coughing, hiccups, struggling, respiratory dysrhythmias and laryngospasm were all recorded in both groups during the induction period. Following the loss of consciousness, 5% Dextrose-0.2 % NaCl infusion was commenced through an intravenous peripheral catheter. Following i.v. injection of 1 mg/kg succinylcholine, all patients were intubated with proper endotracheal tubes. The systolic and diastolic blood pressures and heart rates of the patients were recorded every five minutes. Following induction, anaesthesia was maintained with 70 % N_2O, 30%O_2 and 1 % enflurane for E Group or 1 % isoflurane for I Group. As soon as anaesthesia was

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Table I. The mean ages of the patients studied and the mean duration of the surgery in both groups.

	Age (year)	Duration of The Surgery (minute)
ENFLURANE	8.20 ± 2.6	55.85 ± 18.52
ISOFLURANE	7.60 ± 3.1	47.10 ± 30.28

Table II. Recovery Scoring Scale

MOTOR FUNCTIONS	Can move four extremities	2
	Can move two extremities	1
	Can move none of them	0
RESPIRATION	Can breathe deeply and cough	2
	Dyspnoeic	1
	Apnoeic	0
CIRCULATION	0-20 mmHg difference of BP from control	2
	20-25 mmHg difference of BP from control	1
	More than 25 mmHg difference from control	0
CONSCIOUSNESS	Awake	8
	Sleepy, easily awaken	4
	Awaken only by stimulation	3
	Awaken by continuous stimulations	2
	Responses only to painful stimulation	1
	No response to painful stimulation	0
SKIN	Pink, dry and normothermic	2
	Pale, yellow, patchy etc.	1
	Cyanotic, sweaty	0

Table III.Systolic and diastolic blood pressures (mmHg) and heart rates of the patients studied.

		Control	Induction	Preoperatively	
				10 minute	20 minute
ENFLURANE	Systolic BP	111 ± 25.69	111 ± 25.50	106 ± 24.16	108 ± 24.54
	Diastolic BP	69 ± 15.38	70 ± 10.57	66 ± 12.36	68 ± 13.59
	Heart rate	132 ± 29.30	127 ± 29.49	123 ± 27.32	125 ± 28.97
ISOFLURANE	Systolic BP	114 ± 25.80	115 ± 26.52	110 ± 24.85	112 ± 25.84
	Diastolic BP	71 ± 9.74	73 ± 9.53	73 ± 10.22	75 ± 8.78
	Heart rate	122 ± 26.62	131 ± 30.68	130 ± 29.39	134 ± 31.16

Table IV. Characteristics of anaesthesia induced by enflurane or isoflurane.

	Duration of anaesthesia (min)	Induction period (sec)	Full recovery period (min)
ENFLURANE	68.75 ± 21.46	162.50 ± 95.41	28.85 ± 6.58
ISOFLURANE	63.00 ± 32.97	171.45 ± 85.53	20.90 ± 6.97*

* Significantly different than that of enflurane group ($p < 0.05$).

Table V. Extubation and recovery scores

	Extubation scores	Recovery Scores*		
		10 min.	20 min.	30 min.
ENFLURANE	12.50 ± 2.88	13.85 ± 1.95	14.50 ± 3.45	16
ISOFLURANE	13.00 ± 2.20	14.55 ± 1.93	15.80 ± 0.89	16

* Recovery Scores were evaluated after arrival in the recovery room.

ended, the patients were brought to the recovery room. During resting period here, their respiratory and circulatory functions, motor activities, consciousness and skin findings were evaluated every 10 minutes. This scoring was also done immediately after the extubation as "the extubation score". The scoring scale used in their sense is shown in table II. In recovery room, the same nurses took care of the patients and they didn't know which inhalational agent was used. The time required to reach a total of 16 points was determined to be the recovery period.

The data that we obtained were evaluated with the "Student's t test" and $p < 0.05$ was considered to be statistically significant. All values are expressed as "mean ± S.D".

RESULTS

There was no statistically significant difference between the two groups concerning the systolic and diastolic blood pressures and heart rates obtained for control (preanaesthetic), induction period and during anaesthesia, as seen in table III. The induction period lasted in 162.5 ± 95.41 seconds for E Group, whereas it was found to be 171.45 ± 85.53 seconds in the I Group. There was no statistically significant difference between these values as shown in table IV. As seen in the table, there wasn't a significant difference concerning the mean duration of anaesthesia between two groups, either. The recovery period for the E Group was 28.85 ± 6.58 minutes, whereas it was only 20.90 ± 6.97 minutes for the I Group, showing a statistically significant difference ($p < 0.05$). On the other hand, it was obvious that the recovery points for the I Group were always higher than the E Group for the same periods (Table V).

While coughing in 3 (15 %) patients and ventricular arrythmias in 1 (5 %) patient were seen in the E Group, in the I Group 6 (30 %) patients coughed and 1 (5 %) patient had involuntary muscle movements during induction period.

DISCUSSION

Recently, it was proposed not to premedicate paediatric outpatients scheduled for surgery in order to shorten the recovery period. Since most of the children enter the operation theatre crying and in great anxiety, even they were premedicated, it does not seem to be applicable in the practice.

It is very well known that, stress-induced increase in their serum catecholamine levels may result in cardiac dysrhythmias.

On the other hand, halothane, one of the commonly used inhalational general anaesthetics, makes the myocardium sensitive to catecholamine-induced dysrhythmias (6). Studies performed with enflurane and isoflurane have shown that these agents have only minor effects in this regard (4). This is why they were preferred at our department for paediatric outpatients.

Fisher, Robinson et al (9), in their study performed on 66 children, considered the induction time to be

the time between the application of the mask and preparing the skin for the surgery and found this period to be 192 sec. for enflurane and 198 sec. for isoflurane. In the same study, there was no difference concerning nausea and vomitting in the recovery period whereas 28 % of laryngospasm was recorded in the isoflurane group. Wren et al (10), in their study (1985), which was performed on 248 children, had compared the characteristics of induction and recovery of isoflurane and had found that 90 sec. were needed for unconsciousness and 10 min. were needed for tilting head up postoperatively, which they took as the criteria for recovery. Umo et al (11), in their study done on 101 children without premedication, found the induction time for halothane and isoflurane to be 201 sec. and 325 sec. and the recovery time to be 27 min. and 24 min. respectively. They considered the fixation of the pupilla centrally as the criterion for the induction. In 1986 Kingston (12), in his study done on 40 children without premedication, examined the characteristics of induction and recovery for isoflurane. His criterion for induction was the permission of the patient for a smooth intubation and for recovery was the reaction for pharyngeal aspiration. The investigator stated that the induction period in halothane group and the recovery period in isoflurane group were significantly shorter. In five of the 20 patients, given isoflurane, airway irritability signs (cough, breath holding etc.) were observed.

In our opinion, the values obtained for induction and recovery periods in the forementioned studies were different from each other due to the different criterion. On the other hand, we believe that the criteria, offered by these investigators to specify especially the recovery time, such as the reaction for pharyngeal aspiration and tilting the head up, are not suitable.

Since the aim of the study is to investigate the time required for recovery for patients who are supposed to be sent home after the surgical procedure and anaesthesia; we insist that their respiratory and circulatory functions, motor activities and level of consciuosness should be equivalent to how they were in the preanaesthetic period.

Concerning the agents, enflurane and isoflurane, used in our study in respect to their effects on the functions of the circulatory system and induction time, there was not any significant difference. When recovery time was concerned, which was the aim of our study, there was a significant superiority in the I Group. In our opinion, the only drawback of isoflurane administration in the paediatric anaesthesia was that it caused respiratory tract irritation resulting in coughing, breath holding, and although rarely observed, laryngospasm. The regard what we and other investigators observed was that all these unwanted side-effects ceased in a short time without requiring any additional therapy.

In conclusion, knowing the fact that premedication with suitable narcotics and anticholinergics can prevent the airway irritability caused by isoflurane induction with the cardiovascular stability and the shorter and more comfortable recorvery period it offers, isoflurane is a suitable and preferable anaesthetic agent to be administered to the paediatric outpatients.

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