

Sevoflurane Versus Halothane in Tonsillectomy and Adenoidectomy Operations in Children

ÇOCUKLARDA TONSİLLEKTOMİ VE ADENOİDEKTOMİ OPERASYONLARINDA HALOTAN VE SEVOFLURANIN KARŞILAŞTIRILMASI

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Summary

Sevoflurane and halothane were compared in a randomized prospective study in 40 children undergoing outpatient tonsillectomy and/or adenoidectomy. Anesthesia was induced with Halothane 4% in N₂O-0, (60%-40%) in Group H and with Sevoflurane 8% in N₂O-0, (60%-40%) in Group S. Maintenance was obtained with Halothane 1% in N₂O-0, (60%-40%) in Group H and with Sevoflurane 3% in N₂O-0, (60%-40%) in Group S. Induction and recovery characteristics and perioperative hemodynamic parameters were compared. Mean time from induction to loss of eyelash reflex was found to be shorter in Group S. Also the time periods between the end of anesthesia and extubation, response to noxious and verbal stimuli and leaving the operating room were found to be significantly shorter in group S. Mean blood pressures were significantly lower in Group S after induction and at consecutive 10th, 25th, 30th and 35th minutes. Mean heart rates were significantly lower in Group H in the 10th, 15th and 20th minutes after induction. There were no major side effects encountered. It is concluded that sevoflurane is a better alternative than halothane for tonsillectomy and/or adenoidectomies in children.

Key Words: Pediatric anesthesia, Halothane, Sevoflurane, Tonsillectomy, Adenoidectomy, Ambulatory anesthesia

T Klin J Med Res 1999, 17:159-165

Tonsillectomy and adenoidectomy operations are usually performed in the pediatric patients and these patients usually do not require hospitaliza-

Received: 23.06.1999

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^ A brief abstract of this study was presented at 7th European Society of Anaesthesiologists Annual Congress 1999 Amsterdam, Holland and XXXII. Turkish Anesthesiology and Reanimation Congress 1998 Antalya, Turkey.

T Klin J Med Res 1999, 17

Özet

Günübirlik tonsillektomi ve/veya adenoidektomi uygulanacak 40 çocukta sevofluran ve halotan randomize prospektif bir çalışma ile karşılaştırıldı. Anestezi induksiyonu, Grup H 'de %60-%40 N₂O-0, içinde %4 halotan ile, Grup S 'de %60-%40 N₂O-0, içinde %8 sevofluran ile sağlandı. Idame Grup H 'de %60-%40 N₂O-0, içinde %1 halotan ile. Grup S 'de %60-%40 N₂O-0, içinde %3 sevofluran ile sağlandı. İndüksiyon, derlenme özellikleri ve perioperatif hemodinamik parametreler karşılaştırıldı. İndüksiyondan kirpik refleksinin kaybolmasına dek geçen zamanın ortalaması Grup S 'de daha kısa bulundu. Anestezinin sonundan ekstübasyona, sözel ve ağırlı uyaranlara yanıt ve ameliyat odasından çıkışa dek geçen zaman Grup S 'de anlamlı olarak kısa bulundu. Ortalama kan basınçları, induksiyondan 10, 25, 30 ve 35 dk sonra Grup S 'de, ortalama nabız sayıları ise induksiyondan 10, 15 ve 20 dk sonra Grup H 'de anlamlı olarak düşüktü. Önemli bir yan etki gözlenmedi. Sevofluranın çocuklarda tonsillektomi ve/veya adenoidektomilerde halotana göre daha iyi bir alternatif olduğu sonucuna varıldı.

Anahtar Kelimeler: Pediatrik anestezi, Halotan, Sevofluran, Tonsillektomi, Adenoidektomi, Günübirlik anestezi

T Klin Araştırma 1999, 17:159-165

tion. In our hospital, tonsillectomy and adenoidectomy operations are mostly performed in ambulatory basis as well. In outpatient anesthesia, recovery of patients in a short time is gaining more importance for economical use of physical sources and the medical and paramedical staff.

Intravenous cannulation is usually performed in the operating room for pediatric patients for whom ambulatory surgery is planned. Accessing the vein is usually hard in an awake child who is usually frightened or irritated because of the unusual environment of the operating room (OR) and

who is away from his or her parents. This situation generally makes it necessary to induct anesthesia using volatile agents before accessing veins. Face mask induction with volatile agents is also an unpleasant experience for pediatric patients, which do not co-operate.

Sevoflurane is a relatively new volatile anaesthetic agent with low blood/gas partition coefficient (1,2). It is reported to be well tolerated during induction and has a relatively nice odor (3,4). The rapid and smooth induction and rapid recovery characteristics that sevoflurane possesses, makes it a new alternative to halothane for pediatric outpatients (5-14). It is reported to cause less airway irritation than halothane, which makes it more suitable for induction (15).

Halothane is a widely used volatile anaesthetic agent, which is potent and provides sufficient depth of anesthesia easily. But it has a disturbing unpleasant odor and it is reported to cause more arrhythmia in high concentrations during induction (16).

In this study we planned to compare the induction and recovery characteristics and perioperative hemodynamic effects of sevoflurane and halothane used for induction and maintenance of anesthesia in children undergoing ambulatory tonsillectomy and/or adenoidectomy operations.

Materials and Methods

After ethics committee approval and parental consent, 40 patients aged between 2 and 8 years in ASA I class, planned to undergo ambulatory tonsillectomy and/or adenoidectomy operations were included in the study. Patients were weighed on arrival to the ambulatory surgery unit and were not premedicated. The patients were allocated into one of the two study groups: Group H and Group S according to a table of random numbers, to receive halothane and sevoflurane respectively. Patients were monitored with an ECG monitor (Hellige Sevomed SMS 182, Hellige GMBH, Freiburg im Breisgau, Germany) using D II derivation, non-invasive blood pressure and a pulse oximeter (Nellcor N-180, Nellcor Incorporated Hayward, CA USA). Patients in Group H received Halothane 4% in N₂O 60% and O₂ 40% while patients in Group S received sevoflurane 8% in N₂O 60% and

O₂ 40% mixture during anesthesia induction. Vaporizers (Blcase -Datum for Sevoflurane and Dragerwerk A.G. Liibeck, Germany for Halothane) were recently calibrated. Volatile agents were administered by a semi-closed circle system with soda-lime CO₂ absorbent. 6 liters per minute fresh gas flow rate was used.

In both groups after the induction of anesthesia, the minimal electrical current that produced normal response to a train of four (TOF) stimulus applied with a mini nerve stimulator (Mini Stim MS II, LifeCare Inc.) by the electrodes placed on the ulnar nerve was recorded in order to standardize the endotracheal intubation time. Eyelash reflex was examined until it could not be observed. Sevoflurane was reduced to 3% and Halothane was reduced to 1% immediately after loss of eyelash reflex. At that time intravenous cannulation was performed and 0.9% NaCl solution was administered for maintenance. After access of the vein atropine sulfate 0.0075 mg/kg was given intravenously and atracurium besilate 0.5 mg/kg iv. was administered. Endotracheal intubation was performed with an appropriate size oral endotracheal tube when no response to TOF at the current that had been recorded to result in normal response. Face mask ventilation and endotracheal intubation were performed by the same, experienced anesthesiologist.

Induction time which was determined as the time from induction of anesthesia to loss of eyelash reflex, time from the administration of atracurium besilate to endotracheal intubation were recorded. Complications during induction, as well as during maintenance and recovery of anesthesia were also recorded.

Heart rates, systolic, diastolic and mean blood pressures before induction of anesthesia, right after the induction when the eyelash reflex was lost, right after endotracheal intubation, after application of the gag, after the incision, and at 5 minute intervals during the course of the operation, right after extubation of the patient, and at 5 minute intervals after termination of anesthesia till it was decided to take the patient out of the operation room were recorded. Anesthesia was maintained with the same concentrations of gases until the end of the operation.

After the removal of tonsils and/or the adenoid and hemostasis was maintained, 0.01 mg/kg atropine iv. and 0.05 mg/kg neostigmine iv. were used to antagonize any residual neuromuscular block in all patients. Then the circuit was flushed with oxygen to wash out remaining anaesthetic gases and 100% O₂ was administered till spontaneous ventilation of the patients became sufficient, patients were extubated by the same experienced anesthesiologist when their muscle tonus returned to normal clinically, also confirmed by the nerve stimulator. Patients were taken out of the OR to the post anesthesia care unit (PACU) when their spontaneous ventilation were sufficient and no desaturation was observed while patients breathed air.

Time to eye opening with vocal stimulus (calling the patients name and ordering to open his/her eyes), time to first response to noxious stimuli, time to leaving the OR after the termination of anesthesia were recorded. Postoperative nausea, vomiting and other complications were also recorded.

In the early postoperative period after the termination of anesthesia when no response to noxious stimuli was observed, bleeding from the operation site was observed in a patient in group H, and anesthesia was re-induced in order to allow the surgeon to achieve adequate hemostasis. Data recorded from the particular patient after this moment were not considered for this study.

Power analysis was performed with two tailed a value of 0.05 and b of 0.15 according to determine the size of the patient groups. Data were analyzed with the computer program "SPSS for Windows® release 6.0" (SPSS Inc.). Data with normal distribution were analyzed with Student's t-test, data without normal distribution were analyzed by Mann-Whitney U - Wilcoxon Rank Sum W test and consecutive data from the same patient were analyzed by Friedman two way analysis of variance. Significant values for p were acclaimed to be less than 0.05.

Results

Mean ages, sex, mean body weights, mean duration of anesthesia and operations were not different between the groups ($P>0.05$) (Table 1). Mean

basal electrical current values raising normal response to TOF, mean doses of atropine, neostigmine and atracurium, mean times from muscle relaxant administration to endotracheal intubation, mean duration between induction of anesthesia and incision and between induction of anesthesia and application of the mouth gag were also statistically similar in both groups ($P>0.05$).

Mean duration from induction of anesthesia to loss of eyelash reflex was significantly shorter in the sevoflurane group compared to halothane group ($p<0.001$). Mean duration from termination of anesthesia to extubation was significantly shorter in the sevoflurane group compared to halothane group ($p=0.016$). Mean duration from end of anesthesia to responses to noxious and verbal stimuli was also shorter in Group S compared to Group H ($p=0.017$, $p<0.001$ respectively). Mean duration from end of anesthesia to leaving the OR was also shorter in Group S compared to Group H ($p=0.001$) (Table 2).

Systolic blood pressures measured right after endotracheal intubation; mean and diastolic blood pressures measured right after induction and 25 minutes after induction; systolic, mean and diastolic blood pressures after incision and after application of the gag and 10, 30 and 35 minutes after induction were significantly lower in the sevoflurane group compared to halothane group. Other hemodynamic parameters were not statistically different between groups (Figure 1).

Heart rates measured at 10th, 15th and 20th minutes after induction and right after incision were significantly higher in the Group S (Figure 2).

Table 1. Patient characteristics (Mean \pm SD or number of occurrences) in groups.

	Group H	Group S
Number Of Patients	20	20
Age (years)	4.77 \pm 1.45	4.70 \pm 1.45
Weight (kg)	18.50 \pm 5.98	18.50 \pm 4.05
Sex M / F	14 / 6	14 / 6
Duration of Operation (min.)	27.75 \pm 11.76	35.75 \pm 16.69
Duration of Anesthesia (min.)	41.90 \pm 13.11	49.45 \pm 17.16

Group H = Halothane, Group S = Sevoflurane

Table 2. Induction and recovery characteristics of patients in groups. (Mean ± SD)

	Group H	Group S
Atracurium dose in induction (mg)	9.17±3.02	9.23±2.04
Face Mask to Loss of Eyelash (min.)	2.90±1.21	1.30±0.57#
Muscle Relaxant to Intubation (min.)	2.85±1.63	2.95±1.36
End of Anesthetics to Extubation (min.)	7.26±2.13	5.65±1.84*
End of Anesthetics to Response to Noxious Stimuli (min.)	8.63±2.67	6.76±2.00*
End of Anesthetics to Eye Opening (min.)	16.79±3.17	10.95±3.50#
End of Anesthetics to Leaving the OR (min.)	13.84±2.73	10.75±2.81#

*p<0.05, #p<0.01

Group H = Halothane, Group S = Sevoflurane

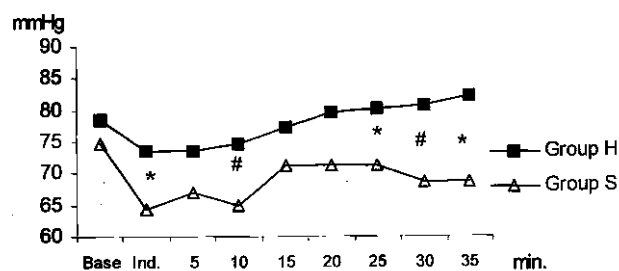


Figure 1. Mean Blood Pressures in groups.
Group H = Halothane, Group S = Sevoflurane
* p<0.05, #p<0.01

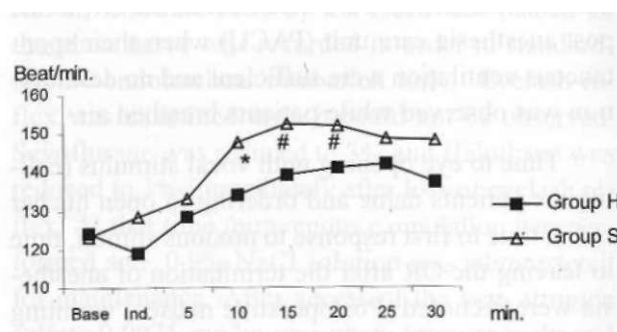


Figure 2. Heart rates in groups.
Group H = Halothane, Group S = Sevoflurane
* p<0.05, #p<0.01

Table 3. Perioperative side effects in groups. (Number of occurrences)

	Group H			Group S		
	Induction (n=20)	Per-op (n=20)	Post-op (n=19)	Induction (n=20)	Per-op (n=20)	Post-op (n=20)
Coughing	3		4	0		5
Laryngospasm	0	0	1	0	0	0
Excitation	5		3	1		7
Nausea	0		2	1		1
Vomiting	0		6	0		4
Ventricular Extrasystole	0	2	0	0	0	0

Group H = Halothane, Group S = Sevoflurane

Complications during induction, during operation and in the first 30 minutes of the postoperative period are listed in Table 3.

Discussion

In the pediatric patients induction of anesthesia is a common problem when the patient is not mentally prepared for the operation. It is hard to prepare the child for such an experience even with profes-

sional guidance, which is usually not available. Children are usually unwilling to accept needles and it is usually an unpleasant experience to be anesthetized with a face mask. Halothane which is used for induction in children is known to have undesirable effects but is a potent and non-irritating volatile agent. Complications encountered during high dose halothane induction lead anesthesiologists to find new alternatives to halothane in pediatric anesthesia induction.

Sevoflurane is a relatively new volatile agent, which is reported to have characteristics suitable for induction of anesthesia. Its low blood/gas partition coefficient results in rapid onset and rapid recovery from anesthesia whereas relatively pleasant and non-pungent odor is reported to help performing a smooth induction and patient satisfaction (3,4,7,17-19). Doi et al. reported that sevoflurane causes less airway irritation than halothane, enflurane or isoflurane which makes it more suitable for induction (15,20). Although in another report airway reflex response to sevoflurane is reported to be similar to halothane/nitrous oxide anesthesia (5).

In planning this research we considered three measures: Whether sevoflurane is superior to halothane on behalf of tolerability, whether sevoflurane causes a marked difference in induction and recovery characteristics and whether it leads to more hemodynamically stable anesthesia.

Induction times with sevoflurane in children are reported to be between 0.68-2.15 minutes (1,4,6,9,11,13,14,16,18). Our results are parallel to these reports. Time to loss of eyelash reflex in patients induced with sevoflurane is less than half the time in patients induced with halothane.

Sevoflurane is reported to potentiate neuromuscular block like other volatile agents. It is reported that sevoflurane may be used solely for endotracheal intubation at high concentrations (21,22). It is also reported that isoflurane and sevoflurane at the same MAC, augments and prolongs the neuromuscular blocking effects of vecuronium, pancuronium and atracurium to a similar degree (23). Pittet et al reported a significantly prolonged recovery of the vecuronium induced neuromuscular blockade with isoflurane compared to halothane (24). However, they noted that isoflurane and halothane cause a similar increase in neuromuscular potency of vecuronium. In the concentrations of halothane and sevoflurane used in our study, we did not observe a significant difference in duration from administration of volatile agent to disappearance of response to TOF in the study groups.

Although sevoflurane caused significantly lower blood pressures at different measurements, we have not observed a clinically important bradycardia or hypotension. Heart rates were even high-

er in the sevoflurane group. Atropine administered right after the induction could have prevented the possible bradycardias. Sevoflurane is reported not to cause tachycardias as seen with isoflurane at doses higher than 1 MAC (1). Sevoflurane is reported to depress cardiac contractility and cause a dose dependent decrease in blood pressure (1). It is also reported that sevoflurane causes less myocardial depression than halothane in children during induction of anesthesia (25). Mild hypotension such as seen in our study in Group S may be beneficial during ENT operations as it may decrease bleeding and improve exposure of the operative field for the surgeon.

Sevoflurane is reported not to make myocardium sensitive to endogenous or exogenous catecholamines (1). So sevoflurane causes less arrhythmias. There are reports that demonstrate less arrhythmia with sevoflurane compared to halothane (16,26). Sevoflurane is reported to decrease cardiac output but to a lesser degree than halothane. Tomatir et al have demonstrated a greater decrease in systolic blood pressures and heart rate in children after induction with halothane compared to sevoflurane (27). Since sevoflurane causes relaxation of the vascular smooth muscles directly even at low concentrations such as 0.4-0.8 MAC without significant sympathetic nerve activity or increases in noradrenaline levels, it decreases systemic vascular resistance and blood pressure. In our study we observed lower blood pressures in the sevoflurane group.

Sury et al reported that rapid recovery from sevoflurane exposes children to discomfort and children, may require more analgesia (28). Pain leads to agitation in some children. Excitement is reported to be more frequent with sevoflurane compared to halothane in children undergoing ENT surgery (26). Hall et al reported more excitement in adults in which induction of anesthesia was performed with sevoflurane compared to propofol (17). Welborn et al reported a lower incidence of postoperative agitation with sevoflurane compared to desflurane and halothane (29). We also observed that children in Group S were more agitated postoperatively. This may be prevented by early administration of analgesics during or before recovery from sevoflurane.

Even though there are some reports that nitrous oxide or volatile anesthetic agents may influence postoperative nausea and vomiting, it is reported that volatile agents including sevoflurane do not influence the incidence of postoperative emesis (30). Our results are consistent with these findings.

In conclusion, in this study sevoflurane is found to be a better alternative than halothane in pediatric ambulatory ENT surgery, since it was well tolerated during induction of the pediatric patients. In the concentrations we used it possesses better recovery characteristics and less complications than halothane with comparable hemodynamic responses.

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