

## Anesthesia in the Surgery of Strabismus: Role of Anesthetic Agents in the Ocular Deviation and Surgical Outcome

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### Abstract

**Purpose:** To determine whether the changes in the ocular alignment following general anesthesia, maintained with two different inhalational anesthetic agents, sevoflurane and desflurane, can be used as a predictor for surgical outcomes in children with esotropia.

**Methods:** The authors obtained digital photographs of 42 children with esotropia; 21 patients underwent strabismus surgery with general inhalation anesthesia with sevoflurane (group A), 21 patients with inhalatory anesthesia with desflurane (Group B), as maintenance general anesthesia agents.

For each patient, the corneal reflexes position were digitally measured and compared with the preoperative ocular deviation's angle; the correlation with surgical outcome, one year after, was considered.

**Results:** The patients in both groups showed a decrease of the squint angle, or eye's gap position after the induction of general anesthesia. In group B, this divergence was significantly higher than in group A ( $P < 0.001$ ). In both groups, there was a linear correlation between the preoperative angle and shortly after the induction of general anesthesia. Patients ranging a corneal reflexes position within 1 SD ( $15\Delta$ ) evidenced higher success of surgery ( $p < 0.05$ ) of patients  $> 1$  SD.

**Conclusion:** Changes in the ocular deviation with sevoflurane and desflurane, can be predictive for surgery outcome in children with esotropia. Furthermore, desflurane evidenced greater effects on the ocular deviation compared to sevoflurane, thus confirming to be the inhalational anesthetic of choice in strabismus surgery.

**Keywords:** Sevoflurane; Desflurane; Anesthesia; Surgery; Strabismus

### Introduction

General anesthesia alters the eyeball's position in squint patients, as well as in orthophoric one's [1]. Many anesthetic agents were investigated in both excitatory and inhibitory synaptic transmission, using experimental approaches [2,3]. As far as interaction between volatile anesthetics and neuromuscular blockers is concerned, it was hypothesized that muscle relaxation could be the result of combined drug effects on the nicotinic acetylcholine receptor (nAChR). The results suggest that the enhancement of non-depolarizing muscle relaxants induced neuromuscular blockade by volatile anesthetics could be induced in part by a combined effect of these drugs on the nAChR [4].

Recent results suggest that sevoflurane and isoflurane reduce sodium-dependent synaptic vesicle exocytosis by blocking  $\text{Na}^+$  sodium channels sensitive to tetrodotoxin at the mouse neuromuscular junctions, with skeletal muscle relaxation [5]. Recent studies enhanced the first direct action on presynaptic ion channels, filling the gap between neurochemical studies on anesthetic effects on transmitter release [3].

Several studies have evidenced that the alignment of the eyeballs during general anesthesia could provide a further intraoperative support, as an alternative to possible adjustable sutures, not adoptable in pediatric field [4,6-12]. However, the eyeballs alignment during the anesthesia can depend on the preoperative deviation.

The correlation between eyeball's position changing in esotropic patient's, during inhalational anesthesia with sevoflurane or desflurane, was investigated; further information about prognostic positive outcome were considered

The study interest was focalized on the variations of the strabismus angle during general anesthesia, to evaluate a possible prognostic index.

### Materials and Methods

Forty-two patients with convergent strabismus were divided in two groups: 21 patients were subjected to the strabismus surgery under general inhalation anesthesia with sevoflurane (group A), 21 patients under inhalation anesthesia with desflurane (group B). The mean age was 6 years SD (range 4-10) in both groups. There were no clinical and refractive anomalies differences between males and females in the two groups.

Exclusion criteria included patients with neurological disorders, nystagmus, unstable fixation, severe cognitive impairment, significant (AV pattern, hypertrophy >4Δ), restrictive strabismus, or patients with history of previous interventions were excluded. The deviation angle with the prismatic Cover test, before, one day and one year after surgery, was measured by the same ophthalmologist. Cover test is considered better than the Hirschberg or Krimsky tests, as reported in Korea by Lee and Lee JA HY [13].

The ocular deviation from digital images was evaluated, by measuring the position of the corneal reflexes, before and after the induction of general anesthesia. The digital image at 40 cm distance from the patient's forehead was obtained, while he was looking at the camera's lens, with a forehead ruler, determining the corneal reflexes position. After the induction of general anesthesia, a photo was taken, at 40 cm distance from the forehead, with a ruler 4 mm beyond the glabella, shortly above the corneal reflexes.

Strabismus angle was identified between the nose-temporal limbus and the corneal reflex, calculating the distance between the nasal limbus and corneal reflex, which can be considered half of the corneal diameter.

The difference between the strabismus angle, shortly before and after anesthesia induction was calculated; the value expressed in millimeters was converted into prismatic diopters, by multiplying it by 14, as in the formula: Δ/mm=14 [3].

General anesthesia with halothane (1.0% < MAC < 2.0%) was induced, until the venous access was got; then, after administration of propofol (0.3 mg/kg) laryngeal mask was positioned in both groups. Halotane was discontinued and when BIS was ≥ 70 and/or MAC < 1%, sevoflurane in group A and desflurane in group B started. Anesthesia was maintained with sevoflurane (1.5% < MAC < 2.5%) in group A and desflurane (6% < MAC < 8%) in group B, without muscle relaxants use. ECG, heart rate, pulse oximetry, non-invasive blood pressure and end-tidal carbon dioxide) were monitored. Bispectral index (BISpectral™ Index, Covidien, Mansfield, MA, USA) between 40 and 60 was titrated.

The prophylaxis of postoperative nausea and vomiting (PONV) with Ondansetron 100 mcg/kg<sup>-1</sup> IV and dexamethasone 150 mcg/kg<sup>-1</sup> IV was realized. Metoclopramide 0.25 mg/kg<sup>-1</sup> IV was used as rescue medication. Suppository paracetamol 500 mg after anesthesia induction was administered, repeated every 12 hours for two days.

All included patients underwent a traditional unilateral/bilateral recession surgery (depending on the strabismus type) of the medial rectal muscles. The relationship's existence between the preoperative and intraoperative deviation, using a regression formula, was supported [2,4], while no correlation were reported in other cases [3,5]. Different responses during general anesthesia, between esotropic and exotropic patients, were observed [4] because of the variable results with Hirschberg and Krimsky tests [3].

The correlation between eyeball's position changing in esotropic patient's, during inhalational anesthesia with sevoflurane or desflurane, was investigated; further information about prognostic positive outcome were considered.

Surgery was adequate when an ocular deviation's angle within 8 prism diopters (PD) of orthophoria in the first postoperative day was kept. A linear regression analysis was performed to identify the correlation between the preoperative and shortly induction deviation's angle; P-values less than 0.05 were considered statistically significant.

## Results

Patients of both groups evidenced a decrease of the strabismus angle or divergence of the eyeballs after the induction of anesthesia. In group A, the strabismus angle, before and after the anesthesia induction was 39.8Δ (prismatic diopters).

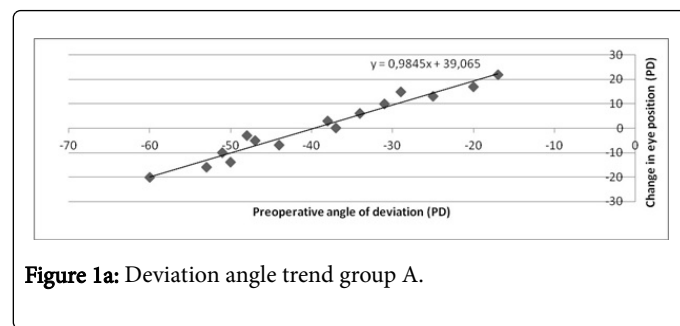
In group B, the difference was 47.2Δ (prismatic diopters), higher than in group A (P < 0.001). This data suggests that desflurane produces a greater divergence of the eyeballs compared to sevoflurane. The differences were statistically significant (Mann-Whitney U test, P < 0.05).

The results, expressed as mean ± SD and SE of the differences in prismatic diopters between group A and group B, are shown in Table 1.

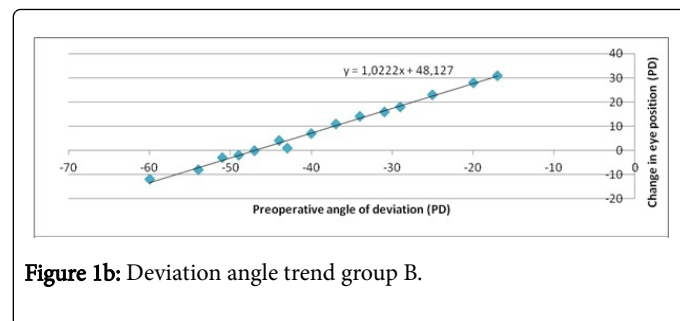
Group A			Group B		
M	SD	SE	M	SD	SE
39.8 ±	± 12.57	4.71	47.2	± 12.2	5.52
Asymmetry Coefficient: 0.57			Asymmetry Coefficient: -0.3		
Coefficient of Kurtosis: 2.15			Coefficient of Kurtosis: 2.99		

**Table 1:** Ocular deviation angles before and during anesthesia with sevoflurane or desflurane.

In both groups the relationship can be expressed by the following linear regression formulas: For group A treated with sevoflurane: A=1.015 P+39.80; for group B treated with desflurane: A=1.015 P+47.2; Where P is the preoperative angle deviation, A is the eye's alignment during anesthesia. The positive values represent the exotropias, the negative one's the esotropias (Figure 1a and Figure 1b).



**Figure 1a:** Deviation angle trend group A.



**Figure 1b:** Deviation angle trend group B.

Ocular deviation induced by sevoflurane and desflurane can be derived from regression line formulas compared to preoperative eye's deflection. The patients presenting corneal reflexes (A in the formula) within one standard deviation (15Δ) as compared to the expected value after the general anesthesia induction had a higher surgical

success rate ( $P < 0.05$ ) than those whose position of the corneal reflexes under general anesthesia was abnormal (greater than one standard deviation).

Mioresolution was not necessary, because of skeletal muscle relaxation induced by halogenated, due to neurotransmission blockade at either pre or postsynaptic level.

## Conclusion

Ocular deviation after sevoflurane and desflurane anesthesia's induction in Group A and Group B is similar, with a linear correlation with the preoperative angle. However, the patients of group B were characterized by a larger angle compared to patients of group A.

In our study the changes of ocular deviation after halogenated anesthesia induction in both groups of esotropic patients, reported a linear correlation with the preoperative deviation angle. This linear relationship depends on the volatile anesthetic, based on the previous formulas reported. The influence induced by two different anesthetics, sevoflurane and desflurane on the deviation angle in esotropic subjects was confirmed; the question if their effects on the eyeball's position and the level of induced deviation could be predictive for the surgical outcome was the focus.

Study confirmed that eyeballs position plays a key role in determining the technical project and the surgical outcome in subjects with convergent strabismus. General inhalation anesthesia remains the landmark in ophthalmosurgery pediatric patients. Anyway, sevoflurane and desflurane evidenced different effects on the eye's deviation; desflurane showed higher effects on the ocular deviation compared with sevoflurane. For these reasons, sevoflurane confirms to be the inhalational anesthetic of choice in strabismus surgery, because of the minor eyeball's deviation.

Last but not least, its lower irritative effects on the airways are a reference point of general anesthesia induction in pediatric patients.

## Financial Disclosure

The authors have no proprietary or commercial interest in any materials discussed in this article.

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