



# Oculocardiac reflex during strabismus surgery

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### ABSTRACT

The activation of oculocardiac reflex (OCR) is common during the strabismus surgeries. OCR is known as a trigemino-vagal reflex, which leads to the various side effects including bradycardia, arrhythmia, or in some cases cardiac arrest. This reflex could be activated during intraorbital injections, hematomas, and mechanical stimulation of eyeball and extraocular muscles surgeries. The incidence of OCR varies in a wide range, from 14% to 90%, that depends on anesthetic strategy and drug used for the surgery. The efficacy of various anticholinergic and anesthetic agents on declining the OCR reflex has been evaluated in different studies, especially in children. Although the detection of OCR goes back to 1908, its exact effect is not well recognized during strabismus surgery. In this review, we aimed to summarize the studies investigated the efficacy and potential of various anesthetic medications on inhibiting the OCR in children undergoing strabismus surgery.

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## Introduction

Manipulation of orbital structure can lead to oculocardiac reflex (OCR) or trigemino-vagal reflex, stimulation of trigeminal nerve, and reduction of heart rate from baseline. OCR was firstly introduced by Aschner in 1908 and proposed as more than 20% decrease in heart rate following eye manipulation (1). The reflex is associated with the appearance of sinus bradycardia as the most common manifestation, arrhythmia, reduced arterial pressure, ventricular fibrillation, asystole, or cardiac arrest (2). Various stimuli can cause and exacerbate the OCR such as contraction of ocular muscles especially medial rectus, intraorbital injections, hematomas, mechanical stimulation, ocular manipulation, pain, etc. These stimuli are the possible risk factors of OCR during every ocular surgery (3). The estimated prevalence of OCR contains a wide range, from 14% to 90%, which

depends on the definition of OCR in each study. In 1973, Apt et al. showed the occurrence rate of OCR almost 67.9% in patients undergoing strabismus surgery, thus ocular surgeries were proposed as one of the risk factors of OCR (4). In this review, we aim to review studies investigated and compared the efficacy of different anesthetics in reducing the OCR during squint surgeries of children.

## Literature review

### *Incidence of OCR during eye surgeries*

Based on investigations, various clinical procedures and manipulations can elicit the OCR including acute glaucoma, extracapsular cataract surgery, phacoemulsification cataract surgery, laser in-situ keratomileusis surgery, orbital surgery, and craniomaxillofacial surgery (5,6).

Strabismus is a common disorder due to

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abnormal alignment of the visual axes. Strabismus surgery is a clinical procedure, which deals with six extraocular muscles responsible for eyeball movement within the orbit. Because of the high frequency of this surgical approach, it is proposed as the most common eye surgery especially in pediatrics. OCR is also the possible adverse effect of this surgical method. Incidence of OCR can be associated with various clinical manifestations, which might be fatal mostly in pediatric patients. Various investigations have been conducted to decrease the reflex by administering retrobulbar block and anticholinergics, different anesthetic agents, and the management of possible risk factors (7-11). Despite different efforts to reduce the possibility of OCR during orbital surgeries, there is no certain result on this issue (12).

### **Strabismus surgery and OCR**

Strabismus surgery might be associated with OCR and further detrimental consequences especially in children. Understanding the OCR and the ability to manage this phenomenon is important during every eye manipulation and surgery. Despite the awareness of surgeons and anesthetists, various aspects of exact mechanism

and clinical presentations of OCR remain uncertain. Based on the investigation of Braun et al., it is essential to accurately control the heart rate during surgery. The OCR is composed of two phases including bradycardia with decreased heart rate and the following tachycardia in which that heart rate will be boosted after releasing the traction (13).

Various anesthetics, used in investigations, affect each stages of the OCR, control the reflex, and eventually change the incidence and prevalence of OCR. Atropine can be used before of the initiation of OCR or during prolonged and severe bradycardia, to inhibit the occurrence of unfavorable consequences of the reflex, such as cardiac arrest and sudden death.

### **Different anesthetics to reduce the OCR incidence**

Anticholinergic agents such as atropine and glycopyrrolate have been used in some investigations to evaluate their efficacy in reducing the incidence rate of OCR (14-16). Some investigations studied the efficacy of different agents on reducing the frequency of OCR in pediatrics strabismus surgeries, which are summarized in Table 1.

**Table 1.** Studies compared different anesthetics in reducing the OCR during strabismus surgery

Author Year Reference	Patients	Anesthetic regimens	Outcomes
<b>Lübbers 2008 (6)</b>	120 children (1-9 years old)	(Ketamine 1.0 mg/kg or midazolam 0.15 mg/kg) + 0.75 mg/kg remifentanyl and continuous infusion at 0.5 mg/kg/min anesthesia or sevoflurane 2.0-3.0 %	Higher incidence of OCR in remifentanyl group (58.3%) compared to sevoflurane group (28.3%)
<b>Oh 2007 (10)</b>	237 children (2-10 years old)	Anesthesia with thiopental and rocuronium 123 patients (sevoflurane) 114 patients (desflurane)	No difference in the incidence of OCR between sevoflurane (26.0%) and desflurane (28.0%) anesthesia
<b>Marsch 2009 (17)</b>	280 children (1-9 years old)	Group 1: ketamine Group 2: midazolam	Incidence of OCR was similar in ketamine and midazolam groups
<b>Choi 2009 (18)</b>	61 children	Group 1: ketamine 1.0 mg/kg Group 2: midazolam 0.15 mg/kg	No difference in the incidence of OCR between groups
<b>Hahnenkamp 2000 (24)</b>	39 children (4-14 years old)	Group P: Propofol/alfentanil Group S: Sevoflurane Group K: Ketamine/midazolam Group H: Halothane	Ketamine was associated with the lowest incidence of OCR followed by sevoflurane, halothane, and propofol.
<b>Choi 2007 (25)</b>	120 children	Group 1: 1 mg/kg ketamine Group 2: 2 mg/kg ketamine Group 3: 3 mg/kg propofol	Lower incidence of OCR with ketamine compare to propofol

Pre-anesthetic medications were administered before the strabismus surgery including atropine sulphate to block peripheral muscarinic receptors of heart, and retrobulbar xylocaine hydrochloride to block ciliary ganglion. According to the results, no OCR occurred during the surgery, and atropine was able to inhibit the OCR (7). Peribulbar block via administering 3-4 ml of bupivacaine 0.25% was also applied in one randomized, double-blind study of the squint surgery in children. According to the findings, peribulbar block significantly decreased the frequency and intensity of OCR compared with local anesthesia (8).

In other studies, various anesthetic regimens have been used to compare their efficacy on the reduction of the OCR during squint surgery (17,18).

Remifentanil, a synthetic opioid, was firstly used in 1996 in a clinical study (19). This drug has exclusive characteristics including significant clearance, great influence, and no associate accumulation complication, which make it a noteworthy choice for anesthetics procedures especially in infants and children. Remifentanil is a fast-acting intravenous opioid agonist with parasympathetic stimulation and negative chronotropic effects, which lead to bradycardia (17). It has been shown that without applying anticholinergic blockade, administering fast-acting opioids such as fentanyl, sufentanil, and remifentanil could facilitate the bradycardia due to OCR during the strabismus surgery (20). In the study of Chung et al., remifentanil was continuously administered during the anesthesia in strabismus surgery; continuous application of anesthetic led to hemodynamic stability (9).

Sevoflurane and desflurane are volatile anesthetic agents especially used in infants and children. Desflurane has faster effect in comparison with sevoflurane. Desflurane is a pungent gas mostly used for preserving general anesthesia and sevoflurane is an inhaled anesthetic agent used in pediatric surgeries (21). According to one previous investigation, sevoflurane has been associated with a significant and greater prevalence of OCR during the squint surgery compared with propofol (22).

Although desflurane is suggested to stimulate the sympathetic activity and induce heart rate, its effect on OCR has not been compared with other drugs during the squint surgery. In the study of Oh et al., no significant different was observed between the efficacy of desflurane and sevoflurane regarding the inhibition of OCR during strabismus surgery in children. Moreover, both desflurane and sevoflurane were beneficial for inducing and preserving the anesthesia (10). Sevoflurane with vagolytic effect can strongly increase the heart rate compared with agents that have sympathetic

activation effect such as desflurane (22).

Ketamine is known as the only anesthetic agent with sympathetic action that can counteract vagal stimulation and control the occurrence of OCR. The efficacy of ketamine has been also investigated and proposed in some studies as an anesthetic agent, which has cardiostimulatory effect through stimulating sympathetic nervous system activity and considerably controlling the incidence of reflex (23). In one randomized study, ketamine has shown better efficacy in reducing the frequency of OCR compared with propofol in children (24). The estimated efficacy of ketamine not only was greater than propofol, but also higher than sevoflurane and halothane (25).

In another study, it was suggested that ketamine did not reduce the incidence of OCR in comparison with midazolam, but it was associated with lower adverse effects including postoperative nausea, vomiting, and emergence agitation (26).

## Conclusion

Each medication affects a specific phase of OCR, and it is important to be aware of the exact function of the applied anesthetics. Applying preanesthesia medications and various anesthetic agents might be useful strategies in reducing the OCR during strabismus surgery, which are needed to be further investigated in future studies.

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## Conflict of Interest

The authors declare no conflict of interest.

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