Comparison of desflurane with sevoflurane for the incidence of oculocardiac reflex in children undergoing strabismus surgery

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Background. The oculocardiac reflex (OCR) is frequently observed during strabismus surgery. This study was designed to evaluate and compare the effect of sevoflurane and desflurane on the incidence of OCR.

Methods. After obtaining Institutional Review Board approval and informed consent from parents, we enrolled 237 paediatric patients, aged 2–10 yr, undergoing strabismus surgery. No premedication was given. Anaesthesia was induced with thiopental and rocuronium. Patients were randomly allocated to one of the two anaesthetic regimens. Group S (n=123) received sevoflurane and Group D (n=114) received desflurane, both with 60% N₂O/O₂ for maintenance of anaesthesia. The OCR was defined as ≥20% decrease in heart rate (HR) from baseline values obtained immediately before muscle manipulation. If the HR did not increase after release of muscle tension, atropine 0.01 mg kg⁻¹ was administered.

Results. There were no significant differences between the two groups in age, sex, body weight, and the number of muscles operated upon. The mean values of baseline HR were 123 (16) min⁻¹ in Group S and 121 (18) in Group D (NS). The minimum HR was 106 (22) min⁻¹ in Group S and 103 (21) in Group D (NS). There was no difference in the incidence of OCR between sevoflurane (26.0%) and desflurane (28.0%) anaesthesia.

Conclusions. Both agents can be used safely during strabismus surgery in paediatric patients.

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The oculocardiac reflex (OCR) is triggered by pressure on the globe, conjunctiva and orbital structures, and traction on the extraocular muscles. The afferent limb consists of the trigeminal nerve and the efferent limb is the vagal nerve. Hence, the OCR is also known as the trigemino-vagal reflex. The most common manifestation is sinus bradycardia, although many different cardiac dysrhythmias may occur.¹

The incidence of the OCR during strabismus has been variously reported as 14% to 90%, depending on the anaesthetic agent, premedication, and the definition of OCR used. Studies demonstrate a higher incidence in children who tend to have more vagal tone.²⁻⁴

Sevoflurane is associated with a lower incidence of OCR than halothane or propofol,⁵ but desflurane has not been studied in comparison with other agents. As it increases sympathetic activity and heart rate (HR) in a concentration-dependent manner, we hypothesized that its use should be associated with a relatively low incidence of OCR. The aim of the present study was to evaluate the incidence of OCR during desflurane anaesthesia and compare it with that during sevoflurane anaesthesia in children undergoing strabismus surgery.

Methods

After Institutional Review Board approval and informed consent from the parents, 237 ASA class I paediatric patients, aged between 2 and 10 yr undergoing strabismus surgery, were enrolled. Patients with cardiovascular...
OCR with desflurane or sevoflurane

Table 1 Patient characteristics. Age is expressed as median (range), sex as number, and others as mean (SD)

<table>
<thead>
<tr>
<th></th>
<th>Sevoflurane (n=123)</th>
<th>Desflurane (n=114)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex (M:F)</td>
<td>55:68</td>
<td>53:61</td>
<td>0.785</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>6.9 (2–10)</td>
<td>7.1 (2–10)</td>
<td>0.132</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>24.1 (8.6)</td>
<td>25.6 (8.2)</td>
<td>0.314</td>
</tr>
<tr>
<td>Muscles operated (n)</td>
<td>1.7 (0.52)</td>
<td>1.5 (0.54)</td>
<td>0.066</td>
</tr>
</tbody>
</table>

Table 2 The incidence of OCR according to anaesthetic groups. Data are expressed as mean (SD) or number (% incidence). HR, heart rate; OCR, oculocardiac reflex

<table>
<thead>
<tr>
<th></th>
<th>Sevoflurane (n=123)</th>
<th>Desflurane (n=114)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline HR (min⁻¹)</td>
<td>123 (16)</td>
<td>121 (18)</td>
<td>0.270</td>
</tr>
<tr>
<td>Lowest HR (min⁻¹)</td>
<td>106 (22)</td>
<td>103 (21)</td>
<td>0.295</td>
</tr>
<tr>
<td>Incidence of OCR (n, %)</td>
<td>32/123 (26.0)</td>
<td>32/114 (28.0)</td>
<td>0.723</td>
</tr>
</tbody>
</table>

Results

Patient characteristics are given in Table 1. There were no significant differences regarding sex, age, body weight, or number of muscles operated. OCR was seen in 26.0% (32/123) of patients in Group S and 28.0% (32/114) in Group D (NS: χ²=0.127, P=0.71). The lowest HR during muscle manipulation was 50 min⁻¹ (52% reduction from baseline, in an 8-yr-old girl) in Group S and 55 min⁻¹ (55% reduction from baseline, in a 9-yr-old boy) in Group D. The mean baseline HR was 123 (16) min⁻¹ in Group S and 121 (18) min⁻¹ in Group D. The mean minimum HR was 106 (22) min⁻¹ in Group S and 103 (21) in Group D (NS: Table 2).

When the patients were divided into two age groups (2–5 and 6–10 yr), baseline HR were significantly decreased as age increased and the incidence of OCR was significantly lower in 2–5 yr group compared with the 6–10 yr group (Table 3).

In most patients demonstrating OCR, HR returned to baseline value after release of the muscle and only two patients (discussed earlier) needed atropine as treatment due to severe bradycardia (60 min⁻¹). There were no other clinically significant arrhythmias. Arterial pressure was maintained within 20% of preoperative values.

Discussion

Because desflurane increases sympathetic activity, we hypothesized that the incidence of OCR during paediatric strabismus surgery under general anaesthesia would be lower with desflurane than with sevoflurane. However, our study found no difference between the two agents.

Anticholinergic prophylaxis decreases the incidence of OCR.9–11 However, atropine may cause bigeminy and increase ectopic beats and these arrhythmias are more persistent than the OCR.12 It is known that an intrinsic counter-regulatory process exists to restore the HR during the constant pressure on the eyeball or traction of the external eye muscles. This phenomenon is also named ‘vagal escape’ or ‘OCR fatigue’.13–14 The use of atropine
as the treatment of bradycardia is still controversial due to its latency. Gentle surgical manipulations are most important for prophylaxis and once the severe bradycardia develops, it must be treated by releasing the traction. Most of our patients studied here, including those who showed OCR, underwent surgery without significant hemodynamic derangements without the use of atropine.

Inhalation anaesthetics decrease HR in the isolated heart but mostly increase it in vivo, and the differences between agents in this regard are explained by differences in their vagolytic action. In contrast to other agents, desflurane is the only agent which invariably increases sympathetic activity, which contributes to the increase in HR. It is a pungent gas, and the increased sympathetic outflow is believed to be the result from stimulation of receptors in or near the airways, rather than by baroreceptor desensitization, which is most marked when the concentration is rapidly increased. However, increased sympathetic outflow seems to play only a minor role in the increase of HR during steady-state anaesthesia with desflurane, during which the main factor is, as with other inhalation anaesthetics, vagal inhibition. We recorded the baseline HR just before traction on the muscle, by which steady-state conditions should have been achieved, and sympathetic effects on the heart should by then have been minimal. The major influence on the incidence of OCR would be the vagolytic effect of desflurane. Cardiac vagal activity, measured by HR variability, is least with desflurane and sevoflurane, intermediate with isoflurane and enfurane, and greatest with halothane. The vagolytic effects of sevoflurane and desflurane are equal, hereby perhaps explaining the similar incidence of OCR in the two study groups.

Our results also show that among the children aged 2–10 yr, the incidence of OCR is lower in the 2–5 yr age group compared with the 6–10 yr age group. The spectral analysis of HR variability has shown that parasympathetic activity increases from 3 to 6 yr of age and then decreases from 6 to 15 yr of age in healthy children. Already increased parasympathetic activities might have a relationship with the lower incidence of OCR in younger age group in our study.

The limitation of our study is that we did not measure the end-tidal concentration of anaesthetic agent; we only controlled the inhaled concentration. The end-tidal concentration may thus be lower than the intended 1.3–1.5 MAC of anaesthetic concentration, and we may not have achieved equivalent levels of MAC with the two agents. Another limitation is that we simply observed HR as the definition of OCR. Although the most common manifestation of the OCR is sinus bradycardia, a wide spectrum of cardiac dysrhythmias may occur, including junctional rhythm, atrioventricular blockade, atrial or ventricular premature beats, and even asystole. However, Allison and colleagues reported that the incidence of arrhythmia during strabismus surgery with sevoflurane was only 4%, whereas that with halothane was 42%. We also noted that no patient showed significant arrhythmias, which needed treatment during the study period. It is true that we might have missed the arrhythmias but the expected incidence and clinical importance of arrhythmias are considered to be low.

In summary, the incidence of OCR during anaesthesia for strabismus surgery with sevoflurane and desflurane in children were similar at 26% and 28%, respectively, and did not differ significantly. The incidence of OCR was lower in children aged 2–5 yr compared with those aged 6–10 yr. Both sevoflurane and desflurane can be used effectively and safely during strabismus surgery in paediatric patients.

### References


### Table 3 The incidence of oculocardiac reflex according to age groups. HR, heart rate; OCR, oculocardiac reflex. *P<0.05 v 2–5 yr group*

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Baseline HR (min⁻¹)</th>
<th>Lowest HR (min⁻¹)</th>
<th>Incidence of OCR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2–5 yr (n=86)</td>
<td>130 (16)</td>
<td>117 (16)</td>
<td>11/86 (12.8)</td>
</tr>
<tr>
<td>6–10 yr (n=151)</td>
<td>117 (19)</td>
<td>98 (20)</td>
<td>53/151 (35.1)</td>
</tr>
</tbody>
</table>

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16 Picker O, Scheeren TW, Arndt JO. Inhalation anaesthetics increase heart rate by decreasing cardiac vagal activity in dogs. Br J Anaesth 2001; 87: 748–54
17 Ebert TJ, Perez F, Uhrich TD, Deshur MA. Desflurane-mediated sympathetic activation occurs in humans despite preventing hypotension and baroreceptor unloading. Anesthesiology 1998; 88: 1227–32
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