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The association between the oculocardiac reflex and post-operative vomiting in children undergoing strabismus surgery

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Abstract

The oculocardiac reflex (OCR) is a potentially serious complication of ophthalmic surgery which is most commonly elicited during paediatric strabismus surgery. Post-operative vomiting (POV) is also extremely common after such procedures and may result in admission following planned day-case surgery. Although many factors play a part in the occurrence of POV, stimulation of the trigemino-vagal reflex arc is thought to explain the particularly high rate of vomiting after strabismus surgery. The OCR and the vaso-vagal response share this neuronal pathway, the bradycardia of the OCR often being the only objective feature of the vaso-vagal response while the patient is anaesthetised. The aim of this study was to investigate the possible association between the occurrence of the OCR and subsequent POV in children undergoing strabismus surgery. We have studied this relationship in 79 children, aged between 1 and 13 years, undergoing strabismus surgery under standardised anaesthetic conditions. A positive OCR was regarded as a drop in heart rate of 10% or more, or the onset of a dysrhythmia. An intraoperative OCR was elicited in 51 (64.6%) of the 79 children, whilst 29 (36.7%) developed POV in the subsequent 24 h period. There was a significant association between a positive intraoperative OCR and POV ($p = 0.01$): children with a positive OCR were 2.6 times more likely to vomit than those without the reflex. We conclude that there is an association between the occurrence of the OCR and POV and discuss possible preventive strategies.

Key words Oculocardiac reflex, Surgery – strabismus, Vomiting – post-operative, Incidence, Anaesthesia – paediatric, Outpatient

Post-operative nausea and vomiting is particularly common after paediatric strabismus surgery, occurring in over a third of children over 2 years of age.[1] In addition to the distress it causes to both child and parent, post-operative vomiting (POV) is also the most frequent cause for unplanned admission after day-case surgery.[2] Although many factors may influence the occurrence of POV, its particular propensity for occurring after strabismus surgery has led to the theory that an oculo-emetic reflex is responsible. This has been described as a reflex resetting of the vomiting centre in the medulla following stimulation of the ophthalmic division of the trigeminal nerve during extra-ocular muscle manipulation.[3]

The oculocardiac reflex (OCR) is also a common occurrence in paediatric strabismus surgery, occurring in two-thirds of children over 2 years of age.[4] This is a trigemino-vagal reflex that causes an intraoperative bradycardia or dysrhythmia during ocular manipulation. The OCR is part of the vaso-vagal response, a positive OCR during strabismus surgery being predictive of a vaso-vagal response occurring during post-operative suture adjustment.[5] The vaso-vagal response can be provoked by a wider array of stimuli than the OCR and produces a range of visceral effects: trigeminal stimulation, fear, pain, the Valsalva manoeuvre and emotional shock may all precipitate the vaso-vagal response, which may cause sweating, pallor, nausea, emesis, fainting, bradycardia and/or cardiac dysrhythmia. The only objective feature of the OCR while the patient is anaesthetised is an abnormal electrocardiogram, but a concurrent effect on the vomiting centre may be partly responsible for nausea and emesis in the post-operative period.

To determine whether a positive intraoperative OCR is associated with POV in children undergoing strabismus surgery, we

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have prospectively studied the occurrence of both in 79 children undergoing strabismus surgery under standardised anaesthetic conditions and report our results.

Patients and methods

A series of healthy children undergoing strabismus surgery in the Surgical Day Unit at Birmingham Children's Hospital were enrolled into the study after parental consent. Only those children undergoing strabismus surgery to horizontal rectus muscles for the first time and who were classified as ASA group I were included in the study (the American Society of Anesthesiologists group I classification includes those patients with no organic, physiological, biochemical or psychiatric disturbance whose pathological process for which the operation is to be performed is localised and does not entail a systemic disturbance). All children who had undergone previous ophthalmic surgery, those who required regular oral medication and those with special anaesthetic requirements were excluded. In total, 79 children fulfilled the criteria.

A standardised anaesthetic regimen was used for all children, which included: a period of 6 h solid fast and 2 h liquid fast, EMLA cream applied to the dorsum of the hands pre-operatively but no other pre-operative medication. The anaesthetic was induced with propofol and maintained with nitrous oxide, isofluorane and oxygen; spontaneous ventilation was facilitated with a laryngeal mask. Topical amethocaine prior to conjunctival closure and diclofenac suppository provided prophylactic post-operative analgesia. The strabismus surgery was performed by a consultant or an experienced specialist registrar.

The patient's age and operative details were entered into a database (Fig. 1). A positive OCR was said to have occurred if the baseline heart rate decreased by at least 10% or if a dysrhythmia occurred. On occurrence of the OCR, the surgeon released traction on the rectus muscle. If the bradycardia was profound and/or refractory to release of muscle traction or if a dysrhythmia had occurred, atropine 15 μg/kg was administered intravenously by the anaesthetist.

Section I of the database was completed by the surgeon and section II by the anaesthetist. The recovery room staff and the nurses in the day-case ward were asked to fill in sections III and IV of the database form respectively. Section V was filled in by the surgeon or an orthoptist who contacted the parents by telephone 24 h after surgery.

Results

Seventy-nine patients aged between 1 and 13 years were enrolled into the study. Fifty-one (64.6%) developed a positive OCR during surgery; the other 28 (35.4%) did not. Table 1 illustrates the characteristics of these two groups. The mean age of children with a positive OCR was 5.8 ± 2.5 years compared with 5.7 ± 2.7 years in those without a measurable OCR (two-tailed unpaired *t*-test $p = 0.9$). The mean duration of surgery was 37.2 ± 6.0 min in the group with a positive OCR and 41.0 ± 7.3 min in the negative OCR group (two-tailed unpaired *t*-test $p = 0.1$). Thirty-two (40.5%) of the children studied underwent bimedial rectus recessions, 46 (58.2%) underwent a recession/resection procedure, and a unilateral muscle recession was performed on one child. An operative procedure including muscle resection was not significantly more likely to result in a

SECTION I
Patient's name: D.O.B.: Telephone no:
Strabismus type: Eso/Exo Left/Right/Alt
Date of surgery: Time start: Time finish:
Surgery performed:

SECTION II
First muscle
Pre-traction rate: Pre-traction rhythm:
Per-traction rate: Per-traction rhythm:
Second muscle
Pre-traction rate: Pre-traction rhythm:
Per-traction rate: Per-traction rhythm:
Atropine given for bradycardia/dysrhythmia: Yes/No

SECTION III
Did the patient vomit during the recovery period? Yes/No
If Yes, how many times?

SECTION IV
Did the patient vomit on the ward? Yes/No
If Yes, how many times? Was an anti-emetic required? Yes/No
Was the patient kept in hospital overnight? Yes/No If Yes, why?

SECTION V
Did the patient vomit after hospital discharge? Yes/No
If Yes, how many times?
Were any further problems encountered?

Fig. 1. *Database form.*

Table 1. *Association between clinical characteristics and the occurrence of the oculocardiac reflex*

Characteristic	Positive OCR (n = 51)	Negative OCR (n = 28)	Statistical analysis
Mean age (years)	5.8 ± 2.5	5.7 ± 2.7	Unpaired, two tailed t-test $p = 0.9$
Mean duration of surgery (min)	37.2 ± 6.0	41.0 ± 7.3	Unpaired, two-tailed t-test $p = 0.1$
No. of procedures involving muscle resection	28 (54.9%)	18 (64.3%)	χ^2 test $0.5 > p > 0.25$
No. of procedures performed by registrar	14 (27.5%)	9 (32.1%)	χ^2 test $0.5 > p > 0.25$

positive OCR than a single or bilateral muscle recession (χ^2 test $0.5 > p > 0.25$). A consultant performed the majority of the procedures (70.9%); an experienced specialist registrar performed the remainder. Using χ^2 analysis there was not a significant association between seniority of surgeon and occurrence of the OCR ($0.5 > p > 0.25$).

Of the 79 patients, 29 (36.7%) developed POV. Table 2 compares these children's operative details with the details of those who did not develop POV in the post-operative period. The only significant association found was between the occurrence of an intraoperative OCR and subsequent POV. Of the 51 children who had a positive OCR during surgery, 24 (47.1%) subsequently developed POV, whilst of the 28 children who did not develop an OCR, 5 (17.9%) developed POV (χ^2 test $p = 0.01$). Children with a positive OCR were 2.6 times as likely to develop POV than those with no measurable reflex.

Nine children required the administration of atropine per-operatively to reverse profound bradycardia or a dysrhythmia; 5 (55.5%) members of this group suffered POV in the post-operative period. Two of the 24 patients with a positive OCR and POV developed further symptoms of a vaso-vagal response following discharge from hospital; these symptoms included sweating, pallor and fainting and warranted a home visit by a general practitioner.

Discussion

Fifty-one (64.6%) of the 79 children studied developed the OCR during their strabismus surgery, a similar incidence to that found in other studies.[5–8] Twenty-nine (36.7%) vomited in the 24 h post-operative period, a proportion similar to that reported in previous studies (30–59%).[1,3,6,7,9] In addition to POV, 2 children developed other features of the vaso-vagal response including fainting after discharge from hospital.

In our group of 79 healthy children undergoing strabismus surgery for the first time under standardised anaesthetic conditions, there was a significant association between the occurrence of the OCR and POV ($p = 0.01$). If the definition of the OCR is tightened to include only those children with an induced bradycardia 20% below the baseline heart rate, the association becomes even more significant (27.8% of the children developed this degree of bradycardia, 63.6% subsequently developed POV; χ^2 test $p < 0.005$). No other patient or surgical variables tested were significantly associated with either the occurrence of the OCR or the development of POV.

Many factors such as the patient's age and gender, use of premedication, anaesthetic technique and type of surgery have been shown to influence the rate of POV;[1] our results suggest that the OCR is an important inciting factor in emesis following paediatric strabismus surgery. A number of studies in the anaesthetic literature have previously studied the relationship between OCR and POV with mixed and confusing results. Many of these studies have included patients who have had previous strabismus surgery, and are flawed by lack of a standardised anaesthetic technique, the use of premedications, anti-emetics and prophylactic anti-cholinergic agents.[6,7,10] The anaesthetic used in this prospective study was standardised and no premedications, anti-emetics, prophylactic anti-cholinergic agents or opioid analgesia were used. Several prospective, randomised studies have indicated that spontaneous ventilation during anaesthesia (as used in this study) is not associated with an increased incidence of the OCR during strabismus surgery.[8,11] It is clearly desirable to reduce the incidence of both the OCR and

Table 2. *Association between clinical characteristics and the occurrence of post-operative vomiting (POV)*

Characteristic	POV (n = 29)	No POV (n = 50)	Statistical analysis
Mean age (years)	6.4 ± 2.5	6.4 ± 2.4	Unpaired two-tailed t-test $p = 0.97$
Positive oculocardiac reflex	24 (82.8%)	27 (54.0%)	**χ^2 test $p = 0.01$**
Mean duration of surgery (min)	37.3 ± 6.4	39.6 ± 7.1	Unpaired two-tailed t-test $p = 0.3$
No. of procedures involving muscle resection	17 (58.6%)	29 (58.0%)	χ^2 test $p > 0.5$
No. of procedures performed by registrar	7 (24.1%)	16 (32.0%)	χ^2 test $0.5 > p > 0.25$

POV, and possible methods for prophylaxis include pharmacological inhibition of either the efferent or afferent pathways of the reflex arc. Although prophylactic anti-cholinergic agents such as atropine prevent the bradycardia produced by the OCR there are conflicting reports as to whether they lower the incidence of post-operative emesis.[7,10] This may imply that the effect of the OCR on the vomiting centre in the medulla may not be reliant purely on cholinergic pathways but on other neurotransmitters.[7] Anti-cholinergic agents, when administered in doses adequate to prevent the vagal consequences of the OCR, may themselves cause side-effects such as arrhythmias and tachycardia.[12] Prophylactic anti-emetics such as ondansetron and droperidol may prevent post-operative vomiting in some cases, but for every patient in whom prophylactic anti-emetic therapy is successful at preventing POV, another two will not benefit from the drug and will, additionally, be at risk of side-effects such as extra-pyramidal reactions.[2]

Local anaesthetic infiltration of the orbit has been shown to inhibit the OCR by blocking the afferent limb of the reflex[13,14] and obviates the need for systemic medication. Since retrobulbar injections risk perforation of the globe, we suggest that a sub-Tenon's injection using a blunt-ended cannula is the optimal method for anaesthetic infiltration. If sub-Tenon's infiltration with local anaesthetic is performed following conjunctival incision and before muscle traction this, in theory, would reduce the incidence of the OCR and subsequent emesis while providing excellent post-operative analgesia. We are currently testing this theory in a randomised trial.

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