The Intraoperative Oculocardiac Reflex as a Predictor of Postoperative Vaso-Vagal Responses During Adjustable Suture Surgery

Richard W. Hertle, MD, David B. Granet, MD, and Sule Zylan, MD

ABSTRACT
Adjustable suture surgery has become a popular method of strabismus correction in those cases in which results are less predictable, such as reoperations, thyroid ophthalmopathy, and blind eyes. Complications related to adjustable strabismus surgery are, in general, no different than those related to standard surgical techniques. We noticed a subgroup of patients who experienced significant vaso-vagal responses (V-VR) during postoperative adjustment and sought to discover a method of identifying these patients prior to adjustment.

Sixty patients were studied prospectively from July 1991 to July 1992. All patients had surgery under general anesthesia and were adjusted 24 hours later. A positive oculocardiac reflex (OCR) occurred when a 10% or greater intraoperative change in heart rate was associated with traction on an extracocular muscle. A positive V-VR postoperatively consisted of one or more subjective findings (dizziness, light-headedness, nausea, or body temperature changes), and two or more objective findings (10% or greater change in heart rate, hypotension, pallor, diaphoresis, vomiting, disorientation, or loss of consciousness). Variables studied for predictive value included OCR, age, sex, strabismus type, previous surgery, muscle adjusted, and systemic disease.

Twenty-five patients (41.6%) had a positive V-VR during adjustment. Twenty-seven patients (45%) had a positive OCR. Eighty-five percent of patients with a positive OCR and 9% of patients with a negative OCR had a positive V-VR. Younger patients were also more likely to have a positive V-VR.

A positive intraoperative OCR under general anesthesia during strabismus surgery is highly predictive of a postoperative V-VR during planned adjustment.

INTRODUCTION
The oculocardiac reflex (OCR) is any intraoperative decrease in heart rate by 10% or more, or dysrhythmia during ocular manipulation. This reflex was first described by Aschner and Dagnini in 1908. Reports describing the operative complications, pathophysiology, incidence, risk factors, treatments, and preventative methods have been published in the surgical and anesthesia literature.9 A variety of stimuli are known to produce an OCR. These include pressure on the globe, traction on the extracocular muscles, acute glaucoma, orbital hematoma, retinal surgery, intraocular and orbital injections, injury to the eye and orbit, nasopharyngeal manipulation, and blepharoplasty.

This trigemino-vagal reflex is part of the vaso-vagal response (V-VR). The V-VR differs in that there is more organ involvement in both the afferent and efferent arcs. Vagus nerve stimulation in the V-VR involves the visceral tissues and cerebral blood flow.11-15 The most common precipitating stimuli are trauma, pain, fear, Valsalva maneuver, and emotional shock. Premonitory symptoms include feeling alternately hot and cold, yawning, sweating, nausea, dizziness, and light-headedness.11-13 Signs include bradycardia, pallor, emesis, disorientation, loss of consciousness, cardiac arrhythmias, cardiac arrest, and death.13,15,16 The most common manifestation of the V-VR is “fainting,” which is usually inconsequential in healthy patients unless there is associated trauma from the fall.

We noticed that some patients experienced various degrees of V-VRs during postoperative adjustment of strabismus surgery. This prospective study was undertaken to identify perioperative variables which may predict this response.

From the Children’s Hospital of Philadelphia and The Scheie Eye Institute, The University of Pennsylvania, Philadelphia, Pa.
Reprint requests should be addressed to Richard W. Hertle, MD, The Children’s Hospital of Philadelphia, 34th St and Civic Center Blvd, Philadelphia, PA 19104.

SEPTEMBER/OCTOBER 1993, VOLUME 30, NUMBER 5
MATERIALS AND METHODS

All patients undergoing planned adjustable suture extracocular muscle surgery from July 1, 1991 to June 31, 1992 were prospectively studied. The following data were routinely collected as part of a prospective data base in all patients undergoing adjustable strabismus surgery by one author (R.W.H.). These included: (1) name; (2) age; (3) sex; (4) systemic medications and illnesses; (5) best corrected visual acuity in each eye; (6) refractive error; (7) disease in the other eye; (8) primary strabismus diagnosis and age at that time; (9) present strabismus diagnosis; (10) previous strabismus surgery and type (if available); (11) perioperative horizontal and vertical angle of deviation with full refractive error in prism dipters with accommodation controlled at 6 meters in primary position, 30° right and left gaze and up and down gaze, right and left head tilt, and to an accommodative stimulus at near (14 cm); (12) results of version testing; (13) forced ductions; (14) sac-cadic velocities (if accomplished); (15) surgical procedure; (16) results before and after adjustment; (17) amount of adjustment (in mm); (18) deviation after adjustment; (19) the deviation at 6 weeks; and (20) 6 months after surgery.

All surgery was performed under general endotracheal anesthesia. Pre-anesthetic medications included midazolam (Versed), fentanyl, and glycopyrrolate. Induction was performed with a mixture of thiopental (Pentothal) and Propofol. Anesthesia was maintained with a mixture of nitrous oxide and halothane. Surgery was performed in standard manner using a "slip knot" technique and a traction "bucket handle" suture of 6-0 polyglactin (Vicryl) placed near the limbus. All patients had the muscle on the adjustable suture "over" recessed in the anticipation of future adjustment (advancement). This was the case for all these patients. The adjustment was performed on all these patients the morning following surgery (20 to 24 hours later) under topical anesthesia (proparacaine drops and 4% cocaine pledget) with best corrected refraction.

The first maneuver was to grasp the pole sutures (those directly connected to the muscle which then pass through the scleral tunnel) with one needle holder and the slip knot loop suture with another needle holder. As the muscle is pulled forward by exerting traction on the pole sutures, the slip knot is moved posteriorly. It is during this maneuver, not traction on the globe using the "bucket handle" traction stitch, that the V-VR was recorded. The traction stitch is used to move the eye if more recession is required as part of the adjustment process. All these patients needed advancement. We routinely measure the postoperative deviation at distance and near, 15 to 20 minutes after the eye patch has been removed from the operated eye. The patient is in a seated position and adjusted without the use of a speculum in the same chair in a supine position. They are then returned to the sitting position and the deviation is remeasured. These steps are repeated until the desired deviation is achieved.

Additional information was recorded specifically for this study. The intraoperative OCR was considered "positive" when, during traction on any extraocular muscle at surgery, a simultaneous reduction in the patient's heart rate of greater than 10% from baseline occurred. The blood pressure was also recorded but a change was not necessary for the patient to have a "positive" OCR. This is because blood pressure, in this situation, is physiologically related to the duration, not magnitude, of change in heart rate.

V-VR postoperatively during adjustment (while the patient was supine) consisted of one or more subjective occurrences (dizziness, light-headedness, nausea, and warmth), and two or more objective findings (a change in heart rate of 10% from baseline, hypotension, pallor, diaphoresis, vomiting, disorientation, and loss of consciousness). The blood pressure was measured before, during, and immediately after adjustments using a standard sphygmomanometer. The pulse rate was continuously monitored throughout the adjustment.

The dependent variable studied was the V-VR. Independent variables included the OCR, age, sex, strabismus type, previous surgery, muscle adjusted postoperatively, and systemic disease. Statistical analysis was performed using the Wilcoxon-White (two-sample rank test), and chi-squared test.

RESULTS

Sixty patients were prospectively studied. Ages ranged from 12 to 79 years with a mean of 37 years. Sixty percent (24 patients) were women. Thirty-one patients had surgery to correct exotropia, 20 to correct esotropia, and 9 to correct a hypertropia. Twelve patients (20%) had associated systemic disease. This included hypertension and cardiac disease (6 patients), hypertension only (2 patients), cardiac disease only (1 patient), diabetes mellitus (2 patients), and AIDS-related complex (1 patient).

Twenty-five patients (41.6%) had a positive V-VR during postoperative adjustment. Subjective responses reported most often were temperature changes (24 patients), light-headedness (17 patients), and nausea (10 patients). Dizziness was reported in six patients.

All patients with a positive V-VR had a change in heart rate of greater than 10% from baseline measured in the supine position, prior to adjustment. Twenty-one of 25 patients (84%) had a drop in heart rate while the remaining four had an increase.

Signs of a positive V-VR included hypotension (blood pressure below 60 mm Hg diastolic) in 7 patients, pallor (change in color of face) in 17 patients, diaphoresis in 24 patients, vomiting in 2 patients, disorientation in 2 patients, and loss of consciousness in 1 patient. This was a 31-year-old man who regained consciousness within seconds after opening an ammonia capsule under his nose.

Twenty-seven patients (45%) had a positive OCR. Twenty-three of these patients (85%) had a postoperative V-VR during adjustment while four patients (15%) had no V-VR. Two (6%) of the 33 patients with a negative OCR had a postoperative V-VR and the remaining 21 (94%) had no V-VR (Fig 1). These differences were statistically significant ($P < .0005$) (Fig 1).
FIGURE 2 shows the age comparison between positive and negative V-VR. The average age of patients with a positive V-VR was significantly younger ($P < .05$) than those patients without a V-VR, although the minimum and maximum ages, and standard deviation were not statistically different.

FIGURE 3 shows the relationship between gender and the presence of a V-VR. Sixteen of 36 (44%) men had a positive V-VR and 20 of 36 (56%) had a negative V-VR while 11 of 24 women (46%) had a positive V-VR and 13 of 24 (54%) had a negative V-VR. There were no significant differences in these values.

Thirty-one patients were exotropic, 20 esotropic, and 9 hypertropic. Thirty-five percent of exotropes, 55% of esotropes, and 33% of hypertropes had a positive V-VR. There was a tendency for exotropes to have less V-VR, although this did not reach statistical significance.

Of the 27 patients with a positive V-VR 15 (56%) had previous surgery while 12 (44%) did not. Of the 33 patients with a negative V-VR, 14 (42%) had previous surgery and 19 (58%) did not. These differences were not statistically significant.

Of 23 medial rectus muscles, 29 lateral rectus muscles, 5 superior rectus muscles, and 3 inferior rectus muscles, 52%, 48%, 40%, and 33% had positive V-VRs respectively. There were no significant differences.

In 12 patients with concomitant systemic disease, nine patients (75%) had a positive OCR. Of these nine patients, seven (78%) had a positive V-VR. Of the three patients without an OCR, one had a V-VR and two did not. This is not significantly different from the results for the population as a whole (85% of patients with a positive OCR had a V-VR).

DISCUSSION

The use of the adjustable suture in the surgical management of strabismus has gained increasing popularity since Jampolsky's descriptions and modifications in 1974 and 1975. This has increased the success rate over traditional surgical approaches 15% to 25% in complicated strabismus cases (reoperations, restrictive, and paralytic strabismus). The major difference is the ability to adjust the operated muscle's position after the primary procedure while the patient is alert. In general, complications related to adjustable suture surgery are no different than standard strabismus surgery. Because of the need for postoperative adjustment of operated muscles, the patients are subjected to some increased discomfort, anxiety, and the possibility of V-VRs.

The OCR is reflexive bradycardia precipitated by traction on the extraocular muscles, globe, lids, and other orbital tissues. Most of the descriptions of this reflex and its clinical implications have been observed in patients during strabismus surgery under general anesthesia. This is mediated by trigeminal afferent neural impulses and vagal efferent impulses. These same vagal efferent impulses to the central nervous system mediate the subjective and objective responses associated with vaso-vagal episodes. This can be explained by the physiology of the trigemino-vagal reflex arc. In the anesthetized patient, the main evidence of an abrupt increase in vagal tone is a change in heart rate with other meningeal or cerebral signs blunted by the anesthetic agent. While awake, this response includes other signs and symptoms such as body temperature changes, nausea, vomiting, diaphoresis, pallor, light-headedness, and loss of consciousness. The OCR has been reported to occur in as high as 68% of patients undergoing strabismus surgery. Consistent with other series of patients, 45% of the 60 patients in this study had a positive intraoperative OCR.

Iseberg and Blechman were the first to report the occurrence of the OCR postoperatively, during manipulation of adjustable sutures. Flynn estimated a low occurrence rate during adjustable suture surgery, and in
a survey of the membership of The American Association of Pediatric Ophthalmology and Strabismus, the incidence of symptomatic V-VR responses occurring during suture adjustment as reported by responding surgeons was 0.28%. A similarly low incidence of a postoperative OCR was observed by Vrabec et al in 4.5% of their patients.

Events occurring during postoperative adjustment have been defined as OCR, vagal, and vaso-vagal. This may be contributing to reported difference in these events occurring in previous studies. The strict definition of a V-VR in this study required objective and subjective components. This methodology was used in an attempt to try and differentiate the bradycardia associated with traction on an extraocular muscle (OCR) from the association with various systemic signs and symptoms of valgal activity (V-VR). A "positive" V-VR during adjustment consisted of one or more subjective occurrences (dizziness, light-headedness, nausea, and warmth), and two or more objective findings (a change in heart rate of 10%, hypotension, pallor, diaphoresis, vomiting, disorientation, and loss of consciousness).

This definition of vaso-vagal activity is consistent with current medical descriptions. Other discrepancies between previous studies, in addition to inconsistent definitions of vagal responses and the OCR, include time after surgery adjustment is completed, methods of measurement, medicines, anesthetic agents used, as well as neglect of other patient variables. None of the previous studies identified preoperative or intraoperative risk factors associated with the presence or absence of an OCR or a "vagal" response. This study has clear definitions; differentiations are made between an OCR and a V-VR and selected variables were analyzed for their statistical association. Twenty-five patients (41.6%) in this prospective series experienced a V-VR during postoperative adjustment.

A positive, intraoperative OCR was the only preoperative or perioperative variable highly predictive of a postoperative V-VR (Fig 1). Eighty-five percent of patients who had a positive intraoperative OCR went on to have a positive V-VR, while only 9% of patients with a negative OCR had a positive V-VR. Only two patients who experienced a positive V-VR did not have a positive intraoperative OCR. A V-VR was also increased in younger patients (Fig 2). There was no predictive value to the muscle adjusted, strabismus type, or the presence of systemic disease. Patients who had exotropia tended to have an increased amount of V-VRs, although this did not reach statistical significance.

We prospectively determined the incidence of the intraoperative OCR and subsequent presence of a postoperative V-VR in the 60 study patients undergoing planned adjustable suture surgery. Surgery was performed uniformly under general anesthesia by the same surgeon and anesthesiologist with the same pre-anesthetic and anesthetic medications. All adjustments were performed the following day under topical anesthesia (proparacaine drops and 4% cocaine pledget) with the patient on no analgesics or sedating medicines. The patient was sitting for measurement of alignment and was supine in the same chair for adjustments. Another investigator monitored the patient's pulse, blood pressure, and subjective signs and symptoms of vagal responses during adjustment. These variables were controlled for throughout this study so as to not affect the presence or absence of a V-VR.

It has been suggested that there may be differences between adjustments made a few hours after surgery versus 24 hours later. Recently Eustis et al performed a prospective evaluation of the occurrence of vagal responses during postoperative suture adjustment, which they defined as a drop in pulse rate greater than 10% of baseline or a drop systolic blood pressure 35 mm Hg below baseline. In 20 patients adjusted 4 to 6 hours after surgery, they found 65% to have a vagal response during adjust-
ment which was significantly different from 10 control patients. Only two patients were “symptomatic” during the vagal response. In contrast, Vrabec et al found only 4.5% of their patients, adjusted the following day, to have an “oculocardiac” reflex during postoperative adjustment, with one “symptomatic.” 22 Patient characteristics, variable definitions (eg, “vagal,” “symptomatic”), methodology, analysis, and interpretive bias all may contribute to differing results. We strictly controlled the acquisition and analysis of patient data while maintaining a uniform surgical technique. A strict definition of an OCR and postoperative V-VR rather than “symptomatic” versus “asymptomatic” may have resulted in more patients being “positive” in the present study. 1,13,23,24 These definitions of OCR and V-VR are instrumental parts of this report. This study, in conjunction with that of Eustis et al, suggests that time after surgery may not be an important variable in the predisposition to a postoperative OCR or V-VR.

It is agreed that most patients undergoing adjustment after strabismus surgery experience some level of anxiety or discomfort. These afferent emotional and painful stimuli may also be related to a V-VR. These are difficult to measure and we made no attempt to measure these and analyze their predictive value in determining the presence or absence of a V-VR. The OCR is less reliable after retrobulbar anesthesia and is often eliminated by this technique. 3,6,14 The intraoperative OCR cannot be used as a risk factor for a postoperative V-VR if local anesthesia is used.

Our results also suggest that vagal responses are common in patients (41.6% in this series) undergoing adjustment. 20,22,25,26 We have also confirmed that most of these V-VRs are clinically inconsequential. 19,21,22 We have found a statistically significant correlation between the presence of an OCR and V-VR. We made no attempt to correlate the degree of OCR during surgery with the degree of a V-VR during adjustment.

Although most adjustable suture surgery is performed without “clinically significant” V-VR (as defined by observer not patient), this study shows that patients who have a positive intraoperative OCR have an 85% chance of experiencing a postoperative V-VR by the criteria mentioned previously. These results are not intended to deter surgeons from using this valuable technique. Although some degree of V-VR occurred in 41% of patients, this did not interfere with successful adjustment in any patient. If the surgeon is aware that a V-VR may be more likely in a certain patient, then preadjustment precautions can be made. These can include simple precautions such as adjusting the patient in the supine position and having available ammonia capsules, atropine, and minimal equipment for measurement of vital signs.

REFERENCES

10. Matarasso A. The oculocardiac reflex in blepharoplasty surgery. Plast...