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ORIGINAL ARTICLE

Demographic and surgical factors affecting the oculocardiac reflex during strabismus surgery

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Abstract

Purpose: Determination of demographic and surgical factors affecting oculocardiac reflex (OCR) in strabismus surgery.

Methods: 38 patients were included in the study. 74 muscles were operated. Horizontal muscle recession or resection, inferior oblique (IO) muscle recession surgery were performed. Patient's age, gender, heart rate (HR) at the beginning of surgery, surgery duration, presence of OCR, number of muscles, and muscle type were recorded. A 20% decrease in HR during muscle traction constituted the patient group with OCR.

Results: 43 medial rectus (MR), 19 lateral rectus (LR), 9 IO, 2 superior rectus, and 1 inferior rectus muscle surgeries were performed. OCR occurred in 20 (52.6%) patients. When the OCR and non-OCR groups were compared, no significant differences were found in terms of age, gender, surgery duration, and HR. The mean number of operated muscles in patients with OCR was 2.15±0.87 muscles, and in patients without OCR, it was 1.72±0.46 muscles (p=0.72). 4 (20%) of the patients with OCR had undergone single muscle surgery, 8 (40%) had undergone 2 muscle surgeries in the same eye, and 8 (40%) had undergone bilateral surgery (p=0.70). In the OCR group, there were 14 (32.6%) MR, 4 (21.1%) LR, and 7 (75%) IO, and the difference was due to IO (p=0.024). OCR occurred in 18 (40%) muscles in horizontal muscle recession, 2 (10.5%) in resection, and 7 (75%) in IO recession (p=0.02), and the difference was due to IO recession. When muscle traction was released, OCR returned to normal in all patients.

Conclusion: OCR is a life-threatening process that may have complications such as bradycardia and asystole. We think that OCR will be frequently encountered during IO surgery and that the surgery should be performed with low traction.

Keywords: Bradycardia; oculocardiac reflex; strabismus surgery.

The oculocardiac reflex (OCR) is a phenomenon defined by bradycardia or dysrhythmia during ocular surgery.[1] Manipulation of the orbital structure stimulates the ophthalmic nerve, an afferent branch of the trigeminal nerve, and stimulates the vagus nerve, an efferent branch of the trigeminovagal pathway, thus sending a signal to the sinoatrial pathway in the heart and causing bradycardia.[2] Pressure applied to the extraocular muscle, intraorbital injections, mechanical stimulation, ocular manipulations, pain, and similar stimuli can trigger OCR.[3] Although the definition of OCR is not clear in the literature, the prevalence of OCR varies between 14% and 90% according to various

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definitions.[4,5] Many factors such as preoperative anxiety, topical anesthesia preference, intraoperative hypoxia–hypercarbia, intraoperative metabolic acidosis, young age, drugs affecting vagal tone, and anesthetic agents used during surgery are effective in the occurrence of OCR.[6,7] There is no gold standard method that can prevent the occurrence of OCR due to surgical factors during surgery. The only definitive method is to eliminate the pressure on the eyeball structures. The aim of this study is to determine the demographic and surgical factors that affect OCR during strabismus surgery.

Materials and Methods

Approval for the study was obtained from the ethics committee of a tertiary hospital. (B.30.2.ODM.0.20.08/101). The Declaration of Helsinki was adhered to. The records of patients who underwent strabismus surgery between January 2021 and January 2024 in a tertiary ophthalmology clinic were retrospectively reviewed. For each patient, best corrected visual acuity, autorefraction with cycloplegic, anterior and posterior segment examination, and comprehensive eye examination findings including strabismus findings were recorded from the patient files. The medical data of 150 patients were examined. Most of the patients were in the pediatric age group. It was planned to include patients who had undergone strabismus surgery and had complete clinical follow-up data and perioperative follow-up data. It was planned to exclude patients with additional systemic diseases that could affect hemodynamic status, such as systemic hypertension, cardiac arrhythmias, thyroid diseases, endocrine, and hormonal diseases. It was also planned to exclude patients who required intervention due to hemodynamic abnormalities in the perioperative period, who had abnormalities such as hypoxia, hyperoxia, hypocarbia, and hypercarbia and who underwent correction, and who could not undergo stable deep general anesthesia. No difference was made in terms of the muscle and surgical procedure intervened in strabismus surgery. 40 patients were included in the study. Most patients did not have additional systemic diseases. 2 patients had a diagnosis of systemic hypertension and were on medical treatment, so they were excluded from the study. All surgeries were performed by a single surgeon (LNS). The horizontal muscles were reached through a limbal conjunctiva incision and the inferior oblique (IO) muscle through a fornix incision. A horizontal muscle recession or resection, and an IO muscle recession surgery were performed depending on the type of strabismus. The routine practice in our clinic is to relax the muscle to which pressure or tension is applied when OCR occurs. If there is no improvement in bradycardia, the depth of anesthesia, ventilation, and oxygenation are checked and increased if necessary. If bradycardia still persists, intravenous atropine (10–20 µg kg) is administered. Demographic characteristics such as age and gender, heart rate (HR) at the beginning of the surgery (beats/min), surgery duration, presence of OCR, number of eyes and muscles operated on in the same session, muscle type, and anesthetic agents applied to the patients were recorded from the patient files. All patients scheduled to undergo strabismus surgery under general anesthesia in our hospital were allowed to eat and drink up to 8 h before surgery. Intravenous access was provided with a 20- to 24-gauge angiocatheter. Pediatric patients who refused to enter the operating room alone were administered 0.05–0.10 mg midazolam intravenously; otherwise, no premedication was administered. We avoided the use of atropine preoperatively. Basic monitoring, including electrocardiography, capnography, noninvasive sphygmomanometry, pulse oximetry, and measurement, was performed in the operating room. Blood oxygenation was targeted to be maintained within the range of 95–100%. Endtidal carbondioxide was targeted to be maintained within the range of 35–45 mmHg. The hemodynamic status of the patients was monitored throughout the surgery. All patients received propofol (2–2.5 mg/kg), fentanyl (1 µg/kg), rocuronium bromide (0.3–0.4 mg/kg), and sevoflurane inhalation anesthesia during general anesthesia. At the end of the surgery, sevoflurane was discontinued, and the patient was extubated. The patients were transferred to the postanesthesia care unit and then taken to the care unit for monitoring.

A 20% decrease in HR during traction application to the muscles was accepted as the presence of OCR. The frequency of oculocardiac reflexes was recorded, and the patients were divided into two groups as those with and without OCR.

Statistical Analysis

IBM Statistical Package for the Social Sciences Statistics 26 was used to analyze the data. The results were analyzed and compared using descriptive statistics and Chi-square test. Quantitative data were presented as mean±standard deviation, median (min-max) values, whereas categorical data were presented as frequency (percentage). The effects of demographic and surgical factors on the occurrence of OCR were examined in regression analysis. The evaluations were made at the 95% confidence interval, and $p<0.05$ was a statistically significant difference.

Results

Thirty-eight patients were included in the study. All patients were hemodynamically stable during surgery. No patient required additional fluid loading. Blood oxygenation and end-tidal carbon dioxide were within the preoperative target range. The mean age of the patients was 18.82±16.79 (3–65) years. 18 (47%) of the patients were female and 20 (53%) were male. 74 muscles of 38 patients underwent strabismus surgery in the same session. 9 patients underwent single muscle surgery, 16 patients underwent two muscle surgery in the same eye, 3 patients underwent two muscles in both eyes, and 10 patients underwent one muscle in both eyes. 43 medial rectus (MR), 19 lateral rectus (LR), 9 IO, 2 superior rectus, and 1 inferior rectus muscle surgeries were performed. The mean HR measured at the beginning of the surgery was 91.91±22.71 (61–141) beats/min. The mean surgical duration was 42.36±14.69 (15–70) min. OCR occurred in 20 (52.6%) patients. The mean age of patients with OCR was 16.85±16.68 (2, 5–65) years, and 21.02±17.11 (5, 5–63) years in patients without OCR (p=0.45). OCR occurred in 7 (39%) of female patients and 13 (65%) of male patients (p=0.107). There was no significant difference in age and gender between patients with and without OCR. The mean HR at the beginning of surgery in 20 patients with OCR was 107.42±26.0 (15–70) beats/min, and in patients without OCR, it was 97.02±17.62 (15–70) beats/min (p=0.548). The median surgical time for patients with OCR was 45 (17–72) minutes, and for patients without OCR, it was 40 (15–70) min (p=0.249). The mean number of operated muscles in patients with OCR was 2.15±0.87 muscles, and in patients without OCR, it was 1.72±0.46 muscles (p=0.72). 4 (20%) of the patients with OCR had undergone single muscle surgery, 8 (40%) had undergone 2 muscle surgeries in the same eye, and 8 (40%) had undergone bilateral surgery (p=0.70). The results of demographic and surgical factors are given in Table 1.

When the muscles with OCR were grouped, it was seen that 14 (32.6%) MR, 4 (21.1%) LR, and 7 (77.8%) IO muscles developed OCR (p=0.024). OCR developed more frequently in the IO muscle compared to MR and LR (p=0.03). 45 had horizontal muscle recession, 19 had horizontal muscle resection, and 9 had IO recession surgery. In the comparison of OCR according to surgical procedure, OCR occurred in 18 (40%) muscles in recession, 2 (10.5%) in resection, and 7 (75%) in IO recession, (p=0.02) the difference was due to IO recession surgery. A comparison of OCR according to surgical procedure is given in Table 2. When the operated eyes were compared, 10 patients had surgery on one muscle in one eye, 16 had surgery on two muscles in the same eye, and 13 patients had surgery on both eyes; 3 of these had surgery on two muscles in both eyes, and 10 had surgery on one muscle in both eyes in the same session. OCR occurred in 4 (20%) patients in single muscle surgery, 8 (40%) in two muscle surgery for the same eye, and 8 (40%) in both eye surgeries (p=0.75). In regression analysis, it was determined that the IO muscle and IO recession surgery were statistically significant factors in the occurrence of OCR among surgical and demographic factors (p=0.08). In patients with OCR, the pressure applied to the muscle was relieved. HR spontaneously returned to normal in all

Table 2. Comparison of oculocardiac reflex frequency according to surgical procedure

Surgical procedure	Group with OCR (n/%)	Non-OCR group (n/%)
Horizontal muscle recession	18 (40)	27 (60)
Horizontal muscle resection	2 (10.5)	17 (89.5)
IO recession	7 (77.8)	2 (22.2)
MR	14 (67.4)	29 (32.6)
LR	4 (21.1)	15 (78.9)
IO	7 (77.8)	2 (22.2)

OCR: Oculocardiac reflex; n: Count; IO: Inferior oblic; MR: Medial rectus; LR: Lateral rectus.

Table 1. Comparison of demographic and surgical data between OCR and non-OCR groups

Demographic and clinical data	Group with OCR SD	Non-OCR group SD	p
Count of people	20	18	P^t=0.72
Heart beat (min)	107.42±26	97.02±17.26	P^u=0.54
Number of muscles operated on in the same session	2.15±0.87	1.72 (±0.46)	P^t=0.72
Gender (female/male%)	38.9/65	61.1/35	P^x=0.107
Age (years)	16.85±16.68	21.02±17.11	P^t=0.45
Surgical time (min)	45±14.08	40±15.10	P^u=0.24

OCR: Oculocardiac reflex; SD: Standart deviation; Min: Minute; P^t: Independent group t-test; P^u: Mann–Whitney U-test; P^x: Chi-square test.

patients. Asystole did not develop in any patient. Atropine was not required in any patient.

Discussion

OCR is a common condition in strabismus surgery. Demographic and surgical factors such as age, gender, surgical procedure, anesthesia technique, and muscle type may affect OCR. The incidence varies among studies according to the definition of OCR. In this study, a 20% decrease in HR from the moment pressure was applied to the muscle was accepted as OCR. OCR was seen in 20 patients (52.6%). This was similar to the literature.[8,9] In this study, no significant difference was found in the frequency of OCR between male and female genders, although some studies report that OCR is more common in female gender, there are also studies reporting that there is no gender difference in OCR.[10,11] Although not statistically significant, the mean age of patients without OCR was higher.

It is thought that vagus nerve stimulation becomes easier as age decreases, and vagus tonicity decreases with central nervous system development and OCR decreases as age progresses.[12,13] Different results have been reported in terms of OCR incidence according to muscle. When horizontal muscles were compared, OCR incidence was reported to be more frequent in MR than in LR.[14,15] There are also studies reporting that the incidence of OCR decreases toward MR, IO, and LR, there is no difference in OCR incidence between MR and LR, and that the incidence of OCR is not different in these 3 muscles.[8,16,17] It has also been reported that OCR develops more frequently in the oblique muscles than in the horizontal muscles, and this is thought to be due to the anatomical position of the oblique muscles requiring more muscle traction and pressure application.[11] In our study, OCR was most frequently encountered in IO recession surgery, This situation can be explained by the need for more traction due to the position of the muscle. Different results can be obtained between studies due to the variety of muscles and procedures applied to surgery. No statistically significant difference was found in terms of OCR between MR and LR and between recession and resection procedures. In this study, no significant difference was found in terms of OCR incidence in one or two muscle surgeries in unilateral eyes or two or four muscle surgeries in both eyes. This situation was similar to studies in the literature where the OCR incidence was found to be higher in the first operated muscle in the univariate model, and no significant difference was found in the multivariate model.[9] No relationship could be established between OCR and data such as the number of operated eyes and the number of muscles. However, there are studies in the literature reporting an increased incidence of OCR in more muscular surgeries.[8] In another study, regardless of muscle type, the incidence of OCR was found to be higher in the first operated muscle than in the second muscle.[18]

Conclusion

OCR is a life-threatening process that may have complications such as bradycardia and asystole. We think that OCR will be frequently encountered during IO surgery and that the surgery should be performed with low traction.

The limitation of this study may be the relatively small number of patients. We can recommend a study with a larger number of patients.

Ethics Committee Approval: The Ondokuz Mayıs Universty Committee granted approval for this study (date: 15.02.2024, number: B.30.2.ODM.0.20.08/101).

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