J Anesth (2010) 24:757–760
DOI 10.1007/s00540-010-0967-5

CLINICAL REPORT

Coronary artery spasm occurring in the setting of the oculocardiac reflex

Henry R. Kroll · Vivek Arora · David Vangura

Received: 13 January 2010 / Accepted: 29 April 2010 / Published online: 5 June 2010

Abstract The oculocardiac reflex (OCR) occurs in up to 90% of ophthalmological surgeries. Several preventive and treatment strategies have been described. Coronary artery spasm (CAS) plays an important role in the pathogenesis of variant angina and myocardial infarction. We describe an unusual case of a perioperative myocardial infarction due to CAS that occurred in the setting of the treatment of the OCR. We offer insight aimed at minimizing the deleterious effects of the OCR and its management.

Keywords Oculocardiac reflex · Ephedrine · Perioperative myocardial infarction

Introduction

Ophthalmological surgery, similar to other ambulatory surgeries, is associated with a low risk of adverse perioperative cardiac events [1]. Perioperative myocardial infarction (PMI) has been reported to occur in 0.0004% of patients undergoing cataract surgery with local anesthesia [2] and in 0.24% in patients undergoing more invasive ophthalmological surgery under general anesthesia [3]. Although the mechanism of ischemia underlying PMI is still under speculation, the postoperative procoagulant state, plaque rupture, and coronary artery spasm (CAS) are all presumed etiologies [4]. In the perioperative period, the use of sympathomimetic agents, such as ephedrine or metaraminol, has been implicated in several cases of PMI secondary to CAS [5]. Parasympathetic overactivity in the setting of damaged endothelium may induce coronary vasospasm [6]. We report a case of PMI due to CAS in the setting of the oculocardiac reflex (OCR) and its treatment.

H. R. Kroll (✉) · V. Arora · D. Vangura
Department of Anesthesiology,
Henry Ford Hospital, 2799 W Grand Blvd,
Detroit, MI 48202, USA
e-mail: hkroll1@hfhs.org

V. Arora
e-mail: varora1@hfhs.org

D. Vangura
e-mail: dvangur1@hfhs.org

Case description

A 41-year-old male [American Society of Anesthesiologists (ASA) physical status I] with decompensated extropia was scheduled for bilateral strabismus repair under general anesthesia. His height and weight were 183 cm and 80 kg, respectively. He had no history of preexisting cardiovascular disease or of its risk factors, and no history of illicit drug use. He was not taking any prescription or over-the-counter medications. Physical examination was unremarkable. Preoperative blood pressure (BP) was 129/78 mmHg, heart rate (HR) was 75 beats per minute (bpm), respiratory rate (RR) was 18 per minute, and oxygen saturation via pulse oximetery (SpO_2) was 99% on room air. The patient did not have a preoperative electrocardiogram (ECG). Standard ASA monitors, including a 5-electrode/2-lead ECG (II and V_5), were applied to the patient, and the patient had a sinus rhythm of 80 bpm. General anesthesia was induced with propofol 2 mg/kg intravenously (IV) and fentanyl 1.5 μg/kg IV. Tracheal intubation was facilitated with cisatracurium 0.12 mg/kg IV. Anesthesia was maintained with sevoflurane (approximately 2% end-tidal) in 100% oxygen with intermittent boluses of cisatracurium to maintain a train-of-four of 2/4.

Approximately 20 min into the procedure, during right lateral rectus muscle manipulation, the patient had an episode of sinus bradycardia. The lowest recorded HR was 38 bpm, and the BP was 100/40 mmHg. This sudden change in vital signs was attributed to the OCR. The surgeon was informed, and tension on the muscle was released, but there was no increase in HR. Atropine (0.4 mg) was administered IV with no change in HR, and then 20 mg of ephedrine IV in two divided doses, 90 s apart, resulted in an increase in HR to the mid 90 s and BP to 150/90 mmHg. BP, HR, and SpO_2 remained stable throughout the remainder of the procedure. At no time were ECG changes suggestive of ischemia noted. The patient received a total of 1400 ml of lactated Ringer's throughout the surgery, and blood loss was minimal. The surgery lasted a total of 150 min.

At the conclusion of the surgery neuromuscular blockade was reversed with neostigmine 0.04 mg/kg and glycopyrrolate 0.01 mg/kg IV. No rhythm or rate abnormalities were noted at that time. On the return of spontaneous respiration and removal of the surgical drapes, pink frothy secretions were noticed in the endotracheal tube (ETT). The patient exhibited no signs of struggle or biting on the ETT. The SpO_2 dropped from 100 to 91% with a fraction of inspired oxygen (FiO_2) of 1.0. BP then decreased to 80/55 mmHg. The ETT was suctioned, and patient was placed back on positive pressure ventilation (PPV), which resulted in improvement in the oxygen saturation to 100%. A decision was made to not extubate the trachea, and the patient was transferred to the Post Anesthesia Care Unit (PACU) where controlled ventilation was maintained with a FiO_2 of 1.0, RR of 16 per minute, and a tidal volume of 550 ml. The BP further decreased to 80/50, while the HR remained stable in the mid 80s. Ephedrine (10 mg) was administered IV twice, at 5-min intervals, and thereafter the BP remained stable.

A portable chest radiograph (Fig. 1) obtained while the patient was in the PACU revealed bilateral pulmonary edema. A 12-lead ECG showed normal sinus rhythm and no ST-segment changes or Q-waves, but the troponin I level drawn 5 h after the end of the surgery was elevated to 9.78 ng/ml. A cardiology consultation was obtained, and the patient was admitted to the Cardiac Intensive Care Unit (CICU) with a diagnosis of non-ST-segment elevation acute coronary syndrome (NSTE ACS).

In the CICU, the patient was treated for the NSTE ACS with continuous IV heparin. The patient also received oral aspirin, lisinopril, metoprolol, and simvistatin. The PPV was continued, and the patient was diuresed with IV furosemide. A subsequent chest radiograph, 9 h after the event, suggested resolution of the pulmonary edema, and the patient was successfully extubated on postoperative day (POD) 1. Once extubated, the patient did describe a single, self-limited episode of chest pain occurring at rest, 1 week

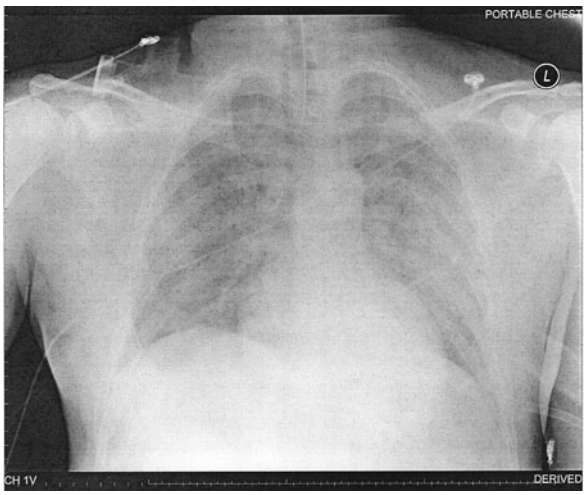

Fig. 1 Portable chest radiogram demonstrating pulmonary edema

prior to surgery. A two-dimensional ECG performed at the bedside on POD 1 revealed a normal left ventricular ejection fraction of 60–65%, mild hypokinesis of the basal-mid inferior wall, and mild left ventricular concentric hypertrophy. A coronary angiogram was also performed which did not show any fixed coronary artery disease. In light of these diagnostic findings, the NSTE ACS was attributed by the Cardiology team to CAS. On POD 2, troponin I was decreased to 6.27 ng/ml, then to 0.57 ng/ml by POD 3. All postoperative ECGs during his hospitalization showed no dysrhythmias, ST-segment changes, or Q-waves. The patient was discharged home from the CICU on POD 3 and prescribed aspirin, lisinopril, metoprolol, and simvistatin. An exercise stress test performed 2 months after surgery did not reveal any evidence of ischemia, and the patient has remained asymptomatic.

Discussion

The OCR is a trigeminal-vagal reflex which manifests as cardiac dysrhythmias, most commonly bradycardia but also nodal, junctional, and ventricular dysrhythmias. The incidence of the OCR in ophthalmological surgery ranges from 32 to 90% [7]. It is more commonly seen in pediatric patients undergoing strabismus surgery, and medial rectus manipulation has been described to be the most sensitive muscle to elicit this reflex [8]. Gentle muscle manipulation, adequate depth of anesthesia, and avoidance of hypoventilation and hypercapnia aid in the prevention of the OCR [8]. The recommended treatment for the OCR includes cessation of muscle manipulation, injection of local anesthetic around the eye muscle, and IV antimuscarinics [9].

In the presence of normal coronary arteries, vagal stimulation is known to cause coronary dilatation [10].

However in the setting of coronary atherosclerosis or endothelial dysfunction, acetylcholine (ACh), via its action on coronary muscarinic receptors, can cause CAS [11]. Sidi et al. [12] reported a case in which multiple doses of succinylcholine may have provoked muscarinic receptor-mediated CAS. It has also been reported that 90% of patients with variant angina demonstrate ACh-induced vasoconstriction [6].

In the perioperative period, CAS has been associated with the recent use of cocaine [13], hyperventilation [14], acute withdrawal of beta receptor and calcium channel blockers [15, 16], and the use of 5-hydroxytryptamine type 3 receptor antagonists [17]. The use of sympathomimetic drugs, such as ephedrine, which is an indirect acting α and β adrenoceptor agonist, has been reported to provoke CAS with or without myocardial infarction (MI) [5, 18]. The supply/demand mismatch induced by CAS plays a critical role in the development of PMI, either in the absence of preexisting occlusive coronary disease or superimposed upon it [19].

Following the guidelines of the American College of Cardiology/American Heart Association (ACC/AHA), a preoperative ECG was not indicated in this previously asymptomatic patient undergoing a low-risk operative procedure. In retrospect, however, given the recent history of chest pain, which was not elicited in the preoperative evaluation, a preoperative ECG may have been warranted. Due to the masking of chest pain by analgesics or residual anesthetics and the low sensitivity and specificity of ECG monitoring in the postoperative period [20], it is often difficult to diagnose PMI based on either the World Health Organization criteria for diagnosis of MI [21] or the universal definition of MI [22]. Thus, a PMI is often diagnosed solely by the presence of myocardial tissue-specific cardiac biomarker (troponin I and T) levels >99th percentile of that recognized in the normal population [23]. This occurred with our patient: based upon the significant troponin I elevation in the setting of pulmonary edema, a diagnosis of PMI was made. Additionally, although serial postoperative ECGs were normal, the mild hypokinesis of the basal-mid inferior wall seen on 2-dimensional echocardiography was consistent with this diagnosis. A normal coronary angiogram on POD 1 ruled out preexisting fixed coronary artery disease or plaque rupture as a cause and therefore suggested CAS to be the inciting event.

The presence of pink frothy secretions emanating from our patient's ETT at the end of surgery was indicative of pulmonary edema, which was later confirmed by a portable chest radiograph. This suggested acute severe left ventricular systolic or diastolic dysfunction due to transient coronary spasm. It is also reasonable to assume that the return of spontaneous ventilation at the end of the procedure, with its concomitant increase in oxygen demand, aggravated the oxygen supply demand mismatch and contributed to further ventricular dysfunction. Negative pressure pulmonary edema was also considered in the differential diagnosis, but was ruled out since the patient was never extubated and since during emergence, the ETT was never noted to be kinked or occluded and the patient was not bucking on the tube. Since this previously healthy fasting patient received only 1400 ml of lactated Ringer's solution over a period of 3 h, acute volume overload was an unlikely cause of the pulmonary edema.

The episode of probable variant angina 1 week prior to surgery reveals that our patient indeed had underlying endothelial dysfunction. The combination of the vagal hyperactivity that occurred during his ocular muscle manipulation and the use of ephedrine, a drug that can elicit CAS, to treat the bradycardia led to myocardial ischemia and the PMI. During the treatment of OCR, ephedrine was administered since the HR did not respond to atropine but, in fact, the IV dose of atropine administered (0.4 mg) was inadequate. In retrospect, the dose of atropine used could itself have actually caused additional vagomimetic effects, thereby contributing to the development of CAS [24].

In order to mitigate the effects of the OCR and prevent further deterioration, when pharmacological therapy is indicated, adequate doses of atropine (0.5 mg up to 3.0 mg), as recommended by the ACC/AHA for treatment of symptomatic bradycardia, should be used. Although ephedrine is not an integral part of the ACC/AHA algorithm for the treatment of symptomatic bradycardia, its use has been advocated as a first-line therapy of bradycardia in the perioperative setting [25]. It must be remembered, however, that ephedrine can induce and propagate cardiac ischemia in a variety of clinical scenarios, including vagal predominate states [5, 12], such as the OCR, which our case has illustrated.

References

1. Warner MA, Shields SE, Chute CG. Major morbidity and mortality within 1 month of ambulatory surgery and anesthesia. JAMA. 1993;270:1437–41.
2. Schein OD, Katz J, Bass EB, Tielsch JM, Lubomski LH, Feldman MA, Petty BG, Steinberg EP. The value of routine preoperative medical testing before cataract surgery. Study of Medical Testing for Cataract Surgery. N Engl J Med. 2000;342:168–75.
3. McCannel CA, Nordlund JR, Bacon D, Robertson DM. Perioperative morbidity and mortality associated with vitreoretinal and ocular oncologic surgery performed under general anesthesia. Trans Am Ophthalmol Soc. 2003;101:209–13 (discussion 13–5).
4. Adesanya AO, de Lemos JA, Greilich NB, Whitten CW. Management of perioperative myocardial infarction in noncardiac surgical patients. Chest. 2006;130:584–96.
5. Khavandi A, Gatward JJ, Whitaker J, Walker P. Myocardial infarction associated with the administration of intravenous

ephedrine and metaraminol for spinal-induced hypotension. Anaesthesia. 2009;64:563–6.
6. Okumura K, Yasue H, Horio Y, Takaoka K, Matsuyama K, Kugiyama K, Fujii H, Morikami Y. Multivessel coronary spasm in patients with variant angina: a study with intracoronary injection of acetylcholine. Circulation. 1988;77:535–42.
7. Hahnenkamp K, Honemann CW, Fischer LG, Durieux ME, Muehlendyck H, Braun U. Effect of different anaesthetic regimes on the oculocardiac reflex during paediatric strabismus surgery. Paediatr Anaesth. 2000;10:601–8.
8. Blanc VF, Hardy JF, Milot J, Jacob JL. The oculocardiac reflex: a graphic and statistical analysis in infants and children. Can Anaesth Soc J. 1983;30:360–9.
9. Yamashita M. Oculocardiac reflex and the anesthesiologist. Middle East J Anesthesiol. 1986;8:399–415.
10. Bassenge E, Heusch G. Endothelial and neuro-humoral control of coronary blood flow in health and disease. Rev Physiol Biochem Pharmacol. 1990;116:77–165.
11. Matsuda K, Teragawa H, Fukuda Y, Ueda K, Higashi Y, Sakai K, Miura F, Hirao H, Yamagata T, Yoshizumi M, Chayama K. Response of the left anterior descending coronary artery to acetylcholine in patients with chest pain and angiographically normal coronary arteries. Am J Cardiol. 2003;92:1394–8.
12. Sidi A, Dahleen L, Gaspardone A. Coronary vasospasm during anesthesia induction: awareness, recognition, possible mechanisms, anesthetic factors, and treatment. J Clin Anesth. 2008;20: 64–9.
13. Lustik SJ, Chhibber AK, van Vliet M, Pomerantz RM. Ephedrine-induced coronary artery vasospasm in a patient with prior cocaine use. Anesth Analg. 1997;84:931–3.
14. Nakao K, Ohgushi M, Yoshimura M, Morooka K, Okumura K, Ogawa H, Kugiyama K, Oike Y, Fujimoto K, Yasue H. Hyperventilation as a specific test for diagnosis of coronary artery spasm. Am J Cardiol. 1997;80:545–9.
15. Houston MC, Hodge R. Beta-adrenergic blocker withdrawal syndromes in hypertension and other cardiovascular diseases. Am Heart J. 1988;116:515–23.
16. Engelman RM, Hadji-Rousou I, Breyer RH, Whittredge P, Harbison W, Chircop RV. Rebound vasospasm after coronary revascularization in association with calcium antagonist withdrawal. Ann Thorac Surg. 1984;37:469–72.
17. Arole A, Kroll HR, Brown M. Coronary vasospasm leading to an acute myocardial infarction after the administration of dolasetron. J Clin Anesth. 2005;17:72–4.
18. Enders JM, Dobesh PP, Ellison JN. Acute myocardial infarction induced by ephedrine alkaloids. Pharmacotherapy. 2003;23:1645–51.
19. Landesberg G. The pathophysiology of perioperative myocardial infarction: facts and perspectives. J Cardiothorac Vasc Anesth. 2003;17:90–100.
20. Martinez EA, Kim LJ, Faraday N, Rosenfeld B, Bass EB, Perler BA, Williams GM, Dorman T, Pronovost PJ. Sensitivity of routine intensive care unit surveillance for detecting myocardial ischemia. Crit Care Med. 2003;31:2302–8.
21. Gillum RF, Fortmann SP, Prineas RJ, Kottke TE. International diagnostic criteria for acute myocardial infarction and acute stroke. Am Heart J. 1984;108:150–8.
22. Thygesen K, Alpert JS, White HD, Jaffe AS, Apple FS, Galvani M, Katus HA, Newby LK, Ravkilde J, Chaitman B, Clemmensen PM, Dellborg M, Hod H, Porela P, Underwood R, Bax JJ, Beller GA, Bonow R, Van der Wall EE, Bassand JP, Wijns W, Ferguson TB, Steg PG, Uretsky BF, Williams DO, Armstrong PW, Antman EM, Fox KA, Hamm CW, Ohman EM, Simoons ML, Poole-Wilson PA, Gurfinkel EP, Lopez-Sendon JL, Pais P, Mendis S, Zhu JR, Wallentin LC, Fernandez-Aviles F, Fox KM, Parkhomenko AN, Priori SG, Tendera M, Voipio-Pulkki LM, Vahanian A, Camm AJ, De Caterina R, Dean V, Dickstein K, Filippatos G, Funck-Brentano C, Hellemans I, Kristensen SD, McGregor K, Sechtem U, Silber S, Widimsky P, Zamorano JL, Morais J, Brener S, Harrington R, Morrow D, Lim M, Martinez-Rios MA, Steinhubl S, Levine GN, Gibler WB, Goff D, Tubaro M, Dudek D, Al-Attar N. Universal definition of myocardial infarction. Circulation. 2007;116:2634–53.
23. Alpert JS, Thygesen K, Antman E, Bassand JP. Myocardial infarction redefined—a consensus document of The Joint European Society of Cardiology/American College of Cardiology Committee for the redefinition of myocardial infarction. J Am Coll Cardiol. 2000;36:959–69.
24. Das G. Therapeutic review. Cardiac effects of atropine in man: an update. Int J Clin Pharmacol Ther Toxicol. 1989;27:473–7.
25. Kinsella SM, Tuckey JP. Perioperative bradycardia and asystole: relationship to vasovagal syncope and the Bezold-Jarisch reflex. Br J Anaesth. 2001;86:859–68.