Anesthetic Emergencies in Oral Surgery
Malignant Hyperthermia, Endocrinopathy, and Neurologic Events

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Significant anesthetic emergencies in oral and maxillofacial surgery office are rare events. The safety record of anesthesia in the office environment is excellent with reasonable data. However, emergencies still occur and preparedness is the key to ameliorating the impact of these events. This article addresses several of these emergencies that have a great impact despite their infrequent occurrence. The oral and maxillofacial surgeon should always consider the emergency transfer of patients who have had a significant emergent event to the nearest emergency room of an acute care facility for definitive care.

MALIGNANT HYPERTHERMIA

Malignant hyperthermia (MH) occurs in the office environment and some fatalities have occurred despite proper care and preparation. The Malignant Hyperthermia Association of the United States (MHAUS) has several resources to support clinicians whose patients may have malignant hyperthermia. MHAUS has a 24-hours-per-day, 7-days-per-week phone support answered by volunteer anesthesiologists with extensive knowledge of MH. The phone service is called the MH Hotline and the phone number is 1-800-644-9737 (1-800-MH-Hyper). The service is free of charge, and the help is invaluable. The volunteer anesthesiologists give whatever advice is needed during an ongoing crisis or are available prospectively for advice for cases with potential problems. Valuable information for patients and clinicians alike are available on the MHAUS Web site at www.MHAUS.org.

MH is autosomal dominant inheritable disease with variable penetrance. Its frequency in the United States is approximately 1000 cases per year. Survival has increased dramatically since early use of intravenous dantrolene therapy more than 33 years ago. Before the use of dantrolene therapy, the mortality of MH was approximately 90%.
Once MH is suspected, any triggering agents must be ceased. If an anesthesia machine with volatile anesthetics has been used, converting to bag-valve endotracheal tube ventilation is appropriate. A newer approach to the management of the volatile agents incorporates the use of charcoal filters on both the expiratory and inspiratory limbs of the anesthesia circuit. These filters absorb the volatile agents from the anesthesia machine to levels of less than 5 parts per million (ppm) in less than 2 minutes and effectively maintain those levels for more than 1 hour. Depending on the severity of the event, the carbon filters may need to be changed. It is not always possible to have a clean anesthesia machine in the office-based environment; the charcoal filters are effective and a reasonable substitute in an MH crisis. They are also easily replaced.

Signs of MH include unexplained tachycardia, rapid increase in end-tidal carbon dioxide levels, tachypnea, hyperthermia, masseter muscle spasm, and generalized muscle rigidity. In the office-based environment, an early call (911) for transfer of the patient to an acute care facility capable of treating MH is mandatory. A call to the Malignant Hyperthermia Hotline should also be included in the early processes if there are personnel to so assist. Steps to reduce the severity of the reaction include the rapid administration of dantrolene 2.5 mg/kg as the anchor of treatment. This initial treatment should be followed by additional doses of 1 mg/kg as clinical signs and symptoms continue. In addition, administration of intravenous normal saline, active cooling of body surface areas, and control of dysrhythmias with appropriate therapies is crucial. The most common cause of rhythm disturbances during an MH crisis is related to hyperkalemia. Treatment of hyperkalemia requires glucose and insulin administered intravenously, vigorous diuresis with fluids and furosemide, as well as intravenous calcium chloride (via central intravenous access) or calcium gluconate in peripheral intravenous access. The glucose and insulin combination and calcium force the excess potassium intracelullarly, whereas furosemide provides kaliuresis, which is the renal excretion of potassium. Attention to this detail is imperative: hyperkalemia and coagulopathy are likely the two greatest causes of death from MH. Coagulopathy is a late occurrence; it is usually the result of severe hyperthermia in excess of 41°C.

In principle, MH does not preclude surgery and anesthesia on an ambulatory basis in the hospital or ambulatory surgical center. With common sense, it should not preclude surgery in the office-based environment. Although other publications issue a precautionary note regarding MH-susceptible patients being too risky for the office-based environment, routine dental procedures occur daily in MH-susceptible patients without triggering an MH crisis. In the absence of nontriggering anesthetics, prepared practitioners should not fear that MH-susceptible patients are at any greater risk than non–MH-susceptible patients, with the exception of patients with exertional heat-related illness and central core myopathy.

In addition, there is controversy within the oral and maxillofacial surgical community about how much dantrolene should be available in the office environment. The American Association of Oral and Maxillofacial Surgeons Office Evaluation Manual, eighth edition, 2012, suggests that dantrolene be readily available at any time if triggering agents are present in the office. The greatest controversy is centered on the issue of having only succinylcholine available as a potential triggering agent without volatile anesthetic agents. A recent publication recommended that dantrolene still be available in the office because there have been instances of succinylcholine alone triggering MH. They also suggested that more epidemiologic data be available in the future to either refute or support the need for dantrolene under these circumstances.

There have been adverse reactions to the administration of intravenous dantrolene. The common complications include muscle weakness, gastrointestinal upset, and phlebitis. Serious complications associated with the administration of dantrolene were most likely caused by medical comorbidities rather than the drug itself. However, the complications of the administration are outweighed by the risks of not administering the drug. Many lives have been saved because of the appropriate administration of dantrolene.

A suggested list of rescue medications and equipment is provided in the MH medication and equipment list (Box 1).

ENDOCRINOPATHIES

There are several endocrinopathies that could require emergent treatment in the oral and maxillofacial surgeon’s office. Although there have been other books and reviews discussing endocrinopathies in the dental office, most of these are rarely if ever seen by the oral and maxillofacial surgeon. On a survey of large anesthesia and surgery departments at an academic medical center, the number of attending physicians who had seen or treated many of these acute endocrinopathies was very small. In a sampling of more than 300 faculty physicians with greater than 15 years of
postresidency practice, none had ever seen thyroid storm, myxedema coma, adrenal collapse, or acute parathyroid dysfunction (Herlich A, unpublished data, 2012).

GLYCEMIA CONTROL

Treating diabetics on an ambulatory basis has become the norm rather than the exception. The goal should be to maintain the euglycemic state and rapidly return the patient to an environment in which they can manage their food intake and glucose control.12 To prevent postoperative nausea and vomiting (PONV), it is a common practice to administer dexamethasone intravenously as part of multimodal therapy. Two articles in the anesthesia literature have implied that this practice should be examined in patients with glucose control problems. In nondiabetic patients undergoing craniotomy, a single dose of perioperative dexamethasone significantly increased the blood glucose levels and peak 9 hours after surgery.13 Another study examined the use of dexamethasone for postoperative PONV in morbidly obese patients undergoing gastroplasty. These investigators also found significant postoperative blood glucose levels in patients who received dexamethasone compared with the control group in patients with impaired glucose tolerance.14 A recent article in the clinical nutrition literature investigated outcomes of both hypoglycemia and hyperglycemia in the diabetic patient who is critically ill. The article emphasized that hyperglycemia in the critically ill diabetic patient had a stronger association with mortality than in the nondiabetic patient. Hypoglycemia was associated with increased mortality in both the nondiabetic and diabetic patient. In addition, glycemic variability had a stronger association with mortality in nondiabetic critically ill patients than in critically ill diabetic patients.15 One review suggested that diabetic ketoacidosis (DKA) and hyperglycemic hyperosmolar nonketotic (HHNK) state are increasing in frequency as well as increasing mortalities with the extremes of age.16 Acute status changes in the diabetic patient should therefore prompt transfer to an acute care environment as quickly as possible for accurate and expeditious treatment.

The diabetic patient may present to the office with clinically significant hypoglycemia. Symptoms include confusion, dizziness, diaphoresis, tachycardia, hunger, tremulousness, and possibly seizure activity. Simple treatment can vary from supplementing the patient with any oral glucose-containing solutions to providing dextrose in the patient’s intravenous fluids. Intravenous dextrose is available in ampules of 50 mL at 25% and should be administered in increments of 1 to 2 mL/kg until symptoms are corrected or reasonable blood glucose is achieved by a point-of-care testing device for blood glucose. Any patient who has an abnormal level of consciousness should not be encouraged to correct their hypoglycemia via the oral route because aspiration may be a risk. If intravenous access is not possible or has infiltrated, intramuscular glucagon is an appropriate alternative.

The severe hyperglycemic state may present as DKA or as a nonketotic hyperglycemic patient. In both circumstances, the patient requires rapid transfer to a hospital setting wherein appropriate fluid and medication correction are indicated. Nevertheless, immediate emergent treatment requires appropriate recognition. Patients are usually tachypneic, tachycardic, have abdominal pain, temperature alteration, and ketones on their breath if they present with DKA. The office-based management requires immediate administration of intravenous normal saline and regular insulin.

### Box 1
MH medication and equipment list (www.MHAUS.org)

**Drugs**
- 36 vials of dantrolene (powder); 20 mg/vial reconstituted with 36 vials of sterile water, 60 mL each
- Sodium bicarbonate 8.4% (50 mEq) × 5 ampules
- Dextrose 50 g × 2 insulin 100 units regular (drug refrigerator)
- Furosemide/Lasix 40-mg vials × 4
- Calcium gluconate 1000 mg × 4
- Calcium chloride 1000 mg × 2
- Lidocaine 100 mg/5 mL × 10 or 100 mg/10 mL × 10 or amiodarone 300 mg ampules × 3

**Equipment**
- Large intravenous catheters (sizes 18, 16, 14)
- 60-mL syringes × 5 for reconstitution/delivery of dantrolene
- Minimum of 3 L of cold normal saline for patient cooling (500-mL or 1000-mL bags are appropriate)
- A supply of ice with large and small plastic bags for patient cooling (substitute ice packs for wounds)
- Helpful stationary supplies for event: MHAUS event logs, MHAUS wall poster for treatment, MHAUS/The Society for Ambulatory Anesthesia transfer guidelines

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100 units per vial to run at 0.1 units/kg/h. Frequent blood glucose assays are mandatory because these patients’ blood glucose levels may decrease precipitously. By the time the patient reaches the acute care/hospital setting, serum potassium, phosphate, significant acidosis, and correction of electrolytes, including sodium, are required. The use of sodium bicarbonate is strongly discouraged unless the patient’s arterial blood gas pH is less than 7.0.

The initial management approaches are the same for both DKA and HHNK state. The average patient who presents with DKA has 5 to 10 L (100 mL/kg) free water deficit. The correction for this free water deficit takes many hours and should not be administered rapidly. Dextrose 5% with 0.45 normal saline is the preferred fluid with concomitant insulin infusion. Total body potassium deficit may be large and this should not be corrected rapidly either. Rapid potassium correction is likely to create life-threatening arrhythmias and too rapid a correction of free water creates the risk of central pontine myelinolysis, which may also have a high mortality. In contrast, the patient with hyperglycemic, hyperosmolar syndrome may have twice the free water deficit of the patient with DKA. The onset of HHNK state is usually a more prolonged and insidious process. In pediatric cases of HHNK, many of these patients are obese. The ability to diagnose dehydration in this population becomes more difficult. In the case of pediatric HHNK, insulin boluses are discouraged. Insulin infusions are less precipitous with respect to glucose reduction. Despite its name, HHNK only presents with coma 30% of the time. Another proportion of patients presents with focal neurologic injury or seizures. Supportive care including fluid replacement and blood pressure support are the most important issues for these patients in an office-based environment. As previously emphasized, the remainder of the complex treatment of these patients must be performed in a hospital environment because blood sugar, fluid, and electrolyte status can be closely observed and rapidly treated as changes occur in the patient. Target blood sugar should be approximately 150 mg/dL and a blood glucose level of less than 100 mg/dL is associated with poor neurologic outcomes. These data are extrapolated from the current critical care literature.

**PHEOCHROMOCYTOMA**

The perioperative initial finding of an unsuspected pheochromocytoma is a challenge in the office-based environment. The oral and maxillofacial surgeon may encounter this neoplasm but is rarely the first clinician to see this patient. Unexpected tachycardia, hypertension, diaphoresis, fever, and orthostatic hypotension may be the first clues to this problem. The differential diagnosis of pheochromocytoma includes thyroid storm, MH, neuroleptic malignant syndrome, serotonin syndrome, or cocaine intoxication. Most pheochromocytomas are norepinephrine-secreting masses. The patient may be asymptomatic in the upright position, such as walking, whereas the seated patient may become symptomatic leaning forward or when intravenous anesthetic agents are administered. Induction of anesthesia may initiate a hyperdynamic episode of a pheochromocytoma that had not been diagnosed before the anesthetic. Unknown pheochromocytomas that are encountered intraoperatively for the first time may have mortalities as high as 50% from myocardial infarctions or strokes. The hallmark of treating these patients involves alpha-blockade and beta-blockade because a large catecholamine surge may overcome only alpha-blockade or beta-blockade alone. Labetalol is the most appropriate intravenous agent in the oral and maxillofacial surgeon’s office. However, caution is needed because labetalol has been associated with precipitating congestive heart failure. Using pure beta-blockade without alpha-blockade may also result in congestive heart failure. For rhythm disturbances combined with hypertensive crises, magnesium sulfate has been successfully used for years. A loading dose of 1 to 2 g over 20 minutes followed by 1 to 2 g/h is a satisfactory dosing regimen. In 1985, the first report of its use in patients with pheochromocytomas was reported. It has subsequently been used successfully in the intraoperative management of patients with pheochromocytomas and with minimal complications.

Drugs that should not be used in patients with pheochromocytomas include meperidine, droperidol, ketamine, and ephedrine. Morphine, as histamine releaser, has also been associated with triggering a hemodynamic crisis. A case report also indicated that metoclopramide (Reglan) has also been implicated in unmasking a previously unknown pheochromocytoma. Indirect-acting agents that include ephedrine are likely to initiate a hypertensive and tachycardic response. If a bolus vasopressor is needed, phenylephrine 50 to 100 µg per bolus is less likely to precipitate problems.

**ADRENAL INSUFFICIENCY**

Clinically significant adrenal insufficiency occurring in the oral and maxillofacial surgeon’s office is a rare event unless the patient has been taking high-dose steroids. Lability of blood pressure, especially
unexplained mild to moderate hypotension, may be the key to the diagnosis. There is not widespread literature to support the concept that this event is common or serious. Most patients with a history of adrenal insufficiency are known before induction of anesthesia or sedation. Nevertheless, there are appropriate treatments for these patients if an episode is encountered. Because glucocorticoids assist catecholamines to increase vascular tone, the immediate administration of glucocorticoids such as hydrocortisone 100 mg helps to reverse the hypotensive episodes. However, preoperative administration of glucocorticoids to prevent adrenal insufficiency varies among investigators, degree of surgical invasiveness, and duration and location of the procedure. Etomidate should not be used in patients with adrenal insufficiency because it inhibits steroid synthesis, which in turn may cause acute adrenal insufficiency.

HYPERTHYROIDISM

Thyroid storm, the most severe form of hyperthyroidism, is very uncommon in the United States in the era of modern medicine. Its onset may occur at any time from the perioperative period to 48 hours after surgery. Symptomatic patients are usually well recognized before surgery and anesthesia. Elective surgery is postponed until they are functionally euthyroid. The differential diagnosis is similar to pheochromocytoma, MH, or cocaine toxicity. These patients present with tachycardia, labile blood pressure, and hyperthermia. Unlike neuroleptic malignant syndrome, these patients are not stuporous but may be delirious. If a patient presents with atrial fibrillation and fever, thyroid storm may be the cause.

Because the mortality of thyroid storm varies from 10% to 75%, emergent treatment is required and should take place in a critical care environment as soon as possible. Treatment includes hydrocortisone 100 mg to reduce the peripheral conversion of thyroxine (T4) to triiodothyronine (T3), sodium iodide, 500 mg to 1 g intravenously to promote the Wolff-Chaikoff (negative feedback for thyroid hormone synthesis) effect, propylthiouracil orally, and, most importantly, beta-blocker therapy, which reduces the peripheral conversion of T4 to T3. Emergent transfer of the patient from the office-based environment is mandatory. The patients require critical care observation for optimal and rapid recovery.

HYPOTHYROIDISM

Hypothyroidism usually has an insidious onset and does not require treatment on an emergent basis in the oral and maxillofacial surgeon’s office. The administration of anesthesia in the patient with overt hypothyroidism (severe) may initiate hypothyroid coma. Unusual sensitivity to sedatives suggests hypothyroidism in unsuspected patients. Elective procedures must be postponed until the patient is optimized. Careful titration of levothyroxine is mandatory and should take place over several days in patients with suspected coronary artery disease. Rapid administration of levothyroxine and the administration of large doses may result in an acute myocardial infarction. Patients with severe hypothyroidism are likely to require stress doses of hydrocortisone because patients with overt hypothyroidism are likely to manifest adrenocortical insufficiency. Complete reversal of all symptoms of hypothyroidism including muscular weakness may take many months. The patient is biochemically euthyroid by thyroid-stimulating hormone, T3, and T4 assays.

NEUROLOGIC EMERGENCIES

Syncope

Establishing the cause of syncope is important and has a so-called 6P outline: preprodromal activity, prodromal activity such as visual symptoms and nausea, predisposing factors, precipitating causes, passerby or witness verification, and the postictal phases including frank seizure activity. Prodromal symptoms classically include nausea, weakness, diaphoresis, and loss of visual clarity.

Pediatric syncope is usually accompanied by much concern from family members and clinicians. Despite the concern, a review in the pediatric cardiology literature indicates that less than 10% of patients evaluated had significant disorder. Causes of pediatric syncope are either cardiac or noncardiac. In the pediatric population, neutrally mediated syncope (noncardiac) is more likely than cardiac. The most common cause of syncope is vasodepressor (vasovagal) syncope. However, an in-depth history is the key to uncovering the cause. Treatment is supportive; use of the recumbent position is usually sufficient along with encouragement and appropriate education. If there is persistent bradycardia, intravenous administration of atropine 12 μg/kg (0.4 mg equivalent in the adult) helps to ameliorate the symptoms. Recurrent syncope should prompt a referral to a cardiologist. In the office-based environment, prolonged recovery or uncovering an arrhythmia should prompt the oral and maxillofacial surgeon to transfer the patient to the emergency room of the hospital for further definitive assessment and treatment. Cardiac causes of
syncope are associated with 85% of sudden deaths in children and adolescents, and 17% of young athletes who have sudden death have a history of syncope. Frequent common causes of syncope include psychological causes, which are seen in adolescents and not in children younger than 10 years of age. A cause of syncope in adolescent girls that should be considered before treatment by the oral and maxillofacial surgeon is pregnancy and pregnancy-related issues such as an ectopic pregnancy. Calling the emergency medical system (911) and establishing intravenous access with a non-dextrose-containing intravenous solution is imperative before transfer to an acute care facility. An ectopic pregnancy requires emergent transfer to a hospital and surgery to remove the ectopic fetus and correct additional bleeding sources.

Adult syncope tends to a more cardiac cause and is more common than pediatric syncope. However, in all age groups, vasovagal causes are still the most common cause of syncope. Cardiac causes of syncope include many rhythm disturbances, most notably prolonged QT syndrome, Wolff-Parkinson-White syndrome, and the Brugada syndrome. The Brugada syndrome is notable for familial sudden death in young adults, caused by a right bundle branch block, and ST elevation in the right precordial leads (V1–V3), and it is unrelated to any structural, electrolyte, or ischemic disturbances. Treatment of syncope in the adult is similar to that of pediatric syncope. Administer oxygen, establish intravenous access, and improve circulation by changing the patient’s position by placing the patient in the recumbent or upright position, depending on the position in which the patient was in at the time of the prodrome or syncope. Some elderly patients may require intravenous fluids to improve their recovery profile from syncope because dehydration in the elderly patient is a common finding.

Seizures

Oral and maxillofacial surgeons are faced with several encounters in their practice lifetimes with patients who have seizures in their offices. A history of seizures is helpful, but other possibilities include head trauma, headaches, nuchal rigidity, febrile illness, and current anticoagulant therapy. Most of these patients have readily identifiable causes of seizures that are likely self-limiting. Systemic reaction to local anesthesia from an inadvertent injection into a vein or artery has a rapid onset of seizure activity. Two-thirds of all systemic reactions were seizure activity according to one prominent report. The use of bupivacaine and etidocaine are specifically notable for problems. Children are particularly vulnerable to local anesthesia–induced seizure activity in the presence of sedation. If an oral and maxillofacial surgeon’s practice uses a eutectic mixture of local anesthesia before placing intravenous access, care must taken to prevent a toxic reaction. The mixture (eutectic mixture of local anesthetics) should not be placed on denuded or injured skin. It should also be used with great care in the young pediatric patient population. Treatment consists of airway management with the administration of oxygen; supportive care; and either a benzodiazepine, such as midazolam in small incremental doses, methohexitol; or propofol in small doses if needed because of sustained activity. All sustained new-onset seizures require immediate assessment in the emergency department of an acute care facility.

**Perioperative Stroke**

Perioperative stroke varies in occurrence from 0.05% to 7% of patients. Many strokes occur in the postoperative period, including after discharge from the postanesthetic care unit. As a result, patients who may have had a perioperative stroke in the oral and maxillofacial surgeon’s office may not be known to the practice unless high-risk patients are followed by postoperative phone calls. Patients who are predisposed to perioperative stroke are those with advanced age, previous stroke, atrial fibrillation, vascular disease, and metabolic disease. Additional factors include female gender, diabetes, chronic obstructive pulmonary disease, smoking, chronic heart failure, and low ejection fraction. Prevention of perioperative stroke requires optimization of risk factors, including use of antiplatelet therapy. If a stroke evolves during procedures in the office, straight-forward treatment is necessary. Classic findings of an acute stroke include acute facial asymmetry, slurring of the speech, limb function asymmetry, and patients stating that they are experiencing the worse headache of their lives. Effective treatment must include the termination of the surgical procedure as soon as it is safe to do so. If there is concern about the airway, the airway needs to be protected from possible aspiration of gastric contents by intubation of the trachea. Blood pressure that is abnormally increased should be carefully and gently lowered to less than 180 mg Hg systolic and 110 mm Hg diastolic. Drugs such as labetalol 5 to 10 mg every 10 to 15 minutes are helpful in controlling the patient’s blood pressure. Esmolol in 10-mg to 20-mg increments helps to lower the patient’s heart rate if it is unacceptably
REFERENCES


