Monitored Anesthesia Care for Ophthalmic Surgery

A knowledge of commonly used anesthesics can improve patients' comfort and forestall adverse events.

BY KEN Y. LIN, MD, PHD, AND JEREMIAH TAO, MD

A general knowledge of proper administration of monitored anesthesia care (MAC) for ophthalmic surgery is advantageous, especially for the novice surgeon. In this installment of "Residents and Fellows," Drs. Lin and Tao outline the various therapeutics of which ophthalmic surgeons should be aware when comanaging anesthesia for ocular surgery. Especially helpful is the table, which summarizes the key properties of common MAC agents.

Even when medications are properly administered to help relax patients, surgeons should use "verbal anesthesia" early and often. Patients often calm down when they hear the ophthalmologist describe the steps of the surgery and they hear that the procedure is going as planned.

I hope you enjoy this installment of "Residents and Fellows," and I extend an invitation to readers to submit topics for publication.

—Sumit "Sam" Garg, MD, section editor

Systemic anesthetics coupled with topical or local anesthesia can alleviate patients' pain, fear, and anxiety about undergoing ophthalmic surgery and can improve outcomes.[1-3] General endotracheal anesthesia, while necessary in certain cases, is not required for most ophthalmic surgery that is performed under MAC. Typically, an anesthesia specialist (anesthesiologist or nurse anesthetist) delivers MAC and is often responsible for titrating sedatives and monitoring respiratory and hemodynamic status. Ophthalmologists, however, should be familiar with the basics of MAC and the effects associated with commonly used anesthetic agents, because they can directly affect intraocular surgery. This article reviews the pharmacology and clinical application of several common MAC agents in anterior segment surgery, topics that are not covered in detail during ophthalmology training.

WHAT IS MAC?

The American Society of Anesthesiologists defines MAC as a specific anesthesia service in which an anesthesiologist has been requested to participate in the care of a patient undergoing a diagnostic or therapeutic procedure. MAC includes a preprocedural visit, intraprocedural care, and postprocedural anesthetic management. MAC also refers to clinical situations in which the patient remains capable of protecting the airway for the majority of the procedure. If a patient is rendered unconscious or loses normal reflexes to protect the airway for an extended period of time, general anesthesia should be considered.

The goal of MAC is to provide analgesia, amnesia, and sedation without compromising protective airway reflexes. An ideal sedative should have a rapid onset but short duration of action to ensure quick awakening and home readiness. Common medications used for sedation in ophthalmic procedures can be classified into three categories: benzodiazepines (eg, diazepam, midazolam), opioids (eg, fentanyl, remifentanil), and anesthetic induction agents (eg, propofol, ketamine). Various combinations of these drugs have been used in tandem. The literature suggests that certain combination regimens have

TABLE. PROPERTIES OF COMMON MONITORED ANESTHESIA CARE MEDICATIONS

	Midazolam	Fentanyl	Remifentanil	Propofol	Ketamine
Analgesia	-	++	++	-	+
Amnesia	+	-	-	+	+
Hypnosis	+	-	-	++	++
Onset	1-1.5 min	Immediate	Immediate	30 s	2-4 min
Duration	1.5-3 h	1 h	3-10 min	3-10 min	5-10 min
Reversal agent	Flumazenil	Naloxone	Unnecessary due to rapid metabolism	-	-
IOP	Decrease	Decrease	Decrease	Decrease	Increase
Sneezing when combined with propofol	+++	-	-	N/A	+
Respiratory suppresion	++	++	+	++	-

- indicates not often observed.
+ indicates sometimes observed.
++ indicates very often observed.

synergism and reduced side effects due to lower dosing of individual drugs. A particular combination of drugs, however, has not been shown to be consistently more effective than others.[4]

COMMON MEDICATIONS FOR INTRAOCULAR SURGERY

Benzodiazepines

Midazolam (Versed; Roche Laboratories), lorazepam, and diazepam are the most commonly used benzodiazepines in eye surgery. Their neuroinhibitory effect is thought to occur via gamma aminobutyric acid receptors and the chloride channel. As such, benzodiazepines have been shown to have anticonvulsant, anxiolytic, anterograde amnesic effects and muscle relaxant activity. All benzodiazepines are eliminated via hepatic metabolism. In patients with hepatic or cardiac impairment, the elimination half-life can be prolonged and should be factored into the preoperative dosing. One major advantage of benzodiazepines is that antagonist agents (flumazenil) are available to reverse the effects if the former are too strong.

Midazolam is the most widely used benzodiazepine because of its rapid and short-acting properties, wide margin of safety, and high therapeutic index. Highly water and lipid soluble, midazolam has a rapid onset of action—within 1 to 1.5 minutes—when given intravenously, and its effects last 1.5 to 3 hours, a considerably shorter duration than for diazepam and lorazepam. In fact, premedication with a low oral dose of midazolam (3.75 mg) has been shown to produce sufficient sedation and anxiolysis with concomitant lowering of systolic and diastolic blood pressures in cataract surgery.[5]

Some cataract surgeons who routinely operate without anesthesia support the use of sublingual midazolam preoperatively, with monitoring of blood pressure and oxygen saturation intraoperatively by trained nursing staff. Sublingual flumazenil (Romazicon; Hoffmann-La Roche) may obviate the need for intravenous access should pharmacologic reversal be needed. Oral diazepam (Valium; Roche Pharmaceuticals) is given in many surgical centers 1 hour before eye surgery. With careful preoperative screening for anxious patients, many cataract surgeons rely on oral medications alone with no anesthetic support. The trend of less reliance on anesthetic support, especially for cataract surgery, is widely expected to grow in the coming years, given the constant emphasis on cost reduction.

Lower doses of midazolam are recommended in cirrhotic patients, the elderly, and alcoholics and also when the agent is used in combination with other sedatives. Midazolam can result in respiratory depression or arrest in these at-risk groups. In addition, in those with renal or heart failure, and in people with reduced CYP3A45 activity, there is a greater risk of elevated active metabolites from midazolam.

Opioid Analgesics

Opioids are widely used in eye surgery, either alone or in combination with propofol and midazolam to achieve synergistic effects. Opioids provide analgesia and offset sympathetic responses to surgical stimuli. Side effects common to all drugs in this class include nausea and vomiting, bradycardia, respiratory depression, postural hypotension, muscle rigidity, and behavioral restlessness.

Fentanyl is a frequently used synthetic opioid. It is 50 to 100 times more potent than morphine on a weight basis. Fentanyl is an agonist for the μ-receptor and widely distributed in the central nervous system. It has a rapid onset of action, providing analgesia almost immediately after intravenous or oral administration. Fentanyl is metabolized in the liver via the cytochrome P450 system. Its effect can be reversed with naloxone.

Remifentanil is derived from fentanyl. The former drug is known for its rapid onset of analgesia and an ultra-short duration of action—only 3 to 10 minutes—due to the agent's rapid hydrolysis by blood and tissue esterase. Its brief duration makes remifentanil easy to titrate intraoperatively. In fact, if reversal is needed, simply waiting for the medication to subside is often sufficient and more effective than administering naloxone.

Alfentanil, another derivative of fentanyl, is five times less potent than fentanyl and has an onset of action of 2 minutes when given intravenously. Alfentanil's duration of analgesia is 10 minutes. Many ambulatory surgery centers prefer this agent, because it is considerably less expensive than remifentanil.

ANESTHETIC INDUCTION AGENTS

Propofol

Propofol is one of the most commonly used intravenous MAC agents owing to its favorable pharmacokinetic properties. Onset of anesthesia usually occurs within 30 seconds of the bolus infusion, and the duration is approximately 3 to 10 minutes, depending on the dose and the rate of administration. Propofol has a unique pattern of clearance. It is rapidly transformed into inactive metabolites, not only in the liver but also in multiple tissue sites, which provides for a rapid recovery even after prolonged infusion. These properties lead to a faster emergence time, a significantly lower mean anesthestic time, and an earlier recovery for patients. In addition, propofol has antiemetic effects.

Propofol causes a 17% to 27% decrease in IOP compared to baseline. This effect is observed within the first minute after infusion and persists even after 7 minutes.[6] Respiratory depression and reduced blood pressure are major side effects of propofol but are not commonly seen after low doses. For MAC, most patients require an infusion of 6 to 9 mg/kg per hour, with maintenance rates of 0.3 to 3 mg/kg per hour. Low doses of propofol lack analgesic properties and produce unreliable amnesia. As such, the drug is often used in combination with other sedatives. Other side effects of propofol include pain on injection, increased oculocardiac reflex, agitation from disorientation, and sneezing.

Several studies have reported that propofol can unmask sneezing by suppressing inhibitory neurons.[7,8] These inhibitory neurons normally keep at bay the sternutatory (sneeze) reflex initiated by the microscope light or by needle/local anesthetic agents entering into periorbital soft tissues or eyelids. Sneezing can have deleterious consequences when a needle is near or surgical instruments are inside the eye.

In a randomized, controlled trial of 81 patients undergoing oculoplastic procedures, sneezing was observed in 32% of patients receiving propofol only. In the propofol and midazolam treatment arm, 64% of patients sneezed. The propofol-opioid combination led to no sneezing, as did the propofol, midazolam, and opioid combination.[9]

Ketamine

Ketamine is a lipophilic anesthetic with sedative, amnesic, and analgesic properties. It is rapidly distributed to highly perfused organs such as the brain. The drug's onset of action is 2 to 4 minutes after intravenous injection, and the duration ranges from 5 to 10 minutes, with recovery time limited to 1 to 2 hours. Ketamine is cleared via both hepatic and renal routes, and the drug is a popular choice for the conscious sedation of pediatric patients.

Ketamine's use is limited by its potential side effects. The agent has been linked to cardiovascular stimulation, elevated IOP and intracranial pressure, emergence phenomenon, hypersalivation, and muscle hyperactivity.[10] These adverse effects are seen more commonly at higher doses. Because of these side effects, ketamine is used less frequently in ophthalmic surgery today than in the past.

Etomidate

Another sedative-hypnotic agent used for procedural sedation is etomidate. Sometimes administered in emergency departments to allow rapid sequence intubation, the drug is thought to work on the gamma-aminobutyric acid receptor to produce hypnosis without analgesia. Like ketamine, etomidate has a rapid onset of action, leading to deep but brief sedation within minutes. The agent has minimal cardiovascular side effects. It can dampen respiratory reflexes, however, and oxygen desaturation is seen more frequently in the elderly. Moreover, the drug can cause adrenal insufficiency. Because of these effects, etomidate is not used in MAC and is more often seen in the context of general anesthesia induction.

CONCLUSION

The table summarizes the key properties of the MAC agents described herein. No single MAC agent or regimen can cater to a spectrum of patient populations and a wide range of eye surgeries. MAC should be individualized to suit the patient, the procedure being performed, and the expected length of the surgery. When verbal comforting and a bottle of tetracaine fail to allay patients' anxiety, the instinct of many residents beginning cataract surgery is to

look helplessly at the anesthesiologist. Pain management is a team effort, however, and a thorough knowledge of the pharmacology of sedative agents and their side effects can help ophthalmologists to anticipate and prevent adverse events. ■

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