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Review article

Monitored anaesthesia care (MAC) and ophthalmic surgery

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Abstract

The use of monitored anaesthesia care (MAC) is increasing with the discovery of newer, more effective and appropriate drugs and techniques. MAC is intended to achieve patient comfort with safety and optimal clinical outcome and is being extensively used worldwide for cataract and other ophthalmic surgeries. This article briefly reviews the conceptual basis of MAC, its use in ophthalmic surgeries, sedative-analgesic drugs commonly used during MAC in eye surgeries, monitoring during MAC in eye surgery and the role of anaesthesia practitioners during MAC.

Key words: anaesthesia, cataract, eye, monitored anaesthesia care (MAC), sedation, surgery

Introduction

Modern medicine offers four types of anaesthesia including local, regional, general, and monitored anaesthesia care (MAC). Local or regional anaesthesia are limited to use of local anaesthetics while sedatives and other agents are used in general anaesthesia (GA) and MAC. GA is a deep state of sleep where the patient loses consciousness and sensations and usually requires assisted ventilation. MAC also uses sedatives and other agents, but the dose is low enough that patients remain responsive and breathe without assistance. Local anaesthesia and regional anaesthesia are often supplemented by MAC particularly in simple procedures and minor surgeries (Nguyen, 2000).

It is important to distinguish MAC from moderate sedation. While MAC may include the administration of sedatives and/or analgesics often used in moderate sedation, the provider of MAC must be prepared and qualified to convert to GA when necessary. Further, a provider's ability to intervene to rescue a patient's airway from any sedation-induced compromise is a prerequisite to the qualifications to provide MAC. By contrast, moderate sedation is not expected to induce a depth of sedation that would impair the patient's own ability to maintain the integrity of his/her airway. Moreover, it must be remembered that the need of proper preoperative assessment and preparation, adequate fasting as well as continuing or withholding of medications for concurrent systemic diseases in patients scheduled for surgery under MAC are not essentially different from that for GA (ASA, 2008).

MAC is intended to provide anxiety relief, pain relief, amnesia, comfort and safety during surgical procedures (Sa Rego and White, 1998). Maximizing patient satisfaction is one of the goals during MAC (Dexter et al 1997). The objectives and goals are accomplished by means of good preoperative communication and instruction, appropriate use of sedatives and analgesics, low levels of visual and auditory stimuli in the operating room while maintaining good verbal communication with the patient, and by keeping the patient warm and covered. Immediate availability of the usual monitoring device and emergency system is a must for MAC (Smith and White, 1992).

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MAC and ophthalmic surgery

Cataract and vitreoretinal surgery are the most frequently performed intraocular procedures (Congdon et al 2004). The need of limited tissue handling and minimal trauma makes ophthalmic surgery suitable for local or regional anaesthesia supplemented by MAC. Cataract surgery and other ocular interventions are among the commonest procedures carried out under MAC (Watcha, 1997). For all practical purposes, it can be generalized that the required dose of analgesics and sedative hypnotics during MAC are proportional to the intensity of noxiousness. Further, the choice of analgesics and sedatives may depend on the presence of co-morbidities in patients. In addition, the choice of analgesia and sedation may depend on the type of local or regional technique used for anaesthesia. The type of blocks used for ophthalmic surgery alters the sedation requirements due to patient discomfort or fear, or by making the surgical procedure difficult. Frightening visual experience while undergoing phacoemulsification has been reported in a significant number of patients (Tan et al 2006). Patients have been reported to perceive light and colours, or even the surgeon's hands and instruments (Yaylali et al 2003, Rengaraj et al 2004) and subjectively feel pain during iris manipulation, globe expansion and lens placements (Naor and Slomovic, 2000, O'Brien et al 2001) while undergoing surgery under topical anaesthesia. More intraoperative and postoperative discomfort has been reported in patients undergoing surgery under topical anaesthesia than other injection blocks (Jafirakis et al 2001, Srinivasan et al 2004, Friedman et al 2001, Kallio et al 2001). MAC has been used in other ophthalmic procedures such as enucleation and evisceration (Burrough, 2003). As long as the procedure is suitable and the patient is cooperative and understanding, there may be no limit of surgical procedure to be carried out under MAC.

The need of sedation, analgesia and monitoring during MAC depend on the types of eye procedure and the local anaesthetic techniques used (Vann et al 2007). The sedative analgesic techniques used during MAC have evolved with the availability of newer short-acting sedative hypnotics and analgesic agents. An ideal agent (or combination) would be easily titrated to produce the desired effects, have low incidence of perioperative side effects, and allow for rapid recovery.

Several drugs and combination can be used during eye surgeries but this article focuses on the most commonly used drugs during MAC.

Midazolam (White & Negus, 1991; Omoigui, 1999; Mercandetti, 2008)

It is a short-acting benzodiazepine sedative-hypnotic useful in patient requiring short-term sedation and is an effective amnestic agent. Its loading dose ranges from 0.025 to 0.05 mg/kg intravenously. The maintenance dose is 1-2 µg/kg/min intravenously titrated to the effect. Its most important contraindications include narrow angle glaucoma, preexisting hypotension and sensitivity to propylene glycol (the diluent). Its sedative effects may be antagonized by theophylline. Narcotics and erythromycin may accentuate the sedative effects of midazolam by decreasing its clearance. Midazolam must be used with caution in patients with congestive heart failure, pulmonary diseases, renal impairment and hepatic failure.

Propofol (Ferrari & Donlon, 1992; Omoigui, 1999; Vann et al 2007)

It is a phenolic compound unrelated to other types of anticonvulsants. It has general anaesthetic property and has the advantages of antiemetic property, lower incidence of awareness, and more satisfactory sedation. Pain on injection is the most commonly reported side effect among patients given propofol. The loading dose of propofol during MAC is 0.2 mg/kg followed by maintenance of 0.1-0.2 mg/kg/min (6-12 mg/kg/hr). It is contraindicated in documented hypersensitivity. Its dose must be reduced when used concomitantly with benzodiazepines, opioids and phenothiazines. Theophylline may weaken its effect and a dose decrease may be required. It should not be administered with blood or blood products using the same intravenous catheter. Patients may develop apnoea and hypotension during its use and therefore require continuous respiratory and cardiovascular monitoring. The patient's movement is a common undesirable response to stimulation seen in eye surgery patients during propofol sedation (Oei-Lim et al 2006).

Fentanyl (Sa Rego & White, 1998; Omoigui, 1999; Mercandetti, 2008)

Opioid analgesics are often used during MAC procedures for pain relief. Fentanyl is a commonly used drug during MAC. It is a potent narcotic analgesic with a much shorter half-life than morphine sulphate. Many consider it as the drug of choice for conscious sedation-analgesia. It is an ideal agent for analgesic action of short duration during anaesthesia and the immediate postoperative period. It is used at a dose of 0.5-1.0 μg/kg/dose intravenously or intramuscularly repeated every 30-60 minutes. It is contraindicated in documented hypersensitivity. Concomitant use of phenothiazines antagonizes the analgesic effects of fentanyl. Adverse effects of fentanyl may be potentiated by concurrently administered tricyclic antidepressants. Fentany must be used with caution in patients with hypotension, respiratory depression, constipation, nausea, emesis and urinary retention. Chest wall rigidity is a frequently encountered problem with fentanyl.

Remifentanil (Rosow, 1993; Omoigui, 1999; Vann et al 2007)

It is an ultra-short acting opioid with elimination half time of 10 minutes and context sensitive half time of 3-5 minutes. Although remifentanil is capable of producing all the usual opioid-related side-effects, its rapid elimination reduces the duration of these undesirable effects. Remifentanil is given as an intravenous bolus of 0.5-1 μg/kg over 30-60 seconds followed by infusion of 0.025-0.1 μg/kg/min. Infusion rates greater than 0.2 μg/kg/min are generally associated with respiratory depression. Bradycardia, nausea vomiting and recall are the frequently encountered problems with remifentanil.

Clonidine (Kumar et al 1992; Omoigui, 1999)

Alpha-2 agonists reduce central sympathetic outflow and have been shown to produce effective anxiolysis and sedation. Oral clonidine 300 μg has been shown to provide effective anxiolysis for elderly patients undergoing ophthalmic surgery under local anaesthesia and also to decrease the incidence of intraoperative hypertension and tachycardia. It is used as an intravenous bolus of 0.1-0.2 mg (2-4 μg/kg) over 5 minutes. The intravenous infusion dose of clonidine is 1-2 μg/kg/hr. Hypotension, bradycardia, rebound hypertension on withdrawal, urinary retention and nausea vomiting are its important adverse effects.

Dexmedetomidine (Aantaa et al 1990; Alhashemi, 2006; Vann et al 2007)

It is a highly selective a-2 agonist which is more potent than clonidine. It has sedative, anxiolytic and analgesic properties without respiratory depression. Its actions are similar to benzodiazepines when used for premedication. When used at a dose of 1.0 μg/kg intravenously followed by infusion of 0.1-0.7 μg/kg/hr, it produces satisfactory sedation but at the cost of cardiovascular depression and prolonged recovery room stay. The actual place of dexmedetomidine for sedation during eye surgeries under MAC is yet to be ascertained.

Although ketamine in a sub-anaesthetic doses produces analgesia while preserving airway patency, ventilation and relative cardiovascular stability, its side effects, such as hypertension and psychomimetic emergence reaction, limit its use as a sole sedative agent for MAC (Loots & Wiseman, 2006). However, favourable results have been reported when ketamine has been used in combination with other sedative agents (Frey et al 1999; Moorthy & Valluri, 2002; Rand et al 2000). Besides, various other drugs and combinations are being used for sedation and analgesia during MAC for eye procedures, but there is lack of sufficient evidence to indicate one drug or combination to be superior to others in terms of outcomes such as pain, adverse events and patient satisfaction (Katz et al 2000, Vann et al, 2007).

Monitoring during MAC

The anaesthesiologist is responsible for providing the patient with an optimal balance between patient comfort and safety using the appropriate sedative, analgesic, anaesthetic and cardiovascular drugs (Sa Rego & White, 1998). It is important to ensure that the monitoring techniques used during MAC are effective, simple to operate, non-invasive and economical (Sa Rego et al 1997). The basic monitoring standards during MAC by anesthesiologists are not different from that of GA. The basic monitoring during MAC includes assessment of oxygenation, ventilation, temperature and continuous presence of qualified anaesthesia personnel (ASA, 2005). In addition, it is essential to monitor the level of sedation in patients undergoing surgery under MAC (Sa Rego et al 1997). Ramsay scale (Ramsay,

1974) and the Observer's Assessment of Alertness/ Sedation scale (Cherni et al 1990) are the two commonly used sedation assessment tools. The Visual Analogue Scale for sedation, though useful for other types of surgical procedures, (Smith et al 1994) is not obviously suitable for ophthalmological procedures. The EEG Bispectral index has been shown to correlate well with the depth of sedation (Liu et al 1996) but can be of limited practical use in ophthalmological surgical procedures. Proximity of the operation site to the patient's airway and surgical draping not only make monitoring difficult but also hamper ventilation during surgery (Inan et al 2003), warranting special attention.

Continuous presence of a qualified anaesthesia practitioner is an essential part of monitoring of patients undergoing surgery under MAC. Changing surgical techniques have influenced the practice of anaesthetic care. The cost-effectiveness of monitoring by anaesthetic practitioners during eye surgeries is being questioned. Studies have shown the need of intervention by anaesthesiologists in more than one third of the patients undergoing cataract surgery under local/ regional anaesthesia (Rosenfeld et al 1999, Pecka & Dexter, 1997). Monitoring by trained Respiratory Care Practitioners and Registered Nurses (with provision of ready availability of anaesthesiologists for consultation) have shown anaesthesiologist consultation in 4% (Zakrzewski et al 2005) and 9% (Tantri et al 2006) of cases while following standard anaesthetic protocol. Identified conditions for the increased need of interventions by an anaesthesiologist include systolic hypertension, cardiac arrhythmias, pulmonary diseases, renal diseases, previous or current cancers, and ASA physical status III or more (Rosenfeld et al 1999; Heindl, 2005; Tantri et al 2006).

The practices of monitoring of the patients during local/regional anaesthesia for ophthalmological surgeries seem to vary widely throughout the world. More than 95% of Australian and American ophthalmologists and more than 70% of Singaporean ophthalmologists use trained anaesthesia practitioners for monitoring during cataract surgery compared to less than one third in countries like Malaysia and Thailand (Eichel & Goldberg 2005; Wagle et al 2007). However, the technique using intravenous sedation with block anaesthesia and presence of anaesthesia personnel for monitoring during the case has been considered the preferred approach by an expert panel of surgeons and anaesthesiologists convened for decision analysis of anaesthesia management for cataract surgery (Reeves et al 2001). Monitoring by anaesthesia personnel during cataract surgery can be further justified by the patient's and surgeon's satisfaction (Fung et al 2005).

Conclusion

MAC is being used extensively in cataract surgery and other ophthalmic procedures worldwide for ensuring patient comfort and safety as well as for the patient's and the surgeon's satisfaction. The development of appropriate and suitable drugs and techniques for MAC has further increased its practice and utility. However, it is essential to ensure adequate preoperative assessment and preparation as well as recommended basic standard of monitoring of oxygenation, ventilation, haemodynamic parameters, temperature and level of sedation by qualified anaesthesia personnel, which is not different from that required for GA.

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