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Anesthesia Techniques for Otologic Surgery

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Abstract

The middle ear surgery anesthesiologist has multiple competing concerns when supporting the patient with middle ear diseases, but the priority must be focused on adequate resuscitation to facilitate surgical hemostasis and to choose better anesthesia method. A broad, evidence-informed knowledge of airway management, resuscitation, physiology, pharmacology, and critical care is required to address the unique pathophysiological processes encountered in middle ear surgery. Judicious selection of anesthetic agents is crucial to ensure optimal outcomes. In this review, we describe approaches for the induction and maintenance of general anesthesia for the patient with middle ear surgery. Considerations for ongoing resuscitation and hemodynamic instability with the focus on the choice of anesthesia method (Local, General) and type of agent. The use of anesthesia for middle ear surgery will be explored and discussed with respect to the administration of anesthetic induction and maintenance agents. Practices at our institution are reviewed, including the administration of high-dose opioids as an integral part of both resuscitation and anesthesia for the patient with middle ear disease.

Keywords: Middle ear surgery, Otologic surgery, Local anesthesia, General anesthesia

1. Introduction

An air-filled cavity between oval window and tympanic membrane is called the middle ear. Facial nerve is traversed this cavity via the sty-lomastoid foramen prior of exiting the skull.

A tube called eustachian tube is connecting the middle ear to the nasopharynx, it is close to the labyrinth of the inner ear temporal lobe, jugular bulb and cerebellum (Fodale et al., 2008;Bayramet al., 2012) The middle ear is formed of three ossicles, stapes, malleus and incus. These ossicles are responsible of the transmission of sound vibration from eardrum to the cochlea. The middle ear is in close to the cerebellum, temporal lobe, the labyrinth of the inner ear, and the jugular bulb. The facial nerve is providing the facial expression via motor innervation muscles (Bayramet al., 2012; Xu 2018).

2. Middle ear surgeries with anesthesia

All ages patients might be affected by middle ear diseases. In children, common middle ear surgery like myringotomy, tympanoplasty, cochlear implantation mastoidectomy and grommet insertion (Xu 2018). In adults, pathologic conditions of middle ear requiring surgery include stapedectomy or ossiculoplasty for otosclerosis, tympanoplasty (reconstructive surgery of tympanic membrane, or eardrum), removal of cholesteoma and mastoidectomy for removal of infected air cells within the mastoid bone (Xu 2018). Although all surgery can be performed under general anesthesia but some of these operations can be done under local anesthesia.

3. Choice of anesthetic in middle ear surgery

the perioperative period, a great care should be given with size consideration and delicate of content of the middle ear and the unique location. In addition to a special considerations of monitoring the facial nerve provision, a field of bloodless surgery, management of airway, head positioning attention of patient, calm recovery and smooth and the middle ear affection by nitrous oxide and vomiting and postoperative nausea prevention (PONV) (Elsharnouby et al., 2006; Yosry and Othman, 2008; Sung 2018; Xu 2018).

Minimizing the bleeding or/and reach a bloodless surgical field is the ideal target for any surgeon as even small amounts of blood could be obscured by microsurgery view of the surgeon. In order to minimize the bleeding, pharmacological and physical techniques are combined for better results. To avoid congestion and venous obstruction, attention to the position of the head of patient is important. Furthermore injury to the cervical spine and the brachial plexus might occur because of torsion or extreme hyperextension (Elsharnouby et al., 2006; Radwan et al., 2018).

Good analgesia, rapid 1/2Q8 recovery and vomiting and avoidance of nausea are essential for most outpatient of the middle ear surgery (Dal et al., 2004).

Auscultating for carotid bruit before surgery for patients with carotid atherosclerosis, carotid blood flow is important. In addition, depth of anesthesia monitoring could be useful in case of sudden unexpected patient movement, which could lead to the risk of failure of surgery (Elsharnouby et al., 2006; Fodale et al., 2008; Yosry and Othman, 2008; Radwan et al., 2018; Sung 2018).

In the general anesthesia, laryngeal mask airway (LMA) is used to maintain the airway, or endotracheal intubation; intubation may be more appropriate if extreme neck extension or rotation is required. Meanwhile wide range of devices and suitable alternative are now possible for common middle ear surgery. The Patient undergone surgery of reconstructive middle ear, and in order to avoid prosthesis displacement, no coughing start recovery is important. The nitrous oxide use is controversial in the middle ear surgery.

After middle ear surgery, Postoperative nausea and vomiting (PONV) might happened, which could be minimized by antiemetic prophylaxis and anesthetic technique choice (Fodale et al., 2008; Yosry and Othman, 2008; Radwan et al., 2018;Sung 2018).

Muscle relaxants should be avoided in case of otologic surgery is facial nerve paralysis, and a nerve stimulator is often employed for intraoperative monitoring of evoked facial nerve electromyo-graphic activity. It is important to consider the need for neuromuscular monitoring arises in advance, before choosing a dose and an agent that ensures the return of function (Sung 2018; Fodale et al., 2008; Radwan et al., 2018; Yosry and Othman, 2008).

4. Preparations of pre-operation

Considering the history of hypovolemia, anemia, and cardiovascular disease, could minimize the possibilities of hypotension. For pediatric patients, it is important to care for syndromes of coexisting and any present infection of respiratory tract especially the upper part, with consideration to the preoperative assessment regular components.

In adults, although complicated preparations should be considered under general anesthesia, local or general anesthesia might be done for simple middle ear surgery.

General anesthesia may be performed for patients of total loss of hearing since they lose the ability of hindering cooperation. While local anesthesia would be better choice for patients with ability of hearing, communicating and cooperating with full understanding the procedures of the operation (Amin et al., 2018).Benzodiazepines with anxiolysis premedication (oral) or intraoperatively used standard sedation could be introduced (Guntz et al., 2005).

A bloodless operative field is essential, because even a few drops of blood can obscure the surgical field. Physical and pharmacologic techniques are used: a head-up tilt 15to 20, avoidance of venous obstruction, normocapnia, and controlled hypotension. Controlled hypotension is defined as a reduction of systolic blood pressure to 80 mm Hg90 mmHg, a reduction of mean arterial pressure to 50 mm Hg to 65 mm Hg in patients without hypertension, or a reduction of 30%of baseline mean arterial pressure in patients with hypertension (Olgun, et al., 2012).

5. Anesthesia selection

Local and general anesthesia are two different modalities of anesthesia used in ear surgery. While each offers its own advantages and disadvantages, usually the choice of anesthesia in ear surgery depends mainly on the surgeon's preference.

Auriculotemporal nerve provides the meatus of outer auditory, innervation to the ear is provided by four nerves. The great nerve of auricular (auricular nerve) is suppling part of external auditory meatus and the lower and medial area of aurical. The tympanic cavity is supplied by the tympanic nerves, and the external auditory meatus and the concha are supplied by the auricular branch of the vagus nerve (Fodale et al., 2008; Yosry and Othman, 2008; Radwan et al., 2018; Sung 2018).

In conclusion, with careful patient selection, local anesthesia with sedation is a good alternative to general anesthesia for simple middle ear surgery (Steinlechner et al., 2006; Fujii 2008; Merkus et al., 2018).

Advantages and disadvantages of general anesthesia: Despite these advantages, however, and the special concerns of general anesthesia for middle ear surgery outlined earlier, most middle ear surgery is still performed under general anesthesia.*(1)* General anesthesia (GA) offers comfort to the patient and ease to the surgeon, especially for patients who can't tolerate the procedures under local anesthesia. *(2)* Less nausea and vomiting. *(3)* General anesthesia with TIVA provides a better recovery profile(Squire et al., 2018).

Advantages and disadvantages of local anesthesia: Local anesthesia can be considered for uncomplicated middle ear surgery. Thus, by selection of patient carefully, explanation clearly before operation and the use of sedation properly, otologic surgery under local anesthesia could be positively performed, with high patient and operator satisfaction and acceptance(Ryu et al., 2008; Zeng et al., 2018).

Although LA for middle ear surgery is a well-established procedure, yet, only a limited number of otolaryngologist adopt it (20 % in UK) (Chou et al., 2018).

The Advantages of Local Anesthesia: Local anesthesia (LA)*(1)* decreases the operative time. *(2)* Improves hemostasis and allows intra-operative hearing assessment.*(3)* Less bleedingless cost, The cost effectiveness of LA is agreed upon by many authors (Merkus et al., 2018)**,**the shorter operative time, saving the cost of GA and shorter hospital stay all contribute to the low cost of LA as compared to GA. *(4)*Similarly, the noise during surgery and anxiety, followed by dizziness, backache, claustrophobia, and earache most common discomforts reported. Nevertheless, 89% of patients claimed that they would prefer local anesthesia for similar operations in the future. Pain was felt mainly at the beginning of surgery when multiple injections of local anesthetic were given, and perhaps the preoperative application of lidocaine and prilocaine (EMLA) could have assisted in this(Becker and Reed, 2006). *(5)* Postsurgical analgesia. *(6)* Better and faster patient's mobilization. *(7)* Intraoperatively ability to hearing test. *(8)*Patients who underwent middle ear surgery under local anesthesia experienced less immediate postoperative pain than those under general anesthesia. A multimodal analgesic approach combining opioids, nonsteroidal anti-inflammatory drugs/coxibs, ½Q14 and acetaminophen is generally appropriate. A recent study found blockade of the auricular branch of the vagus nerve with 0.2 mL of 0.25% bupivacaine to be more effective than intranasal fentanyl (2 mg/kg) in management of postoperative pain in infants and children undergoing myringotomy and tube placement (Tomita et al., 2009). *(9)*For the surgeons, the main advantage of performing middle ear surgery under local anesthesia is the ability to test hearing during surgery (Neal et al., 2010;Habibollahi et al., 2011; Abdellatif et al., 2012).

Disadvantages of Local Anesthesia: *(1)*In spite of its advantages surgeons were always concerned that patients may not tolerate discomfort during the operation.*(2)*The main concerns of not performing middle ear surgery under local anesthesia are that patients may not tolerate the discomfort and the possibility of sudden movement.*(3)* Potential toxicity, as near-toxic plasma levels of local anesthetic have been reported in the first 5 minutes following infiltration for tympanoplasty. *(4)* Head may be obscured by drapes during surgery. *(5)* Extra vigilance is required for possible respiratory depression or airway obstruction (Razavi 2018).

6. Agent's selection

There are many product- and patient-specific factors that must take into account when selecting an anesthetic agent. It is important to consider all of these factors when developing the pre- and post-anesthesia plan.

6.1. Propofol

The term Propofol (ICI 35868) is an IV anaesthetic agent which has specific properties includes, amenestic,hypnotic and sedative. These characters causesfast loss of consciousness. Propofol up to date is the first and best choice as day care drug for surgeries because of its short elimination half-life, high plasma clearance, and intrinsic anti emetic features (Keskin et al., 2017). The most important advantages of using Propofol could be the easy use and control, less PONV comparing to other agents, no anti-reaction, no dysphoria and finally fast recovery (Bujedo 2018). Nevertheless, the Propofol has disadvantages which could be considered as drawback of use, including the pain at the site of the injection, haemodynamic and depression the respiratory system (Kerker et al., 2010; Chidambaran et al., 2015).

Benedik and Manohin (2008) compared safety and efficacy of propofol versus midazolam for conscious sedation in middle ear surgery. The study demonstrated that propofol was associated with significantly shorter recovery time and better patient and surgeon satisfaction compared with midazolam. Adverse effects of propofol and midazolam, such as respiratory depression, hypotension, and sudden intraoperative movements, are obvious drawbacks (Cai et al., 2009).

6.2. Alpha-2 agonists

Alpha-2 agonists such as clonidine or, more recently, dexmedetomidine. Dexmedetomidine has been approved by the Food and Drug Association (FDA) in 1999 for sedation of mechanically ventilated patients (Figure 1).

The use of Dexmedetomidine have been used for specific procedures outside the operation room.

Dexmedetomidine have been found as a very positive agent since it was been tested in various clinical studies in the current balanced anesthesia practice (Pankaj and Rajan, 2014).

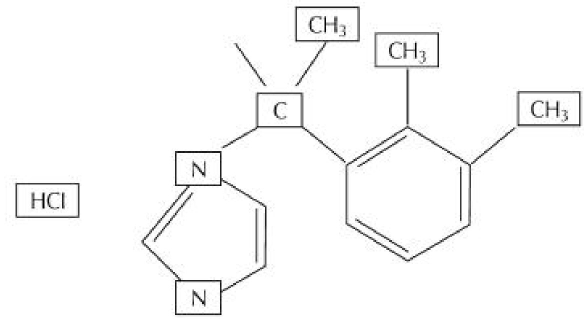

Figure 1 Chemical Structure of Dexmedetomidine (Hariharan and Natarajan, 2017)

It has some advantages, as they produce arousable sedation, analgesia, and a modest reduction in heart rate and blood pressure without respiratory depression, particularly important when the head is obscured by surgical drapes. (Yuen 2009).Dexmedetomidine has been used successfully as the primary sedative with supplementary low-dose propofol and midazolam for monitored anesthesia care during awake thyroplasty, a procedure that requires the patient to verbalize when asked and otherwise remain immobile (Busick et al., 2008).

Surgeons reported satisfactory operating conditions, and patients had no recall of the procedure and no pain (Poon and Irwin, 2009). It also has a role in awake craniotomy (Sehra, et al., 2018).Thus, dexmedetomidine could be used in a similar way for middle ear surgery but has not been widely reported in the literature.

The alpha-2 adrenoceptor agonists, clonidine and dexmedetomidine, have been discussed earlier in relation to their sedative and analgesic properties. They also markedly reduce catecholamine secretion, are anesthetic sparing, and produce moderate bradycardia and hypotension.(Ayoglu et al., 2008).A randomized study investigating the effective-ness of dexmedetomidine in reducing bleeding during septoplasty and tympanoplasty operations demonstrated dexmedetomidine significantly reduced bleeding and fentanyl requirement in septoplasty and reduced fentanyl requirement in tympanoplasty operations, but the decrease in bleeding was not significant (Ayoglu et al., 2008).

Durmus and colleagues31 used dexmedetomidine to improve the quality of surgical field in both tympanoplasty and septoplasty, and concluded that dexmedetomidine is a useful adjuvant to decrease bleeding.

6.3. The Laryngeal Mask Airway (LMA)

One of the most important measures employed for patients under general anesthesia in the operating room, was to maintain patent airway and provide suÿcient ventilation. Although several techniques and devices were developed for this purpose, most of them have special requirements.

The management of the airways is an essential component of anesthesia training and the inability to establish a secure airway is the most prevalent concern about anesthesia, in relation to mortality and morbidity. Laryngeal mask airway (LMA) plays an important role in modern anesthesia.

It is usually used to maintain the airway during spontaneous breathing of patients undergoing elective short term surgeries, having a difficult airway and under emergency situation. Correct placement of LMA needs some degree of expertise (Yazicioglu et al., 2005; Bhattacharya et al., 2008; Lin et al., 2011; Dutt et al., 2012; Kumar et al., 2012; Radheyet al., 2017). However, LMA can be used in emergency conditions, where patients cannot be intubated. In an emergency practice, LMA is considered to be better than mask ventilation, yet has lower applicability compared with endotracheal intubation. The design of LMA allows for a patent way for ventilation from the epiglottis opening through the ventilation system. The LMA uses an inflatable silicon cuff to provide a laryngeal seal (Radhey et al., 2017).

If the position of the LMA is optimal, its orifice will be appropriately inserted through the glottis. The tip of the LMA is placed in the initial parts of the esophagus, lateral portion of pear-shaped cavity and superior edge of the base of the tongue. The inflatable cuff is adjusted according to the anatomy of the airway and provides a relatively tight barrier against air leak. Proper placement of the LMA is required for appropriate anesthesia depth and suppression of airway reflexes to avoid gag reflex, coughing, and laryngeal spasm (Radhey at al., 2017). Various anesthesia methods and techniques for LMA placement have been suggested (Dutt et al., 2012). The time needed for placement, to provide ventilation is referred to as the placement time. In the study of Lin et al (2011), the mean of placement time was 16 seconds. Some anesthesiologists use muscle relaxant to facilitate LMA placement (Lin et al., 2011). Using LMA is easier in comparison with intubation and is associated with smooth emergence. If this is not done in the appropriate time, especially in high risk patients (e.g. patient with ischemic heart disease or hypertension) or patients with hypersensitive airway, adverse reactions, such as straining, coughing and intense abdominal muscle movement can lead to undesirable complications. The determination of the optimal time for LMA placement is of prime importance (Yazicioglu et al., 2005; Park and Kang, 2007). Therefore, the aim of the present study was to determine the appropriate placement time in patients under general anesthesia.

Endotracheal intubation and laryngoscopy during general anesthesia is associated with many potential complications such as sore throat, cough, dental injury, difficult emergence, and use of muscle relaxants for tube insertion (Taheri et al., 2009). In comparison, the LMA is free from such complications, and a smooth recovery can be attained easily. It also offers advantages of intravenous sedation with less risk of over sedation and obstructive apnea (Lygia, 2018). Safety and efficacy of the LMA were compared with endotracheal intubation in patients who underwent otologic surgery in a retrospective chart review study conducted at a military tertiary care teaching hospital. No major airway complication was reported in either group; a significant decrease in the use of neuro-muscular blockers was noted in the LMA group, and total anesthetic time was also shorter in this group. There was no difference in the incidence of PONV or duration of post anesthesia care unit stay(Ayala et al., 2009).The use of the LMA for head and neck procedures is reviewed by Mandel in this issue.

6.4. Vasodilators Sodium Nitroprusside and Nitroglycerin

The vasodilators sodium nitroprusside and nitroglycerin have become less popular because of adverse effects and the availability of better agents. Sodium nitroprusside is very potent and has a fast onset and offset, but it has several serious adverse effects including tachyphylaxis, rebound hypertension, organ ischemia, and cyanide toxicity(Degoute, 2007).Sodium nitroprusside employed as an adjunct to sevoflurane anesthesia in children improved surgical field visibility but provoked lactic acidosis and increased hypercapnia (Degoute, 2007). Nitroglycerin is a short acting nonspecific direct vasodilator of venous and arterial vessels, which does not produce toxic metabolites. Compared with sodium nitroprusside, nitroglycerin is less effective in inducing hypotension and does so more slowly (Degoute, 2007).Both agents require close blood pressure monitoring, preferably with an arterial line.

6.5. Sevoflurane

In the present study, anaesthesia was maintained during surgery with sevoflurane. Furthermore, the low solubility of sevoflurane makes it a good agent for rapid induction and fast emergence from anaesthesia with reduced airway irritability. In addition, a previous investigation showed that although sevoflurane has a hypotensive effect, it does not alter cerebral blood flow, whereas propofol has less protective effect on inner ear microcirculation (Merkus et al., 2018). Many studies have concluded that magnesium sulphate reduces anaesthetic and analgesic requirements for surgery. Steinlechner et al (2006), found that magnesiumsulphate lowered cumulative remifentanil requirements after cardiac surgery, and Olgun et al (2012), showed that magnesium sulphate reduced propofol, remifentanil, and vecuronium consumption. The results of the present study suggest that magnesium sulphate has a more powerful anaesthesia-potentiating effect than remifentanil.

V A slightly elevated position of the head reduces arterial and venous pressures in areas above the heart; however, it increases the risk of air embolism. In the presence of hypotension, elevating the head will further compromise perfusion of the head and neck region. Pharmacologic agents used for controlled hypotension in ear, nose, and throat surgery include: inhalation anesthetics (eg, isoflurane and sevoflurane), vasodilators (eg, sodium nitroprusside and nitroglycerin), beta adrenoceptor antagonists (labetalol and esmolol), alpha-2 adrenergic agonists (clonidine and dexmedetomidine), opioids (remifentanil), (Degoute et al., 2007) and more recently magnesium sulfate (Ryu et al., 2009). However, controlled hypotension is not without risk; in addition to the adverse effects of certain pharmacologic agents, it can cause tissue hypoxia by reducing microcirculatory autoregulation of vital organs.

Controlled hypotension is required for middle ear surgery to achieve a bloodless operative field (Jackevičiūtė et al., 2018). Vasodilators(nitroprusside, nicardipine, and nitroglycerine), alpha2A adrenergic agonists (clonidine and dexmedotomidine), betaadrenergic antagonists (propranolol and esmolol), alphaand beta-adrenergic antagonists (labetolol), and high doses of potent inhaled anesthetics (halothane, isoflurane, and sevoflurane) have been used to control hypotension during middle ear surgery (Jackevičiūtė et al., 2018). Remifentanil is also well known to induce good surgical conditions by controlling hypotension during tympanoplasty (Degoute et al., 2003; Degoute et al., 2001;Bayram, 2012). However, intraoperative remifentanil infusion can cause postoperative hyperalgesia (Fodale et al., 2008), and early postoperative analgesia is necessary after remifentanil based anesthesia (Gollapudy, 2018).

Remifentanil is an ultrashort-acting mu receptor agonist. It is able to decrease systemic blood pressure, reduce blood flow to the middle ear, and produce better visibility in the operative field without impairing autoregulation of the middle ear microcirculation (Degoute 2003; Degoute 2007). The proposed mechanism of action is via central sympathetic blockade. Degoute et al., (2003), reported that remifentanil combined with sevoflurane in children enabled controlled hypotension, reduced middle ear blood flow, and provided a good surgical field for middle ear surgery with no additional need for other hypotensive agents. Furthermore, remifentanil reduced sevoflurane requirement and helped avoid the use of muscle relaxants. There is some evidence that intraoperative infusion of high doses of remifentanil can cause postoperative hyperalgesia, increasing the postoperative analgesic requirement but this is controversial (Lee et al., 2005; Bayram et al., 2012).

Magnesium sulfate is a noncompetitive N-methyl-D aspartate (NMDA) receptor antagonist with anti-nociceptive effects, and it inhibits entry of calcium ions into cells. Magnesium sulfate is used as a vasodilator for controlled hypotension. Ryu et al., (2009), compared remifentanil and magnesium sulfate for middle ear surgery in terms of hemodynamic effects and postoperative pain when combined with sevoflurane. They reported no significant difference over time in mean arterial pressure or heart rate between the drugs. Patients in the magnesium sulfate group had a lower sevoflurane requirement than those receiving remifentanil. Overall, magnesium sulfate was associated with more stable perioperative hemodynamics and produced better analgesia and less PONV compared with remifentanil.

Otologic surgical procedures are associated with facial nerve paralysis, and thus facial nerve protection is an important consideration. Preservation of the facial nerve can be easily confirmed if the patient is not paralyzed (Miller, 2005), but use of muscle relaxants compromises the interpretation of evoked facial electromyographic activity. Since any sudden movement could jeopardize surgery, it has been suggested that partial neuromuscular blockade as determined by train-of-four peripheral nerve stimulation be used (Cai et al., 2009).

In moderate concentrations, isoflurane lowers blood pressure via a vasodilating effect while preserving cerebral autoregulation. However, at higher concentrations, it causes an increase in intracranial pressure due to increased cerebral blood flow and impairment of cerebral autoregulation (Degoute et al., 2001). Sevoflurane produces its hypotensive effect by direct vasodilatation without modifying cochlear blood flow (Kuratani and Oi, 2008; Hayama et al., 2012). In addition, it has a low blood gas solubility and low airway irritability, making it a good agent for gas induction in pediatric patient, although its use is commonly associated with emergence agitation and negative postoperative behavioral changes in this group (Hayama et al., 2012). In high concentrations, inhalation anesthetics interfere with the measurement of evoked ½Q11 potentials use for facial nerve monitoring.

This study shows that when combined with sevoflurane, remifentanil and magnesium sulphate produced similar intraoperative conditions and haemodynamics during middle ear surgery. However, our results demonstrate that magnesium sulphate has more advantages during the emergence and postoperative periods, and that its usage was associated with more stable perioperative haemodynamics (smaller increases in MAP and HR) and better recovery profile (less postoperative pain and fewer PONV incidents) than remifentanil (Ryu et al., 2009).

Middle ear surgery is associated with a high incidence of PONV, which can approach 80%.18 This problem can be managed by adopting a total i.v. anesthesia technique incorporating propofol, by administering anti-emetics such as dexamethasone or a serotonin 3A receptor antagonist, or by both.18 In the present study, patients in the magnesium sulphate group had a lower incidence of PONV than those in the remifentanil group, which we suspect may be related to a lower consumption of sevoflurane during anesthesia, (Ryu et al., 2009). Since remifentanil itself had no overall impact on PONV. (Ryu et al., 2009).In a previous study, middle ear surgery was performed as a day-case procedure, and only one-third of patients could be discharged on the day of surgery, primarily because of PONV. (Ayala 2009).Accordingly, because PONV can be a barrier to early recovery and discharge, the use of intraoperative magnesium sulphate may be beneficial in patients undergoing middle ear surgery. In addition to PONV, patients in the magnesium sulphate group tended to experience less postoperative shivering, which concurs with previous investigations on the subject (Kazerani et al., 2009; Leal et al., 2011).

6.6. Beta Adrenoceptor

Beta adrenoceptor blockade decreases myocardial contractility and heart rate, while alpha blockade produces vasodilatation (Degoute et al., 2007). Adverse effects include bronchospasm, prolonged hypotension, and conduction blockade. Esmolol is a short-acting beta-1 adrenoceptor antagonist, which has an onset time of about 3 minutes and duration of action of approximately 10 minutes. It decreases blood pressure by lowering heart rate and reducing renin activity and catecholamine levels (Casamayor, et al., 2018).Compared with sodium nitroprusside, beta adrenoceptor antagonists lower blood pressure and reduce blood flow to the middle ear and improve surgical field without metabolic complications (Degoute et al 2001).

So search for an appropriate and easily available pre-medicant to make general surgical anesthesia more stress-free is going on for the last few years. It has been demonstrated that beta-adrenoceptor blocker, in low therapeutic doses, causes only modest reduction in cardiac output while decreasing the incidence of arrhythmia and myocardial ischaemia after laryngoscope and intubations(Ijipma et al., 2018). Even a single dose of beta-blocker given as pre-medications decreases the incidence of myocardial ischaemia (Frank 2016). Propranolol has been shown to exert a alleviating effect in anxiety in addition to beta-blockade.

Furthermore it is generally of low cost and there is convenience about its dosing and routes of administration.

Magnesium sulphate is a non-competitive N-methyl-Daspartate (NMDA) receptor antagonist with antinociceptive effects and also inhibits the entry of calcium ions into cells. Magnesium sulphate has been investigated in the context of controlling hypotension as a vasodilator, but no comparative study has been performed on the use of magnesium sulphate or remifentanil for controlled hypotensionduring middle ear surgery (Talaat et al 2018).

6.7. Total Intravenous Anesthesia (TIVA)

In another study comparing propofol-based anesthesia with inhalation anesthetic techniques in terms of recovery profile and incidence of postoperative nausea and vomiting (PONV) for middle ear surgery, TIVA was associated with more rapid emergence and less nausea and vomiting (Chou et al., 2018).

The etiology of PONV is multifactorial and depends on various factors, including patient demographics, history of PONV, anesthetic technique, use of nitrous oxide, duration of anesthesia and operation, and even surgical experience (Isik et al., 2006).

TIVA reduces PONV compared with using volatile agents (Sehra, et al., 2018). Use of nitrous oxide is associated with a higher incidence of PONV. Patients operated on by residents required more aggressive prophylaxis for PONV than those operated on by specialists (Radwan et al., 2018). Prophylactic administration of anti-emetic medication also decreases the incidence of PONV.

Isik et al (2006), compared the efficacy of ondansetron (0.1 mg/kg), dexamethasone (0.15 mg/kg) and a combination of ondansetron (0.1 mg/kg) and dexamethasone (0.15 mg/kg) for prevention of PONV in a randomized double-blind study involving 90 ASA I and II ½Q12 patients. They concluded that prophylactic therapy with ondansetron together with dexamethasone is superior to either drug alone.

Another study comparing the efficacy of combining granisetron and dexamethasone to either drug alone yielded similar ½Q13 results.This also holds true in pediatric patients (Alipour et al., 2013).

Thus, the combination of a selective 5-hydroxy tryptamine type 3 receptor antagonist together with dexamethasone is more effective in preventing PONV than either drug alone. Kim et al (2013), compared the antiemetic efficacy of dexamethasone combined with midazolam and concluded that the addition of midazolam did not significantly reduce the overall incidence of PONV compared with dexamethasone alone. However, the addition of midazolam did lower the incidence of vomiting and the need for rescue antiemetic (Kim et al., 2013).

Versus volatilebased anesthesia for middle ear surgery long has been a subject of debate.

Sehra, et al (2018),compared PONV, pain, and conditions for surgery in patients who had undergone middle ear surgery under TIVA using remifentanil and propofol, with technique using fentanyl, propofol, and isoflurane maintenance. More patients in the inhalation group suffered from PONV (25%) versus the TIVA group (8%) in the recovery room. In the early postoperative period, the TIVA group reported higher pain scores and required more morphine in the recovery room, but there was no significant difference at 2, 4, 6, 8, 12, and 18 hours. Conditions for surgery in the TIVA group were reported to be superior(Radwan et al., 2018).

6.8. Nitrous Oxide

Since pressure levels of medical gases are reduced in several steps from high pressure in gas tanks to ambient pressure within the anesthesia machine, there may be a simple and cheap technical strategy to discover dangerous nitrous oxide misconnections when providing anesthesia. The pressure within gas tanks is first reduced to a medium pressure for all gases prior to entering the pipelines of the hospital, and is then being reduced in a last step within the anesthesia machine to ambient air pressure. According to our suggestion, nitrous oxide could be “marked” with a lower pressure than oxygen and room air within the hospital’s gas pipeline system. Subsequently, a simple manometer in the anesthesia machine directly prior to flow meter controls could detect any misconnection of gas pipelines by pressure differences(**Figure 1 A, B**) Mitterlechner et al., 2018.

However, it is unknown whether a reduced nitrous oxide pressure provides adequate flow to ensure constant tidal volumes. We tested maximum achievable nitrous oxide flows at different pressures within an anesthesia machine. Our formal hypothesis was that there would be no differences in maximum gas flows when using different pressures within the nitrous oxide pipeline Table 1. (Mitterlechner et al., 2018).

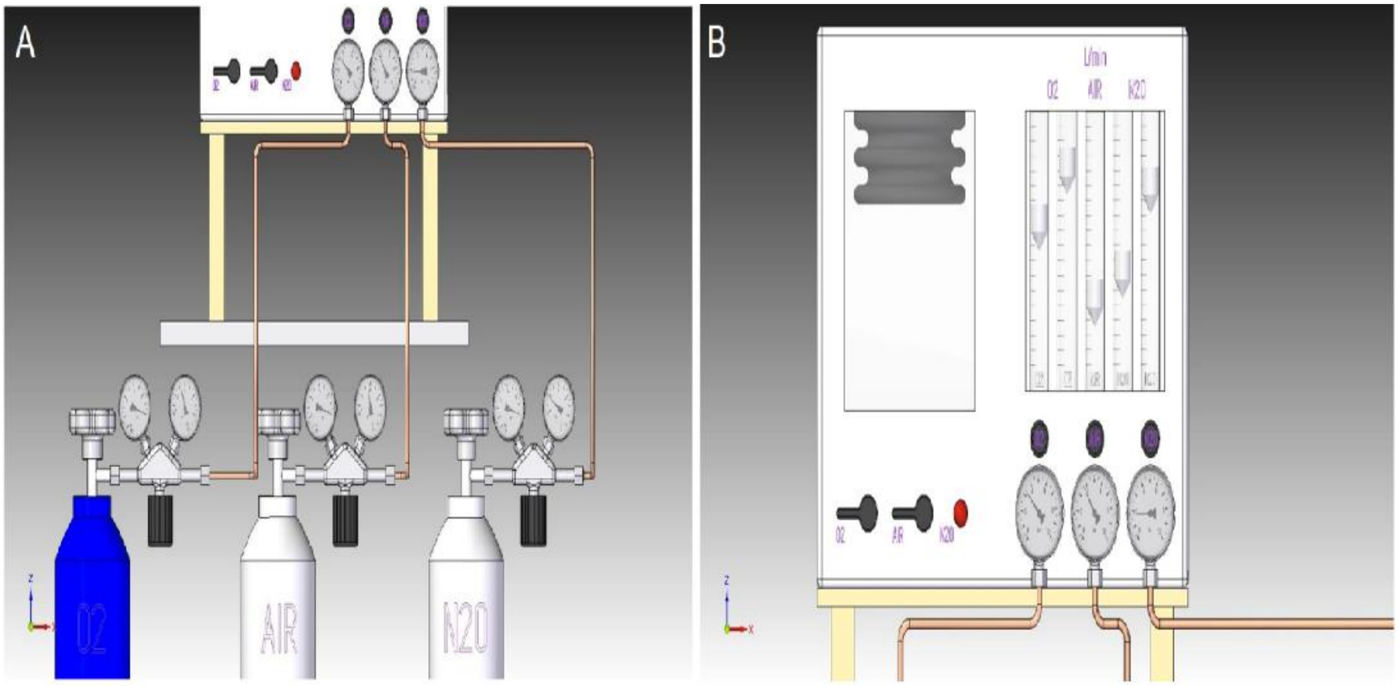

Figure 1: Proposed setting with different pressures.

Note: (A) Gas tanks with the adjustable pressure transducers. All tanks are filled to their maximum pressure (left manometer). Gas pipeline line pressures for oxygen (and air) are explicitly higher than that for nitrous oxide (right manometer). (B) Pressure levels in gas pipelines generated by pressure transducers fixed on the gas tanks can be controlled with a manometer in the anesthesia machine. Any misconnection between nitrous oxide (N_2O) and oxygen (O_2) can be detected there by comparing pressures.

Table 1: Results for gas flows depending on changes of nitrous oxide (N_2O) supply line pressure

Pressure N_2O line (hPa)	O_2 flow at 50% N_2O (L/min)	O_2 flow at 70% N_2O (L/min)	N_2O flow at 50% N_2O (L/min)	N_2O flow at 70% N_2O (L/min)	P between N_2O flows
5000	10±0	4.2±0	10±0	10±0	
4500	10±0	4.2±0	10±0	10±0	
4000	10±0	4.2±0	10±0	10±0	
3500	10±0	4.2±0	10±0	10±0	
3000	10±0	4.2±0	10±0	10±0	
2500	10±0	4.2±0	10±0	10±0	
2000	10±0	4.2±0	10±0	10±0	
1500	10±0	4.2±0	10±0.2	10±0	0.343
1000	7.8±0.2(0.03)	3.8±0.2(0.001)	7.8±0.2(0.001)	9.0±0.4(0.001)	0.001
500	4.2±0.6(0.001)	1.8±0.4(0.001)	4.2±0.6(0.001)	4.0±0.6(0.001)	0.71
0	0±0(0.001)	0±0(0.001)	0±0(0.001)	0±0(0.001)	

Note: N_2O flows automatically decrease in dependence of decreasing pressures in the N_2O supply line (pressure N_2O line). Oxygen (O_2) flows are reduced manually at the anesthesia machine to maintain stable nitrous oxide - oxygen ratios. Data are given as the mean ± SD. Distribution of data was analyzed using Kolmogorov-Smirnov analysis; we used unpaired Student's *t*-test for comparison of nitrous oxide flows at a given pressure between the two gas mixture ratios; we further used paired Student's *t*-test to detect changes in gas flow for each gas in regard of reduced nitrous oxide supply line pressure (comparison within group). Numbers in brackets represent *P* value within group compared to previous result; 1000 hPa is 1 bar.

The use of nitrous oxide in anesthetic practice has declined in recent years as a result of concerns over both physical and metabolic effect (Sanders et al., 2008; Irwin et al., 2009).The use of nitrous oxide in middle ear surgery is particularly controversial. Nitrous oxide is more soluble than nitrogen in blood and in high concentrations enters the middle ear cavity more rapidly than nitrogen leaves, causing a raise in middle ear pressure if theeustachian tube is obstructed (Swaminathan andVBalakrishnan, 2018).During tympanoplasty, the middle ear is open to the atmosphere; thus there is no build-up of pressure, but once a tympanic membrane graft is placed the continued use of nitrous oxide might cause displacement of graft. At the end of surgery, when it is discontinued, nitrous oxide is rapidly absorbed, which may then result in negative pressure also possibly resulting in graft dislodgement, serous otitis media, disarticulation of the stapes, or impaired hearing (Morgan et al., 2006).Thus, the use of nitrous oxide is not recommended in tympanoplasty. Furthermore, a well known adverse effect of nitrous oxide is PONV, and consequently, its use in middle ear surgery may further increase the incidence of PONV above that already associated with this type surgery.

7. Conclusions

The middle ear surgery anesthesiologist has multiple competing concerns when supporting the patient with major surgery (Otologic Surgery), but first and foremost, the choice of anesthesia method (Local or General) must be considered according to the case of the patient. In addition the choice of the agent should be decided after considering several manners and after adequate resuscitation must be assured to enable surgical hemostasis. Furthermore, the judicious selection of anesthetic agents is crucial when supporting the physiology of the severely patientof middle ear surgery. Future studies are warranted to evaluate the effect of different anesthetic regimens on physiological endpoints and clinical outcomes.

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