Intermittent Apnea and Total Intravenous Anesthesia for Microscopic Laryngeal Surgery

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Intermittent apnea with inhalational anesthesia has been reported to improve the visualization of the larynx but it has some disadvantages from inhalational anesthetics. The authors evaluated the use of total intravenous anesthesia instead of inhalation anesthesia in 30 patients undergoing microscopic laryngeal surgery. Anesthesia was started with propofol, fentanyl and cisatracurium. The patients were ventilated with 100% oxygen and the period of intermittent apnea, guided by pulse oximetry and end tidal carbon dioxide monitoring, was started by removal of the endotracheal tube. This technique provided a good visualization and immobile field for the operation. The average duration of apnea was 258 $\pm$ 107 sec. The number of periods of apnea ranged from 1 to 4. A few patients showed some sympathetic responses to surgical stimuli. In conclusion, intermittent apnea with total intravenous anesthesia, with appropriate precaution, could be used without any serious adverse outcome for microscopic laryngeal surgery.

Keywords : *Intravenous anesthesia, Intermittent, Apnea, Laryngeal surgery*

J Med Assoc Thai 2004; 87(5): 547-50

The optimal condition for microscopic laryngeal surgery is a clear vision of the larynx without any movement during the operation. This requires the artificial airway to be as small as possible and minimal movement from ventilation during the surgery. Therefore, under this surgical requirement, anesthesia is difficult because the procedure shares a common airway. Laser is frequently used for this type of surgery. It has the risk of combustion of the tube and inhalational anesthetic agents[1-3]. Jet ventilation via a small metallic tube seems to be one of the solutions, but it has risks of barotrauma and smoke suffocation. It is not suitable for patients with upper airway obstruction[4]. During the jet ventilation, some movements occur. Anesthesia with intermittent apnea and withdrawal of endotracheal tube may be another solution[5]. If a patient receives full oxygenation and ventilation, his ventilation can be safely interrupted for a while, like holding the breath while diving in a swimming pool. Nevertheless, inhalational anesthetic agents still have a combustion risk and need to be interrupted during the apneic period. Currently, new short-acting intravenous anesthetic agents, opioids and muscle relaxants have been developed. Total intravenous anesthesia might be appropriate for this procedure[6-8]. With this in mind, the authors conducted a clinical trial to evaluate the feasibility, usefulness and problems of intermittent apnea with total intra-venous anesthesia during microscopic laryngeal surgery.

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Material and Method

The Ethic Committee of the Faculty of Medicine, Chulalongkorn University approved the study protocol. Thirty ASA physical status I or II patients, 2-65 years of age, who were scheduled for elective microscopic laryngeal surgical procedures were recruited into the study. Patients who were morbidly obese, tracheostomized or had high risk for aspiration were excluded. Written informed consent was obtained from every patient. In cases that laser

was used during the procedure, laser precaution was appropriately followed[9].

Every patient received premedication with atropine 0.01 mg/kg IM for drying secretion and bradycardia attenuation. Midazolam 0.1-0.2 mg/kg was also given orally for anxiolytic and amnesic effect. Then intravenous dexamethasone 0.2 mg/kg was given at the beginning of the operation for prevention of laryngeal edema.

After preoxygenation for 5 min, induction was started with intravenous fentanyl 1 mcg/kg plus propofol 1-2 mg/kg. Then ventilation with a mask was performed and cisatracurium 0.1-0.2 mg/kg was given intravenously. Operating laryngoscope and oral endotracheal tube was inserted when full relaxation was indicated by the absence of muscle response from the nerve stimulator at the ulnar nerve.

Intermittent propofol 0.5 mg/kg was injected when there was a sign of awakening, increasing blood pressure or increasing heart rate. More muscle relaxant and fentanyl were added as required. During the surgical procedure, intermittent apnea and withdrawal of endotracheal tube were allowed when vital signs were within normal range (20% of baseline), oxygen saturation not below 99%, and end tidal carbon dioxide less than 40 mmHg. When oxygen saturation from the pulse oximeter decreased to 97%, reinsertion of the endotracheal tube through the operating laryngoscope was immediately established. Then the oxygenation was rapidly restored by ventilation with 100% oxygen.

The monitoring throughout the procedure included noninvasive blood pressure, electrocardiogram, pulse oximetry, end tidal carbon dioxide (Datex, Finland)[10], airway pressure, and fractional inspire oxygen concentration. Oxygen saturation change, apnea duration, number of intubations and operation time were accordingly recorded.

At the end of operation, the patients were extubated under the following conditions:

1. Good consciousness: responds to command appropriately,

2. Adequate respiration: end tidal carbon dioxide less than 55 mmHg with spontaneous respiratory rate more than 8 times per min,

3. Recovery of muscle strength: muscle power grade 4-5 and train of four from neuromuscular stimulation showing no fading (atropine and prostigmine for reversal of muscle relaxant were given when necessary)

Related complications such as laryngeal edema, hypoxia, and hypercarbia were documented.

Results

There were 19 male and 11 female patients recruited into the study. Six of them were children below 15 years old. The age ranged from 2 to 65 years old. The weight ranged from 12 to 84 kg. Eighteen patients had a history of previous microscopic laryngeal surgery from 1 to 30 times.

All patients completed the study without any serious adverse outcome. The average time from starting of anesthesia until the end of operation was 24.9 min (ranged 10-50 min). The mean $\pm$ SD of dosages of propofol, cisatracurium and fentanyl were 9.5 ± 3.5 mg/kg/hr, 0.46 ± 0.15 mg/kg/hr, and 3.3 ± 1.3 mcg/kg/hr respectively.

The authors used ordinary polyvinyl chloride endotracheal tubes, which had the a range from 4.0 to 7.5 mm of internal diameter. Nine patients could complete the operation within one apnea session. The overall average of the first apnea duration of 30 patients was 258.0 ± 107.0 sec. The longest duration of apnea safely performed was 500 sec. The duration of apnea decreased with the following session of apnea (Table 1). The average rising of end tidal carbon dioxide was 12.6 ± 5.1 mmHg.

The most common problem during the operation was a cardiovascular problem: sinus tachycardia, premature ventricular contraction, premature atrial contraction and hypertension (Table 2). One patient had oxygen saturation below

Table 1. Number and mean duration of apnea session

Number of apnea (times)	Number of patients	Mean duration (sec)	Standard deviation
1	9	258.0	107.0
2	12	213.3	95.1
3	3	176.2	59.1
4	6	152.2	80.4

Table 2. Incidence of peri-anesthetic adverse events

Adverse events	Number of patients
Hypertension	4
Sinus tachycardia	3
Premature ventricular contraction	1
Premature atrial contraction	1
Sinus bradycardia	1
Muscle weakness	2
Awareness	1

90% for a while because of a technical difficulty in reinserting the endotracheal tube. The problems after operation were sinus bradycardia, muscle weakness which required another dose of reversal and awareness. The patient who had awareness could recall the intraoperative event 24 hours later. She reported some discomfort due to the instrument in her mouth without any pain. All of the above problems resolved without any serious consequence.

From the surgical point of view, the visualization of the glottis in all patients was graded as excellent and good. Removing the endotracheal tube provided space and an unobstructed view for surgery especially a lesion located at the posterior part of the glottis. The authors used carbon dioxide laser in 27 patients and potassium titanyl phosphate (KTP) laser in one patient.

Discussion

The authors demonstrated that intermittent apnea with total intravenous anesthesia could be used successfully and safely for microscopic laryngeal surgery in appropriately selected patients with the anesthetic protocol.

Previously, Cohen and Hawkins used halothane or isoflurane for anesthesia management of microlaryngeal laser surgery with apneic technique[11, 12]. The surgery was performed without the impediment of an endotracheal tube. They showed that the procedure was safe and free of complications but they needed to interrupt the inhalation anesthesia during the apneic period and the inhaled anesthetics could come out from the patients causing a combustion risk and pollution to the surgeon. They also limited each apneic episode to 2 min, whereas, in the present study the episode could be prolonged up to 500 sec. The average first apnea duration was 258.0 $\pm$ 107.0 sec, and most of them was longer than 2 min. Later the limit of apneic episode was relaxed to 5 min in adults and 2-4 min in children[5, 13]. Some of the present patients safely performed beyond this limit when allowed by their cardiopulmonary reserve and using pulse oximetry monitoring. The response time of the pulse oximetry should be set as short as possible to rapidly reflex the patient's oxygenation condition[14].

Most recorded complications in the present study were caused by some sympathetic responses to surgical stimuli. The authors might lower these complications by increasing the dose of propofol or changing the opioids from fentanyl to remifentanil, which could be given in higher doses to increase the depth of anesthesia without any accumulation or delayed awakening.

The authors also had some limitations with the choice of muscle relaxants. At first it was anticipated that the operation in some patients might finish shortly due to the unobstructed view of surgery from preliminary studies, so the short-acting muscle relaxant, mivacurium, would be a favorable drug of choice. However, at the beginning of the study the medication was withdrawn from Thailand because of some marketing problems. Cisatracurium, an intermediate acting muscle relaxant, was used instead but it might have too long a duration of action for short procedures in some patients.

In conclusion, the intermittent apnea with total intravenous anesthesia could be used without any serious adverse outcome for microscopic laryngeal surgery and it provided a good operative field for the procedure.

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การวางยาสลบโดยใช้ยาฉีดร่วมกับกลั้นหายใจเป็นระยะสำหรับการส่องกล้องผ่าตัดกล่องเสียง

เทวารักษ์ วีระวัฒกานนท์, ภาคภูมิ สุปิยพันธุ์, วีระชัย คีรีกาญจนะรงค์, อรลักษณ์ รอดอนันต์, พรอรุณ สิริโชติวิทยากร

มีรายงานการให้ยาดมสลบและหยุดหายใจชั่วขณะระหว่างการผ่าตัดกล่องเสียงว่าทำให้มองเห็นได้ดี แต่ยังมีข้อเสียบางประการจากยาดมสลบ เราจึงศึกษาการใช้ยาสลบชนิดฉีดในการผ่าตัดชนิดนี้กับผู้ป่วย 30 ราย ยาที่ใช้ประกอบด้วยโปรโปฟอล เฟนตานิล และซิสอะทราคูเรียม ช่วยหายใจด้วย 100% ออกซิเจน หยุดหายใจและถอดท่อหายใจเป็นระยะโดยอาศัยการตรวจวัดออกซิเจนที่ปลายนิ้วและคาร์บอนไดออกไซด์ในลมหายใจให้อยู่ในระดับที่ปลอดภัยตลอดเวลา เทคนิคนี้ทำให้บริเวณผ่าตัดนิ่งและมองเห็นได้ชัดเจน ช่วงเวลาที่หยุดหายใจเฉลี่ยครั้งละ 258 ± 107 วินาที ทำผ่าตัดได้เสร็จภายใน 1-4 ครั้ง ผู้ป่วยบางรายมีอาการแสดงของการกระตุ้นจากการผ่าตัดเช่น ความดันเลือดขึ้นและหัวใจเต้นเร็ว อย่างไรก็ตามวิธีนี้สามารถใช้ได้โดยไม่มีภาวะแทรกซ้อนที่เป็นอันตรายรุนแรง ถ้าใช้ด้วยความระมัดระวัง