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Monitored Anesthesia Care Thoracoscopic Surgery in Primary Pneumothorax: Case Seires

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Abstract **Case Report**

Background: Video-assisted thoracoscopic surgery (VATs) is becoming more common because of its effectiveness and less invasiveness. With this change, the anesthetic practice is also needed to be modified. We report cases in which patients maintained spontaneous breathing without intubation through monitored anesthesia care (MAC) during VATs. ***Methods:*** We performed MAC on 18 patients undergoing VATs for primary pneumothorax without intubation. With standard monitoring, MAC was performed by using midazolam (0.1 mg/kg), remifentanil (0.03-0.1 μg/kg/min), propofol (0.5 mg/kg before incision, additional 20 mg as needed) and oxygen (5 L/min) via nasal prong with capnogram. ABGA was performed immediately after bullectomy or the patient's saturation dropped to less than 90%. ***Results:*** The duration of anesthesia and operation time were 60.0 (55.0, 63.8) min and 35.0 (30.0, 37.3) min. Doses of midazolam, propofol and remifentanil were 5.0 (5.0, 10.0) mg, 90.0 (70.0, 120.0) mg and 0.2 (0.2, 0.3) mg, respectively. PaO2 and PaCO2 during the operation were 108.8 (81.6, 190.2) mmHg and 57.9 (52.9, 62.8) mmHg. MAC provided adequate sedation and analgesia for VATs except for one case converted to general anesthesia for severe adhesions. Flumazenil was used in 7 patients (38.8%) in the anesthesia recovery phase. ***Conclusions:*** MAC can be a good alternative to general anesthesia in patients undergoing VATs for the treatment of primary pneumothorax.
Keywords: MAC, Noninvasive ventilation, Primary spontaneous pneumothorax, Spontaneous ventilation, Video-assisted thoracoscopic surgery.

INTRODUCTION

Lung surgery using video-assisted thoracoscopy (VAT) is widely used because it is less invasive and less damaging than open thoracotomy. With this change in surgical method, anesthetic techniques that have fewer side effects and are less invasive are being explored, and attempts are being made to provide anesthetic management without intubation in VAT surgery [1].

Anesthetic techniques for VAT surgery include general anesthesia, loco-regional block, and monitored anesthesia care (MAC), which all have their own advantages and disadvantages. General anesthesia guarantees a loss of consciousness and adequate pain management. However, the perioperative mortality rate is known to be higher than anesthesia without intubation, and the main reason for this is respiratory complications [2]. Since the patient is mechanically ventilated during general, problems such as atelectasis, physical damage caused by ventilator [2,3], iatrogenic damage related to intubation [4,5], and residual neuromuscular block can occur. Loc-regional block can reduce the incidence of respiratory complications by foregoing neuromuscular blockers and intubation [6]. MAC does not require difficult techniques and, as a result, is easy to perform and can minimize surgery time [1]. In addition, MAC can be used in patients who are ineligible for general or loco-regional anesthesia, such as those with decreased respiratory function or coagulation disorder [5, 7]. However, the biggest disadvantage of loco-regional block or MAC is that conversion to general anesthesia may be necessary under certain circumstances during surgery, including excessive adhesion, difficulty of progression due to inadequate lung collapse, intra-operative hypoxia or hemodynamic instability, inadequate sedation or pain management, or cases requiring isolation of the two lungs due to unilateral ventilation [1].

In our institution, we performed non-intubated video-assisted thoracoscopic surgery (NIVATs) with MAC for primary idiopathic pneumothorax in cases with a low probability of conversion to general anesthesia due to minimal adhesion. We report the

successful use of MAC, which provided sufficient sedation and pain management in the simple procedure of bullectomy and required a smaller amount of drugs to be used.

SUBJECTS AND METHODS

We performed 18 VAT surgeries on patients with idiopathic pneumothorax between September 2016 and May 2017 using MAC. MAC was not used if difficult airway management was expected (Mallampati class >3, BMI >30). Patients that did not have primary idiopathic pneumothorax may have needed to be converted to general anesthesia due to adhesion; therefore, in those cases, general anesthesia was selected over MAC. The 18 patients who underwent MAC were young and slim patients without prior medical history (mean age=24.0 years, average BMI=19.4 kg/m^2).

An oximeter, non-invasive blood pressure monitoring device, electrocardiogram (ECG), and electroencephalography monitorbrain wave monitor (entropy, GE Healthcare, USA) were used, and 5 L/min oxygen was delivered via nasal prongs during MAC. A capnogram was also utilized. The patient was first placed in the lateral decubitus position and sedated with intravenous bolus administration of 0.1 mg/kg midazolam. If loss of consciousness was not achieved, an additional 0.1 mg/kg was given. Remifentanil was then continuously infused at 0.05 µg/kg/min. After the loss of consciousness (entropy <70), the surgical area was sterilized. 30 seconds before local anesthesia to surgical site, propofol 0.5 mg/kg was infused in order to prevent patient movement and alertness. The level of sedation was evaluated by the attending anesthetist using a modified Observer's Assessment of Alertness/Sedation (OAA/S) Scale [8]. Deep sedation with modified OAA/S score of 0 was the goal for the time of local anesthesia with lidocaine and the start of the surgery, and a modified OAA/S score of 2 was aimed for the intraoperative period. After the start of operation, an additional 20 mg propofol was infused if the entropy value was greater than 70, and the remifentanil infusion rate was adjusted between 0.03–0.1 µg/kg/min depending on the presence of a pain reaction. Arterial blood gas analysis (ABGA) was performed if the peripheral arterial oxygen saturation fell below 90%, and ABGA was performed regardless of peripheral saturation after bullectomy. After suturing, we stopped continuous infusion of remifentanil and waited for recovery. If the recovery was slow, flumazenil, a reversal agent for midazolam, was considered. If the return of consciousness was delayed by more than 10 minutes after additional propofol administration and there was no other abnormality in vital signs, 0.25 mg of flumazenil was administered and the patient was observed in the recovery room. Uniportal VATs, with one or two bullectomies, was performed, and adhesiolysis was performed if needed to secure visibility. The line of incision was extended using a wound protector (SurgiSleeve wound protector, Medtronic, USA) and linear cutting stapler (Reach Surgical, China), and a roticulator (aesculap, USA) and thoracoscope (Linvatec, USA) were inserted. After bullectomy, the incision site was sutured.

Data were collected from the electronic medical records of our institution. Baseline characteristics (height, sex, age, weight, and past medical history) were confirmed, and intra-operative information (vital signs, drug administration, operation time, and ABGA) was obtained through anesthesia records. Results are shown as the numbers or median (IQR).

RESULTS

One out of the 18 patients included in this study was converted from MAC to general anesthesia due to severe adhesion that caused patient movement during adhesiolysis and difficulty in securing surgical visibility. This patient was a 35-year-old male with BMI 25.4 who underwent surgery 3 days after the occurrence of spontaneous pneumothorax. There were no issues with patient sedation or vital signs. At the time of conversion, additional propofol and muscle relaxant were administered before inserting a laryngeal mask airway in the lateral decubitus position. General anesthesia was then maintained using sevoflurane and remifentanil, and low-volume ventilation (5–6 ml/kg) was used to ensure surgical visibility. The baseline characteristics of the patients are summarized in Table 1, and anesthetic information is summarized in Table 2.

Time spent in operation room was 60.0 (55.0–63.8) minutes, and actual operation time, from incision to suturing, was 35.0 (30.0–37.3) minutes. The difference in operation time was not significant, since the same operation was performed using the same protocol. The operation was performed as indicated in the Results section. Surgical visibility was adequately secured, as seen in Fig. 1 and 2.

The total amount of drugs administered was 5.0 (5.0–10.0) mg for midazolam, 90.0 (70.0–120.0) mg for propofol, and 0.2 (0.2–0.3) mg for remifentanil. The average amount used and individual variability were increased for propofol because additional amounts were administered while using the electroencephalography while midazolam was only used for anesthesia induction. The number of propofol administrations was 2.0 (1.0–3.0).

Hypotension during the stay in the operation room (systolic <90 mmHg, diastolic <50 mmHg) occurred in three patients. No drug administration or procedure was needed to treat the hypotension, and all patients recovered from hypotension with adjustments in the remifentanil and fluid administration rate. Oxygen saturation decreased to 84% in one patient but recovered with adjustment in the remifentanil

administration rate and amount of oxygen administered. Intraoperative ABGA found an arterial pH of 7.29 (7.28–7.32), PaO_2 of 108.8 (81.6–190.2) mmHg, $PaCO_2$ of 57.9 (52.9–62.8) mmHg, and HCO^{3-} of 27.1 (24.9–29.0) mmol/L. The minimum value of PaO_2 was 66.1 mmHg, and the maximum value of $PaCO_2$ was 72.5 mmHg.

During recovery, flumazenil was administered in seven patients (38.8%) according to the criteria listed above. Subsequently, all patients regained consciousness and were discharged from the recovery room without any abnormal signs.

Table-1: Patient Characteristics

Variable	
Age (yr)	18.0(16.3, 26.5)
Sex (M/F)	12/6
Weight (kg)	59.5(49.3, 64.5)
Height (cm)	59.5(49.3, 64.5)
BMI (kg/m^2)	19.3(18.0, 20.9)

Values are presented as numbers or median (IQR)

Table-2: Anesthetic Data

Variable	
Intraoperative events (cases/total)	
Hypotension (Systolic BP < 90 mmHg, diastolic BP < 50)	3/18
Desaturation (SpO2 < 90%)	1/18
Bradycardia (HR < 60 beats/min)	3/18
Duration	
MAC (min)	60.0 (55.0, 63.8)
Surgery (min)	35.0 (30.0, 37.3)
Sedatives and analgesics	
Total dose of midazolam (mg)	5.0 (5.0, 10.0)
Total dose of propofol (mg)	90.0 (70.0, 120.0)
Total dose of remifentanil (mg)	0.2 (0.2, 0.3)
ABGA	
pH	7.29 (7.28, 7.32)
PaCO2 (mmHg)	57.9 (52.9, 62.8)
PaO2 (mmHg)	108.8 (81.6, 190.2)
HCO^{3-} (mmol/L)	27.1 (24.9, 29.0)
BE (mmol/L)	1.2 (-0.7, 2.2)

Values are presented as numbers or median (IQR). MAC: monitored anesthesia care.

Legend for figures

Fig-1: Operation view. Non-dependent lung is well collapsed

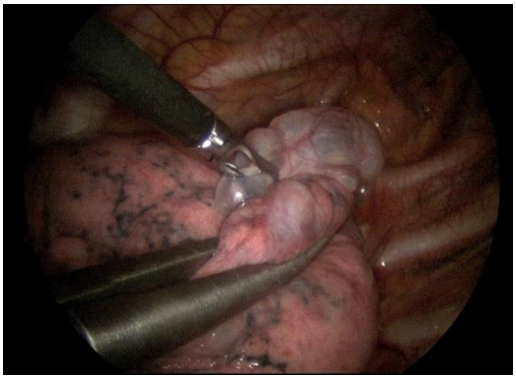

Fig-2: Operation procedure Bullectomy is performed using a linear cutting stapler and a roticulator

DISCUSSION

For VATs, loco-regional block can be used alone or in combination with general anesthesia or MAC [6]. Since the VATs performed during this study were uniportal surgeries with a small incision, we used MAC, which is simple and uses smaller amounts of drugs. The application of MAC has the advantage of preventing intubation-related complications, allowing free position alteration, and reducing drug administration and drug-related adverse events. In addition, since MAC does not require the use of a neuromuscular block, the risk of residual neuromuscular block is also reduced [1]. Since the maintenance of spontaneous respiration does not restrict the function of the diaphragm, it does not compromise the functional residual volume and prevents atelectasis [9]. It can also be achieved with a relative lack of experience—with one-lung—ventilation. However, conversion to general anesthesia must be anticipated, and this is a disadvantage of using loco-regional block or MAC.

In this study, one patient underwent intraoperative conversion to general anesthesia. When the thoracoscope was inserted under MAC, severe adhesion was observed, contrary to prior expectation. The adhesiolysis was needed for parietal pleura, and general anesthesia was necessary because parietal pleura had pain nerve distribution. Therefore, the decision was made to convert to general anesthesia due to the need for a neuromuscular block and deep anesthesia. After administration of the muscle relaxant, the airway was secured with laryngeal mask airway in the lateral decubitus position, and general anesthesia was maintained using sevoflurane. A laryngeal mask was used because it has a higher rate of successfully securing the airway in the lateral decubitus position than intubation [10]. There are various conditions aside from that mentioned above that would require conversion to general anesthesia; therefore, the criteria for conversion should be determined prior to surgery and appropriate preparations should be in place. Pneumothorax surgery using a thoracoscope can be performed under unilateral lung ventilation using a double-lumen tube or two-lung ventilation using single-lumen intubation or a laryngeal mask airway. Two-lung ventilation makes it difficult to obtain operative view, but this can be managed by lowering the tidal volume, and our institution adopts this method as well.

Previous studies show great variability in the amount of drugs used. Propofol use varied between 40 mg and 180 mg, and the number of additional administrations varied from 0 to 5. The variability can be large according to the patient's reaction to the drug and strength of stimulation and this can complicate the prediction of the amount of required drug use. In 38.8% of the patients, flumazenil was used for the reversal of midazolam. Compared to the results of a study by Masuda *et al*. [11] that reports good patient satisfaction with few complications in tooth extraction using midazolam 3 mg and propofol [11], this study required a greater amount of midazolam on average. Though there is a difference in the type of surgery, patient's average weight, and surgery time, flumazenil use could have been reduced with less use of midazolam.

Choi *et al*. evaluated the ABGA results from 21 patients who underwent the same surgery under one-lung ventilation. They found PaO_2 was 132 ± 26.3 mmHg, and $PaCO_2$ was 40 ± 5.5 mmHg under one-time respiratory volume of 10 mL/kg and respiratory rate of 12/min [12]. ABGA of the patients examined here for PaO_2 and $PaCO_2$ of 108.8 (81.6, 190.2) mmHg and 57.9 (52.9, 62.8) mmHg, respectively. Compared to Choi *et al.*'s results, there was not much difference in PaO_2 but there was some difference in $PaCO_2$. Unlike Choi *et al.*, who used positive pressure ventilation (PPV), our cases used sedatives and opioids under spontaneous respiration, which probably reduced the ventilatory volume. However, considering the normal intraoperative vital signs, lack of post-operative complications, and the fact that hypercapnia causes ventilation-perfusion mismatch correction and increases lung compliance, patients were monitored without additional management [13]. However, MAC has a disadvantage of the need for constant monitoring by an anesthetist due to the large variability in spontaneous respiration caused by drugs, and for preparing for conversion to general anesthesia. In order to improve this issue, MAC using TIVA may be a good option. Maintenance of drug concentrations using TIVA may

be able to reduce variability, such as that seen with a decrease in spontaneous respiration due to transient increase in blood flow and active site concentration after bolus administration.

The amount of time needed for anesthetic management and surgery was 60.0 (55.0–63.8) minutes and 35.0 (30.0–37.3) minutes, respectively. This result is comparable to that reported by Ambrogi *et al*. [14], who reported 78 and 37 minutes of anesthetic management and operation time, respectively, for bullectomy with intubation. There is a difference because of the time it takes to change the position and intubate. In addition, the lack of neuromuscular block, even with the adequate acquisition of surgical visibility, is thought to maintain the elasticity of the diaphragm and volume of the thoracic cavity [15].

In conclusion, NIVATs using MAC can be an alternative anesthetic method that can reduce drug requirement and concerns about intubation. However, there are a few issues to be addressed, including the difficulty of deep sedation due to ventilatory maintenance with spontaneous respiration alone, hinderance of the operation due to muscle contraction because of the lack of neuromuscular blocker use, need for conversion to general anesthesia under certain circumstances, and need for airway management in the lateral decubitus position. Due to such difficulties, this method requires closer monitoring from the anesthetist. Future prospective randomized controlled trials of bigger patient populations is required to confirm stable sedation with reduced amount of drug usage.

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