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Original Article

# Comparison of auditory evoked potential index and clinical signs as indicator for laryngeal mask airway insertion

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ABSTRACT

*Objective:* Auditory evoked potential (AEP) index is one of the several physiological parameters for assessing the depth of anesthesia. The purpose of this study was to investigate whether the AEP monitoring could provide a better information for assessment of anesthesia level in classic laryngeal mask airway (C-LMA) insertion than the use of clinical signs in general anesthesia with single standard dose of intravenous propofol and fentanyl.

*Methods:* One hundred and seventy adult patients requiring general anesthesia for minor surgery were recruited and randomized to receive AEP monitoring (group A) or judgment of clinical signs (group B) for assessment of anesthesia depth and optimal condition to insert the C-LMA. The insertion conditions, including jaw relaxation, movements, presence of airway trauma and airway reflex, successful insertion rate and induction time were recorded and compared.

*Results:* The two groups were demographically similar. In group A, baseline heart rate was slower than group B (74 ± 14 *vs.* 78 ± 14 beats/min, $p = 0.0267$) and persisted throughout the whole study period. There was no significant difference in the change of heart rate during induction of general anesthesia between both groups. The incidence of movement was reduced in group A patients with AEP monitoring in comparison with group B patients (2.4% *vs.* 28.2%, $p < 0.0001$); of the unwanted events, swallowing was 0% versus 7.1%, $p = 0.0126$; laryngospasm was 0% versus 4.7%, $p = 0.0430$ and emergence of airway reflex was 1.2% versus 11.8%, $p = 0.0050$; the successful insertion rate was 100% versus 94.1%, $p = 0.0232$; and jaw relaxation was 83.5% versus 70.6%, $p = 0.0448$. There were no differences between both groups in trauma and induction time.

*Conclusion:* This study demonstrated that AEP index provided better information for C-LMA insertion with higher successful rate, less emergence of airway reflex and lower incidence of movement during induction of general anesthesia with single dose of intravenous propofol and fentanyl.



## 1. Introduction

The classic laryngeal mask airway (C-LMA) has been widely used with increasing day-case surgery. In clinical practice, the signs of loss of eyelash reflex and jaw relaxation are used for assessing optimal level of anesthesia for insertion of the C-LMA, but its reliability is in doubt.[1–4] Some patients show inadequate anesthesia with movements of the body or presence of airway reflex after LMA insertion. There are several physiological parameters under investigation to evaluate the status of anesthesia, some of which have been introduced in clinical practice.[5–7] Auditory evoked potential (AEP) monitoring has been used to quantify the pharmacokinetic and pharmacodynamic action of anesthetic agents that may detect the transition from consciousness to unconsciousness.[5,7–13] The A-Line™ AEP monitor, a new device for AEP measurement, converts the morphological change of AEP to a numerical index (A-Line ARX

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Index™ [AAI]). Some investigations have shown that AEP is able to predict the reactions of patient with well-defined stimulation such as insertion of LMA and skin incision.[10–12]

The aim of this study was to investigate whether AEP monitoring could be superior to the assessment by clinical signs as indicator in discriminating the anesthetic depth and determining the optimal timing for C-LMA insertion following induction of general anesthesia with single dose of intravenous propofol and fentanyl.

## 2. Methods

This study was approved by the ethics committee of Sin Lau Christian Hospital and written informed consents were obtained from all patients. Patients with ASA physical status I and II, aged 18–70 and scheduled for elective minor surgery under general anesthesia, were assigned randomly into two groups using a computer-generated table of random digits for assessment of adequate depth of anesthesia for insertion of C-LMA. Patients in group A underwent A-line™ AEP monitoring. The AEP signals were converted into A-line ARX-index (AAI) generated by the A-Line™ AEP monitor version 4.1 (Danmeter A/S, Odense, Denmark). The AAI scales ranged from 100 (awake) to 0, and a value between 15 and 30 indicated adequate anesthesia.[10] The time for insertion of C-LMA was determined by an AAI value less than 30 and persisting for 3 s or more in group A patients or by clinical signs including loss of eyelash reflex and jaw relaxation in group B patients. Exclusion criteria included neurological disorders, impairment of hearing acuity, mental impairment, medications with hypnotics, and antidepressants, substance abuse, a history of gastrointestinal reflux, reactive airway diseases, obesity (body mass index $> 30\ kg/m^2$) and potential difficult airway (Mallampati score $> 2$, mouth opening $< 25$ mm, and cervical spine disease). Finally, 170 patients (85 in group A and 85 in group B) were recruited for study.

Pre-anesthetic medication was omitted. On arrival at the operation room, standard monitoring was applied including pulse oximetry, continuous ECG and noninvasive blood pressure (BP). Baseline BP and heart rate (HR) were recorded prior to induction of anesthesia and measurements were repeated, 1 min and 5 min after insertion of C-LMA. Venous access was established with a 20-G cannula for the intravenous fluid infusion and administration of induction agents. All patients were hydrated with normal saline. All patients were pre-oxygenated with 100% oxygen at tidal volume ventilation. Anesthesia was induced with intravenous fentanyl 1 μg/kg, followed by a bolus dose of intravenous propofol 2.5 mg/kg 2 min later, given over 30 s in conjunction with lidocaine 40 mg for reducing the painful injection of propofol.[14] Manually controlled positive pressure ventilation with 100% oxygen was applied when apnea was noted after propofol injection. In group A, additional dose of propofol 1 mg/kg was given if the AAI did not reach the designated value within 2 min. In group B, after propofol injection, the eyelash reflex of the patient was sought by continuously stroking the eyelashes after the patient had closed the eyes spontaneously and upon loss of eyelash reflex, jaw relaxation was checked until the mouth could be opened enough for insertion of the C-LMA. Additional dose of propofol 1 mg/kg was given when jaw relaxation was not enough to insert the C-LMA within 2 min. Extra-dose of propofol was given to those in whom obviously inadequate anesthesia was noted after C-LMA insertion. The size of C-LMA was 3 for women and 4 for men. The insertion of C-LMA was performed by an anesthesiologist who had experience of C-LMA anesthesia for at least 3 yr. Proper position of C-LMA was confirmed by observing the respiratory movement and chest expansion, and gas leak was not evidenced as the airway pressure was below 25 $cmH_2O$, otherwise, the C-LMA was removed and reinserted with reinforced dose of propofol 1 mg/kg if necessary. The number of attempts for successful insertion of LMA was recorded. After 1-min observation for successful insertion, anesthesia was maintained according to the clinical requirement. The manually controlled ventilation was adjusted to keep the end-tidal carbon dioxide tension between 30–35 mmHg. During the surgery, C-LMA cuff pressure was monitored intermittently and maintained less than 50 $cmH_2O$ by sphygmomanometer.

The insertion conditions of C-LMA was evaluated by the anesthesiologist in-charge with six variables by which jaw relaxation was graded as full or limited, head or limb movement as absent or present, coughing or gagging as absent or present, swallowing as absent or present, laryngospasm as absent or present, and trauma as absent or present. Bodily movement was defined as moving of the head or limbs. Laryngospasm was defined as evidence of upper airway obstruction or the presence of strider which was relieved by deepening of anesthesia or administering muscle relaxant. Coughing, gagging, swallowing and laryngospasm were defined as airway reflexes. Jaw relaxation was graded as full and limited (full = no resistance, limited = tight but could be opened just enough to insert C-LMA). The induction time was defined as the space of from the time after propofol injection to the time when LMA insertion was decided. The insertion conditions were evaluated on the first attempt. Reinsertions of C-LMA were designated as LMA insertion failures. At the end of surgery, upon removal of C-LMA, the pharyngolaryngeal trauma was considered as bloody secretion seen on the C-LMA.

All values are expressed as mean ± SD or number (percent) unless otherwise stated. The Pearson's chi-square test was used for categorical variables, whereas 1-way analysis of variance was used for continuous variables. A $p$ value $< 0.05$ was considered to be statistically significant. Data analysis was performed using the JMP software program (SAS Institute Inc, Cary, NC).

## 3. Results

Patients in groups A and B were demographically similar, as shown in Table 1. During the procedure, three patients in group A needed another dose of propofol to decrease the AAI below 30 and the insertion time of C-LMA were 150 s, 180 s and 240 s, respectively. No patient in the group B needed extra-dose of propofol to offer proper clinical conditions for LMA insertion, but seven patients who experienced severe coughing, swallowing and laryngospasm needed extra-dose of propofol to deepen the anesthetic level to secure a patent airway after LMA insertion. All patients did not recall their anesthetic events.

Serial changes of hemodynamic variables during study period are presented in Fig. 1. There were no differences in baseline systolic BP and diastolic BP between both groups (136 ± 19 *vs.* 139 ± 20 mmHg and 72 ± 13 *vs.* 74 ± 15 mmHg). The baseline HR in the group A was slower than that in the group B, with lingering throughout the whole induction period. HR as measured 1 min and 5 min after C-LMA insertion was significantly lower in the group A (74 ± 14 *vs.* 78 ± 14 beats/min, $p = 0.0267$; 67 ± 9 *vs.* 71 ± 11 beats/min, $p = 0.0036$; 64 ± 9 *vs.* 68 ± 10 beats/min, $p = 0.0046$; respectively). The systolic BP as measured 1 min after C-LMA insertion was significantly lower in the group A (103 ± 13 *vs.*

**Table 1**
Demographic data for patients in the groups A and B.

| Characteristic | A group ($n = 85$) | B group ($n = 85$) | $p$ |
|---|---|---|---|
| Gender (male) | 26 (31) | 26 (31) | NS |
| Age (yr) | 42 ± 9 | 41 ± 10 | NS |
| Body weight (kg) | 63 ± 12 | 61 ± 14 | NS |
| Body height (cm) | 161 ± 8 | 162 ± 7 | NS |

Data are presented as mean ± SD or number (percentage) Group A = AEP monitoring; group B = clinical signs assessment. NS = not significant.