의학석사 학위논문

A comparison of conventional and modified jaw thrust maneuvers for tracheal intubation using a lightwand

광봉을 이용한 기관내 삽관시 통상적 하악 견인법과 수정된 하악 견인법의 비교

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A comparison of conventional and modified jaw thrust maneuvers for tracheal intubation using a lightwand

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ABSTRACT

Introduction: A lightwand is an effective device for tracheal intubation, and has been widely used in clinical practice. We evaluated the effects of conventional and modified jaw thrust maneuvers on lightwand search time, number of intubation attempts, intubation time, hemodynamic changes, and postoperative sore throat in patients undergoing orotracheal intubation using a lightwand.

Methods: Sixty adult patients were included in the study. After induction of anesthesia, intubation was performed using a lightwand under conventional (n=30) or modified jaw thrust (n=30) maneuvers. In the conventional group, the lightwand was inserted with the right hand after the mandible was lifted by placing the thumb of the left hand into the mouth. In the modified group, the lightwand was inserted while jaw thrust was achieved by an assistant using two hands. Lightwand search time (time from insertion of the lightwand to the moment of transillumination over the cricothyroid membrane), number of intubation attempts, and time to achieve intubation were assessed. Heart rate and mean arterial pressure were measured before and after intubation. Postoperative sore throat was evaluated at 1 and 24 h after surgery using a 0−100 mm visual analogue scale (VAS).

Results: Lightwand search time was significantly shorter in the modified group compared to the conventional group (7.2 [4.6] s vs. 12.1 [9.1] s, mean [SD], respectively; P=0.016). The modified group had shorter intubation time than the conventional group (21.0 [6.6] s vs. 27.9 [9.9] s, respectively; P=0.004). The number of intubation attempts, and hemodynamic changes after intubation were similar between the two groups. The incidence and severity of postoperative sore throat were lower at 24 h after surgery in the modified group compared with the conventional group (P=0.011).

Conclusion: The modified jaw thrust maneuver facilitated lightwand-guided intubation, and reduced the incidence and severity of postoperative sore throat compared to the conventional method.

Keywords: lightwand, conventional jaw thrust, modified jaw thrust

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INTRODUCTION

A lightwand uses the principle of transillumination of the soft tissues of the anterior neck to guide the tip of the tracheal tube into the laryngeal inlet. It has been a useful and effective device in airway management, particularly in patients with difficult airways including limited neck motion, cervical spine disease, or limited mouth opening [1-3].

Lightwand-guided intubation is generally performed under conventional jaw thrust, a single-handed chin lift [4]. The conventional jaw thrust may enlarge the oropharyngeal space and expand the laryngeal inlet. However, collapsed oropharyngeal cavity and laryngeal structures resulting from the loss of muscle tone in anesthetized patients can disturb the advancement of a lightwand. Moreover, the lightwand is advanced and used to search the laryngeal inlet blindly in the oropharyngeal cavity. Thus, the tongue, larynx, and surrounding structures can be injured unless sufficient space is secured during advancement of the lightwand [5].

The modified jaw thrust maneuver by an assistant lifts the tongue base and epiglottis forcefully from the posterior pharyngeal wall, providing more space in the oropharynx and expanding the laryngeal inlet [6]. We hypothesized that the modified jaw thrust maneuver would facilitate lightwand-guided intubation, and compared the lightwand search time, intubation time, and postoperative sore throat between conventional and modified jaw thrust manueuvers for lightwand-guided intubation.

METHODS

The present study was approved by the Ethics Committee of our hospital (no. 20150216/16-2015-27/031). Written informed consent was obtained from all patients. The trial was registered at the Clinical Research Information Service (KCT0001485).

Adult patients scheduled for elective surgery requiring tracheal intubation were enrolled into the study. Patients were excluded if they had a known or predicted difficult airway, diseases or anatomical abnormalities in the neck, larynx, or pharynx, body mass index $\geq$30 kg cm^{-2}, or were at risk of aspiration. Patients with an expected duration of intubation shorter than 1 h or longer than 6 h were also excluded.

Patients were randomly allocated to one of two groups: receiving lightwand-guided intubation under single-handed jaw thrust (conventional jaw thrust group) or two-handed jaw thrust by an assistant (modified jaw thrust group), using a computer-generated program (Random Allocation Software, ver. 1.0; Isfahan University of Medical Sciences, Isfahan, Iran) with a block size of 4 and a 1:1 allocation ratio. The randomization sequence was kept in consecutively numbered, opaque, sealed envelopes. An investigator who was not involved in the study determined the treatment allocation by opening the envelope in the sequence when the patient arrived in the operating room. Due to the nature of the study, only the patients were blinded to the group assignments.

No premedication was administered to the patients. Intraoperative monitoring included electrocardiogram, pulse oximetry, gas analyzer, and noninvasive arterial pressure monitoring. Anesthesia was induced using propofol 1.5 mg kg^{-1} and fentanyl 1.5−2.0 μg kg^{-1}, and rocuronium 0.6 mg kg^{-1} was administered to achieve maximum neuromuscular blockade. The lightwand (Surch-Lite™) was lubricated with water-soluble jelly, and inserted into the tracheal tube. It was bent at 6.5 cm from the distal end at a 90° angle. The internal diameter of the tracheal tube was 7.5 mm for male patients, and 7.0 mm for female patients. Lightwand-guided tracheal intubation was performed by two experienced board-certified anesthesiologists. The height of the operating table was adjusted to allow maximal visualization of the patient's anterior neck. The lightwand was turned on when it was inserted into the mouth. In the conventional jaw thrust group, the tracheal tube with the lightwand was inserted through the midline with the right hand after the mandible was lifted by placing the thumb of the left hand against the mandibular molars and gripping the mandible. In the modified jaw thrust group, the tracheal tube with the lightwand was inserted while an assistant stood facing the operator by the side of the patient's body and displaced the mandible forward by placing his or her fingers behind the mandible angle, and opened the mouth using the thumbs. Lightwand search time was counted from turning on the lightwand to the moment of transillumination over the cricothyroid membrane [7]. When a central, clear and bright transillumination was seen on the cricothyroid membrane, the lightwand was withdrawn, and the tracheal tube was advanced. Successful intubation was confirmed by capnography. Light search time was permitted up to twice, with

25 s permitted for each trial. If the light was not found within 25 s, a further attempt was made after 1 min of mask ventilation with 2−5 vol.% sevoflurane in oxygen. If lightwand intubation was not successful after two trials, it was recorded as a failure, and tracheal intubation was performed with the technique used in the other group or by direct laryngoscopy. The result was also considered a failure if esophageal intubation occurred. Failed intubations were not included in the determination of lightwand search time in either group. The number of intubation attempts and the time to intubation were recorded. Intubation time was defined as the time from turning on the lightwand to confirming successful placement of the tracheal tube (the appearance of $EtCO_2$ trace on the monitor screen), excluding the time taken for ventilation between attempts. Mean arterial pressure (MAP) and heart rate (HR) were also recorded before and after tracheal intubations using the lightwand. Lightwand search time, number of intubation attempts, and time to achieve intubation were recorded for each intubation. Adverse events during intubation, including aspiration or regurgitation, hypoxia (SpO_2 <90%), bronchospasm, or dental trauma, were recorded. Intracuff pressure was maintained at 25 cmH_2O using a handheld aneroid manometer (VBM, Sulz am Neckar, Germany) by monitoring and readjusting every 30 min.

If requested, an intravenous patient-controlled analgesia (PCA) device was connected to the IV line at the end of the operation. Residual neuromuscular block was reversed with pyridostigmine and glycopyrrolate. When patients had

fully recovered and were able to obey commands, the trachea was carefully extubated after gentle suctioning of oral secretion.

Postoperative sore throat was evaluated at 1 and 24 h after tracheal extubation by observers blinded to the group assignments. Sore throat was evaluated using a 0−100 mm visual analogue scale (VAS; 0 [*no pain*] to 100 [*worst pain imaginable*]). The incidence of sore throat was determined as 'No' in cases with VAS of 0 or 'Yes' for all other VAS values.

The primary outcome of the present study was intubation time. Based on the results of a preliminary study, 28 patients per group were required to detect a significant difference in the time for lightwand intubation at a significance level of 95% and a power of 90%. Thus, 31 patients per group were enrolled to compensate for possible dropouts. SPSS for Windows software (ver. 20; IBM Corp., Armonk, NY, USA) was used to conduct statistical analyses. The categorical and continuous data are expressed as frequencies (%) and means (standard deviation [SD]), respectively. The lightwand search time, intubation time, and severity of postoperative sore throat were assessed using the Mann−Whitney *U*-test. The number of intubation attempts and the occurrence of postoperative sore throat were compared using Fisher's exact test. Hemodynamic data were analyzed by repeated measures analysis of variance. In all analyses, $P<0.05$ were taken to indicate statistical significance.

RESULTS

A total of 70 patients were recruited between April and August 2015. Of these, eight patients did not meet the inclusion criteria. The remaining patients were randomized into the two groups. One patient in each group was excluded because of delayed extubation. Thus, 60 patients were included in the analysis (Fig. 1).

Patient characteristics, thyromental distance, Mallampati score, postoperative PCA use, type of surgery, surgery duration, anesthetic time, and duration of tracheal intubation are shown in Table 1.

Lightwand search time was significantly shorter in the modified group compared to the conventional group (7.2 [4.6] s vs. 12.1 [9.1] s, mean [SD], respectively; P=0.016). The modified group also had shorter intubation time than the conventional group (21.0 [6.6] s vs. 27.9 [9.9] s, respectively; P=0.004). The number of intubation attempts was similar between the two maneuvers (Table 2).

In both groups, hemodynamic variables (MAP and HR) decreased between baseline and preinduction, and increased after tracheal intubation. However, there were no significant differences in hemodynamic changes between the groups (Fig. 2).

The incidence and severity of postoperative sore throat at 1 h after surgery were similar between the two groups. However, at 24 h after surgery, postoperative sore throat occurred less frequently (13.3% vs. 40.0%,

respectively ; P=0.039) and the severity of sore throat was significantly lower in the modified group compared to the conventional group (P=0.011) (Table 3 and Fig. 3).

None of the patients experienced adverse events such as aspiration or regurgitation hypoxia, bronchospasm, or dental trauma during lightwand-guided intubation.

Table 1. Characteristics of patients undergoing lightwand-guided intubation using the conventional or modified jaw-thrust maneuver.

	Conventional (n = 30)	**Modified (n = 30)**
Age (years)	55 (16)	55 (18)
Gender (M/F)	14/16	16/14
Weight (kg)	62.5 (8.5)	60.2 (9.6)
Height (cm)	162.8 (8.5)	162.3 (7.1)
Mallampati score (I/II)	21/9	22/8
Mouth opening (cm)	4.5 (0.6)	4.6 (0.4)
Thyromental distance (cm)	6.8 (0.6)	6.9 (0.7)
PCA (Y/N)	23/7	23/7
Type of surgery		
General surgery	18	18
Urologic surgery	5	2
Orthopedic surgery	6	6
Gynecological surgery	1	4
Operation time (min)	114.7 (75.0)	112.1 (82.0)
Anesthetic time (min)	153.2 (86.1)	154.8 (91.5)
Duration of tracheal intubation (min)	141.0 (85.4)	142.2 (90.8)

Values are means (SD) or number of patients. PCA, patient-controlled analgesia

Table 2. Characteristics related to lightwand-guided intubation using the conventional or modified jaw-thrust maneuver.

	Conventional (n = 30)	**Modified (n = 30)**	**P-value**
Lightwand search time (s)	12.1 (9.1)	7.2 (4.6)	0.016
Number of attempts			0.492
1	28 (93.3)	30 (100.0)	
2	2 (6.7)	0 (0.0)	
Fail	0 (0.0)	0 (0.0)	
Time for tracheal intubation (s)	27.9 (9.9)	21.0 (6.6)	0.004

Values are means (SD) or number of patients (%).

Table 3. Incidence of postoperative sore throat

	Conventional (n = 30)	**Modified (n = 30)**	**P−value**
1 h after surgery	14 (46.7)	9 (30.0)	0.288
24 h after surgery	12 (40.0)	4 (13.3)	0.039

Values are number of patients (%)

Figure 1. Flow diagram. In total, 70 patients were assessed for eligibility; 8 did not fulfill the inclusion criteria. Sixty-two patients were randomized into two groups, and one patient in each group was excluded because of delayed extubation. Thus, 60 patients were included in the analysis.

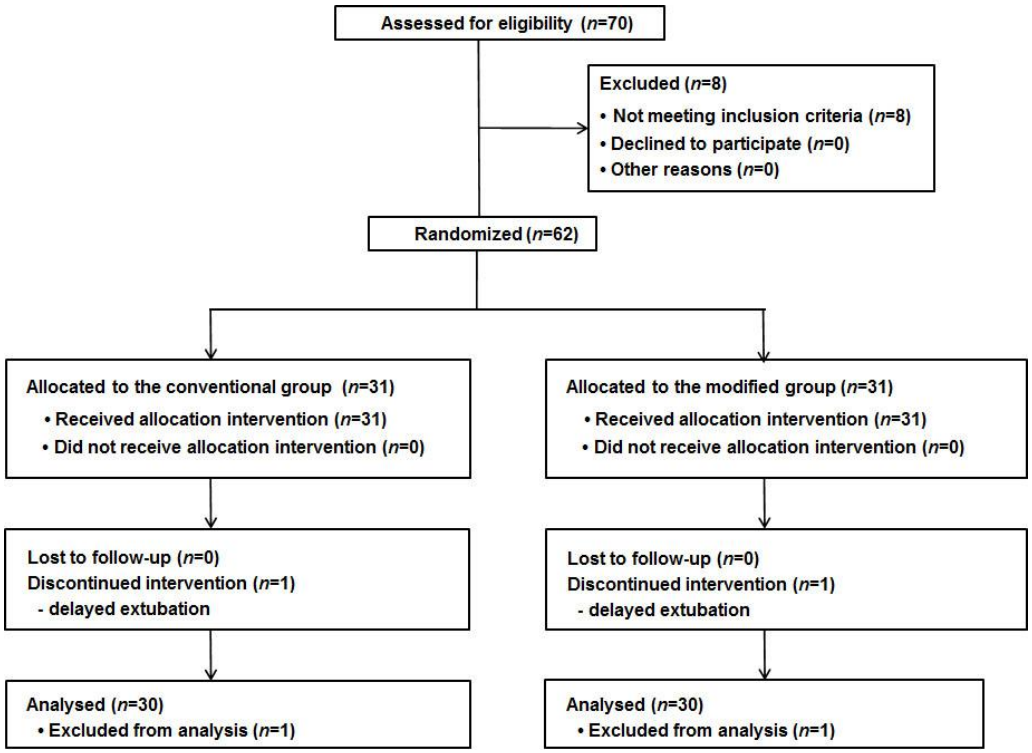


Figure 2. Mean arterial pressure (MAP) and heart rate (HR) during lightwand-guided intubation.

Values are means (SD)

*P<0.05 compared with baseline in each group

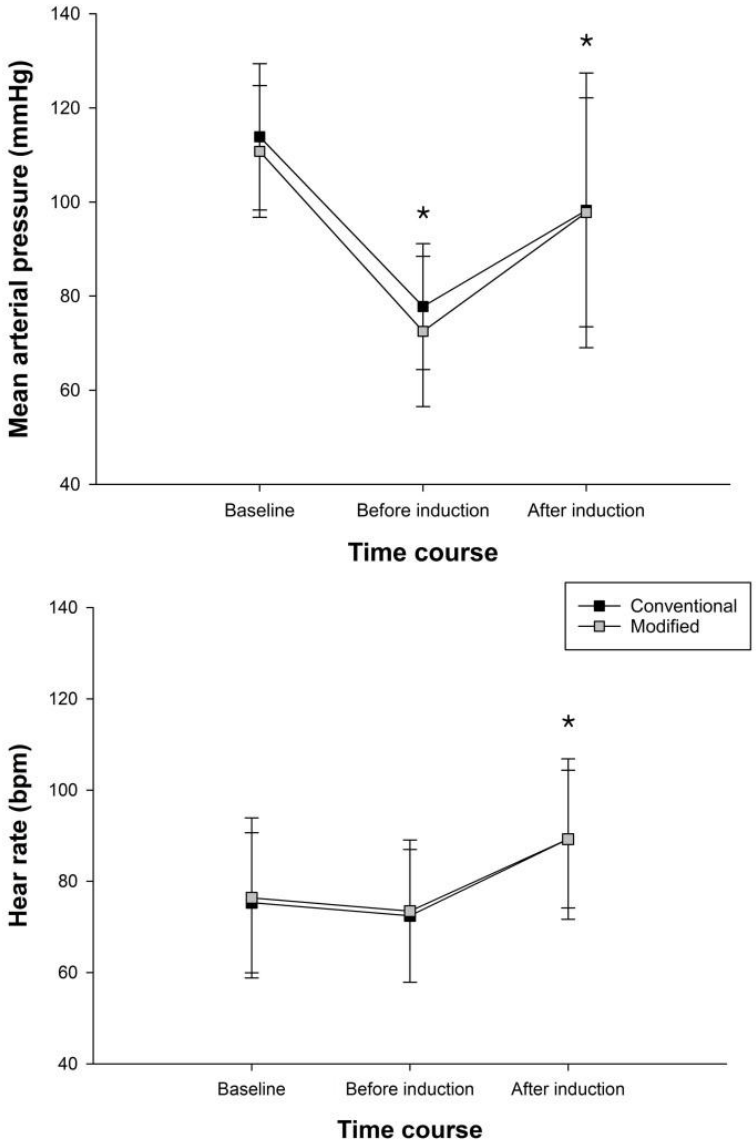
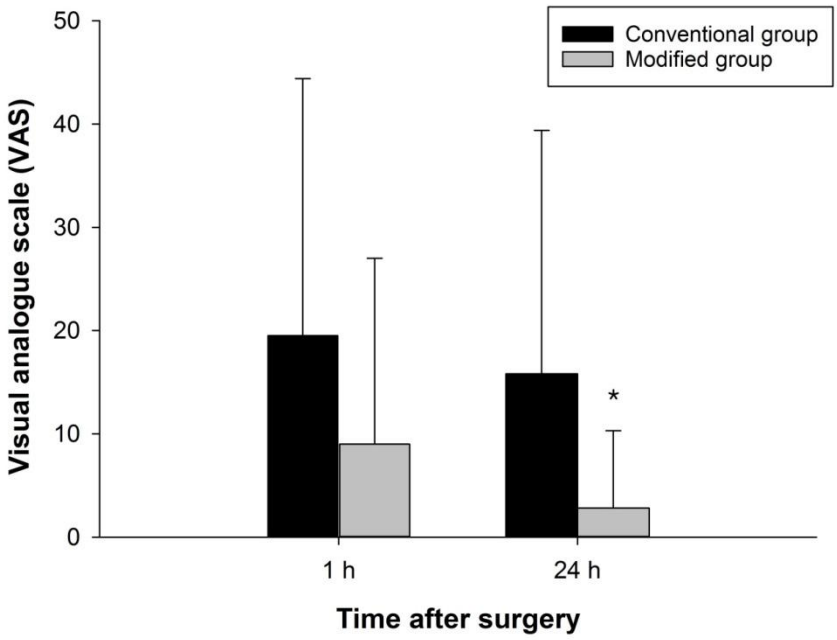


Figure 3. Severity of postoperative sore throat.

Values are means and error bars indicate 1 SD.

*P<0.05 compared with the conventional group.



DISCUSSION

This study showed that the modified jaw thrust maneuver reduced lightwand search time, time for achieving tracheal intubation, and the incidence and severity of postoperative sore throat at 24 h after surgery compared to the conventional method.

During lightwand-guided intubation, the lightwand is introduced into the oropharynx and advanced behind the tongue. A bright glow at the level of the hyoid bone indicates that the lightwand tip is in the vallecula. When the lightwand tip enters the glottis, a bright, well−defined circle of light can be seen over the cricothyroid membrane. Despite visualization of a central bright transillumination, resistance to advancement of the tube can occur due to impingement of the tracheal tube into the laryngeal structures [4, 8].

In the present study, lightwand search time and intubation time were significantly shorter in the modified jaw thrust group compared to the conventional group. The conventional jaw thrust opens the mouth and enlarges the oropharyngeal cavity by lifting the jaw [9]. However, in some cases such as limited mouth opening, it cannot be sufficient to introduce and advance the lightwand with a tracheal tube in the oropharynx. Furthermore, to facilitate the lightwand-guided intubation, a firm anterocaudal jaw thrust should be maintained with opening the mouth by placing the thumb against the mandibular molars and gripping the mandible. However, if the surface of

mandibular molars is rough or the patient is edentulous, firm pressure with the thumb on the molars or gingiva is difficult to maintain. The epiglottis can also disturb the passage of the lightwand [5]. Previous case reports showed that the epiglottis was malpositioned into the laryngeal inlet during fiberoptic evaluation after lightwand-guided intubation [10, 11]. If there is resistance preventing passage of the lightwand into the trachea, the obstructing epiglottis may be avoided by a series of rocking or scooping movements redirecting the tip to the trachea. Thus, it is necessary to secure sufficient oropharyngeal space as well as to widen the laryngeal inlet for free movement of the lightwand, including rotation, withdrawal, or scooping to facilitate advancement of the tube into the trachea.

The modified jaw thrust maneuver displaces the mandible anteriorly with the assistant's fingertips placed under each side of the mandible angle and the mouth opened using both thumbs [12, 13]. Maximal mandibular protrusion by the assistant forcefully elevates the base of the tongue and epiglottis, securing a larger oropharyngeal space for movement of the lightwand. Furthermore, it has been reported to provide a clear view at the epiglottis during fiberoptic intubation [14, 15]. Thus, the modified jaw thrust maneuver can provide additional advantages compared to the conventional method for lightwand-guided intubation.

Lightwand-guided intubation is a blind technique. Thus, the tongue, pharyngeal mucosa, and laryngeal structures can be damaged during blind

advancement of the lightwand, resulting in postoperative sore throat and hoarseness. When light search or tube advancement into the glottis is difficult, multiple attempts are performed to redirect the tube tip using the light as a guide. This results in contact with the oropharyngeal and laryngeal structures. Furthermore, small movements of the hand will translate to larger movements at the tip due to the lever-arm nature of the lightwand [8]. In the present study, the modified jaw thrust group showed a lower incidence and less severity of postoperative sore throat at 24 h after surgery than the conventional group. The modified jaw thrust maneuver widens the oropharyngeal cavity and laryngeal inlet forcefully, resulting in less contact with the oropharyngeal and laryngeal structures. Thus, it is helpful to reduce postoperative sore throat.

In addition, the lightwand-guided intubation may causes less dental contact compared to other devices, such as direct laryngoscope or videolaryngoscope because the lightwand is thinner. During lightwand-guided intubation in patients with weak teeth, sufficient mouth opening is necessary for insertion and movement of the lightwand to prevent dental contact. The modified jaw thrust maneuver can secure and maintain wider mouth opening during the procedure compared to the conventional method, and may result in less dental trauma.

This study had several limitations. First, the investigators that performed lightwand-guided intubation were not blinded to the group assignment. However, they followed the standardized and detailed protocol. Moreover, the

investigators that evaluated the postoperative sore throat, and all of the patients were blinded to the group allocation. Second, patients with a known or predicted difficult airway were excluded from the present study. Thus, further studies in patients with difficult airways are required. Third, we did not evaluate coughing or events during extubation that might have caused injury and irritation, but the same extubation protocol was applied in all patients.

In conclusion, the modified jaw thrust maneuver is a simple and effective method to facilitate lightwand-guided intubation and reduce postoperative sore throat following tracheal intubation.

REFERENCES

1. American Society of Anesthesiologists Task Force on Management of the Difficult A. Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. *Anesthesiology* 2003; **98**: 1269-77.

2. Turkstra TP, Craen RA, Pelz DM, Gelb AW. Cervical spine motion: a fluoroscopic comparison during intubation with lighted stylet, GlideScope, and Macintosh laryngoscope. *Anesthesia and analgesia* 2005; **101**: 910-5, table of contents.

3. Rhee KY, Lee JR, Kim J et al. A comparison of lighted stylet (Surch-Lite) and direct laryngoscopic intubation in patients with high Mallampati scores. *Anesthesia and analgesia* 2009; **108**: 1215-9.

4. Agro F, Hung OR, Cataldo R et al. Lightwand intubation using the Trachlight: a brief review of current knowledge. *Canadian journal of anaesthesia = Journal canadien d'anesthesie* 2001; **48**: 592-9.

5. Aoyama K, Takenaka I, Nagaoka E et al. Potential damage to the larynx associated with light-guided intubation: a case and series of fiberoptic examinations. *Anesthesiology* 2001; **94**: 165-7.

6. Murashima K, Fukutome T. Effect of jaw-thrust manoeuvre on the laryngeal inlet. *Anaesthesia* 1998; **53**: 203-4.

7. Chen TH, Tsai SK, Lin CJ et al. Does the suggested lightwand bent length fit every patient? The relation between bent length and patient's thyroid prominence-to-mandibular angle distance. *Anesthesiology* 2003; **98**: 1070-6.

8. Davis L, Cook-Sather SD, Schreiner MS. Lighted stylet tracheal intubation: a review. *Anesthesia and analgesia* 2000; **90**: 745-56.

9. Iqbal R, Gardner-Thorpe C, Thompson J et al. A comparison of an anterior jaw lift manoeuvre with the Berman airway for assisting fibreoptic orotracheal intubation. *Anaesthesia* 2006; **61**: 1048-52.

10. Takenaka I, Aoyama K, Abe Y et al. Malposition of the epiglottis associated with fiberoptic intubation. *Journal of clinical anesthesia* 2009; **21**: 61-3.

11. Ikegami N, Kikuchi A, Tamai S. Epiglottic prolapse induced by lighted stylet tracheal intubation. *Journal of anesthesia* 2011; **25**: 294-7.

12. Albrecht E, Schoettker P. Images in clinical medicine. The jaw-thrust maneuver. *The New England journal of medicine* 2010; **363**: e32.

13. Uzun L, Ugur MB, Altunkaya H et al. Effectiveness of the jaw-thrust maneuver in opening the airway: a flexible fiberoptic endoscopic study. *ORL; journal for oto-rhino-laryngology and its related specialties* 2005; **67**: 39-44.

14. Durga VK, Millns JP, Smith JE. Manoeuvres used to clear the airway during fibreoptic intubation. *British journal of anaesthesia* 2001; **87**: 207-11.

15. Aoyama K, Takenaka I, Nagaoka E, Kadoya T. Jaw thrust maneuver for endotracheal intubation using a fiberoptic stylet. *Anesthesia and analgesia* 2000; **90**: 1457-8.

국문 초록

서론: 광봉은 기관내 삽관을 유용하게 하는 장치이며 임상에서 널리 사용되고 있다. 저자들은 광봉을 이용한 기관내 삽관시 통상적 하악 견인법과 수정된 하악 견인법이 광봉 찾기 시간, 기관 삽관 시도 회수, 기관 삽관 시간, 혈역학적 변화, 그리고 수술 후 인후통에 미치는 영향을 평가하였다.

방법: 성인 환자 60 명을 대상으로 하였다. 마취유도를 한 후 기관내 삽관을 통상적 하악 견인법 (n=30) 또는 수정된 하악 견인법 (n=30)으로 기관내 삽관을 시행하였다. 통상적 하악 견인법 군에서는 왼손의 엄지를 입 안으로 넣어 하악을 들어 올린 상태에서 광봉은 오른손으로 잡고 삽입 하였다. 수정된 하악 견인법 군에서는 보조자가 두 손을 이용하여 턱을 들어올려준 상태에서 광봉을 삽입하였다. 광봉 찾기 시간 (광봉을 입에 삽입한 시간부터 윤상성대막 위로 투조가 나타난 시간), 기관 삽관 시도 회수, 그리고 기관 삽관 시간을 평가하였다. 심박수와 평균 혈압을 기관 삽관 전과 후에 측정하였다. 수술 후 인후통을 수술 후 1 시간 그리고 24 시간에 0-100 mm 시각적 아날로그 동통 스케일을 이용하여 평가하였다.

결과: 광봉 찾기 시간은 통상적 하악 견인법 군보다 수정된 견인법 군에서 유의하게 짧았다 (수정된 하악 견인법 군 vs. 통상적 하악 견인법 군; 7.2 [4.6] 초 vs. 12.1 [9.1] 초, 평균 [표준 편차]; P=0.016). 수정된 하악 견인법 군에서 기관 삽관 시간도 통상적 하악 견인법 군보다 짧았다 (수정된 하악 견인법 군 vs. 통상적 하악 견인법 군; 21.0 [6.6] 초 vs. 27.9 [9.9] 초; P=0.004). 기관 삽관 시도 회수와 삽관 후 혈역학적 변화는 두 군간 비슷하였다. 수술 후 인후통의 빈도와 강도는 수술 후 24 시간에 평가 하였을 시 수정된 하악 견인법 군에서 통상적 하악 견인법 군보다 덜 하였다 (P=0.011).

결론: 수정된 하악 견인법이 광봉을 이용한 기관내 삽관을 용이하게 하였으며 통상적 하악 견이법과 비교 하였을 때 수술 후 인후통의 빈도와 강도를 낮춰주었다.

주요어: 광봉, 통상적 하악 견입법, 수정된 하악 견인법

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