



# Fluoroscopic Comparison of Cervical Spine Motion Using LMA CTrach, C-MAC Videolaryngoscope and Macintosh Laryngoscope

Servikal Omurga Hareketi: LMA CTrach, C-MAC Videolaringoskop ve Macintosh Laringoskopun Floroskopik Karşılaştırması

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**Objective:** Endotracheal intubation should be performed with care when cervical spine (C-spine) injury is suspected. The aim of this study was to evaluate the movement of the C-spine using fluoroscopy during intubation with Laryngeal Mask Airway (LMA) CTrach, C-MAC videolaryngoscope and Macintosh laryngoscope.

**Methods:** This was a single-centre, prospective, observational, controlled trial. In total, 22 surgical patients aged 18-65 years planned to undergo operation under general anaesthesia, were enrolled. X-ray images of the C-spine were obtained using fluoroscopy with the patients' head in a neutral position. All patients underwent laryngoscopy using a Macintosh blade, LMA CTrach and C-MAC videolaryngoscope, and fluoroscopic images of the C-spine were obtained. All the patients were intubated at the last laryngoscopy simulation (using the C-MAC). The atlanto-occipital distance (AOD) and angles between C<sub>0</sub>C<sub>1</sub>, C<sub>0</sub>C<sub>2</sub>, C<sub>0</sub>C<sub>3</sub>, C<sub>0</sub>C<sub>4</sub>, C<sub>1</sub>C<sub>2</sub> and C<sub>2</sub>C<sub>3</sub> lines were measured and compared between each device.

**Results:** The mean AOD was measured as 20.4 mm in a neutral position, which decreased to 13.1, 17.2 and 12.3 mm after the insertion of the Macintosh laryngoscope, LMA CTrach and C-MAC videolaryngoscope, respectively. The differences were significant (p<0.001). Moreover, significant difference was noted in C<sub>0</sub>C<sub>2</sub>, C<sub>0</sub>C<sub>3</sub> and C<sub>1</sub>C<sub>2</sub> angles with the insertion of the three devices (p<0.001). The LMA CTrach resulted in significantly lesser C-spine movements in C<sub>0</sub>C<sub>2</sub>, C<sub>0</sub>C<sub>3</sub> and C<sub>0</sub>C<sub>4</sub> angles compared to the Macintosh laryngoscope and C-MAC videolaryngoscope (p<0.001).

**Conclusion:** The LMA CTrach resulted in lesser C-spine movements compared to Macintosh laryngoscope and C-MAC videolaryngoscope. In case of the C-spine injury, LMA CTrach may be preferred and may cause fewer traumas during endotracheal intubation.

**Keywords:** Cervical spine motion, LMA C Trach, videolaryngoscopy, fluoroscopy

**Amacı:** Servikal omurga hasarından şüphelenildiğinde endotrakeal entübasyon dikkatli yapılmalıdır. Bu çalışmanın amacı LMA (Laryngeal Mask Airway) CTrach, C-MAC Videolaringoskop ve Macintosh Laringoskop ile entübasyon sırasında floroskopi ile servikal omurga hareketini değerlendirmektir.

**Yöntemler:** Bu tek merkezli, prospektif, gözlemsel kontrollü bir çalışmaydı. Çalışmaya 18-65 yaşları arasında genel anestezi altında operasyon uygulanan 22 hasta dahil edildi. Endotrakeal entübasyondan önce, hastanın başı nötr konumda iken servikal omurga floroskopi görüntüleri elde edildi. Tüm hastalarda standart Macintosh laringoskop, LMA CTrach ve C-MAC Videolaringoskop kullanıldı. Laringoskopi simülasyonları sırasında servikal omurgadaki değişikliklerin floroskopik görüntüleri elde edildi. Tüm hastalar son laringoskopi sırasında C-MAC kullanılarak entübe edildi. Floroskopi görüntüleri üzerinde C<sub>0</sub> C<sub>1</sub>, C<sub>0</sub> C<sub>2</sub>, C<sub>0</sub> C<sub>3</sub>, C<sub>0</sub> C<sub>4</sub>, C<sub>1</sub> C<sub>2</sub> ve C<sub>2</sub> C<sub>3</sub> arasındaki Atlantookspital mesafeler ve açılar ölçüldü ve aradaki farklar cihazlar arasında karşılaştırıldı.

**Bulgular:** Ortalama Atlantookspital mesafe, nötral pozisyonda 20,4 mm ölçüldü ve sırasıyla Macintosh laringoskop, LMA CTrach ve C-MAC Videolaryngoscope'in yerleştirilmesinden sonra 13,1, 17,2 ve 12,3'e düştü ve aradaki farklar anlamlıydı (p<0,001). C<sub>0</sub> C<sub>2</sub>, C<sub>0</sub> C<sub>3</sub> and C<sub>1</sub> C<sub>2</sub> açılarında üç cihazın yerleştirilmesi ile de nötral pozisyona göre anlamlı fark vardı (p<0,001). LMA CTrach C<sub>0</sub> C<sub>2</sub>, C<sub>0</sub> C<sub>3</sub> and C<sub>0</sub>C<sub>4</sub> açılarında Macintosh laringoskop ve C-MAC Videolaringoskop ile karşılaştırıldığında servikal omurgada anlamlı olarak az harekete neden oldu (p<0,001).

**Sonuç:** Entübasyon sırasında LMA CTrach, Macintosh ve C-MAC videolaringoskoptan daha az servikal omurga hareketine neden olduğundan; servikal travmalı hastalarda daha uygun bir seçenek olabilir.

**Anahtar Kelimeler:** Servikal omurga hareketi, LMA Ctrach, videolaringoskopi, floroskopi

## Introduction

Cervical spine (C-spine) injuries occur in 1.5%–4% of all major trauma cases, and one-third of patients with C-spine injury require intubation after the injuries (1, 2). When the C-spine is unstable, there is a potential risk for spinal cord damage during endotracheal intubation with intervention and manipulations that cause head extension (3).

The Laryngeal Mask Airway (LMA) CTrach (The LMA, North America Inc. San Diego, CA, USA) is a modified version of the intubating laryngeal mask airway (ILMA) with a fiberoptic system and a detachable liquid crystal display screen that allows real-time view of the airway during orotracheal intubation (4). Due to its unique design, it conforms to normal curvature of the upper airway and can be inserted in a neutral position of the head and neck (5). The C-MAC videolaryngoscope (Karl Storz, Tuttlingen, Germany) with a modified Macintosh blade may be a useful alternative for both routine and difficult airway management.

Previous studies on C-spine movements during endotracheal intubation have compared direct laryngoscopy using a Macintosh blade with different airway devices including various videolaryngoscopes (6–10). The ideal device for endotracheal intubation in an emergency or elective C-spine instability setting remains controversial. To date, no study has examined specifically C-spine movements using the LMA CTrach in comparison to the Macintosh laryngoscope and C-MAC videolaryngoscope.

The aim of this study was to evaluate C-spine movements during endotracheal intubation of healthy surgical patients using LMA CTrach, C-MAC videolaryngoscope and a conventional laryngoscope using a Macintosh blade.

## Methods

This study was conducted in accordance with the ethical principles for human investigations, as outlined by Declaration of Helsinki. After the institutional ethics board approved the study (Committee No: 2008/42, İAEK: 7/1, Kocaeli University, 04/22/2008) and after patients provided written informed consent, 22 patients with American Society of Anesthesiologists (ASA) I or ASA II, aged 18–65 years, weighing 55–95 kg, were included in this prospective study. This was designed as a crossover study. Three different intubation techniques were applied consecutively in one patient, and the same patient served as a control. The patients were planned to undergo elective surgery under general anaesthesia and required orotracheal intubation. Excluded patients were those who were pregnant, non-fasted, had symptomatic or untreated gastroesophageal reflux, had a body mass index of  $>35 \text{ kg m}^{-2}$ , had previous neck surgery, had unstable C-spine, had known or expected difficult airway, or had a head and neck pathology.

At the preoperative visit, the following measurements were recorded: age, height, weight, body mass index, Mallampati classification (obtained with the patient in the sitting posi-

tion, tongue out, without phonation), thyromental and sternomental distances (measured with the patient in the sitting position, with the head in extension), mandibular protrusions (A: the lower incisors can be protruded anterior to the upper incisors, B: the lower incisors can be brought edge to edge with the upper incisors, C: the lower incisors cannot be brought edge to edge with the upper incisors) and interincisor distance (mouth opening). Patients were pre-medicated with midazolam  $0.03 \text{ mg kg}^{-1}$ . After standard monitoring (electrocardiogram, pulse oximetry and non-invasive blood pressure) and pre-oxygenation with 100% oxygen, anaesthesia was induced with thiopental  $5 \text{ mg kg}^{-1}$  and fentanyl  $1 \mu\text{g kg}^{-1}$ . Following the induction of anaesthesia, the patients were manually ventilated using a facemask. Rocuronium  $0.6 \text{ mg kg}^{-1}$  was administered; subsequently, the evoked response of the adductor pollicis muscle to the ulnar nerve stimulation at the wrist (TOF-Guards Acceleromyograph; TOF-Guard; Organon Teknika, Oss, Netherlands) was used to ensure adequate neuromuscular blockade. When the TOF ratio was zero in all patients, endotracheal intubation simulations were performed. Anaesthesia was maintained with 2% sevoflurane in 50% oxygen and nitrous oxide during the simulations.

Fluoroscopy is a technique that provides real-time X-ray imaging, which is particularly useful for guiding various diagnostic and interventional procedures. As endotracheal intubation is a dynamic process, spine movements can be variable during intubation. We determined the time point where the fluoroscopy images were captured as: ‘the insertion of the airway devices and obtaining a view of larynx’. The study was conducted in four stages. Each patient underwent Macintosh laryngoscopy, LMA CTrach and C-MAC videolaryngoscopy. At the first stage, a fluoroscopic (Siemens AG, Munchen, Germany) image of the C-spine with the head in a neutral position was obtained. After the images were captured, laryngoscopy was performed using a Macintosh no. 3 blade, and the fluoroscopic image of the C-spine was obtained with the Macintosh blade in the pharynx. At the third stage, the Macintosh blade was withdrawn and a suitable LMA CTrach device was inserted in the pharynx, and the fluoroscopic image of the C-spine was obtained with the LMA CTrach in the pharynx. At the fourth stage, a C-MAC videolaryngoscope with a no. 3 blade attached was inserted in the pharynx, and the fluoroscopic image of the C-spine was obtained with the C-MAC videolaryngoscope in the pharynx.

The patients were ventilated through a mask in between the laryngoscopy procedures. The patients were intubated at the last stage with a polyvinylchloride endotracheal tube (internal diameter 8.0 mm for men and 7.5 mm for women) using the C-MAC videolaryngoscope (Karl Storz, Tuttlingen, Germany). All laryngoscopy procedures were performed, and the X-ray images were obtained at the same time with an assistant holding the head and applying manual in line stabilisation. We calculated the equivalent dose as 0.05 mSv for the four fluoroscopy procedures, and this was approximately 1/50 of the neutral daily radiation exposure. The quality of the glottis view was recorded using Cormack and Lehane classification

(grade 1: entire glottis aperture; grade 2: partial glottis aperture; grade 3: free edged or ventral face of epiglottis; and grade 4: no recognisable structure). All the device insertions and intubations were performed by an investigator skilled at endotracheal intubation (>120 successful endotracheal intubations with all three devices) to minimise the bias. We used a size 3 LMA CTrach for patients weighing <50 kg, a size 4 LMA CTrach for patients weighing 50-70 kg and a size 5 LMA CTrach for patients weighing >70 kg. Before the insertion, the viewer was attached to the LMA CTrach and focused by obtaining a sharp image of a sheet of text held 1 cm in front of the fiberoptic channel port. Cricoid pressure was not applied in this study. If intubation procedure lasted more than 120 seconds for each device, it was recorded as a failed attempt. The operation room staff and study team used radiation-resistant eyewear as well as upper and lower lead aprons with thyroid protection during the complete procedure. The study team also used radiation-resistant surgical gloves. The body of the patient was shielded with lead aprons except the head and neck. A radiologist blinded to the groups of the patients, evaluated the X-ray images, applied the lines to the X-ray images and measured the angles.

We determined the atlanto-occipital distance (AOD), reference lines, common line and angles in accordance with literature studies (Figure 1) (6, 8).

**C<sub>0</sub>** (Mc Gregor's) line: Line extends from the upper surface of the posterior edge of the hard palate to the most inferior point of the occipital bone.

**C<sub>1</sub>** line: Line passing through the anterior and posterior arches of the atlas.

**C<sub>2</sub>, C<sub>3</sub> and C<sub>4</sub>** lines: Lines parallel to the inferior endplates of the vertebrae.

**AOD:** Vertical distance between the most inferior point of the occipital bone and the C<sub>1</sub> reference line measured in millimetre (mm).

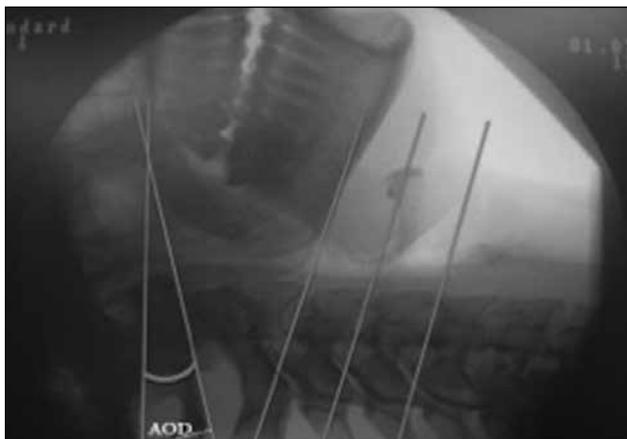


Figure 1. Fluoroscopic image of the upper C-spine and the skull base. This image shows the AOD and standard of the reference lines  
AOD: atlanto-occipital distance

The lower horizontal edge of the radiograph was used as a common reference line.

Angles between C<sub>0</sub> C<sub>1</sub>, C<sub>0</sub> C<sub>2</sub>, C<sub>0</sub> C<sub>3</sub>, C<sub>0</sub> C<sub>4</sub>, C<sub>1</sub> C<sub>2</sub> and C<sub>2</sub> C<sub>3</sub> lines were measured using a goniometer. All angles were calculated from the vertebrae minus the next vertebrae.

Angles between C<sub>0</sub> C<sub>1</sub>, C<sub>0</sub> C<sub>2</sub>, C<sub>0</sub> C<sub>3</sub>, C<sub>0</sub> C<sub>4</sub> = C<sub>0</sub> to common line angle minus C<sub>1</sub>, C<sub>2</sub>, C<sub>3</sub> and C<sub>4</sub> to common line angle, respectively.

Angle between C<sub>1</sub> C<sub>2</sub> = C<sub>1</sub> to common line angle minus C<sub>2</sub> to common line angle.

Angle between C<sub>2</sub> C<sub>3</sub> = C<sub>2</sub> to common line angle minus C<sub>3</sub> to common line angle.

**Statistical analysis**

Using previously published data for the C<sub>1</sub> C<sub>2</sub> angle from Rudolph et al. (6), we calculated the sample size as 22 patients for 80% power to detect a 10% difference in the C<sub>1</sub> C<sub>2</sub> angle. We used the Statistical Package of Social Science of Windows 16 (SPSS Inc.; Chicago, IL, USA) software. Values were given as mean ± standard deviation or median (interquartile range). For categorical data, we used chi-square test. For continuous data, normality was checked using the Kolmogorov-Smirnov test. If the distribution was found to be normal, parametric tests (Paired sample t-test) were used for the analysis; otherwise, nonparametric tests (Wilcoxon-Signed Ranks test) were used. Distribution was not normal for the measurement of C<sub>0</sub> C<sub>1</sub> using the Macintosh laryngoscope, C<sub>0</sub> C<sub>4</sub> in a neutral position, C<sub>2</sub> C<sub>3</sub> in a neutral position and C<sub>2</sub> C<sub>3</sub> angles using the LMA CTrach. A value of p<0.05 was considered as statistically significant.

**Results**

The demographic characteristics of patients are summarised in Table 1. Macroglossia was not detected in any patient. All patients' mandibular protrusions were 'A' except one. All patients were easily ventilated, only one of them needed Guedel airway insertion. Eighteen patients were intubated success-

Table 1. Demographic variables of patients. Values are mean (SD) or number (n)

Age (years)	39.4 (12.9)
Gender (Male/Female) (n)	4/18
ASA I/II	16/6
Mallampati I/II	17/5
Teeth morphology full/lack	17/5
Sternomental distance (cm)	14.6 (2.2)
Interincisor distance (cm)	4.4 (0.5)
Weight (kg)	74.8 (18.3)
Tiromental distance (cm)	8.1 (1)
Cormack-Lehane grade (I/II)	20/2

Table 2. AOD (mm) and C-spine motion measurements of patients using the Macintosh laryngoscope, LMA CTrach or C-MAC videolaryngoscope. Values are mean (SD) or median (interquartile range)

	N	Mac	CT	VL	N-Mac	N-CT	N-VL
AOD (mm)	20.4 (3.8)	13.1 (3.3)	17.2 (3.7)	12.3 (3.3)	p<0.001	p<0.001	p<0.001
C <sub>0</sub> C <sub>1</sub> (°)	8.8 (5)	5 (2.5)*	5.6 (0.8)	7.3 (2.5)	p=0.207*	p=0.005	p=0.200
C <sub>0</sub> C <sub>2</sub> (°)	19.9 (6.2)	40.9 (6.2)	30.3 (6.6)	42.3 (6.9)	p<0.001	p<0.001	p<0.001
C <sub>0</sub> C <sub>3</sub> (°)	21 (4.9)	46.5 (6.6)	31.2 (7.7)	45.6 (6.2)	p<0.001	p<0.001	p<0.001
C <sub>0</sub> C <sub>4</sub> (°)	20 (6.5)*	49.5 (8.6)	32.5 (8.4)	51.5 (5.2)	p=0.012*	p=0.010*	p<0.001*
C <sub>1</sub> C <sub>2</sub> (°)	25.8 (5.9)	37.9 (4.5)	31.6 (8.1)	35.1 (6.7)	p<0.001	p<0.001	p<0.001
C <sub>2</sub> C <sub>3</sub> (°)	11 (0)*	11.2 (1)	10 (1)*	11.8 (1.5)	p=0.861*	p=0.433*	p=0.064*

\*p values of AOD and the angles compared with the head in a neutral position and in laryngoscopy position using the LMA CTrach, Macintosh or C-MAC videolaryngoscope.  
\*Wilcoxon-Signed Ranks test was used. Values are median (interquartile range).  
AOD: atlanto-occipital distance; N: neutral; Mac: Macintosh; CT: CTrach; VL: videolaryngoscope; SD: standard deviation.

fully at the first attempt, but 4 patients were intubated at the second or third attempt.

The mean AOD was measured as 20.4 mm in the neutral position, which decreased significantly during the laryngoscopy procedure using all the three devices (Table 2).

The mean angle value measured between C<sub>0</sub> C<sub>1</sub> lines was 8.8 degrees in the neutral position and decreased to 5, 5.6 and 7.3 degrees when Macintosh blade, LMA CTrach and C-MAC videolaryngoscope, respectively, were inserted, and laryngoscopy was simulated.

The mean angle values in neutral position between C<sub>0</sub> C<sub>2</sub>, C<sub>0</sub> C<sub>3</sub>, C<sub>0</sub> C<sub>4</sub> and C<sub>1</sub> C<sub>2</sub> lines were measured as 19.9, 21, 20 and 25.8 degrees, respectively. All angles between C<sub>0</sub> C<sub>2</sub>, C<sub>0</sub> C<sub>3</sub>, C<sub>0</sub> C<sub>4</sub> and C<sub>1</sub> C<sub>2</sub> lines were significantly increased from the neutral position when the Macintosh blade, LMA CTrach and C-MAC videolaryngoscope were inserted, and laryngoscopy was simulated (p<0.001, p=0.012 for Macintosh laryngoscope and p=0.010 for the LMA CTrach in the C<sub>0</sub> C<sub>4</sub> angle).

The p values, measured values of angles in the neutral position and values of angles during laryngoscopy using the LMA CTrach, C-MAC videolaryngoscope and Macintosh laryngoscope are outlined in Table 2.

When the LMA CTrach was compared to Macintosh laryngoscopy, the AOD and the measured values of angles between C<sub>0</sub> C<sub>2</sub>, C<sub>0</sub> C<sub>3</sub>, C<sub>0</sub> C<sub>4</sub> and C<sub>1</sub> C<sub>2</sub> lines were significantly lower. The p values are summarised in Table 3.

When the LMA CTrach was compared to C-MAC videolaryngoscopy, the measured values of angles between C<sub>0</sub> C<sub>1</sub>, C<sub>0</sub> C<sub>2</sub>, C<sub>0</sub> C<sub>3</sub>, C<sub>0</sub> C<sub>4</sub>, C<sub>1</sub> C<sub>2</sub> and C<sub>2</sub> C<sub>3</sub> lines were significantly lower. The p values are summarised in Table 3.

When C-MAC was compared to Macintosh laryngoscope, no significant difference was observed in the angles measured between C<sub>0</sub> C<sub>1</sub>, C<sub>0</sub> C<sub>2</sub>, C<sub>0</sub> C<sub>3</sub>, C<sub>0</sub> C<sub>4</sub>, C<sub>1</sub> C<sub>2</sub> and C<sub>2</sub> C<sub>3</sub> lines. The change in AOD was not significant (Table 3).

Table 3. Comparison of p values of AOD and all angles using the LMA CTrach, Macintosh and C-MAC videolaryngoscope

	CT-Mac	CT-VL	Mac-VL
AOD (mm)	p=0.003	p=0.100	p=0.100
C <sub>0</sub> C <sub>1</sub> (°)	p=0.714*	p=0.040	p=0.105*
C <sub>0</sub> C <sub>2</sub> (°)	p<0.001	p<0.001	p=0.800
C <sub>0</sub> C <sub>3</sub> (°)	p<0.001	p<0.001	p=0.600
C <sub>0</sub> C <sub>4</sub> (°)	p<0.001	p<0.001	p=0.700
C <sub>1</sub> C <sub>2</sub> (°)	p=0.004	p=0.020	p=0.100
C <sub>2</sub> C <sub>3</sub> (°)	p=0.336*	p=0.003*	p=0.100

\*Wilcoxon-Signed Ranks test was used. CT: LMA CTrach; VL: videolaryngoscope; AOD: atlanto-occipital distance

## Discussion

This study showed a remarkable movement of the C-spine during laryngoscopy, which is proved by the evaluation of a significant change of certain angles from the neutral position and the decrease in AOD. The changes in the angles were observed using the LMA CTrach, Macintosh blade and C-MAC videolaryngoscope. Intubation attempt using the LMA CTrach resulted in lesser C-spine movements in certain angles when compared to the conventional laryngoscopy using the Macintosh blade and C-MAC videolaryngoscopy.

Similar studies have reported that the C-spine motion mostly exceeds between C<sub>0</sub> and C<sub>4</sub> cervical segments with different types of airway devices, such as the conventional laryngoscope with Macintosh and Miller blades, Bonfils rigid fibre-optic intubation device (Karl Storz Endoscopy-America, Inc. CA, USA), fibreoptic bronchoscope, GlideScope (Verathon Medical, Bothell, WA, USA) and Trachlight stylet (Laerdal Medical Limited, Kent, UK) (6, 8-12). Regarding these stud-

ies, our major aim was to investigate the C-spine motion between C<sub>0</sub> and C<sub>4</sub> cervical segments. Although videolaryngoscopes improve the laryngeal view and have an easy learning curve, no advantages over Macintosh laryngoscopy in terms of the C-spine motion and intubation procedure time have been observed (13-17). Consistent with these studies, our study revealed that the C-MAC videolaryngoscope has no superiority over Macintosh laryngoscope regarding the C-spine motion. However, the degree of C-spine movements with videolaryngoscopes remains controversial. GlideScope (Verathon Medical) videolaryngoscopy resulted in reduced movements of the C-spine in patients with unsecured C-spines compared to conventional Macintosh laryngoscope in a study that used video motion analysis (18). Truview videolaryngoscope (Truphatek International, Netanya, Israel) was associated with an improved laryngeal view and less movement at the C-spine (19). In a fluoroscopic study of a comparison of AirWay Scope (Pentax Corporation, Tokyo, Japan), McCoy laryngoscope and Macintosh laryngoscope, the AirWay Scope (Pentax Corporation) produced lesser movement of the upper C-spine in patients with a normal C-spine (20). In a cine-fluoroscopy study, the use of a GlideScope videolaryngoscope (Verathon Medical) produced better glottic visualisation but did not significantly decrease the movement of the nonpathologic C-spine when compared with direct laryngoscopy (14).

Videolaryngoscopy devices have a great variety. In an emergency situation, it is recommended to use the videolaryngoscopy device that proper experience has been acquired. As the patients included in the study did not have expected difficult airways, we preferred the C-MAC videolaryngoscope with the Macintosh blade because we had a good experience with C-MAC. Many of these devices have various sizes, angles of blades and different laryngoscopy techniques (some allowing direct view of glottis versus others allowing an indirect view with increased angles). Relevant differences in C-spine movements may occur between different blades of videolaryngoscopes in an intubation scenario.

Fibreoptic intubation seems to be the preferred airway device over other intubation techniques in case of cervical instability (9, 21, 22). Although intubation with fibreoptic bronchoscope resulted in the lowest cervical motion compared to other intubation devices, fibreoptic intubation is not always possible without the use of head tilt-chin lift or jaw thrust manoeuvres, which causes the mostly intense motion in the unstable cervical segment and thereby great caution should be taken while performing these manoeuvres. Other disadvantages of fibreoptic intubation include longer intubation times and the requirement of a skilled operator (21-23).

The LMA CTrach resulted in lesser C-spine movements compared to laryngoscopy in our study. It has additional advantages, as noted by previous studies, such as easy insertion, high first intubation success rates and the ability of oxygenation and ventilation throughout the procedure (24-26). The intubating laryngeal mask produces segmental movement of the C-spine when applied with manual in-line stabilisation

in patients with C-spine pathology (27). However, supraglottic devices cause C-spine movements lesser or same as that by conventional laryngoscopes (23, 28). Many authors have studied about the fibreoptic intubation, ILMA and Macintosh laryngoscope. Endotracheal intubation with ILMA caused lesser spine movements when cervical extension angles were evaluated (21-24).

The LMA CTrach has a different design and technique of use when compared to the conventional laryngoscopy and videolaryngoscopy. In our opinion, an operator who is experienced in ILMA could easily use the LMA CTrach. Supraglottic airway devices are suggested in case of a 'can't ventilate, can't intubate' scenario, and ILMA is one of the alternative difficult intubation approaches in difficult intubation guidelines when an intubation attempt using a conventional laryngoscopic device fails (29). The LMA CTrach has a remarkable advantage over a standard ILMA with regard to providing a view of glottis. One disadvantage of the LMA CTrach is being a special device, which may not be available in small medical centres and emergency clinics, although it is successfully used in many anaesthesiology clinics around the world.

Limitations of our study were that we studied only healthy adult patients undergoing elective procedures, which did not really represent a true C-spine injury. Moreover, there was the inability to assess cervical movements in the coronal plane as our fluoroscopy images were captured only in the sagittal plane. Another limitation is that only laryngoscopy was performed with the LMA CTrach, an endotracheal tube was not inserted. Passing the endotracheal tube through the LMA CTrach may need additional manoeuvres.

## Conclusion

The LMA CTrach resulted in lesser C-spine movements during endotracheal intubation of healthy surgical patients compared to Macintosh laryngoscope and C-MAC videolaryngoscope. The most important advantage of the LMA CTrach is the ability of oxygenation and ventilation throughout the procedure. It may be considered one of the first-line intubating tools and may be helpful for a less traumatic endotracheal intubation for adult patients with suspected C-spine injury.

**Ethics Committee Approval:** Ethics committee approval was received for this study from the ethics committee of Kocaeli University School of Medicine (2008/42, İAEK: 7/1)

**Informed Consent:** Written informed consent was obtained from patients who participated in this study.

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