Effects of ILMA and ILMA Specific Optimization Maneuvers on Cervical Spine Motion: A Clinical Fluoroscopic Study

Entübasyon Laringeal Maskesi ve Entübasyon Laringeal Maskesine Spesifik Optimizasyon Manevralarının Servikal Vertebra Hareketine Etkisi: Klinik Floroskopik Çalışma

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ABSTRACT Objective: Cervical spine motion must be low in servical trauma patients during intubation. Intubating laryngeal mask airway was designed to facilitate the ventilation and intubation in difficult airways. Some maneuvers needed for optimisation of ventilation or intubation through ILMA. The aim of this study was to compare the effect of the ILMA specific optimization maneuvers on cervical spine motion. **Material and Methods:** 20 adult patients, aged between 18-45 years and ASA physical status 1 or 2 undergoing endotracheal intubation requiring elective surgical operation were enrolled in this study. Demographic variables of patients were recorded. After standard monitoring and following anaesthesia induction with propofol and fentanyl, rocuronium was then administered. Lateral scopies of patients were taken before ILMA insertion (neutral position), after ILMA insertion (ILMA-inplace) and during application of the maneuvers (Chandy, Side-to-Side and Up). The atlantooccipital distance and the cervical spine extension angles (C_0C_1, C_1C_2, C_2C_3) of the patients were calculated from that scopies. **Results:** Demographic and airway variables of patients were similar. Ventilation through ILMA and facemask were easy. All patients were successfully intubated. While the Chandy maneuver resulted in a significant decrease in atlantooccipital distance (p=0.000) and increase in C_0C_1 (p=0.001), C_1C_2 (p=0.01) cervical extension angles, Up maneuver did not lead to statistical difference when compared to the neutral position. The Chandy maneuver also made o reduction in the AOD (p=0.001) and an increase in the C_0C_1 (p=0.002) cervical angle when compared with the ILMA-inplace. We could not detect statistically any difference between ILMA-inplace and Up maneuver. **Conclusion:** Up maneuver could be used rather than Chandy maneuver in cervical trauma suspected patients for optimisation of ventilation or intubation through ILMA.

Key Words: Fluoroscopy; airway management

ÖZET Amaç: Servikal travmalı hastalarda entübasyon sırasında servikal vertebra hareketi az olmalıdır. Entübasyon Laringeal Maskesi (ILMA), zor havayolunda ventilasyon ve entübasyonu kolaylaştırmak üzere geliştirilmiştir. ILMA ile ventilasyon ve entübasyonu optimize etmek için birtakım manevralar gerekebilir. Bu çalışmanın amacı, ILMA spesifik optimizasyon manevralarının servikal vertebra hareketi üzerine etkisini karşılaştırmaktır. **Gereç ve Yöntemler:** ASA I-II fiziki duruma sahip, entübasyon gerektiren elektif cerrahi operasyon gereken, 18-45 yaş arası, 20 erişkin hasta çalışmaya dahil edildi. Hastaların demografik verileri kaydedildi. Standart monitörizasyonu ve propofol, fentanil ile anestezi indüksyonunu takiben roküronyum bromür uygulandı. Hastaların ILMA yerleştirilmeden önce lateral skopileri çekildi (nötral pozisyon), ILMA yerleştirildikten sonra lateral skopi görüntüsü alındı (ILMA- yerinde) ve manevralar (Chandy, Side-to-Side ve Up) uygulanırken skopi görüntüleri alındı. Hastaların bu skopiler üzerinde atlantooksipital mesafeleri ve servikal ekstansiyon açıları (C_0C_1, C_1C_2, C_2C_3) ölçüldü. **Bulgular:** Hastaların Demografik ve havayolu verileri benzerdi. Yüz Maskesi ve ILMA ile ventilasyonları kolaydı. Tüm hastalar başarı ile entübe edildi. Chandy manevrası, nötral pozisyona göre atlantooksipital mesafede azalmaya (p=0,000) ve C_0C_1 (p=0,001), C_1C_2 (p=0,01) açılarında ise anlamlı artışa neden olurken Up manevrası herhangi bir istatistiksel değişikliğe yol açmadı. Chandy manevrası, ILMA-yerinde ile karşılaştırıldığında da atlantooksipital mesafede anlamlı azalmaya (p=0,001) ve C_0C_1 açısında da belirgin artışa (p=0,002) neden olmuştur. Up manevrası ile ILMA-yerinde arasında istatistiksel açıdan fark saptanmadı. **Sonuç:** Servikal travma şüphesi olan hastalarda ILMA ile optimum ventilasyon ve entübasyon şartlarının sağlanması için Chandy manevrası yerine Up manevrası daha güvenle kullanılabilir.

Anahtar Kelimeler: Floroskopi; hava yolu yönetimi

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There is a potential risk of spinal cord damage during tracheal intubation according to the cervical spine motion.[1,2] The ideal device for emergency or elective cervical spine instability settings remains the subject of debate.

Intubating Laryngeal Mask Airway (ILMA or Fastrach; Laryngeal Mask Co., Henley on Thames, UK), was developed to ventilate the patient while intubating the trachea without moving the neck from the neutral position in patients with a potentially unstable cervical spine. Although some studies demonstrated that ILMA is safe for patients with cervical trauma, the effects of some complimentary ILMA-specific maneuvres such as Chandy, Side-to-Side and Up manoeuvres on cervical spine movement has not been studied yet.[3,4]

MATERIAL AND METHODS

After The Local Research Ethics Committee approval and written informed patient consent was obtained, 20 elective ASA physical status I-II adult patients admitted for non-cardiac surgery requiring general anesthesia with endotracheal intubation were enrolled in this study. Patients who were pregnant, non-fasted, had symptomatic or untreated gastroesophageal reflux, body mass index >35 kg/m, previous neck surgery or pathology, unstable C-spine, known or expected difficult airway; Mallampati classification more than III-IV, mouth opening <3 cm and thyromental distance (TMD) <6 cm, sternomental distance (SMD) <12 cm were excluded from the study. At the preoperative visit, we recorded the following measurements: age, gender, height,weight, body mass index (BMI), Mallampati classification (obtained with the patient in the sitting position, tongue out, without phonation), thyromental and sternomental distances (measured with the patient in the sitting position, with head at maximum extension), mandibula 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 can not be brought edge to edge with the upper incisors), tooth morphology and interincisor distance (mouth opening). Patients were premedicated with midazolam 0.03 mg/kg. Standard monitoring included; ECG, pulse oximetry, non-invasive blood pressure and end-tidal carbon dioxide. We put pillows under the patients head during the whole procedure. Patients were pre-oxygenated with 100% oxygen for 3-5 min using a facemask. Anesthesia was induced with propofol 2 mg/kg (calculated according to lean body weight) and fentanyl 1µg/kg. Following induction of anesthesia, the patients were manually ventilated by facemask with 2% sevoflurane in oxygen. We used oropharyngeal airway for optimization of facemask ventilation. If the oral airway could not provide adequate ventilation, these patients were excluded from the study. Rocuronium 0.6 mg/kg was administered and then the evoked response of the adductor pollicis muscle to ulnar nerve stimulation at the wrist (TOF-Guards acceleromyograph; TOF-Guard; Organon Teknika, Oss, The Netherlands) was used to ensure the adequate neuromuscular blockage in all patients. Anaesthesia was maintained with 2% sevoflurane in 50% oxygen and nitrous oxide. First, we took a lateral scopy (Siemens AG., Muenchen, Germany) of patients' with the head in neutral position then put a suitable size of ILMA inplace and inflated its cuff according to the manufacturers' recommendations in neutral position then took the second lateral scopy. We used a size 3 ILMA for patients with body weight <50 kg, a size 4 ILMA for patients 50-70 kg, and a size 5 ILMA for patients >70 kg. Only the posterior surface of the ILMA was lubricated. Then we performed the Chandy, Side-to-Side (always turned to the right side in all patients) and the UP maneuvers in order and also took scopies. Finally, we intubated the patient with ILMA and its specific endotracheal tube (8.0 for men and 7.0 for women). All mask ventilations, device insertions and intubations were made by skilled investigators (at least 4 years experience in anaesthesia and made >50 successful intubations with ILMA) to minimize the bias.

Chandy Maneuver: Is pushing the mask slightly further in (tip of the mask towards the upper oesophageal sphincter).

FIGURE 1: Fluoroscopy of the upper cervical spine and the skull base. This image shows the standard of the AOD, reference lines and the common line (always the basis of the scopy).

Up Maneuver: Consists of backing the airway device out of slowly up to 6 cm without deflating the mask.

Side-to-Side Maneuver (SS): Consists of turning the mask slightly to the right or left side inplace (always turned to the right in this study).

Cricoid pressure was not applied in this study. If intubation took more than 120 seconds then it would be recorded as failure. Study personnel used radiation resistant surgical gloves, eyewear, upper and lower lead aprons with thyroid protection during the whole procedure. Patients were covered with lead aprons for the areas we were not investigating. A radiologist applied the lines to the radiographs, and then we used them for measuring the Atlanto Occipital Distance (AOD) and the angles (Figure 1).

C_0 (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 seen in the lateral X-Ray.

C_1 line: Line passing through the inferior edge of anterior and posterior arches of the atlas.

C_2, C_3 lines: Line parallel to inferior endplates of the vertebraes.

AOD : The vertical distance between the most inferior point of the occipital bone and the C_1 reference line and was measured in millimeter (mm).

C_0C_1, C_1C_2, C_2C_3 Angles (a): All angles were calculated the vertebrae minus the next vertebrae;

C_0C_1 angle; a= C_O to common line angle minus C_1 to common line angle

C_1C_2 angle; a= C_1 to common line angle minus C_2 to common line angle

C_2C_3 angle; a= C_2 to common line angle minus C_3 to common line angle

The lower horizontal edge of the radiograph was used as a common reference line. Positive angles denoted extension and negative angles denoted flexion. AOD, reference lines and the common line for measurements in accordance with the literature before.[5] The angles were measured with a goniometer.

The sample size was determined 20 in each group, allowing an alpha-error of 0.05 and a beta-error of 0.2 (power 80%) to detect a 15% difference for the AOD between the procedures according to the previous published results by Rudolph et al.[5]

We used Statistical Package of Social Science of Windows 16 (SPSS, Inc, Chicago, IL). Values were given as mean (SD). For categorical data, we used the chi-square test. For continuous data; if the distribution was found to be normal parametric tests were used for the analysis; otherwise nonparametric tests were used. For comparing the devices according to the angles; we used Mann Whitney-U test and Student t-test. We used the Bonferoni correction for comparing the group and a p value of <0.01 was considered as statistically significiant (because we have 5 groups to compare).

RESULTS

All patients demographic data were shown in (Table 1). All patients were easily ventilated by facemask and intubated at the first attempt. No patient was excluded from the study due to difficult ventilation. Oral airway was used in ten patients during facemask ventilation. Ventilation via the ILMA was easy in all patients. Macroglossia was not detected in any patient. Head extension and neck flexion was normal in all patients. All patients mandibula protrusions were 'A'. ILMA inplace and Up maneuver showed no statistical differences when

TABLE 1: Demographic variables and airway characteristics of patients.

Age; years	34.8 (12.2)
Gender (Male/Female) (n)	9/11
ASA I/II (n)	18/2
Mallampati I/II (n)	12/8
Tooth Morphology Full/Lack	18/2
Sternomental Distance (cm)	14.7 (1.7)
Interincisor Distance (cm)	4.32 (0.5)
Height (cm)	166.7 (7.6)
Weight (kg)	66.2 (10.4)
BMI (kg/m^2)	24 (3.2)
Thyromental Distance (cm)	7.9 (1.1)

Values are mean (Standard Deviation) (SD) or number (n).
cm: Centimeter; kg: Kilogram; m: Meter.

compared with the heads in a neutral position. When the heads were in a neutral position and the Chandy maneuver compared to each other; AOD (p=0.000) and C_0C_1 (p=0.001) and C_1C_2 (p=0.01) angles were statistically significantly changed. The Side-to-Side maneuver only decreased the AOD significantly and it did not make any change in cervical extension angles when compared to the neutral position (Table 2). Although when the ILMA inplace was compared to the Chandy maneuver; Chandy significantly reduced the AOD (p=0.001) and increased the C_0C_1 angle (p=0.002). The Side-to-Side and UP maneuver did not significantly differ from the ILMA inplace related to the AOD and all cervical extension angles.

DISCUSSION

The main result of this study was Chandy maneuver caused higher cervical spine motion when compared with other optimisation maneuvers.

Recently some authors studied the effect of single handed cricoid pressure on neck movement under manual in-line stabilization (MAILS) and measured neck displacement.[6-8] Donaldson et al. demonstrated that nasal fiberoptic intubation caused less cervical effects than oral intubation and great care should be taken while performing chin lift, jaw thrust and cricoid pressure because these techniques caused the most motion in the unstable cervical segment till C_2.[9] Recently, Turkstra et al., Wong and colleagues, showed the manipulation like handling force maneuver (ventral lifting force) caused extension of C_0 and C_1 levels. They also showed that, fiberoptic intubation is not always possible without the aid of glottic optimization maneuvers and pulling on the tongue alone is sometimes sufficient to open the posterior pharyngeal space and caused less movement but this is not the case when jaw thrust was added to tongue pull.[10,11]

Wahlen and Gercek et al., supported the use of ILMA, oral and nasal fiberoptic intubation in suspected cervical spine injury according to their invivo three- dimensional ultrasound imaging studies (in all three planes). They reported that fiberoptic intubation reduced the cervical spine movement statistically significantly but, took longer intubation times than ILMA and required skilled investigators.[12,13]

Similar to our results , studies have shown that predominant motion of ILMA was exceeded at AOD, C_0-C_1 and C_1-C_2 levels.[14] Another study in 20 patients with cervical pathology reported that posterior displacement of ILMA in MAILS was only 0.5-1 mm between C_2C_5 vertebraes.[15] The most important advantage of ILMA was the ability

TABLE 2: AOD (mm: milimeter) and C-spine motion measurements of patients via the head in neutral position, ILMA inplace, Chandy Maneuver and Up maneuver.

	Neutral	ILMA inplace	Chandy	SS	Up maneuver
AOD (mm)	12.8(2.6)	11.6 (2.1)	9.2(2)†	10.5 (2.6)*	11 (2.6)
C_0C_1 (°)	6.9(13.5)	3.2 (5.9)	-4.5(7.1)†	-0.5 (8)	1.1 (8.7)
C_1C_2 (°)	-23.9(9.4)	-25.1 (15.9)	-28.9(17.4)*	-27.8 (16)	-27.8 (16.6)
C_2C_3 (°)	-1.2(5.2)	-0.1 (3.7)	-2.3(5.6)	0.3 (5.7)	0.1 (4.3)

Values are mean (Standard Deviation). p values were given comparing with the neutral position.
*: p<0.05, †: p<0.002.

of oxygenation and ventilation throughout the whole procedure and ILMA reduced the cervical angles at C_1C_2 and C_2C_3 when compared with the Macintosh laryngoscopy.[16,17] Four airway devices (ILMA, Macintosh, Trachlight and Airtraq) compared with each other at C_5-C_6 level, no difference was detected among groups at that level.[18] We could not detect any difference in motion after C_2C_3 level either. In a 1999 study of human cadavers, Keller et al., found that ILMA exerted pressure during insertion, removal (as we did in our study with Up maneuver) and inflation of the cuff (as we did with ILMA inplace) but the maximum motion of the ILMA was during the intubation. This pressure caused posterior displacement of the cervical spine till C_3. In concordant with our results they also reported that ILMAs' handle was sometimes passed posteriorly like the Chandy maneuver and this can generate much higher pressures.[19] Recenlty a new study compared the Airtraq, ILMA, Trachlight and Macintosh regarding to lateral bending and axial rotation maneuvers (as we did in our study with SS maneuver) in three dimensional imaging and found that cervical motion related to these maneuvres were similar among groups. They demonstrated that ILMA produced motion mostly during flexion and extension maneuvres.[20]

According to the published literature, the need for the Chandy maneuver with ILMA in normal patients, difficult airways (including immobilized cervical spines) and morbidly obese were recorded as 46%, 37% and 26% respectively.[21-23] They also reported that incidence of multiple insertions were significantly lower when Chandy maneuver was used before or during intubation.

28% of normal, 50% of morbidly obese and 63% of cervical collar immobilized patients needed Up maneuver during optimization the glottis while intubation and ventilation through LMA-CTrach.[24-26]

The major limitations of bias in our study was; first the absence of blinding the operators to the device being used, second we studied in healthy patients and elective procedures, third we used pillows in all subjects, fouth our results could not be attributed to the pediatric population and finally our imaging method was only in sagittal plane. Further studies that will work on real cervical spine injured patients and real emergency settings or with collar immobilization were needed.

In conclusion, Up maneuver could be used firstly rather than Chandy maneuver for optimization of ILMA when a cervical spine injury was suspected.

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