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Research

Comparison of Perioperative Results of the Use of a Double-Lumen Tube and Laryngeal Mask Airway in Video-assisted Thoracoscopic Wedge Resection: A Retrospective Clinical Study

Video Yardımlı Torakoskopik Wedge Rezeksiyonunda Çift Lümenli Tüp ve Laringeal Maske Hava Yolu Kullanımının Perioperatif Sonuçlarının Karşılaştırılması; Retrospektif Klinik Çalışma

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ABSTRACT

Objective: To evaluate the feasibility and safety of double-lumen tube (DLT) endotracheal intubation and laryngeal mask airway (LMA) use in the airway management of patients undergoing general anesthesia in thoracoscopic surgery of primary spontaneous pneumothorax.

Methods: For this retrospective observational study, patients were assigned to the LMA group (n=68) and DLT group (n=52) according to the airway method used. Perioperative clinical parameters of patients in both groups were collected through an institutional computer-based documentation system. The SPSS 22.00 program was used for data analysis.

Results: There was no statistically significant difference between the groups in terms of demographic and surgical data (p>0.05). After induction, heart rate (p=0.026) and mean blood pressure (p=0.019) were found to be statistically higher in the DLT group than the LMA group in the T_2 period when patients were treated with LMA or DLT. When the mechanical ventilation data of both groups were compared, plateau pressure, peak pressure, driver pressure, compliance, and calculated mechanical power values were statistically similar between the two groups. The number of patients experiencing sore throats during the postoperative period was significantly lower in the LMA group (n=11, 16.17%) than that in the DLT group (n=12, 23.07%) (p=0.034).

Conclusion: Compared with DLT, the use of an LMA in patients for airway management in video assisted thoracoscopic wedge resection can be performed safely and successfully, providing more stable hemodynamics and similar mechanical ventilation parameters.

Keywords: Laryngeal mask airway, endotracheal intubation, double-lumen tube, wedge resection, primary spontaneous pneumothorax

ÖZ

Amaç: Bu çalışma, primer spontan pnömotoraks tedavisi için torakoskopik cerrahi geçiren hastalarda anesteziye bağlı hava yolu yönetiminde çift lümenli tüp (ÇLT) ile endotrakeal entübasyon ve laringeal maske hava yolunun (LMA) uygulanabilirliğini ve güvenliğini değerlendirmekte ve karşılaştırmaktadır.

Gereç ve Yöntem: Retrospektif gözlemsel çalışma desenindeki bu çalışma için hastalar başvuru sırasına göre ardışık olarak, LMA grubuna (n=68) ve ÇLT grubuna (n=52) atandı. Her iki gruptaki hastalardan perioperatif klinik parametreler kurumsal bilgisayar tabanlı dokümantasyon sistemi aracılığıyla toplandı. Verilerin analizi için SPSS 22.00 programı kullanıldı.

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Bulgular: Gruplar arasında demografik ve cerrahi veriler açısından istatistiksel olarak anlamlı fark saptanmadı ($p>0.05$). İndüksiyon sonrası LMA veya ÇLT ile hastalara müdahale yapıldığı T_2 periyodunda kalp hızı ($p=0.026$) ve ortalama kan basıncı ($p=0.019$) ÇLT grubunda istatistiksel olarak yüksek saptandı. Her iki grupta mekanik ventilasyon verileri karşılaştırıldığında ise plato basıncı, tepe basıncı, sürücü basıncı, kompliyans ve hesaplanan mekanik güç değerleri iki grup arasında istatistiksel olarak benzerdi. Postoperatif dönemde boğaz ağrısı yaşayan hasta sayısı LMA grubunda (n=11, %16.17) ÇLT grubuna (n=12, %23.07) göre anlamlı olarak daha düşüktü ($p=0.034$).

Sonuç: ÇLT ile karşılaştırıldığında video yardımlı torakoskopik wedge rezeksiyonu cerrahisinde hava yolu yönetimi için hastalara LMA uygulanması daha stabil hemodinami ve benzer mekanik ventilasyon parametreleri sağlayarak güvenli ve başarılı şekilde gerçekleştirilebilir.

Anahtar Kelimeler: Laringeal maske hava yolu, endotrakeal entübasyon, çift lümenli tüp, wedge rezeksiyon, primer spontan pnömotoraks

INTRODUCTION

Primary spontaneous pneumothorax (PSP) is a disease characterized by the partial or total collapse of the lung, which is particularly common in young and tall men (1). It is usually possible to expand the lung using tube thoracostomy, but surgery is required for treating prolonged or recurrent PSP cases. Video-assisted thoracoscopic wedge resection is a promising surgical treatment for prolonged PSP (2). In wedge resection procedures in video-assisted thoracoscopic surgery (VATS), one-lung ventilation (OLV) with the operated lung collapsed is considered mandatory to create a surgical field. To provide this condition, general anesthesia with double-lumen endobronchial intubation is applied. However, possible complications of double-lumen endobronchial intubation have been reported in the literature (3,4). Problems such as sore throat and hoarseness are common in the postoperative period because double-lumen tubes (DLTs) are more difficult to manipulate during intubation and have a larger diameter than single-lumen tubes (5). Tracheal rupture is the most serious complication that can be experienced. In addition, barotrauma and volutrauma may be seen due to OLV (6,7). In addition, the bronchoscopy performed for the duration of the procedure and the localization control of the tube can prolong the anesthesia period of the patient.

In this minimally invasive surgical technique, an alternative method has been sought to prevent complications caused by DLT, and laryngeal mask airways (LMA) have been tried in different studies for airway management in VATS. The results obtained show that the use of LMA for airway management is promising (8). However, these studies were conducted on a small number of patients and compared with single-lumen endotracheal tubes (ETT). However, the use of LMAs in thorax surgery is still very limited.

There is no study in the literature examining the effectiveness of DLT and LMA in thoracoscopic wedge resection procedures. Our hypothesis was hat LMA would provide a more comfortable postoperative period for patients. This study provided additional evidence on this issue and to evaluate the intraoperative efficacy, safety, and postoperative results of LMA use in this procedure through comparison with DLTs.

METHODS

Study Design and Patients

Approval this study was approved by the Clinical Research Ethics Committee of Bakırköy Dr. Sadi Konuk Training and Research Hospital (decision no: 2022-04, date: 21.02.2022). For the study, the records of patients who underwent wedge resection with the VATS technique between January 1st, 2020, and December 31st, 2021, were reviewed, retrospectively.

The inclusion criteria were defined as patients with unilateral PSP requiring thoracoscopic wedge resection, aged 18 years and over, American Society of Anesthesiologists physical status I-II, and mallampati score I-II. The exclusion criteria were data loss, body mass index >30 kg/m^2, and history of previous thoracic surgery. The institutional computer-based documentation system and patient follow-up forms were used as data collection tools. A total of 120 consecutive patients who met the inclusion criteria were analyzed in either the DLT or LMA groups according to the airway control method used. All surgeries were performed by the same surgeon (S.K.) and anesthesiologist (G.S.). The study was conducted in accordance with the principles set in the Declaration of Helsinki (as revised in 2013).

General Anesthesia Technique

Before surgery, 22-gauge vascular access was established in all patients, and an infusion with 2-4 mL/kg/st Ringer's lactate solution was initiated for rehydration. Standard monitoring was achieved using electrocardiography, noninvasive blood pressure, and peripheral oxygen saturation. After monitoring, 0.03-0.05 mg/kg midazolam was administered to all patients for premedication. In the DLT group, after induction was achieved using 2 mcg/kg fentanyl, 3 mg/kg propofol, and 0.8 mg/kg intravenous rocuronium, the patients were intubated with a left-sided DLT suitable for their weight and height. The position of the DLT was confirmed through auscultation and fiberoptic bronchoscopy. In the LMA group, after induction was achieved with 1.5 µg/kg fentanyl, 2 mg/kg propofol, and

0.2 mg/kg intravenous rocuronium, a number 3 LMA was placed for women and number 4 for men. The preferred LMA was i-gel (Intersurgical Ltd, Berkshire, UK®).

During OLV, mechanical ventilation of the lung was adjusted to maintain normocapnia and prevent hypoxemia (tidal volume: 3-4 mL/kg, inspiratory, and expiratory ratio: 1:1-1:2, frequency: 15-18, end-tidal carbondioxide ($ETCO_2$) concentration, 35-45 mm Hg), a peak airway pressure of more than 30 cm H_2O was not desired. Anesthesia was maintained with 60-100% oxygen at a flow rate of 3 L/min, and 0.8-1% MAC sevoflurane and IV remifentanil (0.05-0.1 mcg/kg/min) infusion. When the surgical field was closed, all patients were administered 0.7 mg/kg IV meperidine hydrochloride for postoperative analgesia and 4 mg ondansetron for nausea and vomiting prophylaxis. At the end of the surgery, all patients were followed up in the recovery room with mask O_2 (2 L/min) support after extubating. Those with a modified Aldrete score ≥9 were sent to the ward. To provide analgesia in the postoperative period, tenoxicam 20 mg IV twice per day and paracetamol 1g IV three times per day were administered to all patients. Tramadol hydrochloride (1 mg/kg) was administered as rescue analgesia to patients with pain scores ≥4.

Data Collection

Hemodynamic data, mechanical ventilation settings, airway pressures, and compliance of the patients when the patient was monitored (T_1), immediately after intubation (T_2), after clamping in the DLT group, after carbondioxide (CO_2) insufflation in the LMA group (T_3), when the surgical field was closed (T_4), at the end of surgery (T_5), and after extubation (T_6) were recorded. Only hemodynamic data were recorded because the patient was awake during the T_1 and T_6 periods. Driving pressure was calculated using the formula [P plateau- positive end-expiratory pressure (PEEP)], and mechanical power (J/minute) was calculated using the formula [0.098 x tidal volume x respiratory rate x (Ppeak-1/2 x driving pressure)]. In addition, patients were evaluated in terms of duration of anesthesia, surgical duration, length of hospital stay, and postoperative complications.

Surgical Technique

Under general anesthesia, the patient was placed in the lateral decubitus position in the DLT group and the semilateral decubitus position in the LMA group, and three port incisions were made on the upper side of the patient where the surgery was planned. The lung that underwent surgery in the DLT group collapsed by blocking the airway. In the LMA group, after the port placement, CO_2 gas was insufflated into the thoracic cavity at a pressure of 8-10 cm H_2O and the lung collapsed. Surgical exploration was performed by placing 30° optics through the lowest port.

After detecting the bullous area, which is generally located in the upper lobe of the lung, air leak control is performed. Wedge resection was performed on the ruptured and non-ruptured bulla area using an endoscopic stapler. After the wedge resection, air leakage control was repeated. A partial pleurectomy was performed on the apicolateral region of the parietal pleura. At the end of the surgery, 32-French thoracic drains were placed through the port incisions and the procedure was completed. All surgeries were performed by the same surgeon (S.K.).

Outcome Measurements

The primary outcome of the study was to determine the mechanical power values. These are predictors of mechanical ventilation-associated lung injury (VILI) that may develop due to airway dynamics in the DLT and LMA groups. Secondary outcomes were the determination of intraoperative hemodynamic and airway pressure parameters. In addition, the length of hospital stay and postoperative pulmonary complications were recorded.

Statistical Analysis

The G*Power 3.1.9.2 program was used to calculate the sample size of the study. A pilot retrospective study was conducted with ten patients from each group to determine the minimal sample size for the primary outcome. The mean mechanic power value was 7.25±1.16 in the group LMA and 8.47±1.85 in the group DLT. An effect size 0.790 and α error=0.05 with a power of 95% was assumed so that each group had at least 43 participants. We included 68 patients in group LMA and 52 patients in group DLT due to the possibility of dropouts. Patient data from the pilot study were not included in the main study.

The data collected in the study were evaluated using the SPSS 22.00 program for Windows 10. The Kolmogorov-Smirnov test was used to check the normality of the data distributions. For descriptive statistics, categorical variables are given as percentages (%) and numerical variables as mean ± standard deviation. In the comparison of the quantitative data of the two groups when the normality conditions were met, the two-sample independent t-test was used, and Fisher's Exact test was used when the variables were qualitative. The Mann-Whitney U test was used for quantitative variable data comparisons where normality conditions were not met. The statistical significance level of alpha was set as $p<0.05$.

RESULTS

The files of 158 patients who had undergone thoracoscopic wedge resection were retrospectively analyzed for the study. Due to missing data and other exclusion criteria, 22 patients from the LMA group and 16 patients from the DLT group were excluded from the study. In total, the data of 120 patients were analyzed (Figure 1). The demographic and surgical data of the study are summarized in Table 1. There was no statistically significant difference between the groups in terms of age, sex, duration of anesthesia and surgery, and the side of the surgery ($p>0.05$).

When the intraoperative haemodynamic data of the patients were compared, heart rate and mean blood pressure were found to be statistically higher in the DLT group in the T_2 period when the LMA was placed after induction or intubation with DLT was performed ($p<0.05$) (Table 2). When the mechanical ventilation data in both types of airway management types were compared, no statistically significant difference was found in terms of applied PEEP, tidal volume, respiratory rate, and a fraction of inspired oxygen values (Table 3). Similarly, airway pressures and compliance were compared according to the airway technique used. There was no difference between the two groups in terms of plateau pressure, peak pressure, driver pressure, and compliance values. The mechanical power values calculated according to the applied tidal volume, respiratory rate, and formed airway pressures were also

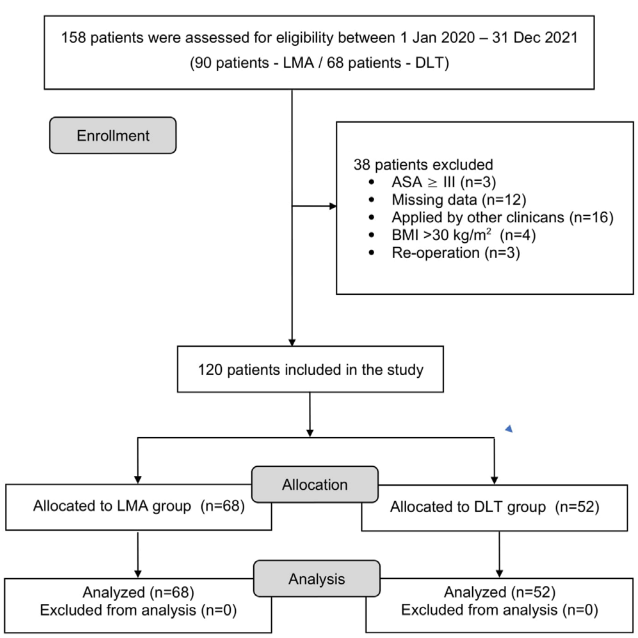

Figure 1. CONSORT flow chart of the study
LMA: Laringeal mask airway, DLT: Double-lumen tube, ASA: American Society of Anesthesiologists, BMI: Body mass index

statistically similar between the two groups (Table 4). When switching to OLV in the DLT group, 43 patients had excellent operative lung collapse and five patients had good. In the other four patients, the lungs did not collapse. The patients were re-evaluated with a bronchoscope, necessary manipulations were made, and the lungs were colocated. In the LMA group, ventilation was not sufficient in two patients after LMA placement, and they were changed to a higher numbered LMA. In both groups, the surgical procedure was completed with the VATS technique. There was no difference between the groups in terms of postoperative complications. The recurrence of pneumothorax occurred in two patients in the LMA group, expansion returned limited in two patients in the DLT group, and pneumothorax recurred in a patient after surgery. Chest drainage time, and hospital stay were also similar between the groups. The number of patients experiencing sore throat during the postoperative period was significantly lower in the LMA group (Table 1).

DISCUSSION

Today, the thoracoscopic wedge resection technique performed for treating prolonged PSP is commonly performed with DLT intubation and OLV. In this study, we compared the efficacy, safety, and perioperative results of the use of LMAs in the surgical treatment of PSP with the use of DLTs to prevent complications of traditional airway management (4-7). Intraoperative and postoperative results from airway management with LMAs provided results similar to those of intubation with DLTs. Therefore, our study shows that thoracoscopic wedge resection can also be performed safely under the LMA.

In traditional thoracoscopy procedures, OLV with DLT is applied to provide the surgical field (9). However, strategies applied during OLV can cause barotrauma and volutrauma. In addition, DLTs themselves can lead to lung injury due to mechanical strain and lower respiratory tract infections (10,11). In addition, various complications such as airway spasm, vocal cord paralysis, laryngeal edema and tracheal stenosis, can be seen more frequently with the use of DLT (12). ETT or cuff erosion damage can result in tracheal stenosis. An overinflated endotracheal cuff may develop during pressure necrosis of the tracheal mucosa, resulting in tracheal constriction. Following DLT intubation, stenosis is defined as thickening of the tracheal wall and accompanying luminal narrowing, most typically in the left or right major bronchial region at the level of the ETT balloon (13).

Another airway method that can be used as an alternative to DLTs during general anesthesia is LMA. Cases in which LMAs

Table 1. **Demographic, anesthetic and surgical data**

	LMA group (n=68)	DLT group (n=52)	p
Age (year)	27±6.18	28±6.55	0.672
Sex			
Female	8 (11.8%)	8 (15.4%)	0.753
Male	60 (88.2%)	44 (84.6%)	
Height (cm)	176.76±.4.28	179.85±7.31	0.159
Weight (kg)	63.88±8.41	67.69±7.89	0.217
BMI (kg/m²)	20.85±2.60	20.89.8±1.80	0.963
ASA			
I	36 (52.9%)	24 (46.2%)	0.713
II	32 (47.1%)	28 (53.8%)	
History of nicotine dependence	36 (52.9%)	28 (53.8%)	0.961
Duration of anesthesia (min)	63.41±10.94	83.08±12.67	<0.001*
Duration of surgery (min)	51.65±9.12	55.38±12.15	0.344
Operation side			
Right	52 (76.5%)	28 (53.8%)	0.193
Left	16 (23.5%)	24 (46.2%)	
ARISCAT score	24.65±2.66	29.08±8.43	0.066
Hypoxemia	-	-	n/a
Postop pulmoner complication	2 (11.8%)	2 (15.4%)	0.862
Sore throat	11 (16.17%)	12 (23.07%)	0.034*
Chest drainage time (day)	2 (1-3)	2 (1-3)	0.561
Lenght of hospital stay (day)	3.17±0.38	3.32±0.63	0.095

*p<0.05 shows statistical significance. Data are presented as the mean and standard deviation, median or number of patients (%) in each group. ASA: American Society of Anesthesiologists, BMI: Body mass index, ARISCAT score: Assess respiratory risk in surgical patients in Catalonia score, DLT: Double-lumen tube, LMA: Laryngeal mask airway

were successfully used in surgeries such as spontaneous pneumothorax and Nuss procedures performed with the VATS technique have been shown in the literature (8,14-16).

Compared with DLT, the use of LMA in thoracic surgery has many advantages. It is easy to use, does not require a laryngoscope for its insertion, usually does not require muscle relaxants, is successfully inserted in a short time, and postoperative sore throat is rare. In our study, the LMA was placed in a very short time, around 10-20 seconds, allowing the surgery to start quickly.

In DLT, on the other hand, there was a delay while waiting for the muscle relaxant effect, and the placement of the tube after intubation was confirmed by both auscultation and using a bronchoscope. Therefore, although the duration of surgery was similar in both groups, the duration of anesthesia was found to be significantly longer in the DLT group.

Tracheal intubation with DLT requires satisfactory mouth opening and full suppression of airway reflexes during tube manipulation because the tube diameter is larger and advanced to the main bronchus. For this reason, the use of deep anesthesia and high-dose muscle relaxants in patients using DLT may cause the recovery time and thus the anesthesia time to be prolonged, especially in short cases such as wedge resection. LMA, on the other hand, is placed by advancing from the oropharynx to the larynx, and because it does not contact the epiglottis and trachea, it stimulates the airway reflexes less than DLT. Therefore, muscle relaxant agents are generally not needed in patients using LMAs. In the presented study, the muscle relaxant dose used in the LMA group was one-quarter of that used in the DLT group. In addition, the infusion dose of the opioid analgesic agent (remifentanil) used for anesthesia maintenance was also statistically significantly lower.

Table 2. Comparison of hemodinamic data between groups

	LMA group (n=68)	DLT group (n=52)	p
SpO_2			
T_1	99.00±0.86	99.46±0.96	0.107
T_2	98.82±1.33	98.08±2.39	0.579
T_3	98.59±1.17	97.69±2.72	0.606
T_4	98.88±1.05	98.46±2.02	0.929
T_5	98.80±1.26	99.50±0.75	0.189
T_6	98.41±1.41	98.62±1.04	0.795
HR			
T_1	81.06±14.15	85.15±9.45	0.351
T_2	72.65±16.18	84.54±9.39	0.026*
T_3	71.65±12.97	72.00±13.39	0.942
T_4	70.82±13.13	71.00±13.91	0.972
T_5	67.60±10.52	69.38±4.89	0.659
T_6	84.76±9.37	87.69±13.98	0.498
MAP			
T_1	65.76±10.74	66.92±14.77	0.805
T_2	66.94±16.28	78.31±7.77	0.019*
T_3	65.06±12.41	63.38±10.36	0.698
T_4	64.65±8.47	59.62±9.33	0.134
T_5	63.00±7.47	58.63±5.20	0.157
T_6	73.88±15.22	76.08±9.55	0.633

*p<0.05 shows statistical significance. Data are expressed as the mean and standart deviation in each group. LMA: Laringeal mask airway, DLT: Double-lumen tube, SpO_2: Peripheral oxygen saturation, HR: Heart rate, MAP: Mean arterial pressure, T_1: Monitoring time, T_2: After intubation, T_3: After clamping in the DLT group, after carbondioxide insufflation in the LMA group, T_4: Closing time, T_5: End of surgery, T_6: After extubation

Table 3. Comparison of mechanic ventilation parameters between groups

	LMA group (n=68)	DLT group (n=52)	p
PEEP			
T_2	5 (3-5)	5 (3-5)	0.699
T_3	5 (3-6)	5 (3-7)	0.857
T_4	5 (3-6)	5 (3-6)	0.382
T_5	5 (5-6)	5 (5-5)	0.317
Respiratory rate			
T_2	15 (12-19)	17 (13-19)	0.132
T_3	15 (12-18)	17 (12-19)	0.063
T_4	15 (12-18)	16 (12-19)	0.460
T_5	15 (12-17)	13 (12-18)	0.667
Tidal volume			
T_2	479.35±46.84	488.31±32.36	0.561
T_3	426.41±73.43	381.54±82.44	0.127
T_4	421.12±78.57	398.85±67.06	0.420
T_5	433.47±72.31	486.50±9.19	0.487
FiO_2			
T_2	50 (40-60)	50 (40-70)	0.427
T_3	45 (40-65)	50 (35-80)	0.454
T_4	45 (40-60)	50 (35-80)	0.659
T_5	50 (40-55)	47 (40-55)	0.621
$ETCO_2$			
T_2	40 (32-47)	41 (36-47)	0.454
T_3	40 (35-48)	40 (31-48)	0.721
T_4	40 (35-44)	38 (29-43)	0.159
T_5	39 (34-44)	34 (32-43)	0.074

Data are presented as the mean and standart deviation, median or number of patients (%), PEEP: Positive end-expiratory pressure, FiO_2: Fraction of inspired oxygen, $ETCO_2$: End-tidal carbondioxide, LMA: Laringeal mask airway, DLT: Double-lumen tube, T_2: After intubation, T_3: After clamping in the DLT group, after carbondioxide insufflation in the LMA group, T_4: Closing time, T_5: End of surgery

The i-gel used in the study is a new-generation LMA, and thanks to its soft silicone structure, it interacts with body temperature, fits more comfortably in the laryngopharynx, and causes less mechanical trauma than traditional LMAs (17,18). Generally because LMAs are non-invasive, different respiratory complications such as sore throat, bronchospasm, laryngeal edema, recurrent laryngeal nerve palsy, vocal cord injury, and tracheal rupture are prevented in patients (19). In this study, the incidence of sore throat was found to be higher in the DLT group, albeit not statistically significant.

When the hemodynamic data of both groups were compared, we found that hemodynamic parameters such as mean arterial pressure and heart rate during airway intervention were lower in the LMA group. This indicates that patients were exposed to less airway stimulation during the LMA procedure. The main reason for this is that the chin-hanging maneuver is not used because the laryngoscope is not used when placing the LMA, and the LMA is not inserted into the trachea. In the presented study, although the dose of muscle relaxants, hypnotic, and analgesic agents used during induction was lower, the hemodynamic parameters of the patients remained more stable while the LMA was placed.

The most important difference between our study and other studies on this subject is that the pressure parameters of

Table 4. Airway pressures data

	LMA group (n=68)	DLT group (n=52)	p
Ppeak			
T_2	14.18±2.81	16.23±5.23	0.177
T_3	17.88±4.36	20.85±6.66	0.152
T_4	17.00±4.50	20.54±6.51	0.089
T_5	15.53±3.62	17.25±3.99	0.308
P plato			
T_2	13.12±2.84	14.23±3.85	0.370
T_3	15.94±3.83	17.62±5.00	0.308
T_4	15.53±4.03	17.31±5.51	0.316
T_5	13.87±2.87	14.88±4.19	0.502
Driving pressure			
T_2	8.24±2.79	9.23±3.85	0.419
T_3	10.94±3.47	12.69±4.60	0.245
T_4	10.53±3.69	12.23±5.19	0.303
T_5	8.73±2.84	10.25±4.02	0.303
Dynamic complians			
T_2	68.21±21.90	69.00±22.77	0.923
T_3	65.55±27.48	51.98±13.16	0.113
T_4	59.25±20.88	53.91±18.13	0.522
T_5	58.59±14.02	55.73±19.71	0.770
Mechanical power			
T_2	6.4±2.1	5.1±2.7	0.451
T_3	7.5±1.8	8.6±3.5	0.242
T_4	7.4±2.4	8.7±3.4	0.221
T_5	7.8±1.5	8.1±3.1	0.914

Data are expressed as the mean and standart deviation in each group. LMA: Laringeal mask airway, DLT: Double-lumen tube, Ppeak: Peak pressure, P plato: Plato pressure, LMA: Laringeal mask airway, DLT: Double-lumen tube, T_2: After intubation, T_3: After clamping in the DLT group, after carbondioxide insufflation in the LMA group, T_4: Closing time, T_5: End of surgery

the airway are discussed in detail. This is because non-physiologic increases in transpulmonary pressure during ventilation cause VILI. In studies on VILI, it has been determined that respiratory rate and inspiratory flow rate are the main factors, except for tidal volume, plateau pressure, and PEEP, which are the static components of respiration, because the number of times per minute a potential volutrauma or barotrauma is delivered to the lungs is related to the respiratory rate. Similarly, the rate at which this potentially occurring trauma is performed is a concept related to the inspiratory flow rate. In isolated lung and animal studies, it has been shown that reducing the respiratory rate helps prevent the formation of VILI (20,21). The concept in which the basic mechanical factors (volume, pressure, velocity, and flow) of mechanical ventilation are gathered under a single definition is mechanical power (energy/time unit). The equation describing the power is simply defined as [0.098 x tidal volume x respiratory rate x (Ppeak-1/2 x driving pressure)] (22).

Particularly in thoracic surgery, respiratory rate is increased during OLV to avoid hypoxemia and hypercarbia in patients. In addition, the drive pressure due to the OLV also increases and can eventually increase the calculated mechanical power, resulting in VILI.

However, it is unclear to what extent the airway device used affects airway pressures and its effect on the mechanical power value. Therefore, in our study, we compared the mechanical power values and other airway pressures calculated from the patients in the LMA and DLT groups, using the same MV mode and providing optimum airway care. According to the results of the study, there was no significant difference between the airway pressures and mechanical power values in all periods between the two groups. In parallel, similar results were obtained for both groups in terms of postoperative pulmonary complications.

On the other hand, the use of LMA may cause some problems during thoracic surgery. Undesirable hypercarbia may develop in patients because the operative lungs are deflated by CO_2 insufflation. This metabolic state, which is easily noticed by the increase in $ETCO_2$ level, may increase sympathetic activity in patients, causing tachycardia, arrhythmia, myocardial ischemia, and cerebral vasodilation to increase cerebrospinal fluid pressure and intracellular acidosis, leading to a narcotic effect. In our study, although $ETCO_2$ levels of the patients in the LMA group were higher than those in the DLT group, no statistically significant difference was found between the groups. We think that hypercarbia did not develop in the patients in the LMA group because of the young age of the patients, the absence of chronic lung diseases, and the short surgical time. In addition, the location of the LMA may change depending on the position during surgery, resulting in airway leakage or a sudden increase in airway pressure. However, in the i-gel LMA type used in this study, these possibilities are minimized due to the silicon structure. In the presented study, no such problems were experienced in the patients. The patients were required to fast for 8 hours before surgery because LMAs generally increase the risk of aspiration, and LMAs were not used in patients with gastroesophageal reflux.

This study has some limitations. Randomization could not be performed because it was a retrospective observational study. Although patients were included in the trial sequentially according to the surgery date, this may have biased patient selection and management. In addition, because the study included patients from a single-center, the results obtained might not reflect the general population. Although the sample size is more significant than in previous studies, it is still not sufficient for a retrospective study. Surgeon's comfort may also change when DLT is compared with LMA. But surgeon's satisfaction or comfort with surgical conditions was not evaluated in this study.

CONCLUSION

The use of LMA provided similar respiratory parameters to DLTs and more stable hemodynamics. The data obtained from the study show that PSP treatment can be performed safely and successfully using LMAs for airway management in thoracoscopic wedge resection surgery. However, larger studies are needed to carry out our limited experience on this subject further and to enable large-scale thoracic surgeries such as lobectomy and pneumonectomy to be performed with LMA.

ETHICS

Ethics Committee Approval: Approval this study was approved by the Clinical Research Ethics Committee of Bakırköy Dr. Sadi Konuk Training and Research Hospital (decision no: 2022-04, date: 21.02.2022).

Informed Consent: Retrospective study.

Authorship Contributions

Surgical and Medical Practices: S.K., G.S., Concept: S.K., G.S., Design: S.K., G.S., Data Collection or Processing: S.K., G.S., Analysis or Interpretation: S.K., G.S., Literature Search: S.K., G.S., Writing: S.K., G.S.

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