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FACTORS ASSOCIATED WITH PLACEMENT FAILURE OF SECOND-GENERATION LARYNGEAL MASK AIRWAY: A RETROSPECTIVE CLINICAL STUDY

İKİNCİ JENERASYON LARİNGEAL MASKE HAVAYOLUNDA YERLEŞTİRME BAŞARISIZLIĞI İLE İLİŞKİLİ FAKTÖRLER: RETROSPEKTİF KLİNİK BİR ÇALIŞMA

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ABSTRACT

Objective: The laryngeal mask airway (LMA) is important for airway management during anesthesia practice. Rarely, when it cannot be placed, it requires alternative interventions. In this study, we aimed to identify factors associated with second-generation LMA placement failure.

Methods: Between 2021 and 2023, medical records of consecutive patients who underwent ureteroscopy for urolithiasis under general anesthesia were retrospectively reviewed. Exclusion criteria were: age <18 years and endotracheal intubation as the first preference for airway management. Patients were divided into two groups: (1) those who were successful in LMA placement; and (2) those in whom LMA placement failed. LMA placement failure and associated factors, including body mass index (BMI), gender, mallampati score, thyromental distance, cervical spine mobility, structural status of teeth, American Society of Anesthesiology score (ASA), and history of difficult airway, were evaluated.

Results: 188 patients analysed: Male gender (67%), ASA-2 was the majority (56%), and the patients had a mean age of 52.9±14.44 and a BMI of 28.9±5.62 kg/m^2. Placement of LMA was successful on initial attempt in 173 (92%); LMA number 4 was most commonly used (57%). Fifteen patients required intubation when the LMA did not settle after three attempts. Comparison of the successful and failed placement groups showed: 14/15 (93.3%) were male (p=0.024). A significant prolongation of anesthesia occurred in patients in whom LMA was not placed (p=0.017).

Conclusion: LMA placement failure occurred in 8% of this cohort and most of these patients were male. After LMA placement failure, anesthesia time is significantly prolonged.

Keywords: Laryngeal Mask Airway, difficult, urogenital surgery, adult

ÖZ

Amaç: Laringeal maske hava yolu (LMA), anestezi uygulaması sırasında hava yolu yönetimi açısından önemlidir. Nadiren yerleştirilemediğinde alternatif müdahaleler gerektirir. Bu çalışmada ikinci nesil LMA yerleştirme başarısızlığıyla ilişkili faktörleri belirlemeyi amaçladık.

Yöntem: 2021-2023 yılları arasında genel anestezi altında ürolitiazis nedeniyle üreteroskopi yapılan ardışık hastaların tıbbi kayıtları retrospektif olarak incelendi. Hariç tutma kriterleri şunlardı: yaş <18 ve hava yolu yönetiminde ilk tercihin endotrakeal entübasyon olması. Hastalar iki gruba ayrıldı: (1) LMA yerleştirmede başarılı olanlar ve (2) LMA yerleştirmenin başarısız olduğu kişiler. LMA yerleştirme başarısızlığı ve vücut kitle indeksi (BMI), cinsiyet, mallampati skoru, tiromental mesafe, servikal omurga hareketliliği, dişlerin yapısal durumu, Amerikan Anesteziyoloji Derneği skoru (ASA) ve zor hava yolu öyküsü gibi ilişkili faktörler değerlendirildi.

Bulgular: Analiz edilen 188 hasta: Erkek cinsiyet (%67), ASA-2 çoğunluktaydı (%56), hastaların ortalama yaşı 52,9±14,44 ve BMI 28,9±5,62 kg/m2 idi. LMA'nın yerleştirilmesi 173 hastada (%92) ilk denemede başarılı oldu; En sık kullanılan LMA 4 numaraydı (%57). Üç denemeden sonra LMA yerleşmeyince 15 hastada entübasyon gerekti. Başarılı ve başarısız yerleştirme gruplarının karşılaştırılması şunu gösterdi: 14/15 (%93,3) erkekti (p=0,024). LMA takılmayan hastalarda anestezi süresinde anlamlı uzama meydana geldi (p=0,017).

Sonuç: LMA yerleştirme başarısızlığı bu grubun %8'inde meydana geldi ve bu hastaların çoğu erkekti. LMA yerleştirme başarısızlığından sonra anestezi süresi önemli ölçüde uzar.

Anahtar Kelimeler: Laringeal Maske, zor, ürogenital cerrahi, erişkin

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Introduction

Since the invention of supraglottic airway devices in 1981 and their subsequent introduction into clinical practice in 1988, their use during general anesthesia has gained popularity for airway maintenance.[1-3] The guidelines advise using the second-generation laryngeal mask airway (LMA) as the initial option for routine airway management and managing of the difficult airway.[3,4] It is recommended to avoid repeated attempts at inserting a supraglottic airway device, as this increases the risk of airway trauma. Instead, an alternative technique should be used to maintain oxygenation and ventilation.[3,4]

The advantages of the LMA over endotracheal intubation include minor hemodynamic changes and reduced risk of cough, laryngospasm, soft tissue trauma, and sore throat.[1,5,6] Although LMAs are considered safe supraglottic airway devices, they can sometimes be challenging to place.[7] A simple, objective, predictive score to identify patients at risk for difficult LMA placement is not currently available. However, a risk identification analysis based on a comprehensive airway assessment must first be performed to obtain such a score. Although there are many studies on LMAs, research on difficult LMA placement is limited.[2,5]

In this study, we aimed to determine risk factors in patients with second-generation LMA placement failure by retrospectively examining the records of patients who underwent ureteroscopy (URS) for urolithiasis. The second objective was to increase the available published evidence concerning factors affecting LMA placement failure.

Methods

In this retrospective study, we reviewed two hundred and fifty-eight patients who underwent elective URS for kidney or ureteral stones at Kocaeli University Hospital between 2021 and 2023. The exclusion criteria encompassed individuals who were below the age of eighteen years and those for whom endotracheal intubation was the primary approach for airway management. The study was approved by the local ethics committee (Approval number: KOÜ GOKAEK-2023/04.08).

The preoperative and intraoperative anesthesia medical records were reviewed. Variables associated with difficult airway for each patient included mallampati classification, thyromental distance (TMD), degree of neck movement, and being edentulous, having removable dentures or natural teeth. Among the demographic data, age, weight, height, body mass index (BMI), gender, American Society of Anesthesiology (ASA) physical status classification, and history of difficult airway were included. It was also recorded if the person performing the preoperative examination was an instructor or a research assistant and whether the person performing the airway management was an anesthesia technician, a research assistant, or an instructor. The ventilation technique was determined by examining the anesthesia monitoring forms of the patients. The patients were classified into three groups: those who underwent endotracheal tube (ETT) insertion without attempting LMA insertion, those who underwent successful LMA insertion, and those who underwent ETT insertion following the failure of LMA insertion. The anesthesia monitoring charts were consulted to obtain the sizes of the ETT and the second-generation LMA inserted during the procedure.

In our center, the LMA ProSeal™ is inserted in patients scheduled to undergo URS without requiring neuromuscular blocking agents if their comorbidity status is favorable. However, an ETT may be the airway intervention of preference in cases with multiple comorbidities. When two attempts to insert the LMA ProSeal™ fail, the LMA Protector™ is used as the next step; if that also fails, an ETT is used to intubate the patient. Direct laryngoscopy is the first attempt at this stage, and if this is unsuccessful, intubation is performed with video-laryngoscopy.

Statistical Analysis

Data analysis was performed using SPSS Statistics for Windows, version 22.0 (IBM Corp, Armonk, NY, USA). Descriptive statistics were used to analyze quantitative data. The normal distribution of continuous variables was tested using the Kolmogorov-Smirnov test. Numeric data that follow a normal distribution are presented as mean ± standard deviation (SD), and numeric data that do not follow a normal distribution are presented as median and interquartile ranges (IQR). Categorical data are expressed as numbers and percentages. The means were compared using an Independent Sample t-test, while the Mann-Whitney U test was used to compare medians. To compare two sets of categorical data, the Chi-Square test was used. A *p*-value of less than 0.05 was considered statistically significant.

Results

Between 2021 and 2023, elective URS was performed under general anesthesia on 258 patients in the operating theater of our hospital. Of these 258 patients, 15 were under 18 years of age. Of the remaining 243 patients, 55 were intubated directly with ETT due to multiple comorbidities. Thus, 188 patients who met the study criteria were included in the study. The demographic characteristics of the patients are presented in Table 1. Some patients' demographic data were not recorded or whose airway parameters were not evaluated due to COVID-19. There are missing data was presented for mallampati classification, TMD, neck movement, tooth structure in Table 2. There was one patient with a history of difficult airway. When fully recorded airway parameters were analyzed, 62% of the first airway examinations in 188 patients were performed by the anesthesia research assistant. The airway management of 173 patients (92%) was successfully

achieved at the first attempt with the LMA ProSeal™, with the number 4 size of LMA ProSeal™ being used the most (57%).

Table 1. Demographic characteristics of the patients.

Number of patients	188
Gender	
Female, n, (%)	62 (33.0)
Male, n, (%)	126 (67.0)
ASA physical status classification, median, [range]	2 [1-4]
ASA 1, n, (%)	50 (26.6)
ASA 2, n, (%)	105 (55.9)
ASA 3, n, (%)	32 (17.0)
ASA 4, n, (%)	1 (0.5)
Age (years), mean ± SD	52.85 ±14.439
Height (cm), mean ± SD	168.40 ±9.091
Weight (kg), mean ± SD	81.49 ±14.841
BMI (kg/m²), mean ± SD	28.85 ±5.624

ASA, American Society of Anesthesiology; SD, Standard deviation; BMI, Body mass index

The outcomes of preoperative airway evaluation and intraoperative airway management are detailed in Table 2. An anesthesia technician performed airway management in 60% of the patients. The mean anesthesia time was 86.8±29.3 minutes. An 8.0 ETT was used in 73% of the 15 patients (8%) in whom the second-generation LMAs (ProSeal™ and Protector™) did not settle after three attempts. Records show that direct laryngoscopy failed in three patients, and they were intubated with an angled spoon video-laryngoscope. The records did not detail how the other 12 patients were intubated.

Comparative outcomes regarding LMA placements that were either successful or failed are presented in Table 3. Male gender was significantly more prevalent in the unsuccessful group compared to the group in which LMA was successful (p=0.024). The anesthesia time of patients in whom LMA was not inserted was also significantly prolonged (104.00±39.06 vs 85.32±27.90 min;p=0.017). In terms or the other parameters compared between groups (age, BMI, ASA score, the person performing the preoperative anesthesia examination, and airway management) there was no difference between the successful and unsuccessful groups (p>0.05 for all). Additionally, there were no statistically significant differences between females and males for age, body mass index, and ASA scores in a gender-based assessment (Table 4).

Discussion

The most notable findings in our study were that LMA failure was significantly more common in male patients and mean anesthesia time was longer in the group with LMA failure. In a study that retrospectively examined the data of patients who underwent elective, non-obstetric surgery between 2008 and 2010, LMA Unique™ was used by anesthesia assistants as the first airway intervention in sixty-nine patients, and it was reported that female gender and neck circumference >44 cm were independent predictive factors for LMA Unique™ failure.[8] In a study involving 15,795 patients using LMA Unique™ between 2006 and 2009, LMA could not be placed in 1.1% of the patients, and these patients were subsequently intubated.[9] Moreover, male gender and having obstructive sleep apnea (OSA) were reported to be significant predictive factors for unsuccessful LMA placement. In addition, BMI >29 kg/m^2, TMD <6 cm, limited neck movement, thick neck, bad teeth, active smoking, and moving the surgical table have also been reported to cause LMA failure. In this study, anesthesia assistants performed airway interventions, as in the present study.[9]

Table 2. Preoperative airway assessment and intraoperative airway management results.

The person who performed preoperative examination	
Anesthesia instructor, n, (%)	71 (37.8)
Research assistant, n, (%)	117 (62.2)
Mallampati Classification	
1, n, (%)	23 (12.2)
2, n, (%)	42 (22.3)
3, n, (%)	6 (3.2)
Missing data, n, (%)	117 (62.2)
Thyromental distance	
<6 cm, n, (%)	5 (2.7)
≥6 cm, n, (%)	82 (43.6)
Missing data, n, (%)	101 (53.7)
Neck movement	
Normal, n, (%)	80 (42.6)
Limited, n, (%)	1 (0.5)
Missing data, n, (%)	107 (56.9)
Tooth structure	
Normal, n, (%)	58 (30.9)
Prosthesis, n, (%)	14 (7.4)
Missing data, n, (%)	116 (61.7)
Airway management	
LMA, n, (%)	173 (92.0)
ETT after LMA, n, (%)	15 (8.0)
The person who performed airway intervention	
Anesthesia technician, n, (%)	112 (59.6)
Anesthesia instructor or research assistant, n, (%)	76 (40.4)
LMA size (number)	
3, n, (%)	15 (8.5)
4, n, (%)	99 (57.2)
5, n, (%)	59 (34.1)
Endotracheal Tube size (number)	
7, n, (%)	1 (6.7)
7.5, n, (%)	1 (6.7)
8, n, (%)	11 (73.3)
8.5, n, (%)	2 (13.3)
Anesthesia time (min), mean ± SD	86.81 ±29.259

LMA, Laryngeal mask airway; ETT, Endotracheal tube; SD, standard deviation

Table 3. The comparative analysis of the outcomes of successful and unsuccessful LMA placement cohorts.

	LMA Placement Successful (*n*=173)	**LMA Placement Failure** (*n*=15)	***p value***
Age (years), mean ± SD	52.64 ±14.515	54.87 ±13.410	0.567
Weight (kg), mean ± SD	81.16 ±15.144	85.40 ±10.329	0.289
Height (cm), mean ± SD	168.05±9.128	172.47±7.809	0.071
BMI (kg/m²), mean ± SD	28.84±5.643	28.98±5.589	0.925
Anesthesia time (min), mean ± SD	85.32 ±27.902	104.00 ±39.060	**0.017**
ASA physical status classification, median, (IQR)	2 (1-2)	2 (2-3)	0.351
Gender			
Female	61 (98.4)	1 (1.6)	**0.024**
Male	112 (88.9)	14 (11.1)	
The person who performed preoperative examination			
Anesthesia instructor, n, (%)	66 (91.5)	5 (8.5)	0.712
Research assistant, n, (%)	107 (93.0)	10 (7.0)	
The person who performed airway intervention			
Anesthesia technician, n, (%)	101 (90.2)	11 (9.8)	0.258
Anesthesia instructor or research assistant, n, (%)	72 (94.7)	4 (5.3)	
Variables with missing data			
Thyromental distance, n, (%)	80 (92.0)	7 (8.0)	
<6 cm, n, (%)	5 (100.0)	0 (00.0)	0.496
≥6 cm, n, (%)	75 (91.5)	7 (8.5)	
Neck movement n, (%)	74 (91.4)	7 (8.6)	
Normal, n, (%)	74 (92.5)	6 (7.5)	0.086
Limited, n, (%)	0 (00.0)	1 (100.0)	
Tooth structure, n, (%)	67 (93.1)	5 (6.9)	
Normal, n, (%)	53 (91.4)	5 (8.6)	0.575
Prosthesis, n, (%)	14 (100.0)	0 (00.0)	
Mallampati Classification, n, (%)	65 (91.5)	6 (8.5)	0.812
Median (IQR)	2 (1-2)	2 (1-2)	

ASA, American Society of Anesthesiology; SD, Standard deviation; BMI, Body mass index; IQR, Interquartile range; kg, kilogram; cm, centimeter. The bold p values indicate a significant comparison with p<0.05.

Table 4. Gender-based assessment of age, body mass index, and ASA scores.

	Female (*n*=62)	**Male** (*n*=126)	***p value***
Age (years), mean ± SD	53.08 ±14.400	52.68 ±14.469	0.859
BMI (kg/m²), mean ± SD	30.20±7.302	28.18±4.466	0.062
ASA physical status classification, median, (IQR)	2 (1-2)	2 (2-2)	0.269

ASA, American Society of Anesthesiology; SD, Standard deviation; BMI, Body mass index; IQR, Interquartile range.

In a report about using the second-generation supraglottic airway device, the LMA Supreme™, difficult LMA placement was noted in 18.3%, and the LMA failure rate was 2.1%. For difficult LMA placement, female gender and mallampati score of 3-4 were the strongest indicators, as well as mouth opening <3 cm, limited neck movement, difficulty with mask ventilation, large tonsils, using a pillow thicker than 3 cm when placing the LMA, and not using muscle relaxants were significant determinants of settlement.[10] The LMA failure rate was around 8% in our study. This higher failure rate may be due to the higher male gender, more than two thirds of the cohort, and the fact that muscle relaxants were not used.

Risk factors reported for difficult LMA placement in the 2021 Canadian difficult airway guideline are absence of teeth or poor oral care, limited mouth opening, mallampati score of 3-4, limited head and neck movement, not using muscle relaxants, neck circumference >44 cm, patient not lying supine, using desflurane, choosing a smaller size LMA than recommended by the manufacturer, and making many placement attempts.[11] In addition, it has been shown that limitation in mouth opening, mallampati score of 3-4, neck flexion and extension movement limitation are predicting LMA failure and that as many predictive criteria as possible should be evaluated in the preoperative period.[4,12] Compared to intubation with ETT, LMA is easier to place, causes less sore throat and less pain when swallowing, and user errors are less common.[13] In terms of who performed airway management, our research found no significant difference between success or failure of LMA placement and who performed the airways management.

It has been shown that second-generation LMAs provide greater protection against aspiration because they have

a bite block, gastric drainage channels, and allow high oropharyngeal leak pressures.[4,14] We routinely use second-generation LMA ProSeal™ with our patients. We chose the LMA Protector™ for the third trial because it has a second gastric drainage channel, the highest initial placement rate of 93%, and the highest oropharyngeal leak pressure of 32 cm H2O.[15]

A study showed that instead of weight-based selection in suitable candidates for LMA selection, TMD-based selection allowed easier LMA placement with less manipulation required.[16] It has been shown in a prospective study that LMA number 4 had the best first-attempt success rate and was placed in a shorter time compared to LMA number 5 in >70 kg obese Chinese male patients.[17]. A retrospective study of 19,693 cases showed that LMAs 4 and 5 had a higher failure rate than LMAs 2 and 3.[18] A further study reported that a choice based on pinna size was more appropriate when choosing the LMA ProSeal™ size to be used, compared to a choice based on weight.[19] A recently reported study found that deciding LMA size by grouping based on neck circumference was more accurate.[20]

LMA placement may be more challenging in males due to the higher prevalence of OSA syndrome and increased airway resistance and obstruction. In a retrospective study covering a three year period, male gender, age >45 years, TMD < 6cm, and neck movement limitation were determined as risk factors for difficult LMA placement.[21] The same authors later proposed a scoring system to predict difficult supraglottic airway ventilation, with male gender = 1 point, age >45 = 1 point, TMD <6 cm = 3 points, presence of neck movement limitation = 2 points (total 7 points) and they reported the score threshold for difficult LMA placement was 4.[22]

The current study has some limitations. There are deficiencies in the data as preoperative oropharyngeal examinations of patients could not be performed routinely during the COVID-19 pandemic. Most airway parameters are also subjective and not based on measurement. Since it is a study conducted in adults, findings are not generalizable to pediatric patients.

Conclusions

Male gender increases the risk of LMA failure and LMA failure prolongs the anesthesia time. The results of this study may be generalized to all surgeries and patients in whom LMA will be placed.

Description

This article was presented as an oral presentation at TARK 2-5 November 2023, Antalya, Türkiye.

Compliance with Ethical Standards

The study was approved by the local ethics committee (Approval number: KOÜ GOKAEK-2023/04.08).

Conflict of Interest

The authors declare no conflicts of interest.

Author Contributions

İAİ, AZİ: Study idea, hypothesis, study design; İAİ, AİE: Material preparation, data collection and analysis; İAİ, AZİ: Writing the first draft of the article; İAİ, AİE, AZİ: Critical review of the article finalization and publication process.

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None.

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