Section: Anaesthesia

Original Research Article

COMPARISON OF LEAK TEST AND FIBREOPTIC BRONCHOSCOPY FOR ASSESSMENT OF LARYNGEAL MASK AIRWAY POSITION IN CHILDREN: AN OBSERVATIONAL STUDY

Vrishali Ankalwar[1], Sheetal R. Shinde[2], Manish V. Patil[3], Mansi Sawarkar[4]. Sneha Gandle[5]

[1]*Associate Professor, Government Medical College, Nagpur, Maharashtra, India.*
[2]*Senior Resident, PCMC PGI, YCM Institute Pimpri-Chinchwad, Pune, India.*
[3]*Assistant Professor, Government Medical College, Nagpur, Maharashtra, India.*
[4]*Assistant Professor, JIET, India.*
[5]*Senior Resident, VDGMC Latur, India.*

Received *: 25/06/2026*
Received in revised form *: 26/07/2026*
Accepted *: 09/08/2026*

Corresponding Author:
Dr. Sheetal R. Shinde,
Senior Resident, PCMC PGI, YCM Institute Pimpri-Chinchwad, Pune, India.
Email: ranirshinde23@gmail.com

DOI: 10.70034/ijmedph.2026.3.701

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (3); 4545-4552

ABSTRACT

Background: Correct placement of the laryngeal mask airway (LMA) is essential to ensure effective ventilation and reduce perioperative complications in pediatric anesthesia. Fibreoptic bronchoscopy (FOB) is considered the gold standard for confirming LMA position; however, it is not always feasible in routine practice. The leak test is a commonly used bedside alternative. This study was conducted to compare leak test grading with FOB evaluation for confirming optimal LMA placement in pediatric patients.

Materials and Methods: This observational study included 60 pediatric patients undergoing elective surgery under general anesthesia with LMA insertion. LMA position was assessed using both the leak test and FOB grading of the glottic inlet. Correlation between the two methods was analyzed using Spearman's correlation. Agreement, reliability, and time required for each method were also evaluated.

Results: Successful LMA insertion was achieved in all patients on the first attempt. Leak test grading showed Grade I position in 70% of patients, whereas FOB most commonly demonstrated Grade II position (43.3%). A strong positive correlation was observed between leak test and FOB grading (Spearman's $\rho = 0.776$, $p < 0.001$). FOB identified higher grades of malposition (Grades IV–V) that were not detected by the leak test. Both methods showed statistically significant distributions ($p < 0.001$), with good internal reliability (Cronbach's $\alpha = 0.883$). The leak test required significantly less time compared to FOB evaluation (6.30 ± 1.11 vs. 17.48 ± 2.22 seconds; $p < 0.001$).

Conclusion: The leak test shows a strong correlation with fibreoptic grading and serves as a rapid and reliable bedside method for assessing LMA position in pediatric patients. However, FOB remains superior for detecting anatomical malposition and should be used when precise confirmation is required.

Keywords: Laryngeal mask airway, pediatric anesthesia, leak test, fibreoptic bronchoscopy, airway management.

INTRODUCTION

The laryngeal mask airway (LMA) is a widely used supraglottic airway device that provides a safe and effective means of airway management in pediatric patients undergoing general anesthesia for elective surgical and diagnostic procedures. Compared with endotracheal intubation, LMA insertion is less invasive, causes fewer airway-related complications, and is associated with greater hemodynamic stability and a lower incidence of postoperative sore throat and coughing, making it particularly advantageous in children (1,2).

Despite its widespread use, successful insertion of an LMA does not always ensure optimal positioning over the laryngeal inlet. Malposition of the device may result in inadequate ventilation, increased airway leak, elevated airway pressures, gastric insufflation, and a higher risk of aspiration. Therefore, confirmation of correct LMA placement is essential to ensure effective ventilation and minimize perioperative airway-related complications (3,4).

Several techniques have been described to assess LMA positioning, including observation of chest expansion, auscultation, capnography, the bubble test, the leak test, ultrasonography, and fibreoptic bronchoscopy (FOB). Among these, the leak test is the most commonly used bedside method because it is simple, rapid, non-invasive, and provides functional information regarding airway seal and adequacy of ventilation (3,5). However, the leak test evaluates airway performance indirectly and cannot visualize the anatomical relationship between the LMA cuff and the glottic opening.

Fibreoptic bronchoscopy is considered the reference standard for assessing LMA position because it allows direct visualization of the glottic structures through the airway tube and enables grading of the anatomical alignment between the LMA and the laryngeal inlet (6). Nevertheless, routine use of FOB is limited by its invasive nature, requirement for specialized equipment and expertise, interruption of ventilation during assessment, and the possibility of obscuration by airway secretions (6,7). Consequently, its use in everyday pediatric anesthesia practice remains restricted.

Previous studies have demonstrated that satisfactory ventilation may still be achieved despite less-than-optimal fibreoptic positioning, suggesting that functional assessment methods such as the leak test may correlate with anatomical placement (3,6,8). However, evidence comparing leak test grading directly with fibreoptic grading in pediatric patients remains limited. Establishing the degree of agreement between these two methods could help determine whether the leak test can reliably predict optimal LMA placement and reduce the need for routine fibreoptic confirmation.

The present observational study was therefore undertaken to compare leak test grading with fibreoptic bronchoscopic grading of the glottic inlet for confirmation of optimum LMA placement following conventional blind insertion in pediatric patients undergoing general anesthesia.

MATERIALS AND METHODS

This prospective observational study was conducted at a tertiary care teaching hospital after approval from the Institutional Ethics Committee between November 2022 and March 2025. Sixty pediatric patients aged 2–12 years, weighing 5–25 kg, with American Society of Anesthesiologists (ASA) physical status I or II, scheduled for elective surgery of less than 2 hours under general anesthesia, were enrolled. Written informed consent was obtained from the parents or legal guardians of all participants.

Patients with anticipated difficult airway (mouth opening <2 cm), increased risk of aspiration, symptomatic gastroesophageal reflux disease or hiatus hernia, laryngopharyngeal anomalies, cervical spine abnormalities, ASA physical status III or IV, body weight <5 kg or >25 kg, or those undergoing surgery lasting more than 2 hours were excluded.

The sample size was calculated based on the expected correlation between fiber-optic bronchoscopic (FOB) grading and leak test grading for laryngeal mask airway (LMA) placement reported by Arıca et al. Assuming a correlation coefficient (r) of 0.693, a two-sided α error of 1%, and 99% power, the minimum required sample size was 37 patients. Sixty eligible patients were ultimately included using consecutive sampling.

All patients underwent standard pre-anesthetic assessment and fasting according to institutional protocol. On the day of surgery, standard monitoring including electrocardiography, non-invasive blood pressure, pulse oximetry, and capnography was instituted. Patients were premedicated with intravenous glycopyrrolate (4 µg/kg), midazolam (0.02 mg/kg), ketamine (1 mg/kg), and fentanyl (2 µg/kg). General anesthesia was induced with intravenous propofol (2 mg/kg), followed by atracurium (0.5 mg/kg) after confirmation of adequate mask ventilation.

An appropriately sized Ambu AuraGain™ laryngeal mask airway (sizes 1, 1.5, 2, or 2.5 according to the manufacturer's weight recommendations) was inserted in the sniffing position by an experienced anesthesiologist. A maximum of two insertion attempts was allowed, after which failed placement was managed with endotracheal intubation.

Following successful placement, the airway seal was evaluated using a leak test and graded as Grade I (no audible leak), Grade II (audible leak with adequate ventilation), or Grade III (clinically significant leak requiring repositioning or replacement). Fiber-optic bronchoscopy was then performed through the airway tube to assess the position of the glottic inlet. FOB findings were graded as Grade 1 (larynx only visible), Grade 2 (larynx and posterior surface of the epiglottis visible), Grade 3 (larynx and epiglottic tip/anterior surface visible), Grade 4 (down-folded epiglottis with anterior surface visible), or Grade 5 (larynx not visible because of a down-folded epiglottis). Adequate ventilation was confirmed by bilateral chest expansion, oxygen saturation ≥95%, square-wave capnography, and normal end-tidal carbon dioxide.

Anesthesia was maintained with oxygen, nitrous oxide, sevoflurane (1.8–2%), and intermittent atracurium (0.1 mg/kg), maintaining a minimum alveolar concentration of 0.8–1.0. At the end of surgery, neuromuscular blockade was reversed with

neostigmine (0.05 mg/kg) and glycopyrrolate (8 µg/kg), and the LMA was removed after return of spontaneous respiration and appropriate recovery.

Hemodynamic parameters including heart rate, mean arterial pressure, oxygen saturation, and end-tidal carbon dioxide were recorded at baseline, after induction, during device insertion, intraoperatively, and after device removal. Supraglottic airway device insertion time and perioperative airway-related complications including cough, laryngospasm, breath-holding, blood staining of the device, lip or dental injury, and sore throat were documented.

Data were analyzed using SPSS version 21 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation or median (interquartile range), whereas categorical variables were presented as frequencies and percentages. Data normality was assessed using the Shapiro–Wilk test. Correlation between leak test grading and FOB grading was evaluated using Pearson's or Spearman's correlation coefficient, as appropriate. Continuous variables were compared using the independent t-test or Mann–Whitney U test, repeated measurements using repeated-measures ANOVA or the Friedman test, and categorical variables using the Chi-square test. A p-value <0.05 was considered statistically significant.

RESULTS

The study included 60 pediatric patients, of whom 53.3% were aged 6–12 years and 75.0% were male. The mean height, weight, and duration of surgery were 108.05 ± 12.20 cm, 18.70 ± 5.66 kg, and 47.52 ± 9.79 minutes, respectively. Modified Mallampati Grade I was observed in 53.3% of patients. LMA size 2.0 was used most frequently (61.7%). First-attempt LMA insertion was successful in all patients, with a mean insertion time of 10.52 ± 1.64 seconds. Airway and gastric tube insertion were easy in 83.3% of patients. [Table 1]

Table 1: Demographics and clinical characteristics of the patients

Demographic Parameter	***n*=60**
Age n(%)	
0-3 years	12(20%)
3-5 years	16(26.7%)
6-12 years	32(53.3%)
Gender male (%): female (%)	45(75%):15(25%)
Height in cms	108.05 ± 12.2
Weight in kg	18.70 ± 5.66
Duration of surgery in min	47.52 ± 9.79
MPG grading I (%): II (%)	32(53.3%):28(46.7%)
LMA size n(%)	
1.5	3(5%)
2.0	37(61.7%)
2.5	18(30%)
3.0	2(3.3%)
Successful insertion in first attempt n(%)	60(100%)
Time for successful insertion of airway in seconds	10.52 ± 1.64
Ease of insertion of airway n(%)	
Easy	50(83.3%)
Difficult	10(16.7%)
Ease of insertion of gastric tube n(%)	
Easy	50(83.3%)
Difficult	10(16.7%)

Data are presented as number (percentage) or mean ± standard deviation (SD), as appropriate. MPG = Modified Mallampati Grade; LMA = Laryngeal Mask Airway.

Based on the leak test, 70.0% of LMAs were classified as Grade I, whereas FOB evaluation identified Grade II as the most common position (43.3%), followed by Grade I (33.3%). Grade III positioning was observed in 16.7% by the leak test and 6.7% by FOB, while Grades IV and V were detected only on FOB evaluation (6.7% and 10.0%, respectively). The distribution of LMA position was statistically significant by both leak test (χ^2 = 36.400, df = 2, $p < 0.001$) and FOB evaluation (χ^2 = 35.333, df = 4, $p < 0.001$). The grading methods demonstrated good internal reliability (Cronbach's α = 0.883). [Table 2]

Table 2: Distribution of LMA Position According to Leak Test and Fibreoptic Bronchoscopy (FOB) Evaluation (n = 60)

Grading	**Leak Test**	**FOB Evaluation**
Grade I	42(70%)	20(33.3%)
Grade II	8(13.3%)	26(43.3%)
Grade III	10(16.7%)	4(6.7%)
Grade IV	-	4(6.7%)
Grade V	-	6(10.0%)
Statistical Analysis	**Leak Test**	**FOB Evaluation**

Chi-square (χ^2)	36.400	35.333
Degrees of freedom (df)	2	4
p-value	<0.001	<0.001
Reliability analysis	Cronbach's alpha = 0.883, Good reliability	

Data are presented as n (%). FOB = Fibreoptic Bronchoscopy; LMA = Laryngeal Mask Airway; χ^2 = Chi-square statistic; df = degrees of freedom. Cronbach's alpha was used to assess the reliability of the grading methods.

Spearman's rank correlation demonstrated a strong positive correlation between leak test grading and FOB grading ($\rho = 0.776$, $p < 0.001$), indicating that higher leak test grades were associated with higher FOB grades. This finding suggests good agreement between the two methods for assessing LMA position. [Table 3]

Table 3: Correlation Between Leak Test Grading and Fibreoptic Bronchoscopy (FOB) Grading

Variable 1	Variable 2	Statistical Test	Correlation Coefficient	p-value	Interpretation
Leak Test grading	FOB grading	Spearman's rank correlation	$\rho = 0.776$	<0.001	Strong positive monotonic correlation

Spearman's rank correlation coefficient (ρ) was used to assess the association between leak test grading and FOB grading. A p-value < 0.05 was considered statistically significant. FOB = Fibreoptic Bronchoscopy.

The mean time required to perform the leak test was 6.30 ± 1.11 seconds, whereas FOB evaluation required 17.48 ± 2.22 seconds. The Shapiro–Wilk test demonstrated a non-normal distribution for both variables ($p < 0.05$). Mann–Whitney U test showed that the time required for FOB evaluation was significantly longer than that for the leak test ($Z = -9.525$, $p < 0.001$). [Table 4]

Table 4: Comparison of Time Required to Perform Leak Test and Fibreoptic Bronchoscopy

Variable	Mean ± SD (seconds)	Median (IQR)	Shapiro–Wilk p-value	Distribution
Leak Test	6.30 ± 1.11	6 (6–7)	<0.001	Non-normal
FOB Evaluation	17.48 ± 2.22	17 (16–18)	0.001	Non-normal
Statistical Test	**Z-value**	**p-value**	**Inference**	
Mann–Whitney U Test	-9.525	<0.001	Time required for FOB evaluation was significantly longer than the Leak Test.	

Data are presented as mean ± SD and median (interquartile range [IQR]). Normality was assessed using the Shapiro–Wilk test. As the data were non-normally distributed, comparisons were performed using the Mann–Whitney U test. FOB = Fibreoptic Bronchoscopy; SD = standard deviation; IQR = interquartile range.

No problems were encountered during either the leak test grading or FOB evaluation. All 60 patients (100.0%) underwent both procedures without any reported problems. No patient experienced a problem during either assessment. The Chi-square test showed no statistically significant difference in the occurrence of problems for either method ($\chi^2 = 0.000$, df = 1, p = 1.000) (Table 5).

Table 5: Problems Encountered During Leak Test Grading and FOB Evaluation

Problem	Leak Test n (%)	FOB Evaluation n (%)
No	60 (100.0%)	60 (100.0%)
Yes	0 (0.0%)	0 (0.0%)
Total	**60 (100.0%)**	**60 (100.0%)**
Statistical Test	Leak Test	FOB Evaluation
Chi-square (χ^2), df, p-value	$\chi^2 = 0.000$, df = 1, p = 1.000	$\chi^2 = 0.000$, df = 1, p = 1.000

Data are presented as n (%). FOB = Fibreoptic Bronchoscopy.

According to the leak test, airway placement was considered acceptable in 50 (83.3%) patients and unacceptable in 10 (16.7%) patients. On FOB evaluation, airway placement was acceptable in 46 (76.7%) patients and unacceptable in 14 (23.3%) patients.

The distribution of acceptable and unacceptable airway placement was statistically significant for both the leak test (Binomial Test, statistic = 50.000, $p < 0.001$) and FOB evaluation (Binomial Test, statistic = 46.000, $p < 0.001$). [Table 6]

Table 6: Evaluation of Airway Placement During Leak Test Grading and FOB Evaluation

Evaluation of Airway Placement	Leak Test n (%)	FOB Evaluation n (%)
Acceptable	50 (83.3%)	46 (76.7%)
Unacceptable	10 (16.7%)	14 (23.3%)
Total	**60 (100.0%)**	**60 (100.0%)**
Statistical Test	Statistic	p-value

Binomial Test – Leak Test	50.000	<0.001
Binomial Test – FOB Evaluation	46.000	<0.001

Data are presented as n (%). FOB = Fibreoptic Bronchoscopy.

Cross-tabulation demonstrated that, among the 50 patients classified as having acceptable airway placement by the leak test, 46 were also classified as acceptable by FOB evaluation, while 4 were classified as unacceptable by FOB evaluation. All 10 patients classified as having unacceptable placement by the leak test were also classified as unacceptable by FOB evaluation.

There was a statistically significant association between leak test and FOB evaluation ($\chi^2 = 39.429$, df = 1, $p < 0.001$; Fisher's exact test). Cramer's V was 0.811 ($p < 0.001$), indicating a very strong association between the two methods. The kappa coefficient was 0.793, demonstrating substantial agreement between leak test grading and FOB evaluation. [Table 7]

Table 7: Cross-tabulation of Evaluation of Airway Placement

LMA Placement by Leak Test	**LMA Placement by FOB Evaluation**		**Total**
	Acceptable	**Unacceptable**	**Total**
Acceptable	46	4	50
Unacceptable	0	10	10
Total	**46**	**14**	**60**
Measure	Result	Interpretation	
Chi-square (χ^2)	39.429	Statistically significant	
Degrees of freedom (df)	1	—	
p-value	<0.001	Significant	
Fisher's exact test	<0.001	Significant	
Cramer's V	0.811	Very strong association	
Kappa coefficient	0.793	Substantial agreement	

FOB = Fibreoptic Bronchoscopy; LMA = Laryngeal Mask Airway.

Using FOB evaluation as the reference standard, the diagnostic performance of the leak test was assessed. The leak test demonstrated a **sensitivity of 100%**, indicating that all airway placements classified as acceptable by FOB evaluation were correctly identified as acceptable by the leak test.

The **specificity was 71.4%**, indicating that the leak test correctly identified 71.4% of airway placements classified as unacceptable by FOB evaluation. The **positive predictive value (PPV) was 92.0%**, indicating that when the leak test classified airway placement as acceptable, there was a 92.0% probability that FOB evaluation would also classify it as acceptable.

The **negative predictive value (NPV) was 100%**, indicating that all airway placements classified as unacceptable by the leak test were confirmed as unacceptable by FOB evaluation.

Table 7A: Diagnostic Performance of Leak Test Compared with FOB Evaluation

Diagnostic Measure	**Value**
Sensitivity	100.0%
Specificity	71.4%
Positive Predictive Value	92.0%
Negative Predictive Value	100.0%

Sensitivity (100.0%): The leak test correctly identified all airway placements that were classified as acceptable by FOB evaluation, demonstrating excellent ability to detect acceptable airway placement.

Specificity (71.4%): The leak test correctly identified 71.4% of airway placements that were classified as unacceptable by FOB evaluation. Thus, some unacceptable placements were classified as acceptable by the leak test.

Positive Predictive Value (92.0%): Among airway placements classified as acceptable by the leak test, 92.0% were confirmed as acceptable by FOB evaluation.

Negative Predictive Value (100.0%): All airway placements classified as unacceptable by the leak test were confirmed as unacceptable by FOB evaluation, demonstrating excellent reliability of an unacceptable leak-test classification.

Overall, the leak test demonstrated excellent sensitivity and negative predictive value, along with a high positive predictive value. However, the lower specificity indicates that a proportion of airway placements considered acceptable by the leak test were classified as unacceptable on FOB evaluation.

LMA repositioning was not required in 50 (83.3%) patients, whereas repositioning was required once in 10 (16.7%) patients. No patient required more than one repositioning. The distribution was statistically significant (Binomial Test, statistic = 50.000, $p < 0.001$). [Table 16]

Table 8: Distribution of LMA Repositioning

LMA Repositioning	Frequency	Percentage
No repositioning	50	83.3%
Once	10	16.7%
Total	**60**	**100.0%**
Statistical Test: Binomial Test, statistic = 50.000, $p < 0.001$		

Data are presented as n (%). LMA = Laryngeal Mask Airway

DISCUSSION

The present observational study compared leak test grading with fibreoptic bronchoscopic (FOB) grading for confirming optimum laryngeal mask airway (LMA) placement in paediatric patients. The study included 60 children, with a predominance of patients aged 6–12 years and males. Successful LMA insertion was achieved on the first attempt in all patients, and airway as well as gastric tube insertion was easy in 83.3% of the study population. These findings indicate that the standard LMA insertion technique provided a high first-attempt success rate and favourable insertion characteristics in children. The relatively short mean insertion time of 10.52 ± 1.64 seconds further supports the ease and efficiency of LMA insertion in this study. These findings are consistent with previous paediatric studies evaluating supraglottic airway devices, which have demonstrated high insertion success and favourable clinical performance in children.[5,8]

In the present study, leak test assessment demonstrated Grade I positioning in the majority of patients (70%), whereas FOB evaluation most frequently demonstrated Grade II positioning (43.3%). FOB also identified Grade IV and Grade V positions in 6.7% and 10.0% of patients, respectively, whereas these grades were not detected by the leak test. This difference highlights the distinction between functional and anatomical assessment of LMA position. The leak test primarily assesses the adequacy of the airway seal and functional performance of the device, whereas FOB provides direct visualization of the relationship between the LMA cuff, glottic aperture, epiglottis, and surrounding laryngeal structures. Consequently, an anatomically suboptimal position may still provide an adequate airway seal and satisfactory ventilation and may therefore remain undetected by functional assessment alone.[6,9]

Despite the differences in the distribution of LMA grades between the two methods, a strong positive correlation was observed between leak test grading and FOB grading (Spearman's $\rho = 0.776$, $p < 0.001$). This indicates that higher grades identified by the leak test tended to correspond with higher grades on FOB assessment and demonstrates a strong monotonic relationship between the two assessment methods. Similar observations have been reported by Joshi et al., who demonstrated that clinical assessment of airway seal correlated well with fibreoptic positioning of the LMA.[9] Gupta et al. also reported that bedside assessment methods showed good agreement with imaging techniques in confirming satisfactory LMA placement.[10] The findings of the present study therefore support the usefulness of leak testing as a practical bedside method for functional assessment of LMA placement when routine fibreoptic confirmation is not feasible.

Further analysis of acceptable and unacceptable airway placement demonstrated substantial agreement between the leak test and FOB evaluation. The leak test classified 83.3% of placements as acceptable compared with 76.7% by FOB evaluation. Of the 50 placements considered acceptable by the leak test, 46 were confirmed as acceptable by FOB, while 4 were found to be unacceptable. Importantly, all 10 placements classified as unacceptable by the leak test were also classified as unacceptable by FOB evaluation. There was a statistically significant association between the two methods ($\chi^2 = 39.429$, $df = 1$, $p < 0.001$), with Cramer's V of 0.811 indicating a very strong association. The kappa coefficient of 0.793 demonstrated substantial agreement between the leak test and FOB evaluation.

The diagnostic performance of the leak test further supports its usefulness as a functional assessment method. Using FOB evaluation as the reference standard, the leak test demonstrated a sensitivity of 100%, specificity of 71.4%, positive predictive value of 92.0%, and negative predictive value of 100%. The 100% sensitivity indicates that all placements considered acceptable by FOB were correctly identified as acceptable by the leak test. Similarly, the 100% negative predictive value indicates that every placement classified as unacceptable by the leak test was confirmed as unacceptable by FOB evaluation. These findings suggest that the leak test was particularly effective in identifying placements that were not functionally satisfactory. However, the specificity of 71.4% indicates that some placements classified as acceptable by the leak test were found to be anatomically unacceptable on FOB assessment. This finding reinforces the concept that adequate airway seal and ventilation do not necessarily equate to ideal anatomical positioning.

Previous fibreoptic studies have similarly demonstrated that adequate ventilation does not necessarily indicate optimal anatomical positioning of the LMA. Von Ungern-Sternberg et al. demonstrated that small pediatric LMAs frequently exhibited partial epiglottic downfolding or suboptimal alignment despite maintaining satisfactory ventilation.[6] Similarly, Ghai et al. observed that a considerable proportion of pediatric

patients required repositioning after fibreoptic assessment, emphasizing that clinical assessment of ventilation alone may underestimate anatomical malposition.[11] In the present study, LMA repositioning was not required in 83.3% of patients, while repositioning was required once in 16.7% of patients. The need for repositioning in a minority of patients further demonstrates that satisfactory initial functional performance does not invariably guarantee optimal anatomical positioning.

The importance of correct LMA positioning extends beyond effective ventilation. Improper positioning has been associated with increased airway leak, gastric insufflation, mucosal trauma, aspiration risk, and displacement during surgery.[12] In the present study, no problems were encountered during either leak test grading or FOB evaluation, with all 60 patients (100%) completing both assessments without reported procedural problems. This finding indicates that both assessment techniques were well tolerated in the study population. However, the absence of complications in the present cohort should be interpreted in the context of the sample size and study population and should not be taken to imply that complications cannot occur with LMA use.

Daya et al. described vocal cord palsy following LMA use, emphasizing the need for correct sizing and positioning to reduce airway-related complications.[13] Therefore, although the leak test provides reassurance regarding functional airway performance and was associated with substantial agreement with FOB in the present study, it should not completely replace anatomical confirmation in selected clinical situations.

The time required to perform the leak test was substantially shorter than that required for FOB evaluation. The mean time for leak test assessment was 6.30 ± 1.11 seconds compared with 17.48 ± 2.22 seconds for FOB evaluation, with the difference being statistically significant ($p < 0.001$). This difference is clinically relevant in paediatric anaesthesia, where minimizing airway manipulation and interruption of ventilation is desirable. The leak test is simple, rapid, inexpensive, and can be performed immediately after LMA insertion without requiring additional specialized equipment. In contrast, FOB evaluation requires specialized equipment and technical expertise and may be affected by secretions, blood, or other factors that can obscure the bronchoscopic view.[6] Although FOB remains the reference method for direct assessment of anatomical positioning, the substantially shorter time required for leak testing supports its utility as a rapid bedside assessment technique.

In the present study, no problems were encountered during either leak test grading or FOB evaluation. This finding, together with the 100% first-attempt insertion success rate and the high proportion of easy airway insertion, suggests that LMA placement and subsequent assessment were technically straightforward in the majority of children. In addition, the fact that only 16.7% of patients required a single LMA repositioning indicates that most devices achieved satisfactory positioning without the need for repeated manipulation. These findings are clinically relevant because repeated airway manipulation in children may increase the risk of airway trauma, haemodynamic changes, or respiratory complications.

In the present study, anaesthesia was maintained at an adequate depth before airway assessment, thereby minimizing ventilation difficulties related to laryngospasm or inadequate anaesthetic depth rather than device malposition. Similar approaches have been adopted in previous paediatric studies evaluating supraglottic airway devices, resulting in low rates of airway complications following LMA insertion.[14] This standardized approach likely contributed to the excellent first-attempt insertion success, the high proportion of easy airway insertion, and the absence of reported problems during leak test and FOB assessment in the present study.

The increasing use of LMAs in paediatric anaesthesia is supported by evidence demonstrating fewer perioperative respiratory adverse events compared with endotracheal intubation during elective surgery.[15] Nevertheless, airway complications remain an important cause of perioperative morbidity in children, particularly when airway devices are improperly positioned.[16,17] Consequently, reliable, rapid, and clinically practical methods for confirming LMA placement remain important. The present findings suggest that the leak test can provide useful functional information regarding LMA position while avoiding the additional time and equipment requirements associated with FOB.

An important finding of the present study is that the leak test performed well when used to identify functionally acceptable airway placement. Its high sensitivity and negative predictive value suggest that an unacceptable leak-test result should be taken seriously, as such findings were consistently associated with unacceptable placement on FOB evaluation. At the same time, the lower specificity indicates that an acceptable leak-test result cannot completely exclude anatomical malposition. Therefore, the leak test should be viewed as a functional screening and confirmation method rather than an exact substitute for direct anatomical visualization.

Overall, the findings of the present study indicate that the leak test is a rapid, simple, and clinically useful bedside method for assessing LMA placement in paediatric patients. The strong positive correlation with FOB grading ($\rho = 0.776$, $p < 0.001$), very strong association (Cramer's $V = 0.811$), substantial agreement ($\kappa = 0.793$), and favourable diagnostic performance demonstrate that the leak test provides reliable information regarding functional LMA placement. Its 100% sensitivity and

100% negative predictive value are particularly noteworthy. However, the identification of additional Grades IV and V malpositions by FOB and the specificity of 71.4% indicate that the leak test may fail to detect some anatomically suboptimal placements that continue to provide adequate airway function.

Thus, while fibreoptic bronchoscopy remains the reference standard because it directly visualizes the laryngeal inlet and identifies anatomical malposition, the findings of this study support the routine use of the leak test for rapid functional confirmation of LMA placement in appropriately selected paediatric patients. Fibreoptic evaluation may be particularly valuable when the leak test suggests inadequate positioning, when ventilation is suboptimal, when repositioning is required, or when precise anatomical confirmation is clinically indicated. The combined use of functional assessment with selective anatomical confirmation may therefore provide a practical balance between efficiency and accuracy in paediatric airway management.

CONCLUSION

The leak test shows a strong correlation with fibreoptic grading and serves as a rapid and reliable bedside method for assessing LMA position in pediatric patients. However, FOB remains superior for detecting anatomical malposition and should be used when precise confirmation is required.

REFERENCES

1. Yu SH, Beirne OR. Laryngeal mask airways have a lower risk of airway complications compared with endotracheal intubation: a systematic review. J Oral Maxillofac Surg. 2010;68(10):2359-2376.
2. Song K, Yi J, Liu W, et al. Confirmation of laryngeal mask airway placement by ultrasound examination: a pilot study. J Clin Anesth. 2016;34:638-643.
3. Brimacombe J, Keller C. Laryngeal mask airway size selection in males and females: ease of insertion, oropharyngeal leak pressure, pharyngeal mucosal pressures and anatomical position. Br J Anaesth. 1999;82(5):703-707.
4. Keller C, Brimacombe J, Keller K, Morris R. Comparison of four methods for assessing airway sealing pressure with the laryngeal mask airway in adult patients. Br J Anaesth. 1999;82(2):286-287.
5. Shimbori H, Ono K, Miwa T, et al. Comparison of the LMA-ProSeal and LMA-Classic in children. Br J Anaesth. 2004;93(4):528-531.
6. Von Ungern-Sternberg BS, Wallace CJ, Sticks S, et al. Fibreoptic assessment of paediatric-sized laryngeal mask airways. Anaesth Intensive Care. 2010;38(1):50-54.
7. Kim J, Kim JY, Kim WO, et al. An ultrasound evaluation of laryngeal mask airway position in pediatric patients: an observational study. Anesth Analg. 2015;120(2):427-432.
8. Park JS, Kim KJ, Oh JT, et al. A randomized controlled trial comparing laryngeal mask airway removal during adequate anesthesia and after awakening in children aged 2 to 6 years. J Clin Anesth. 2012;24(7):537-541.
9. Joshi S, Sciacca RR, Solanki DR, et al. A prospective evaluation of clinical tests for placement of laryngeal mask airways. Anesthesiology. 1998;89(5):1141-1146.
10. Gupta D, Srirajakalidindi A, Habli N, et al. Ultrasound confirmation of laryngeal mask airway placement correlates with fiberoptic findings. Middle East J Anaesthesiol. 2011;21(2):283-287.
11. Ghai B, Ram J, Makkar JK, et al. Fiber-optic assessment of LMA position in children: a randomized crossover comparison of two techniques. Paediatr Anaesth. 2011;21(11):1142-1147.
12. Brimacombe J, Berry A. Insertion of the laryngeal mask airway: a prospective study of four techniques. Anaesth Intensive Care. 1993;21(1):89-92.
13. Daya H, Fawcett WJ, Weir N. Vocal fold palsy after use of the laryngeal mask airway. J Laryngol Otol. 1996;110(4):383-384.
14. Goldmann K, Roettger C, Wulf H. The size 1½ ProSeal laryngeal mask airway in infants: a randomized crossover investigation with the Classic laryngeal mask airway. Anesth Analg. 2006;102(2):405-410.
15. Li L, Zhang Z, Yao Z, et al. The impact of laryngeal mask versus other airways on perioperative respiratory adverse events in children: a systematic review and meta-analysis of randomized controlled trials. Int J Surg. 2019;64:40-48.
16. Mir Ghassemi A, Neira V, Ufholz LA, et al. A systematic review and meta-analysis of acute severe complications of pediatric anesthesia. Paediatr Anaesth. 2015;25(11):1093-1102.
17. Von Ungern-Sternberg BS, Boda K, Chambers NA, et al. Risk assessment for respiratory complications in paediatric anaesthesia: a prospective cohort study. Lancet. 2010;376(9743):773-783.