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Association of Cleft Anatomy with Difficult Laryngoscopy in Children (9 Months-3 Years) Undergoing Cleft Surgery: A Case Series

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Abstract: ***Background**: Airway management in children with cleft lip and palate remains a significant anesthetic challenge because craniofacial deformities may result in difficult laryngoscopy and tracheal intubation. Accurate preoperative prediction of airway difficulty is essential for safe anesthetic planning. This case series was conducted to evaluate the association between cleft anatomy, particularly maximum cleft width, and difficult laryngoscopy in children undergoing primary cleft surgery. **Methods**: An observational case series was conducted on seven children aged 9 months to 3 years undergoing primary cleft lip and/or palate repair. Cleft deformities were classified as unilateral cleft lip and palate, bilateral cleft lip and palate, or isolated cleft palate. Maximum cleft width was measured at the hard–soft palate junction using standardized intraoral landmarks. Airway assessment included mask ventilation, Cormack–Lehane (CL) grade, number of intubation attempts, requirement for external airway maneuvers, and peri-intubation desaturation. Difficult laryngoscopy was defined as Cormack–Lehane Grade III or IV. **Results**: Among the seven patients, 42.9% had bilateral cleft lip and palate, 28.6% had unilateral cleft lip and palate, and 28.6% had isolated cleft palate. The mean maximum cleft width was 11.14 ± 2.56 mm. Difficult laryngoscopy was observed in 4 (57.1%) children, all of whom had wider clefts with a mean cleft width of 12.75 ± 2.27 mm, compared with 9.00 ± 0.87 mm in children without difficult laryngoscopy. Bilateral cleft lip and palate was consistently associated with Cormack–Lehane Grade III or IV and increased intubation attempts. Grade III laryngoscopy was the most frequent finding (57.1%), while Grade IV was observed in 28.6% of cases. **Conclusion**: Greater cleft width and bilateral cleft anatomy were associated with increased difficulty during direct laryngoscopy. Preoperative measurement of maximum cleft width may serve as a simple and useful predictor of difficult airway, allowing better preparation, appropriate airway planning, and improved perioperative safety in children undergoing cleft surgery.*

Keywords: Cleft lip and palate, Difficult laryngoscopy, Pediatric airway, Cormack–Lehane grade, Cleft width

1. Introduction

Cleft lip and cleft palate (CL/P) are among the most common congenital craniofacial anomalies worldwide, occurring in approximately 1 in 700 live births, with considerable geographic and ethnic variation. These anomalies result from failure of fusion of the facial processes during early embryogenesis, leading to defects involving the lip, alveolus, hard palate, soft palate, or combinations thereof. Children with cleft deformities frequently require multiple surgical procedures beginning in infancy, making airway management a critical component of perioperative care. Safe anesthetic management in these patients is often challenging because congenital distortion of the upper airway anatomy increases the likelihood of difficult mask ventilation and difficult laryngoscopy. Consequently, anesthesiologists must anticipate airway difficulty and formulate an appropriate airway management strategy before induction of anesthesia to minimize perioperative morbidity. (1–3)

The anatomical abnormalities associated with cleft lip and palate significantly alter the normal relationships of the oral cavity, tongue, maxilla, palate, and pharyngeal structures. Maxillary hypoplasia, a shortened palate, altered tongue position, reduced oral cavity volume, and discontinuity of the palatal arch contribute to impaired alignment of the oral, pharyngeal, and laryngeal axes during direct laryngoscopy. Bilateral cleft lip and palate deformities often produce more severe anatomical distortion than unilateral clefts because of greater premaxillary protrusion and wider palatal defects. Similarly, increasing cleft width may reduce the available space for laryngoscope manipulation and compromise visualization of the glottis, thereby increasing the incidence of difficult laryngoscopy and multiple intubation attempts. (4–6)

Airway management in infants and young children is inherently more challenging than in adults because of developmental anatomical differences, including a relatively larger occiput, proportionately larger tongue, cephalad and anteriorly positioned larynx, omega-shaped epiglottis, and narrow subglottic airway. In children with cleft deformities, these normal pediatric airway characteristics are compounded by craniofacial abnormalities, making endotracheal intubation technically demanding. Repeated laryngoscopy attempts may result in airway trauma, bleeding from the cleft margins, hypoxemia, laryngospasm, and postoperative airway edema. Therefore, early identification of patients at increased risk of difficult laryngoscopy is essential for ensuring patient safety and reducing anesthesia-related complications. (2,4,7)

Several studies have attempted to identify predictors of difficult airway in pediatric cleft surgery. Conventional bedside airway assessment methods commonly used in adults, such as the Mallampati classification, thyromental distance, or upper lip bite test, have limited applicability in infants and toddlers because of poor cooperation and age-related anatomical differences. Consequently, radiological and anatomical characteristics of the cleft itself have attracted increasing attention as potential predictors of airway difficulty. Previous studies have suggested that bilateral clefts,

complete cleft lip and palate, and larger cleft width are associated with higher Cormack–Lehane grades, increased intubation attempts, and greater reliance on external laryngeal manipulation or advanced airway devices. Nevertheless, the available literature remains limited, particularly in children younger than three years of age undergoing primary cleft repair. (5,8,9)

Direct laryngoscopy using conventional Macintosh or Miller blades continues to be the primary technique for airway management in many centers, particularly in resource-limited hospitals and cleft outreach camps where advanced airway devices such as videolaryngoscopes or fiberoptic bronchoscopes may not be readily available. Under such circumstances, accurate preoperative prediction of airway difficulty based on readily measurable anatomical characteristics becomes even more important. Measurement of cleft width at standardized anatomical landmarks offers a simple, inexpensive, and reproducible method that may assist anesthesiologists in identifying patients likely to experience difficult laryngoscopy before induction of anesthesia. (6,8)

Despite improvements in pediatric anesthesia, evidence correlating specific cleft anatomical characteristics with difficult laryngoscopy remains scarce, especially in the Indian population. Most published reports have focused on individual case reports or heterogeneous patient populations without systematically evaluating the relationship between cleft width, cleft type, and laryngoscopic grade. Therefore, further clinical evidence is needed to determine whether preoperative anatomical assessment can reliably predict airway difficulty and facilitate appropriate airway preparation.

The present case series was undertaken to evaluate the association between cleft anatomy and difficult laryngoscopy in children aged 9 months to 3 years undergoing primary cleft surgery. Specifically, the study assessed the relationship between cleft width measured at the hard–soft palate junction, cleft type (bilateral cleft lip and palate, unilateral cleft lip and palate, and isolated cleft palate), and intraoperative airway outcomes including Cormack–Lehane grade, number of intubation attempts, mask ventilation difficulty, need for external airway manoeuvres, and peri-intubation desaturation. The findings may contribute to improved preoperative airway risk stratification and safer anesthetic planning for pediatric patients undergoing cleft surgery.

Palate repair Cleft classification: Unilateral CLP, Bilateral CLP, Isolated cleft palate Anatomical assessment: Maximum cleft width measured at the hard–soft palate junction using standardized intraoral landmarks Airway assessment: Mask ventilation difficulty, Cormack–Lehane grade, number of intubation attempts, need for external manoeuvres, and peri-intubation desaturation recorded during direct laryngoscopy Definition of difficult laryngoscopy: Cormack–Lehane grade ≥ III

2. Materials and Methods

2.1 Study Design

The present study was conducted as an observational case series to evaluate the association between cleft anatomy and difficult laryngoscopy in children undergoing primary cleft surgery. The study involved detailed clinical and intraoperative assessment of pediatric patients with different types of cleft lip and/or palate. No intervention was performed beyond routine anesthetic management, and all airway observations were recorded prospectively during standard perioperative care. The study aimed to identify whether cleft width and cleft type were associated with the occurrence of difficult laryngoscopy.

2.2 Study Setting

The study was conducted in the Department of Anaesthesiology in collaboration with the Department of Plastic Surgery at a tertiary care teaching hospital over the period of 6 months. All patients underwent elective primary cleft lip and/or palate repair under general anesthesia. Preoperative evaluation, intraoperative airway assessment, and postoperative monitoring were carried out according to the institutional protocols for pediatric cleft surgery.

Participants

Inclusion Criteria

- Children aged 9 months to 3 years.
- Patients undergoing primary cleft lip and/or palate repair.
- Children diagnosed with unilateral cleft lip and palate (UCLP), bilateral cleft lip and palate (BCLP), or isolated cleft palate (ICP).
- Patients who underwent direct laryngoscopy under general anesthesia.
- Parents or legal guardians who provided written informed consent.

Exclusion Criteria

- Children with known syndromic craniofacial anomalies (e.g., Pierre Robin sequence, Treacher Collins syndrome).
- Previous cleft lip or palate surgery.
- Presence of congenital airway abnormalities unrelated to cleft deformity.
- Patients requiring emergency surgery.
- Incomplete perioperative or airway assessment data.

Study Sampling

A consecutive sampling technique was adopted. All eligible children fulfilling the inclusion criteria during the study period were included consecutively until the predetermined sample size was achieved. This approach minimized selection bias and ensured inclusion of all available cases presenting during the study period.

Study Sample Size

A total of 7 children were included in the study. As this investigation was designed as an observational case series, all eligible patients presenting during the study period were enrolled without formal sample size calculation. The sample comprised children with varying cleft anatomy to permit descriptive comparison of airway characteristics among different cleft types.

Study Parameters

The study evaluated demographic, anatomical, and airway-related parameters in children undergoing primary cleft surgery. Demographic variables included age and gender.

Anatomical assessment comprised the type of cleft deformity (unilateral cleft lip and palate, bilateral cleft lip and palate, or isolated cleft palate) and the maximum cleft width, measured in millimeters at the hard–soft palate junction using standardized intraoral landmarks. Airway assessment included the difficulty in mask ventilation, Cormack–Lehane (CL) laryngoscopic grade, number of intubation attempts, requirement for external laryngeal manoeuvres, use of video laryngoscopy or other airway adjuncts, and the occurrence of peri-intubation oxygen desaturation. The primary outcome was the incidence of difficult laryngoscopy, which was defined as a Cormack–Lehane Grade III or Grade IV observed during direct laryngoscopy. These parameters were recorded systematically for each patient to evaluate the association between cleft anatomy and the degree of airway difficulty encountered during anesthesia.

Study Procedure

Following preoperative evaluation and confirmation of eligibility, written informed consent was obtained from the parents or legal guardians. Demographic and clinical details were recorded before surgery. The cleft deformity was classified as unilateral cleft lip and palate, bilateral cleft lip and palate, or isolated cleft palate. Prior to induction of anesthesia, the maximum cleft width was measured at the hard–soft palate junction using standardized intraoral anatomical landmarks with a sterile measuring scale.

General anesthesia was administered according to the institutional pediatric anesthesia protocol. After achieving adequate depth of anesthesia, direct laryngoscopy was performed by an experienced pediatric anesthesiologist using conventional laryngoscopy. During airway management, the ease of mask ventilation, Cormack–Lehane grade, number of intubation attempts, requirement for external laryngeal manipulation, need for alternative airway devices such as video laryngoscopy, and occurrence of oxygen desaturation were recorded. The airway findings were documented immediately after successful endotracheal intubation. Each patient was observed throughout the perioperative period, and all relevant airway data were entered into a standardized case record form.

Study Data Collection

Data were collected prospectively using a predesigned structured proforma. Information regarding demographic characteristics, cleft classification, anatomical measurements, intraoperative airway assessment, and intubation details was documented by the attending anesthesiologist. The collected data were verified for completeness before being entered into the study database.

Data Analysis

The collected data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 26.0. Continuous variables such as age and cleft width were expressed as mean ± standard deviation (SD) or median where appropriate. Categorical variables including cleft type, Cormack–Lehane grade, mask ventilation difficulty, intubation attempts, and difficult laryngoscopy were summarized as frequencies and percentages. Owing to the small sample size and descriptive nature of the study, the findings were analyzed descriptively without formal hypothesis testing. The relationship between cleft anatomy and airway difficulty was interpreted based on observed clinical trends.

Ethical Considerations

The study was conducted after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from the parents or legal guardians of all participating children before enrollment. Confidentiality of patient information was maintained throughout the study by assigning unique identification numbers and restricting access to study records. The study complied with the ethical principles outlined in the Declaration of Helsinki. Since all observations were recorded during routine perioperative management without alteration of the standard anesthetic protocol, no additional risk was imposed on the participants.

3. Results

A total of seven children aged 9 months to 3 years undergoing primary cleft surgery were included in this observational case series. Patients comprised bilateral cleft lip and palate (BCLP), unilateral cleft lip and palate (UCLP), and isolated cleft palate (ICP). Airway assessment included maximum cleft width at the hard–soft palate junction, Cormack–Lehane (CL) grade, number of intubation attempts, and occurrence of difficult laryngoscopy.

Table 1: Distribution of Patients According to Type of Cleft (n = 7)

Cleft Type	Number (n)	Percentage (%)
Bilateral cleft lip and palate	3	42.9
Unilateral cleft lip and palate	2	28.6
Isolated cleft palate	2	28.6
Total	**7**	**100.0**

Among the seven children studied, bilateral cleft lip and palate was the most common deformity, accounting for 42.9% of cases, followed by unilateral cleft lip and palate and isolated cleft palate, each comprising 28.6% of the study population.

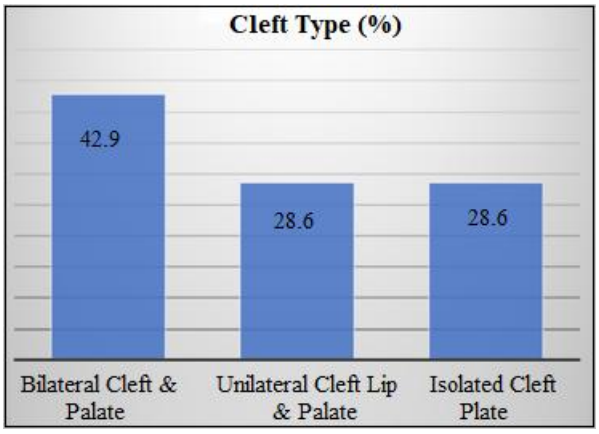


Table 2: Distribution of Maximum Cleft Width according to Cleft Type

Case	Cleft Type	Maximum Cleft Width (mm)
1	Bilateral CLP	15.5
2	Bilateral CLP	13.0
3	Unilateral CLP	10.0
4	Isolated Cleft Palate	8.5
5	Unilateral CLP	8.5
6	Bilateral CLP	12.5
7	Isolated Cleft Palate	10.0

Mean cleft width = 11.14 ± 2.56 mm

The maximum cleft width ranged from 8.5 mm to 15.5 mm, with a mean value of 11.14 ± 2.56 mm. The widest clefts were observed in children with bilateral cleft lip and palate, whereas isolated cleft palate generally demonstrated comparatively smaller cleft widths.

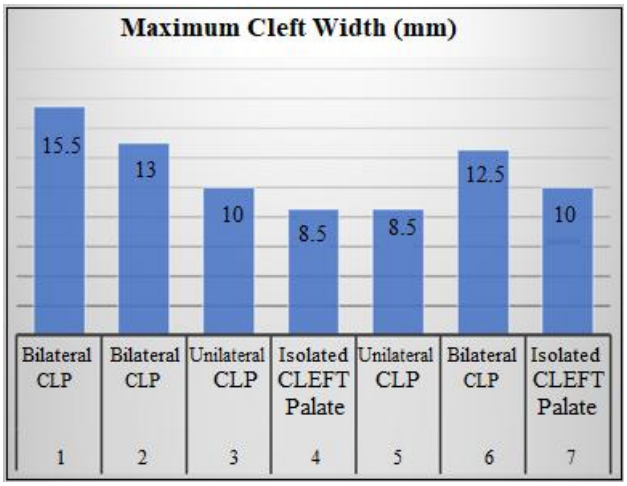
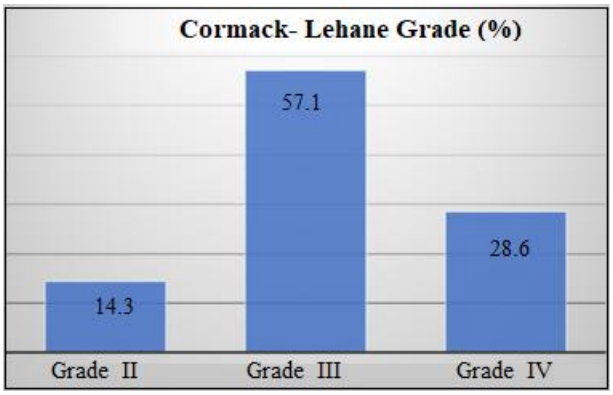


Table 3: Airway Assessment During Direct Laryngoscopy (n = 7)

Variable	Number (n)	Percentage (%)
Cormack–Lehane Grade		
Grade II	1	14.3
Grade III	4	57.1
Grade IV	2	28.6
Number of Intubation Attempts		
One attempt	1	14.3
Two attempts	2	28.6
Three attempts	3	42.9
Four attempts	1	14.3

Cormack–Lehane Grade III was the most frequently encountered laryngoscopic view (57.1%), followed by Grade IV (28.6%). Most patients (42.9%) required three intubation attempts, indicating increased airway difficulty among children with larger cleft deformities.



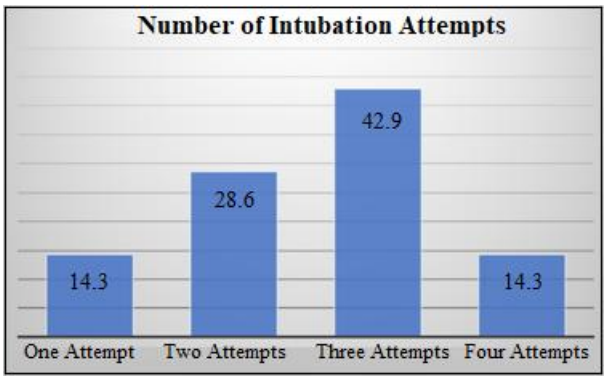


Table 4: Distribution of Difficult Laryngoscopy According to Cleft Type

Cleft Type	Difficult Laryngoscopy	No Difficult Laryngoscopy	Total
Bilateral CLP	3	0	3
Unilateral CLP	1	1	2
Isolated Cleft Palate	0	2	2
Total	4	3	7

Overall, four children (57.1%) experienced difficult laryngoscopy. All cases of bilateral cleft lip and palate demonstrated difficult laryngoscopy, whereas none of the children with isolated cleft palate experienced difficult airway visualization.

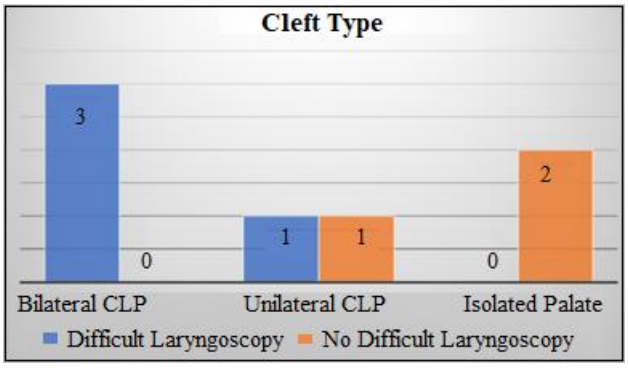
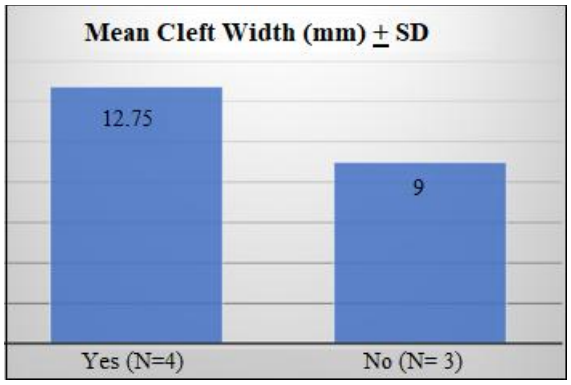


Table 5: Association of Maximum Cleft Width with Difficult Laryngoscopy

Difficult Laryngoscopy	Mean Cleft Width (mm) ± SD
Yes (n = 4)	12.75 ± 2.27
No (n = 3)	9.00 ± 0.87

Children who experienced difficult laryngoscopy had a greater mean cleft width (12.75 ± 2.27 mm) compared with those without difficult laryngoscopy (9.00 ± 0.87 mm).

Bilateral clefts with widths ranging from 12.5–15.5 mm were consistently associated with higher Cormack–Lehane grades and multiple intubation attempts, supporting the observation that increasing cleft width may be associated with increased airway difficulty. This trend is consistent with published evidence demonstrating that greater maximum cleft width is a predictor of difficult laryngoscopy in cleft patients.



4. Discussion

The present observational case series evaluated the association between cleft anatomy and difficult laryngoscopy in seven children aged 9 months to 3 years undergoing primary cleft surgery. The study demonstrated that increasing cleft severity, particularly bilateral cleft lip and palate with greater maximum cleft width, was associated with poorer laryngoscopic view and increased intubation difficulty. Among the seven children studied, bilateral cleft lip and palate was the most common deformity, accounting for 42.9% (3/7) of cases, while unilateral cleft lip and palate and isolated cleft palate each constituted 28.6% (2/7). Difficult laryngoscopy (Cormack–Lehane grade ≥III) was observed in 4 of 7 patients (57.1%), whereas 42.9% had no difficult laryngoscopy. Notably, all three children with bilateral cleft lip and palate experienced difficult laryngoscopy, while none of the children with isolated cleft palate fulfilled the study definition of difficult laryngoscopy. These findings suggest that the anatomical severity of the cleft plays a major role in airway visualization during direct laryngoscopy.

The maximum cleft width in the present series ranged from 8.5 mm to 15.5 mm, with an overall mean of 11.14 ± 2.56 mm. Importantly, children with difficult laryngoscopy demonstrated a considerably greater mean cleft width (12.75 ± 2.27 mm) than those without difficult laryngoscopy (9.00 ± 0.87 mm). The widest clefts (12.5–15.5 mm) were observed exclusively in bilateral cleft lip and palate cases and were consistently associated with Cormack–Lehane Grades III or IV and multiple intubation attempts. These observations indicate that increasing cleft width may adversely affect alignment of the oral, pharyngeal, and laryngeal axes during direct laryngoscopy, thereby increasing airway difficulty.

The findings of the present study are in close agreement with the prospective study conducted by Abdelhameed et al. (2021), who evaluated 189 infants with unilateral complete cleft lip and palate and demonstrated that both alveolar gap and maximum cleft width were powerful predictors of difficult laryngoscopy and intubation ($p \leq 0.001$). They reported 100% sensitivity for both parameters, with specificity of 76.10% for alveolar gap and 82.39% for maximum cleft width. A maximum cleft width cut-off of 11 mm showed an odds ratio of 5.68 for difficult intubation, while an alveolar gap ≤10 mm showed an odds ratio of 4.18. Their results established maximum cleft width as an important objective preoperative predictor of airway difficulty, which is strongly supported by the present study, where children with wider clefts (mean 12.75 mm) experienced difficult laryngoscopy compared with those having narrower clefts (mean 9.00 mm) [10].

Airway assessment in the present study further demonstrated that Cormack–Lehane Grade III was the commonest laryngoscopic finding, observed in 57.1% of children, while 28.6% had Grade IV and only 14.3% had Grade II. Regarding intubation attempts, 42.9% of patients required three attempts, 28.6% required two attempts, 14.3% required four attempts, and only 14.3% were intubated successfully on the first attempt. These findings indicate that poorer laryngoscopic grades were accompanied by increasing intubation attempts, reflecting greater technical difficulty during airway management.

Similar observations were reported by Xue et al. (2006) in their large study involving 985 infants aged 1 month to 3 years. They reported an overall incidence of difficult laryngoscopy of 4.77%, with the highest incidence (7.06%) occurring in infants younger than six months. Importantly, difficult laryngoscopy was most common in children with combined bilateral cleft lip and palate, whereas isolated cleft palate exhibited a much lower incidence. Furthermore, moderately difficult, difficult, and failed intubations occurred predominantly in patients with Cormack–Lehane Grades III and IV, emphasizing the strong relationship between cleft severity and airway difficulty [13]. Although the present study involved a much smaller sample, the observation that all bilateral cleft lip and palate cases demonstrated difficult laryngoscopy is consistent with the findings of Xue et al.

The present findings also correspond with the recent prospective observational study by Shenoy et al. (2025) involving 270 children undergoing cleft surgery. They demonstrated that Cormack–Lehane Grade ≥III was independently associated with perioperative respiratory adverse events. Multivariate analysis showed that CL grade ≥III carried an adjusted odds ratio of 41.79, while a COLDS score ≥15 had an adjusted odds ratio of 18.07 for perioperative respiratory complications. Although the current study did not evaluate respiratory adverse events, four children demonstrated Cormack–Lehane Grade III or IV laryngoscopy, highlighting the importance of anticipating airway challenges and ensuring experienced airway management teams during cleft surgery [12].

The relationship between cleft morphology and airway complications has also been highlighted by Desalu et al. (2010), who prospectively evaluated 50 patients undergoing cleft surgery. They reported airway or respiratory complications in 38% of patients, with difficult and failed intubation occurring in 2% each. Complications were more frequent during cleft palate (38.4%) and combined cleft lip-palate (50%) repairs than isolated cleft lip repair (15.8%), emphasizing that increasing anatomical complexity

contributes to airway difficulty. Their recommendation for skilled anesthetic personnel and meticulous airway preparation is supported by the present study, where patients with bilateral clefts required multiple laryngoscopy attempts [11].

Comparable findings were also reported by Bunsangjaroen et al. (2015), who retrospectively reviewed 469 anesthetic procedures for cleft repair. They found that unilateral cleft lip-palate and cleft palate patients had the highest incidence of difficult intubation (4.48% each). Despite these challenges, successful airway management was achieved in nearly all cases with advanced anesthetic techniques, emphasizing the importance of expertise and preparation during pediatric airway management [14].

The anatomical basis of difficult airway in craniofacial anomalies has been further explained by Kohjitani et al. (2013). Their cephalometric analysis of 210 children demonstrated that difficult laryngoscopy was associated with underdeveloped maxilla and mandible, increased mandibular plane–hyoid distance, deeper oropharynx, and lower laryngeal position in younger children. These craniofacial characteristics may coexist with severe cleft deformities and provide an anatomical explanation for the increased airway difficulty observed in children with wider bilateral clefts in the present study [15].

Overall, the present case series demonstrates a clear clinical trend indicating that greater cleft width and bilateral cleft anatomy are associated with higher Cormack–Lehane grades, increased intubation attempts, and a greater likelihood of difficult laryngoscopy. Although limited by the small sample size, the findings closely parallel those reported in larger observational studies. Careful preoperative assessment of cleft morphology, particularly measurement of maximum cleft width, may therefore assist anesthesiologists in anticipating difficult airway management, ensuring availability of experienced personnel and advanced airway equipment, and ultimately improving perioperative safety in children undergoing cleft surgery

5. Conclusion

The present case series demonstrates that cleft anatomy, particularly bilateral cleft lip and palate and increased maximum cleft width, is associated with greater difficulty during direct laryngoscopy in children aged 9 months to 3 years undergoing cleft surgery. Children with wider clefts (mean 12.75 ± 2.27 mm) exhibited higher Cormack–Lehane grades (III/IV) and required multiple intubation attempts compared with those having narrower clefts (mean 9.00 ± 0.87 mm). All bilateral cleft lip and palate cases experienced difficult laryngoscopy, highlighting the importance of detailed preoperative anatomical assessment. Measurement of maximum cleft width may serve as a simple and useful predictor of airway difficulty. Early anticipation of a difficult airway enables appropriate preparation, experienced airway management, and improved perioperative safety in pediatric cleft surgery.

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