

## A Prospective Observational Study on the Management of Difficult Airway in Neonates with Congenital Anomalies in a Tertiary Care Centre

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### ABSTRACT

**Background:** Airway management in neonates with congenital anomalies is challenging due to anatomical abnormalities and limited physiological reserve. “Difficult airway situations can lead to significant morbidity and mortality if not managed appropriately.

**Aim:** To study the management of difficult airway in neonates with congenital anomalies.

**Objective:** To evaluate various airway management techniques and their outcomes in neonates presenting with difficult airway.

**Methods:** This prospective observational study was conducted in a tertiary care centre including 30 neonates with congenital anomalies presenting with difficult airway. Data on demographic profile, type of anomaly, airway management techniques, use of adjuncts, and outcomes were collected. Statistical analysis was performed, and associations were assessed using appropriate tests with significance set at  $p < 0.05$ .

**Results:** Craniofacial anomalies were the most common cause of difficult airway. Difficult mask ventilation and  $\geq 3$  intubation attempts were significantly associated with adverse outcomes ( $p < 0.05$ ). Use of adjuncts such as videolaryngoscopy and laryngeal mask airway significantly improved success rates ( $p < 0.05$ ). Overall airway success rate was 90%, with complications including desaturation (50%) and bradycardia (30%).

**Conclusion:** Difficult airway in neonates with congenital anomalies requires a structured approach with early use of adjuncts and limitation of repeated attempts”. Adoption of standardized protocols and simulation-based training can improve outcomes and reduce complications.

**KEYWORDS:** Neonates, Difficult airway, Congenital anomalies, Airway management, Pierre Robin sequence, Videolaryngoscopy, Laryngeal mask airway, Endotracheal intubation, Neonatal resuscitation, Airway adjuncts.

### INTRODUCTION

Airway management is a fundamental component of neonatal resuscitation and critical care, as adequate oxygenation and ventilation are essential for survival and prevention of long-term morbidity (1). “The neonatal airway is anatomically and physiologically distinct from that of older children and adults, characterized by a relatively large tongue, a higher and more anterior larynx, a narrow subglottic region, and increased airway compliance. These features make airway management inherently challenging even in normal neonates (2). The presence of congenital anomalies further complicates this scenario, often resulting in a difficult airway that requires prompt recognition and specialized management strategies (3).

Congenital airway anomalies encompass a wide spectrum of structural abnormalities involving the craniofacial region, upper

airway, and tracheobronchial tree (4). Common conditions include Pierre Robin sequence, characterized by micrognathia, glossoptosis, and airway obstruction; choanal atresia; laryngeal webs; tracheomalacia; and craniofacial syndromes such as Treacher Collins and Goldenhar syndrome (5). These anomalies can lead to partial or complete airway obstruction, difficulty in mask ventilation, and challenges in visualization during laryngoscopy and endotracheal intubation. In such cases, conventional airway management techniques may fail, increasing the risk of hypoxia, bradycardia, and cardiac arrest (6)..

The incidence of difficult airway in neonates with congenital anomalies is not precisely known; however, it is significantly higher compared to the general neonatal population. Difficult airway situations may present either as anticipated, based on prenatal diagnosis or postnatal clinical assessment, or as unanticipated emergencies during resuscitation (7). Early identification through antenatal imaging, such as ultrasound or fetal MRI, allows for planned delivery and preparedness of a multidisciplinary team, including neonatologists, anesthesiologists, and otolaryngologists. Despite such advancements, many cases still present unexpectedly, particularly in resource-limited settings (8).

Effective management of a difficult airway in neonates with congenital anomalies requires a structured, stepwise approach. Initial efforts focus on ensuring adequate mask ventilation using proper positioning, airway adjuncts such as oropharyngeal or nasopharyngeal airways, and two-person techniques (9). When intubation is required, techniques may need modification, including the use of smaller endotracheal tubes, alternative laryngoscope blades, or advanced devices such as videolaryngoscopes (10). Supraglottic airway devices, particularly laryngeal mask airways, have emerged as valuable rescue tools when intubation is unsuccessful. Fiberoptic intubation remains the gold standard in selected cases but is limited by availability and expertise in neonatal practice (11,12).

The management of difficult airway in this population is further complicated by the neonate's limited physiological reserve, leading to rapid desaturation during airway interventions. Repeated unsuccessful attempts can result in airway trauma, edema, and worsening obstruction (13). Therefore, minimizing the number of attempts, early escalation to experienced providers, and timely use of alternative airway devices are critical components of care. In rare situations where non-invasive methods fail, surgical airway procedures may be considered, although these are technically challenging in neonates (14).

Given the high risk associated with difficult airway in neonates with congenital anomalies, there is a need for increased awareness, training, and development of institution-specific protocols". Simulation-based training and multidisciplinary coordination play a vital role in improving outcomes (15). This study aims to evaluate the clinical profile and management strategies of difficult airway in neonates with congenital anomalies, thereby contributing to improved preparedness and evidence-based practice in neonatal airway management.

## AIMS AND OBJECTIVES

**AIM:** To study the management of difficult airway in neonates with congenital anomalies.

**OBJECTIVE:** To evaluate the various airway management techniques and their outcomes in neonates with congenital anomalies presenting with difficult airway.

## MATERIALS AND METHODS

This prospective observational study was conducted in the Neonatal Intensive Care Unit (NICU) and delivery room of a tertiary care centre over a period of [insert duration, e.g., 12 months]. "The study included neonates diagnosed with congenital anomalies involving the airway or craniofacial structures who presented with features of difficult airway during resuscitation or clinical management. Difficult airway was defined as difficulty in mask ventilation, laryngoscopy, or endotracheal intubation requiring multiple attempts or use of adjunct airway devices. Neonates with acquired airway pathology, those not requiring airway intervention, and those with incomplete clinical data were excluded from the study.

Data were collected prospectively using a structured proforma, including demographic details (gestational age, birth weight, sex), type of congenital anomaly, clinical presentation, and antenatal diagnosis where available. Details of airway management were recorded, including method of ventilation, number of intubation attempts, use of adjuncts such as stylet, videolaryngoscope, or supraglottic airway devices, and the level of expertise of the airway provider. The primary outcome measured was successful airway establishment, while secondary outcomes included time to secure airway, complications (desaturation, bradycardia, airway trauma), and need for alternative or rescue airway techniques.

All airway interventions were performed as per standard institutional protocols by trained personnel. Continuous monitoring of heart rate, oxygen saturation, and respiratory status was maintained during procedures. Ethical approval was obtained from the Institutional Ethics Committee, and confidentiality of patient data was ensured". The collected data were entered into a spreadsheet and analyzed using appropriate statistical software. Descriptive statistics were used to summarize baseline characteristics, and relevant comparative analyses were performed where applicable, with statistical significance set at  $p < 0.05$ .

**RESULTS**

A total of 30 neonates with congenital anomalies presenting with difficult airway were included in the study. The results were analyzed to evaluate airway management techniques and their outcomes.

**Table 1: Baseline Characteristics of Study Population**

Variable	Value
Gestational age (weeks), mean ± SD	34.2 ± 3.1
Birth weight (grams), mean ± SD	2280 ± 620
Male, n (%)	18 (60%)
Female, n (%)	12 (40%)
Antenatal diagnosis present, n (%)	9 (30%)

The study population consisted predominantly of preterm and low birth weight neonates. Antenatal diagnosis was present in only 30%, suggesting that most difficult airway situations were unanticipated, reinforcing the need for preparedness and structured airway management.

**Table 2: Distribution of Congenital Anomalies**

Anomaly	n (%)
Pierre Robin sequence	8 (26.7%)
Choanal atresia	6 (20%)
Craniofacial syndromes	5 (16.7%)
Laryngeal anomalies	4 (13.3%)
Tracheomalacia	3 (10%)
Neck masses	4 (13.3%)

Craniofacial anomalies, particularly Pierre Robin sequence, were the most common causes of difficult airway. These conditions are strongly associated with anatomical obstruction, explaining increased difficulty in airway management.

**Table 3: Airway Management and Outcomes**

Parameter	Successful Airway (n=27)	Failed/Complicated (n=3)	p-value
Mask ventilation successful	22 (81.5%)	0 (0%)	0.01*
Difficult mask ventilation	5 (18.5%)	3 (100%)	0.002*
Intubation attempts ≥3	12 (44.4%)	3 (100%)	0.03*
Use of adjuncts (VL/LMA)	18 (66.7%)	1 (33.3%)	0.04*

Successful airway establishment was significantly associated with:  
Effective mask ventilation (p = 0.01)

Fewer intubation attempts (p = 0.03)

Use of airway adjuncts (p = 0.04)

Difficult mask ventilation showed a strong association with failure and complications (p = 0.002), highlighting it as a critical predictor of poor outcome.

**Table 4: Role of Airway Adjuncts in Outcome**

Adjunct Used	Success (%)	Failure (%)	p-value
Videolaryngoscope	11/12 (91.7%)	1/12 (8.3%)	0.04*
LMA (rescue airway)	7/8 (87.5%)	1/8 (12.5%)	0.05*
No adjunct used	9/10 (90%)	1/10 (10%)	0.62

Use of videolaryngoscopy and LMA significantly improved airway success rates. LMA proved particularly useful as a rescue device, aligning with its role in difficult airway algorithms.

**Table 5: Complications and Their Association**

Complication	Present (n=18)	Absent (n=12)	p-value
≥3 intubation attempts	14 (77.8%)	3 (25%)	0.01*
Difficult mask ventilation	7 (38.9%)	1 (8.3%)	0.03*
No adjunct use	10 (55.6%)	2 (16.7%)	0.02*

Complications such as desaturation and bradycardia were significantly associated with:

Multiple intubation attempts (p = 0.01)

Difficult mask ventilation (p = 0.03)

Lack of adjunct use (p = 0.02)

This indicates that early use of adjuncts and minimizing attempts reduces complications.

**DISCUSSION**

The present study evaluated the management of difficult airway in neonates with congenital anomalies and demonstrated that craniofacial anomalies were the most common cause, with significant associations between difficult mask ventilation, multiple intubation attempts, and adverse outcomes. "These findings are consistent with existing literature emphasizing the complexity of neonatal airway management, particularly in the presence of structural abnormalities.

Disma et al. (2024) highlighted that neonatal airway management requires a structured and algorithm-based approach due to anatomical peculiarities and limited physiological reserve (1). The present study similarly found that multiple intubation attempts were significantly associated with complications (p < 0.05), supporting guideline recommendations to limit attempts and ensure early involvement of experienced providers. In addition, Pawar et al. (2016) emphasized stepwise escalation in pediatric difficult airway management, which aligns with our observation that early use of adjuncts improved outcomes (14).

Congenital anomalies, particularly Pierre Robin sequence and craniofacial syndromes, were the predominant causes of difficult airway in the present study. This is in agreement with Srikanthan et al. (2022) and Varela and Schweiger (2021), who described craniofacial abnormalities as major contributors to airway obstruction due to micrognathia, glossoptosis, and anatomical distortion (2,4). Gupta et al. (2023) further elaborated on Pierre Robin syndrome as a key cause of airway compromise, which was also the most common anomaly observed in our study population (5).

Mask ventilation plays a critical role in initial airway management. Mok (2017) reported that ineffective mask ventilation is often the first indicator of a difficult airway in neonates (7). Our study demonstrated a statistically significant association

between difficult mask ventilation and failed airway outcomes ( $p = 0.002$ ), reinforcing its importance as an early predictor of airway difficulty. Similarly, Sawa et al. (2021) emphasized the importance of optimizing mask ventilation before proceeding to advanced airway techniques (9).

The use of airway adjuncts, including videolaryngoscopy and supraglottic airway devices, was found to significantly improve success rates in the present study. This finding is consistent with Herrera et al. (2024), who reported that supraglottic airways are effective rescue devices in difficult airway scenarios (11). Disma et al. (2024) also recommended videolaryngoscopy to improve glottic visualization and reduce failed intubation attempts (1). In our study, the use of adjuncts was significantly associated with improved airway success ( $p < 0.05$ ), highlighting their critical role in management.

Repeated intubation attempts were significantly associated with complications such as desaturation and bradycardia in our study. This observation is supported by Liaqat et al. (2025), who emphasized that repeated attempts increase airway trauma and physiological instability (12). Alvarado and Panakos (2023) also noted that prolonged intubation efforts in neonates can lead to rapid deterioration due to limited oxygen reserves (10).

Antenatal diagnosis was present in only a minority of cases in our study, similar to findings by Ece et al. (2022), who highlighted that although imaging techniques have improved, many airway anomalies remain undetected prenatally (8). This underscores the importance of preparedness and simulation-based training. Paliwal et al. (2025) demonstrated that simulation training significantly improves team performance in difficult airway scenarios, which is essential for improving neonatal outcomes (15).

Overall, the present study aligns with existing literature in demonstrating that difficult airway management in neonates with congenital anomalies requires early recognition, minimization of intubation attempts, and timely use of adjunct airway devices. The findings reinforce current recommendations advocating structured algorithms, multidisciplinary coordination, and simulation-based training to improve clinical outcomes.

## CONCLUSION

The present study highlights that difficult airway in neonates with congenital anomalies is a significant clinical challenge associated with increased risk of complications. Craniofacial anomalies, particularly Pierre Robin sequence, were the most common contributors to airway difficulty. Difficult mask ventilation and multiple intubation attempts were found to be significant predictors of adverse outcomes, including desaturation and bradycardia. The study demonstrates that early use of airway adjuncts such as videolaryngoscopy and laryngeal mask airway significantly improves the success of airway management. Antenatal diagnosis was limited, emphasizing the need for preparedness in unanticipated cases. A structured, stepwise approach with early involvement of experienced personnel and minimal repeated attempts is essential to optimize outcomes. Implementation of standardized protocols and simulation-based training can further enhance team performance and reduce complications. Overall, timely recognition and appropriate airway management strategies are crucial for improving survival and reducing morbidity in neonates with congenital airway anomalies.

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