



Original Article

## Adverse Events Associated with Multiple Laryngoscopy Attempts in Children Undergoing Elective Surgery: A Prospective Observational Study

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Received: 10-06-2026

Accepted: 30-06-2026

Available online: 17-07-2026

### ABSTRACT

**Background:** Children possess unique anatomical and physiological airway characteristics that predispose them to rapid oxygen desaturation and cardiovascular instability during airway manipulation. Although several studies have investigated predictors of difficult laryngoscopy and intubation, considerably less attention has been directed toward the adverse events associated with repeated laryngoscopy during elective paediatric anaesthesia. Understanding these complications is essential for improving airway safety and optimizing perioperative management.

**Objective:** To evaluate the incidence, pattern, and severity of adverse events associated with multiple laryngoscopy attempts in children undergoing elective surgery under general anaesthesia.

**Materials and Methods:** A prospective observational study was conducted in a tertiary-care teaching hospital over an 18-month period after Institutional Ethics Committee approval and registration with the Clinical Trials Registry of India. A total of 538 children aged 0–12 years undergoing elective surgery requiring direct laryngoscopy and endotracheal intubation under general anaesthesia were enrolled. Children requiring more than one laryngoscopy attempt constituted the study population for adverse-event analysis. Adverse events including desaturation, tachycardia, bradycardia, laryngospasm, regurgitation, and other airway-related complications were prospectively recorded.

**Results:** Among 538 enrolled children, 122 (22.7%) required multiple laryngoscopy attempts. Most children (77.0%) were successfully managed within two attempts, whereas only 3.2% required four or more attempts. Fifty-eight adverse events were documented in 51 children. Desaturation was the commonest complication (22 events), followed by tachycardia (20 events) and bradycardia (14 events, including two requiring atropine). Laryngospasm occurred in three children and regurgitation in one child. No surgery was abandoned because of airway-related complications. Most adverse events were transient and resolved with prompt airway management.

**Conclusion:** Repeated laryngoscopy during paediatric anaesthetic induction is associated predominantly with transient cardiorespiratory adverse events, particularly desaturation and haemodynamic disturbances. Strategies aimed at maximizing first-pass success and minimizing repeated airway manipulation may substantially improve perioperative airway safety in children.

**Keywords:** Paediatric airway, Laryngoscopy, Adverse events, Endotracheal intubation, Desaturation.

## INTRODUCTION

Safe airway management remains the cornerstone of paediatric anaesthesia. Although direct laryngoscopy and endotracheal intubation are routinely performed during elective surgery, children continue to represent one of the most challenging patient populations because of their distinctive airway anatomy and respiratory physiology. Compared with adults, children possess a relatively larger tongue, cephalad and anterior larynx, narrower subglottic airway, increased oxygen consumption, and lower functional residual capacity, all of which contribute to rapid oxygen desaturation during periods of apnoea. These physiological characteristics considerably reduce the margin of safety available during airway manipulation and increase the likelihood of perioperative adverse events.(1-4)

Repeated laryngoscopy further compounds these physiological challenges. Each additional attempt prolongs interruption of effective ventilation, increases airway trauma, and augments sympathetic and parasympathetic responses. Consequently, multiple laryngoscopy attempts have been associated with desaturation, bradycardia, tachycardia, laryngospasm, airway oedema, mucosal trauma, aspiration, and, in severe circumstances, cardiovascular collapse.(5-10) The probability of these complications rises progressively with each additional airway attempt, making first-pass success an important quality indicator in paediatric airway management.

Most published literature evaluating repeated laryngoscopy originates from emergency departments, neonatal intensive care units, and paediatric intensive care units, where airway interventions are frequently performed in critically ill children with compromised physiology.(11-14) Consequently, the incidence and spectrum of adverse events reported in these settings may not accurately reflect those encountered during elective anaesthesia in the operating theatre. Data specifically evaluating airway complications during routine elective paediatric surgery remain limited, particularly from developing countries.

Previous investigations have primarily focused on predictors of difficult intubation and factors influencing first-pass success. Comparatively fewer studies have specifically evaluated the clinical consequences of repeated laryngoscopy once multiple attempts become necessary.(2,6,10,14) Identification of the adverse events associated with repeated airway instrumentation is clinically important because many of these complications are potentially preventable through improved preparation, optimized airway techniques, and timely involvement of experienced anaesthesiologists.

The present prospective observational study was therefore undertaken to evaluate the spectrum, frequency, and severity of adverse events associated with multiple laryngoscopy attempts in children undergoing elective surgery under general anaesthesia. By characterizing these complications in a controlled operating-room environment, the study aims to provide clinically relevant information that may help improve airway management strategies and enhance perioperative patient safety.

## OBJECTIVE

### Primary Objective

- To evaluate the incidence and pattern of adverse events associated with multiple laryngoscopy attempts in children undergoing elective surgery requiring endotracheal intubation under general anaesthesia.

### Secondary Objectives

- To determine the distribution of adverse events according to the number of laryngoscopy attempts.
- To classify adverse events based on physiological system involvement and clinical severity.
- To identify clinically important airway-related complications associated with repeated laryngoscopy during elective paediatric anaesthesia.

## MATERIALS AND METHODS

**Study Design:** This prospective observational study was conducted over an 18-month period (December 2020 to June 2022) in the Department of Anaesthesiology, Sanjay Gandhi Postgraduate Institute of Medical Sciences (SGPGIMS), Lucknow, after obtaining approval from the Institutional Ethics Committee (IEC No. 2021-59-MED-EXP-36) and registration with the Clinical Trials Registry of India (CTRI/2022/07/044310). Written informed consent was obtained from parents or legal guardians before enrolment.

**Study Population:** Children aged 0–12 years of either sex, belonging to American Society of Anesthesiologists (ASA) physical status I or II and scheduled for elective surgery requiring endotracheal intubation by direct laryngoscopy were included. Children planned for videolaryngoscopy or fibre-optic intubation, emergency procedures, surgeries under regional anaesthesia or supraglottic airway devices, and ASA III–IV patients were excluded.

**Anaesthetic Technique:** Standard ASA monitoring comprising electrocardiography, non-invasive blood pressure, pulse oximetry, and temperature monitoring was instituted. Anaesthetic induction, choice of induction agents, neuromuscular blockade, and airway management were performed according to departmental protocols and at the discretion of the

attending consultant anaesthesiologist. Direct laryngoscopy was performed using Macintosh or Miller blades by junior residents, senior residents, or faculty members.

**Definitions:** One laryngoscopy attempt was defined as insertion of the laryngoscope blade into the oral cavity until its complete removal. Multiple laryngoscopy referred to more than one laryngoscopy attempt performed during airway management, irrespective of whether repeat attempts were required for successful intubation, endotracheal tube exchange, or other airway-related procedures.

**Outcome Measures:** The primary outcome was the occurrence of adverse events associated with multiple laryngoscopy. Adverse events recorded included desaturation, tachycardia, bradycardia, laryngospasm, regurgitation, and the requirement for pharmacological intervention or abandonment of surgery.

**Statistical Analysis:** Continuous variables were expressed as mean  $\pm$  standard deviation or median with interquartile range, while categorical variables were presented as frequencies and percentages. Pearson's chi-square test and Mann–Whitney U test were used where appropriate. A p-value of  $<0.05$  was considered statistically significant.

## RESULTS

A total of 538 children undergoing elective surgery under general anaesthesia requiring endotracheal intubation were enrolled in the study. Among these, 122 children (22.7%) required multiple laryngoscopy attempts and constituted the study cohort for the present secondary analysis of adverse events. The remaining 416 children underwent successful airway management with a single laryngoscopy attempt.

The number of laryngoscopy attempts among the 122 children ranged from two to five. Most children were successfully managed within two attempts, while only a small proportion required four or more attempts. As the number of attempts increased, airway manipulation also increased, predisposing patients to physiological disturbances and airway-related complications.

Among children requiring repeat laryngoscopy, 94 (77.0%) were successfully managed during the second attempt. A further 24 children (19.8%) required three attempts, whereas only four children (3.2%) required four or more attempts. These findings indicate that although repeated laryngoscopy occurred in nearly one-quarter of the study population, prolonged airway instrumentation beyond three attempts was uncommon.

Among the 122 children who underwent multiple laryngoscopy attempts, 51 children experienced one or more adverse events, accounting for 58 individual adverse events. Most complications were transient and predominantly involved the cardiorespiratory system.

**Table 1. Distribution of Children According to Number of Laryngoscopy Attempts (n = 122)**

| Number of Attempts | Number of Children | Percentage (%) |
|--------------------|--------------------|----------------|
| 2 Attempts         | 94                 | 77.0%          |
| 3 Attempts         | 24                 | 19.8%          |
| 4 Attempts         | 2                  | 1.6%           |
| 5 Attempts         | 2                  | 1.6%           |
| <b>Total</b>       | <b>122</b>         | <b>100.0%</b>  |

**Table 2. Spectrum of Adverse Events Associated with Multiple Laryngoscopy Attempts**

| Adverse Event                                      | Frequency |
|----------------------------------------------------|-----------|
| Desaturation                                       | 22        |
| Tachycardia                                        | 20        |
| Bradycardia (resolved after laryngoscope removal)  | 12        |
| Laryngospasm                                       | 3         |
| Regurgitation                                      | 1         |
| Surgery abandoned because of serious adverse event | 0         |
| <b>Total adverse events</b>                        | <b>58</b> |

**Table 3. Distribution of Adverse Events According to Physiological System**

| Physiological System                       | Number of Events | Percentage (%) |
|--------------------------------------------|------------------|----------------|
| Cardiovascular (tachycardia + bradycardia) | 32               | 55.2%          |
| Respiratory (desaturation + laryngospasm)  | 25               | 43.1%          |
| Gastrointestinal (regurgitation)           | 1                | 1.7%           |
| <b>Total</b>                               | <b>58</b>        | <b>100.0%</b>  |

**Table 4. Clinical Severity of Adverse Events**

| Severity                                                                    | Number of Events |
|-----------------------------------------------------------------------------|------------------|
| Mild/transient (resolved spontaneously or after withdrawal of laryngoscope) | 54               |
| Required active intervention                                                | 4                |
| Serious adverse event requiring abandonment of surgery                      | 0                |
| <b>Total</b>                                                                | <b>58</b>        |

Desaturation was the most frequently observed complication, occurring in 22 children, followed closely by tachycardia in 20 children. Bradycardia occurred in 12 children, although only two required atropine administration. Laryngospasm and regurgitation were uncommon, and importantly no patient developed a life-threatening airway complication necessitating abandonment of surgery.

Cardiovascular disturbances represented the largest category of complications, accounting for 58.6% of all adverse events, followed by respiratory complications (43.1%). This finding demonstrates that repeated laryngoscopy not only compromises oxygenation but also produces significant autonomic cardiovascular responses during airway manipulation. The majority of adverse events were transient and resolved promptly following termination of laryngoscopy or routine airway management. Only four events required active intervention, including atropine administration for persistent bradycardia and treatment of laryngospasm. No child experienced permanent morbidity or mortality, and no operative procedure was abandoned because of airway-related complications.

The present analysis demonstrates that multiple laryngoscopy attempts during elective paediatric anaesthesia were associated with clinically significant, predominantly cardiorespiratory adverse events. Although most complications were transient, desaturation emerged as the commonest event, followed by tachycardia and bradycardia. Nearly four-fifths of children requiring repeated laryngoscopy were successfully managed within two attempts, while severe complications remained uncommon in the controlled operating-room environment. These findings emphasize the importance of minimizing repeated airway instrumentation and achieving first-pass success whenever possible.

## DISCUSSION

The present prospective observational study evaluated the adverse events associated with multiple laryngoscopy attempts in children undergoing elective surgery under general anaesthesia. Unlike the previously published analysis from the same thesis, which primarily examined the incidence of multiple laryngoscopy and the factors responsible for repeated attempts, the current study specifically focuses on the clinical consequences of repeated airway instrumentation.<sup>(15)</sup> Among 538 enrolled children, 122 (22.7%) required multiple laryngoscopy attempts and 51 of these children experienced one or more adverse events, emphasizing that repeated airway manipulation is associated with clinically relevant morbidity even in controlled operating-room settings.

One of the most important observations in the present study was that desaturation constituted the commonest adverse event. Children have unique airway anatomy and respiratory physiology characterized by a relatively narrow airway, high oxygen consumption, low functional residual capacity, increased chest wall compliance, and immature respiratory control. These physiological characteristics provide only a limited oxygen reserve during apnoea. Consequently, interruption of ventilation during repeated laryngoscopy rapidly results in oxygen desaturation, especially in infants and younger children. Harless et al. and Heinrich et al. have highlighted that even minor prolongation of airway instrumentation may significantly reduce oxygen saturation in paediatric patients because of their limited physiological reserve.<sup>(1,2)</sup>

The predominance of desaturation observed in the present study is consistent with previous international literature. Lee et al., in a multicentre prospective study involving critically ill children, demonstrated that the frequency of oxygen desaturation increased progressively with increasing numbers of tracheal intubation attempts.<sup>(14)</sup> Likewise, Gálvez et al. reported that infants undergoing repeated laryngoscopy during anaesthetic induction experienced significantly more episodes of hypoxaemia and bradycardia than those successfully managed during the initial attempt.<sup>(16)</sup> These observations reinforce the importance of limiting airway instrumentation and maximizing first-pass success during paediatric airway management.

Tachycardia represented the second most frequent adverse event in our cohort. Direct laryngoscopy stimulates sympathetic afferent pathways within the upper airway, producing catecholamine release and transient increases in heart rate and blood pressure. King et al. first demonstrated these haemodynamic responses more than seven decades ago, and subsequent studies have consistently confirmed that repeated laryngoscopy magnifies sympathetic stimulation.<sup>(17)</sup> Although transient tachycardia rarely produces lasting sequelae in otherwise healthy children, it may increase myocardial oxygen demand and become clinically relevant in patients with congenital heart disease or impaired cardiovascular reserve.

Bradycardia was another important adverse event identified during the study. Most episodes resolved immediately after removal of the laryngoscope blade, whereas only two children required atropine administration. The tendency of paediatric patients to develop vagally mediated bradycardia is well recognized and results from parasympathetic predominance during infancy and early childhood. Coté et al. have described that hypoxaemia, laryngeal stimulation, prolonged airway manipulation, and inadequate anaesthetic depth all contribute to reflex bradycardia during airway management.(18) Early recognition of falling oxygen saturation and timely discontinuation of laryngoscopy probably prevented progression to more severe cardiovascular compromise in the majority of children included in the present study.

Laryngospasm was observed in only three children. Although infrequent, laryngospasm remains one of the most feared complications of paediatric airway management because complete glottic closure can rapidly result in severe hypoxaemia if not promptly treated. Olsson and Hallen demonstrated that repeated airway instrumentation is an important precipitating factor for laryngospasm during anaesthesia.(19) The low incidence observed in our study probably reflects the controlled elective operating-room environment, adequate depth of anaesthesia, and prompt intervention by trained anaesthesiologists. Importantly, no procedure was abandoned because of airway-related complications. This finding contrasts with studies performed in emergency departments and paediatric intensive care units where critically ill children frequently present with compromised physiology before airway intervention. Hasegawa et al. reported substantially higher adverse-event rates among patients requiring repeated intubation attempts in emergency settings, while Nishisaki et al. similarly observed greater airway-related morbidity in paediatric intensive care units.(9,11) The relatively favourable outcomes in our study may therefore be explained by elective case selection, comprehensive preoperative optimization, standard monitoring, controlled anaesthetic induction, and immediate availability of experienced airway personnel.

Although most children requiring repeat laryngoscopy were successfully managed within two attempts, our findings support current difficult-airway recommendations that repeated direct laryngoscopy should be minimized. Every additional attempt increases cumulative airway trauma, prolongs apnoea, and exposes the child to further physiological stress. The American Society of Anesthesiologists Difficult Airway Guidelines recommend early reassessment of airway strategy after unsuccessful initial attempts and timely use of alternative airway devices or more experienced personnel rather than persisting with repeated direct laryngoscopy.(20)

The clinical implications of the present study are therefore considerable. Careful preoperative airway assessment, meticulous preparation of equipment, optimal patient positioning, adequate preoxygenation, appropriate anaesthetic depth, and selection of the correct endotracheal tube before laryngoscopy may substantially reduce the need for repeated airway instrumentation. Simulation-based airway training, structured difficult-airway algorithms, and quality-improvement bundles have also been shown to improve first-pass success and reduce airway-related complications in paediatric practice.(20-22)

The major strength of the present study lies in its prospective design and evaluation of airway complications in children undergoing routine elective surgery rather than emergency airway management. The standardized data collection and inclusion of all clinically relevant adverse events provide valuable insight into the safety profile of repeated laryngoscopy in everyday paediatric anaesthetic practice. Furthermore, by specifically focusing on adverse events rather than predictors of repeated laryngoscopy, this study specifically evaluates adverse events associated with repeated laryngoscopy, an aspect that has received comparatively less attention in previous literature.

Certain limitations should nevertheless be acknowledged. The study was conducted at a single tertiary-care teaching institution, which may limit generalizability. Adverse events were recorded by the attending anaesthesiologist, introducing the possibility of observer bias. In addition, although the study demonstrates an association between repeated laryngoscopy and adverse events, causal inference cannot be established because of its observational design. Future multicentre studies involving larger populations and standardized reporting of airway-related complications would further strengthen the evidence base.

Overall, the present findings demonstrate that repeated laryngoscopy during elective paediatric anaesthesia is associated predominantly with transient cardiorespiratory complications. While severe morbidity was uncommon, the occurrence of desaturation, tachycardia, and bradycardia highlights the importance of optimizing first-pass success and minimizing unnecessary airway manipulation.

## CONCLUSION

Multiple laryngoscopy attempts during paediatric elective anaesthesia are associated with clinically important adverse events, predominantly involving the cardiorespiratory system. Desaturation was the commonest complication, followed by tachycardia and bradycardia. Although most events were transient and resolved with timely intervention, repeated airway instrumentation increased physiological stress and the potential for airway-related morbidity. Emphasis on meticulous airway preparation, adequate preoxygenation, appropriate equipment selection, and early involvement of experienced airway providers may improve first-pass success and enhance perioperative safety in children.

## ACKNOWLEDGEMENT

The authors sincerely acknowledge the Department of Anaesthesiology, Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, for providing the facilities necessary to conduct this study. The authors are grateful to all participating children and their parents for their cooperation throughout the study. The authors acknowledge the contribution of the faculty members, residents, and operating theatre staff involved in perioperative patient care. The authors also acknowledge Dr. Shailendra Vashistha (Assistant Professor, Transplant Immunology HLA Lab, Dept of IHTM, GMC, Kota) and the VAssist Research team ([www.thevassist.com](http://www.thevassist.com)) for their contribution in manuscript preparation and submission process.

**CONFLICT OF INTEREST:** None

**SOURCE OF FUNDING:** Nil

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