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Difficult Tracheal Intubation in Adult Patients Undergoing Head and Neck Surgery: Predictive Factors and Airway Management in a Resource-Limited Setting

[1] Randrianirina Hery Henintsoa, [2] Fidison Franklino, [3] Rosi Imelda, [4] Hanitriniaina Milcka Wendy, [5] Rasamimanana Naharisoa Giannie, [6] Randrianandraina Maholisoa Patrick

[1, 2, 4] Surgical Intensive Care Unit, UH PZAGA, Faculty of Medicine, University of Mahajanga, Madagascar
[3, 5] Emergency Department, UH PZAGA, Faculty of Medicine, University of Mahajanga, Madagascar
[6] ENT Department, UH PZAGA, Faculty of Medicine, University of Toamasina, Madagascar

Corresponding Author: **Randrianirina Hery Henintsoa**

Abstract

Background: Difficult tracheal intubation remains a major challenge in anesthesia because of the risk of hypoxemia, airway trauma, and failure to secure the airway. These challenges are particularly pronounced during head and neck surgery and in resource-limited settings where advanced airway devices are often unavailable. This study aimed to determine the frequency of difficult tracheal intubation, identify its main predictive factors, and describe its management among adults undergoing head and neck surgery in a resource-limited university hospital.

Methods: A prospective, observational, descriptive study was conducted over a 30-month period (January 2017 to June 2020) at the University Hospital Centre Professor Zafisaona Gabriel, Mahajanga, Madagascar. Adult patients undergoing ENT or maxillofacial surgery under general anesthesia with tracheal intubation were included. Preoperative predictors of difficult intubation were systematically assessed. Airway management strategies and clinical outcomes were recorded.

Results: Among 178 included patients, difficult tracheal intubation was predicted in 73 (41.0%) and confirmed in 29 (39.7%) of these patients. Restricted mouth opening was the most frequent predictive factor (42.4%), followed by Mallampati class III–IV (32.8%). Maxillofacial surgery accounted for 67.1% of predicted difficult intubations. The mean number of intubation attempts was 4.2 ± 1.3, and the mean intubation time was 6.0 minutes. The Eschmann tracheal introducer was the most commonly used adjunct (55.2%). Impossible intubation occurred in four patients (13.8%); two required tracheostomy, whereas two were successfully managed by maintaining oxygenation until awakening. Rescue airway management included blind nasotracheal intubation, two-handed face-mask ventilation, and laryngeal mask airway insertion.

Conclusion: Difficult tracheal intubation is common during adult head and neck surgery in our setting. Careful preoperative airway assessment and the rational use of available airway adjuncts remain essential to optimize airway management where advanced airway equipment is unavailable. Improving provider training and expanding access to dedicated airway devices may further enhance patient safety.

Keywords: Difficult Tracheal Intubation, Airway Management, Head and Neck Surgery, Predictive Factors, Resource-Limited Setting, Adult

Introduction

Airway management is a cornerstone of patient safety in anesthesia. Difficult tracheal intubation remains a major concern because of the risk of airway trauma, hypoxemia, and failure to secure adequate oxygenation, all of which may lead to life-threatening complications [1]. Preoperative airway assessment helps identify patients at risk using several clinical predictors. However, no single predictor has sufficient accuracy to reliably identify all cases of difficult intubation [2]. Furthermore, otorhinolaryngological (ENT) and maxillofacial surgeries are particularly associated with difficult airway management due to anatomical abnormalities involving the upper airway. In low-resource settings, airway management is further complicated by the limited availability of recommended advanced airway devices such as videolaryngoscopes and flexible fiberoptic

bronchoscopes [3]. The aim of this study was to determine the frequency of difficult tracheal intubation among patients undergoing ENT and maxillofacial surgery at the University Hospital Centre Professor Zafisaona Gabriel (CHU PZaGa), Mahajanga, Madagascar, to identify its main predictive factors, and to describe its management in a resource-limited setting.

Methods

Study Design and Setting

This prospective, observational, descriptive study was conducted in the operating theatre of the Department of Anesthesiology and Critical Care at the University Hospital Centre Professor Zafisaona Gabriel (CHU PZaGa), Mahajanga, Madagascar, over a 30-month period from January 2017 to June 2020.

Study Population

All adult patients scheduled for elective or emergency otorhinolaryngological (ENT) or maxillofacial surgery requiring general anesthesia with tracheal intubation were eligible for inclusion. Patients who declined to participate were excluded.

Preoperative Airway Assessment

All patients underwent a standardized pre-anesthetic evaluation including a systematic airway assessment.

The following predictors of difficult tracheal intubation were assessed:

- Mallampati class III or IV;
- mouth opening <3 cm;
- thyromental distance <6 cm;
- limited cervical spine mobility;
- retrognathia;
- macroglossia;
- body mass index (BMI) >35 kg/m².

Definition of Difficult Intubation

Difficult tracheal intubation was defined as an intubation requiring more than two laryngoscopic attempts and/or the use of an intubation aid (Eschmann tracheal introducer, tube introducer, or Magill forceps) or an alternative airway technique to achieve successful tracheal intubation.

Impossible intubation was defined as failure to achieve tracheal intubation despite all available airway management techniques.

Anesthetic Management

All patients were monitored according to international standards, including continuous electrocardiography, non-invasive blood pressure monitoring, and pulse oximetry.

The choice of anesthetic induction agents was left to the discretion of the attending anesthesiologist.

Direct laryngoscopy was performed using a conventional Macintosh metal blade.

In cases of difficult intubation, airway management strategies were selected according to the clinical situation and the equipment available. Because neither a videolaryngoscope nor a flexible fiberoptic bronchoscope was available in our department during the study period, the following techniques were used when indicated:

- Eschmann tracheal introducer (gum elastic bougie);
- tube introducer;
- Magill forceps;
- blind nasotracheal intubation;
- two-handed face-mask ventilation;
- supraglottic airway (laryngeal mask airway);
- tracheostomy when airway control could not be achieved using conventional techniques.

Each intubation attempt was limited to approximately 45 seconds, followed by reoxygenation before any subsequent attempt.

Study Variables

The following variables were collected:

- demographic characteristics;
- predictors of difficult intubation;
- type of surgery;
- frequency of predicted and confirmed difficult intubation;
- number of intubation attempts;
- duration of intubation;
- airway devices used;
- alternative ventilation techniques;
- need for tracheostomy.

Statistical Analysis

Data were entered and analyzed using SPSS software version 25.0.

Categorical variables were expressed as frequencies and percentages, whereas continuous variables were reported as mean ± standard deviation or median (range), depending on their distribution.

Results are presented in tables.

Results

Table 1: Predictors of difficult tracheal intubation (n = 73)

	Number (n)	Percentage (%)
Clinical Predictors		
Mallampati class III or IV	24	32.8
Mouth opening <3 cm	31	42.4
Thyromental distance <6 cm	8	10.9
Limited cervical mobility	4	5.5
Anatomical Predictors		
Body mass index >35 kg/m²	13	17.8
Macroglossia	3	4.1
Retrognathia	2	2.7

Note: Individual patients could present more than one predictor of difficult tracheal intubation; therefore, percentages do not total 100%.

During the study period, 178 patients were included. Difficult tracheal intubation (DTI) was predicted in 73 patients (41.0%). Limited mouth opening was the most common predictive factor, identified in 31 patients (42.4%), followed by a Mallampati class III or IV in 24 patients (32.8%). A body mass index (BMI) >35 kg/m² was observed in 13 patients (17.8%), whereas a thyromental distance <6 cm was found in 8 patients (10.9%). The remaining predictive factors were less frequently encountered (Table 1). Several patients presented more than one predictor of difficult tracheal intubation. Maxillofacial surgery accounted for 67.1% (n = 49) of procedures performed in patients with predicted difficult intubation. Among the 73 patients in whom difficult intubation was anticipated, the diagnosis was confirmed during anesthesia in 29 patients (39.7%). Impossible intubation occurred in 4 patients,

representing 13.8% of confirmed difficult intubations. All patients underwent direct laryngoscopy using a conventional metal blade. The number of intubation attempts ranged from 3 to 7, with a mean of 4.2 ± 1.3 attempts. Three attempts were required in 13 patients (44.8%), four attempts in 5 patients (17.2%), five attempts in 6 patients (20.7%), whereas 5 patients (17.2%) required six or more attempts.

Table 2: Devices used for difficult airway management (n = 29)

	Number (n)	Percentage (%)
Conventional metal blade	29	100.0
Eschmann tracheal introducer (gum elastic bougie)	16	55.2
Tube introducer	13	44.8
Magill forceps	7	24.1

Note: More than one device could be used in the same patient.

The intubation time ranged from 2 to 17 minutes, with a mean duration of 6.0 minutes. Each intubation attempt was limited to a maximum of 45 seconds. Successful intubation was achieved within 2–5 minutes in 14 patients (48.3%), within 5–10 minutes in 13 patients (44.8%), and required more than 10 minutes in 2 patients (6.9%). Among the adjuncts used for difficult airway management, the Eschmann tracheal introducer (gum elastic bougie) was the most frequently used device (16 patients; 55.2%), followed by the tube introducer **(**13 patients; 44.8%) and Magill forceps (7 patients; 24.1%). A tracheostomy was required in 2 patients (6.9%) (Table 2).

Regarding airway management strategies, blind nasotracheal intubation was performed as the first-line technique in 9 patients (31.0%) when direct laryngoscopy was not feasible. Among the four cases of impossible intubation, one patient underwent emergency intraoperative tracheostomy after repeated unsuccessful intubation attempts, whereas another underwent primary tracheostomy. In the remaining two patients, the procedure was postponed and anesthesia was discontinued to allow the patients to awaken.

Table 3: Alternative airway management techniques used (n = 29)

	Number (n)	Percentage (%)
Blind nasotracheal intubation	9	31.0
Two-handed face-mask ventilation	8	27.6
Laryngeal mask airway	4	13.8
Tracheostomy	2	6.9

Note: More than one rescue technique could be used sequentially in the same patient.

In cases of difficult face-mask ventilation, several rescue techniques were used to maintain oxygenation. Two-handed face-mask ventilation was performed in 8 patients (27.6%)**,** whereas a laryngeal mask airway provided effective ventilation in 4 patients (13.8%)**,** pending either tracheostomy or awakening of the patient (Table 3).

Discussion

Difficult tracheal intubation remains a major challenge in anesthesiology and critical care because of the risk of failed oxygenation, hypoxemia, and airway-related adverse events, all of which may result in significant morbidity and mortality. Anticipation and appropriate preparation rely on thorough preoperative airway assessment, the availability of suitable airway devices, and the application of airway management algorithms tailored to the clinical context [4, 5].

Conducted in a university hospital with limited resources, the present study aimed to evaluate the frequency of difficult tracheal intubation in patients undergoing ENT and maxillofacial surgery and to describe its management. In our series of 178 patients, difficult tracheal intubation was predicted in 41.0% of cases and confirmed in 29 patients, corresponding to 39.7% of anticipated difficult intubations. This relatively high frequency is likely explained by the surgical profile of our study population, which mainly consisted of patients undergoing ENT and maxillofacial procedures, conditions frequently associated with altered upper airway anatomy [6]. ENT and maxillofacial surgeries are well recognized as high-risk procedures for difficult tracheal intubation because of anatomical changes related to tumors, trauma, infection, or restricted mouth opening [6, 7].

The preoperative predictors assessed in our study included the Mallampati classification, mouth opening, thyromental distance, cervical spine mobility, and selected anatomical characteristics. Limited mouth opening was the most frequently identified predictor (42.4%), followed by Mallampati class III or IV (32.8%). These findings are consistent with previous reports identifying restricted mouth opening, reduced thyromental distance, and a high Mallampati score as important predictors of difficult tracheal intubation [8, 9]. Nevertheless, no single bedside test is sufficiently accurate to reliably predict a difficult airway. Several studies have demonstrated that combining multiple predictors improves diagnostic performance, although sensitivity and specificity remain variable across different populations [10]. Maxillofacial surgery accounted for 67.1% of patients with predicted difficult intubation in our study. This predominance is expected, as these procedures are frequently associated with restricted mouth opening, facial deformities, or distortion of the oral, pharyngeal, and laryngeal axes. Similarly, studies focusing on difficult airway management in ENT surgery have identified cervicofacial anatomical abnormalities as major determinants of poor glottic exposure and difficult tracheal tube advancement [6, 11].

Management of difficult intubation in our series was characterized by a relatively high number of attempts, with a mean of 4.2 ± 1.3 attempts (range, 3–7). This exceeds current recommendations, which advocate limiting repeated laryngoscopic attempts to reduce the risks of airway trauma, laryngeal edema, and hypoxemia. The Difficult Airway Society, the American Society of Anesthesiologists, and the Canadian Airway Focus Group all recommend limiting the number of attempts and promptly modifying the airway strategy following failed intubation [4, 5, 12]. In our setting, the high number of attempts may be explained by the anatomical complexity of the patients, the limited availability of advanced airway devices, and the emergency nature of some procedures, which did not always allow awakening of the patient before securing the airway. The mean intubation time in our study was 6 minutes (range, 2–17 minutes), which is considerably longer than that reported for routine tracheal intubation in patients without anticipated airway difficulty. In difficult airway situations, intubation time inevitably increases because of repeated attempts, the use of adjunctive devices, and changes in airway management strategy. Prolonged airway manipulation is a recognized risk factor for hypoxemia, particularly in patients with limited respiratory reserve [13].

The Eschmann tracheal introducer (gum elastic bougie) was

the most frequently used airway adjunct (55.2%). This finding is probably explained by its availability, low cost, and proven effectiveness in situations of limited glottic visualization. Several studies have shown that the bougie significantly improves intubation success when laryngoscopic views are poor, particularly in patients with high Cormack–Lehane grades [14, 15]. In resource-limited settings, the Eschmann introducer therefore represents a valuable airway adjunct because of its affordability and ease of use. Although current international guidelines recommend the early use of videolaryngoscopy or flexible fiberoptic bronchoscopy in selected cases of anticipated difficult intubation, these devices were unavailable in our institution during the study period. Consequently, airway management relied mainly on direct laryngoscopy, the Eschmann introducer, tube introducers, Magill forceps, and surgical rescue techniques. This difference in available equipment should be considered when comparing our findings with those reported from better-equipped institutions. Several publications have highlighted that low- and middle-income countries face similar challenges related to the limited availability of specialized airway equipment, requiring airway management strategies to be adapted to locally available resources [16, 17]. Four patients in our series experienced impossible tracheal intubation. Two required tracheostomy, whereas the remaining two were successfully managed by maintaining adequate ventilation before awakening the patient. The "cannot intubate, cannot oxygenate" scenario remains one of the most feared emergencies in anesthetic practice. The availability of a structured airway algorithm, early implementation of alternative airway strategies, and prioritization of oxygenation are essential to minimize the potentially catastrophic consequences of this situation [4, 5, 18]. Two-handed face-mask ventilation and laryngeal mask airway insertion were successfully used as rescue techniques to maintain oxygenation in our series. Supraglottic airway devices currently play a central role in difficult airway algorithms, serving as effective rescue devices after failed intubation and, in some situations, as conduits for secondary tracheal intubation [19, 20].

Our findings should nevertheless be interpreted in light of several limitations. First, this was a single-center study with a relatively small sample size. Second, the absence of modern airway devices, particularly videolaryngoscopes and flexible fiberoptic bronchoscopes, limits direct comparison with studies conducted in better-equipped centers. Finally, the descriptive design of our study did not allow assessment of the diagnostic performance of the different predictive tests.

Despite these limitations, our study provides original data on the management of difficult tracheal intubation during ENT and maxillofacial surgery in a resource-limited African setting. It highlights the importance of thorough preoperative airway assessment, continuous training of anesthesia providers, and the implementation of airway management strategies adapted to the constraints of low-resource environments [21].

Conclusion

Difficult tracheal intubation remains a major challenge during ENT and maxillofacial surgery, particularly in resource-limited settings. Our study demonstrates that early identification of predictive factors, especially restricted mouth opening, combined with an airway management strategy adapted to the available resources, can improve airway safety. Strengthening the training of anesthesia providers, promoting the implementation of standardized airway algorithms, and progressively improving technical resources particularly through the acquisition of dedicated difficult airway equipment are essential to optimize patient management and reduce airway-related complications.

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