



Clinical Outcomes of Submental Intubation versus Tracheostomy and Nasotracheal Intubation in the Management of Difficult Airways Due to Maxillofacial Trauma

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ABSTRACT

Background: Airway management in panfacial fractures presents a challenge, as standard oral intubation often precludes surgical fixation. This study evaluated and compared the clinical outcomes of three alternative modalities: submental intubation, tracheostomy, and general anesthesia nasotracheal intubation (GANI).

Methods: A prospective cohort study was conducted at Wahidin Sudirohusodo Hospital, Makassar, Indonesia, from August 2024 to January 2025. Forty patients with complex maxillofacial trauma requiring alternative airway management were included. The primary outcomes measured were procedural duration, length of stay (LOS), and complication rates. Statistical analysis was performed using Kruskal-Wallis and Mann-Whitney U tests.

Results: The cohort was predominantly male (62.5%) with a mean age of 24.78 years. Submental intubation was the most utilized technique (57.5%), followed by GANI (30%) and tracheostomy (12.5%). No complications were recorded across groups (0%). There was a significant difference in procedural duration ($p=0.004$); tracheostomy was the fastest (mean 7.00 min), followed by GANI (8.75 min) and submental intubation (12.83 min). However, tracheostomy was associated with a significantly prolonged LOS (16.40 days) compared to submental intubation (7.48 days) and GANI (7.50 days) ($p=0.008$). No significant difference in LOS was found between the submental and GANI groups.

Conclusion: The procedure has the shortest duration, but may prolong hospitalization and increase the cost of healthcare. Submental intubation is a safe and effective alternative which allows surgical accessibility and provides a similar post-intubation recovery time to nasotracheal, while eliminating the need for tracheostomy in selected complex trauma cases.

The authors declare no conflicts of interest.

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Introduction

Road traffic crashes are a major public health concern, with 1.35 million deaths occurring yearly, mainly among young adults [1]. This global trend is reflected in Indonesia, where recent data from the Central Bureau of Statistics Indonesia (Badan Pusat Statistik) in 2024 recorded over 150,000 traffic accidents annually [2]. High-velocity trauma frequently results in severe maxillofacial injuries, particularly involving the mandible and zygomatic arch. These complex injuries often require surgical intervention via Open Reduction and Internal Fixation (ORIF) to restore anatomical structure and function. However, the nature of these surgeries presents a unique dilemma for the anesthesiologist, as the surgical field often compromises the airway [3].

Securing the airway in patients with panfacial fractures is particularly challenging because standard orotracheal intubation interferes with the intermaxillary fixation required to establish proper dental occlusion [4]. Consequently, alternative airway management strategies are necessary. While nasotracheal intubation (GANI) is a frequent alternative, it is strictly contraindicated in patients with skull base fractures, complex nasoethmoidal injuries, or cerebrospinal fluid rhinorrhea due to the severe risk of intracranial tube passage and meningitis [5]. Tracheostomy is regarded as the gold standard for managing poor airways. However, it is an invasive procedure with high morbidity rates, including tracheal stenosis, hemorrhage, surgical emphysema, and cosmetically unappealing scarring [6].

Hernández Altemir introduced submental intubation in 1986 to overcome the limitations. The technique routes the endotracheal tube through the submental region, allowing unobstructed surgical access to the oral cavity and dental occlusion. It avoids the intracranial risks of nasotracheal intubation and the higher morbidity of tracheostomy, making it a safe and minimally invasive option for complex facial trauma [7-8].

Comparative evidence on the techniques in tertiary care remains limited. This study compared the clinical outcomes of submental intubation, tracheostomy, and nasotracheal intubation (GANI) in patients with difficult oral intubation. Outcomes included operative time, complications, and length of hospital stay to identify the most effective airway management approach for severe maxillofacial trauma.

Methods

Study Design and Setting

A prospective observational cohort study was conducted at Wahidin Sudirohusodo Hospital, Makassar, Indonesia, a tertiary referral center for Eastern Indonesia,

between August 2024 and January 2025. Patients with severe maxillofacial trauma requiring surgery and difficult oral intubation were enrolled using total sampling.

Participants and Sampling

Eligibility included panfacial fractures or Le Fort III craniofacial base injuries requiring general anesthesia, compromised airway patency, contraindications to standard nasotracheal intubation (GANI) related to anatomical factors, or the need for alternative airway access during surgery and intermaxillary fixation. Patients suitable for uncomplicated oral or nasotracheal intubation were excluded.

Study Variables and Procedures

The type of airway management procedure was the primary independent variable. It was categorized into three modes, including submental intubation, tracheostomy, and nasotracheal intubation. Submental intubation is defined as the insertion of the endotracheal tube through the submental skin and the mylohyoid muscle. Tracheostomy is a surgical procedure in which an incision is made in the anterior trachea to create an opening for the endotracheal tube to pass through. In nasotracheal intubation, the endotracheal tube is introduced into the anterior nasal passages. The outcome variables recorded were the duration of the procedure (time in minutes between the beginning of the specific airway maneuver and securement), LOS (days from admission to discharge), and complications (any intraoperative or postoperative adverse event including bleeding, hematoma, infection, and stoma-related issues).

Data Collection

Data were acquired through both primary sources, involving direct clinical observation during pre-operative, intra-operative, and post-operative phases, and secondary sources retrieved from medical records at Wahidin Sudirohusodo Hospital.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics software, version 27.0. Descriptive statistics summarized demographic characteristics using frequencies and percentages for categorical variables and means with standard deviations or medians with ranges for continuous variables. Normality testing was conducted using the Shapiro-Wilk test.

Given the non-normal distribution of procedural duration and LOS data, the Kruskal-Wallis test was employed to compare differences across the three treatment groups, followed by post-hoc pairwise comparisons using the Mann-Whitney U test. A P value of <0.05 was considered statistically significant.

Results

Patient Characteristics

A total of 40 patients with difficult oral intubation secondary to maxillofacial trauma were included in this study. The demographic and clinical characteristics of the study population are summarized in Table 1. The study population comprised more males than females: 25 (62.5%) and 15 (37.5%). The mean age of the cohort was 24.78 ± 6.01 years (range, 16–37 years), signifying that the incidence of maxillofacial trauma was primarily in young adults.

As for the clinical diagnosis, panfacial fractures were the most common reason for alternative airway management, with 40.0% (n=16). Other important diagnoses were panfacial fractures associated with mild traumatic brain injury (17.5%) and various combinations of frontal, maxillary, and mandibular fractures related to

intracranial hemorrhage. Submental intubation was the most commonly used airway management modality in 23 patients (57.5%).

General Anesthesia Nasal Intubation (GANI) was used in 12 patients (30.0%), while tracheostomy was performed in five patients (12.5%). There were no intraoperative or postoperative complications reported in any of the three treatment groups, signifying a high intra- and perioperative safety profile for all modalities used in this cohort of patients.

Descriptive Statistics of Procedural Outcomes

The descriptive statistics for procedural duration and hospital LOS are presented in (Table 2). The mean procedural duration for establishing the airway across all groups was 10.93 minutes (SD ± 4.323), with a range of 5 to 20 minutes.

The mean length of hospital stay was 8.60 days (SD ± 4.482), ranging from 5 to 28 days.

Table 1- Characteristics of Patients

Variable	Frequency (n)	Percentage (%)
Sex		
Male	25	62.5
Female	15	37.5
Primary Diagnosis (Top 3)		
Panfacial fracture	16	40.0
Panfacial fracture + mild TBI	7	17.5
Panfacial fracture + frontal fracture	2	5.0
Airway Management Modality		
Submental intubation	23	57.5
GANI	12	30.0
Tracheostomy	5	12.5
Complications		
Present	0	0.0
Absent	40	100.0

Note: TBI, traumatic brain injury; GANI, general anesthesia nasal intubation.

Table 2- Descriptive statistics of patient demographics and clinical operative variables

Variable	Mean (SD)	Minimum	Maximum
Age (years)	24.78 (6.01)	16	37
Procedural duration (minutes)	10.93 (4.32)	5	20
Length of stay (days)	8.60 (4.48)	5	28

Comparative Analysis of Airway Management Modalities

To evaluate the differences between the three airway management techniques, a Kruskal-Wallis test was conducted as the data did not follow a normal distribution. As shown in (Table 3), there were statistically significant differences between the groups regarding both procedural duration ($p=0.004$) and LOS ($p=0.008$). Tracheostomy demonstrated the shortest mean procedural duration (7.00 minutes), followed by GANI (8.75 minutes), while submental intubation required the longest duration (12.83 minutes).

Conversely, regarding the LOS, patients undergoing tracheostomy experienced the longest hospitalization (mean 16.40 days), whereas those in the submental intubation and GANI groups had significantly shorter hospital stays (7.48 days and 7.50 days, respectively).

Post-Hoc Analysis

A Mann-Whitney U post-hoc analysis was completed to determine specific differences between each group, as shown in Table 4. Based on procedural time, submental intubation was significantly longer than tracheostomy ($p=0.014$) and GANI ($p=0.006$). However, the duration of tracheostomy did not differ significantly from GANI

($p=0.286$). In terms of the LOS, there was a significant difference between tracheostomy and submental intubation ($p=0.003$) with GANI ($p=0.009$). Most importantly, the LOS between the submental intubation and GANI groups was not significantly different ($p=0.556$). This emphasized similar recovery time of submental intubation when compared with nasotracheal intubation.

Discussion

The present study compares three airway management techniques, including submental intubation, tracheostomy, and nasotracheal intubation in patients with maxillofacial trauma that requires surgical intervention. The primary results showed that the airway can be opened with the greatest speed through tracheostomy, while also leading to a much longer hospital stay. Submental intubation had slightly longer procedural duration and presents a similar recovery time as nasotracheal intubation. Furthermore, it has a significantly shorter hospital stay than tracheostomy and is free of complications.

The study population was predominantly young adult males at 62.5% with a mean age of 24.78 years. This is in

line with the global trauma epidemiology, in which young males are the highest risk group for RTA because of higher mobility and the practice of risky behaviors. The results corresponded with Rahpeyma (2013) and Boateng et al. (2023), where a strong male bias was reported in maxillofacial trauma patients who needed alternative intubation. The preponderance of panfacial fractures (40%) in this study also reinforced the importance of the trauma mechanism, which frequently required complex maneuvers of the airway.

The procedural duration was analyzed, and there were statistically significant differences between the groups ($p=0.004$). The quickest procedures were tracheostomy (mean 7.00 minutes), followed by GANI (8.75 minutes) and submental intubation (12.83 minutes). This is expected as the submental intubation requires a series of steps such as submental incision, blunt dissection across the mylohyoid muscle, and exteriorization of the tube. A mean of about 13 minutes is clinically acceptable and not a significant delay to the operative management. This is similar to the results of Beeram et al. (2016) [9], who recorded a mean time of nine minutes, and slightly longer than Shetty et al. (2011) [10], which had times of less than six minutes.

Table 3- Comparative analysis of procedural duration and length of hospital stay stratified by airway management modality

Variable	Submental intubation Mean (min-max)	Tracheostomy Mean (min-max)	GANI Mean (min-max)	P value
Procedural duration (minutes)	12.83 (5-20)	7.00 (5-10)	8.75 (5-12)	0.004
Length of stay (days)	7.48 (5-14)	16.40 (8-28)	7.50 (5-10)	0.008

Note: Kruskal-Wallis test; GANI, general anesthesia, nasal intubation.

Table 4- Post-hoc pairwise comparisons of procedural efficiency and hospitalization duration between treatment groups

Comparison groups	Procedural duration (P value)	Length of stay (P value)
Submental intubation vs. tracheostomy	0.014	0.003
Submental intubation vs. GANI	0.006	0.556
Tracheostomy vs. GANI	0.286	0.009

Note: Post-Hoc Mann-Whitney U Test; GANI, general anesthesia, nasal intubation.

The difference may be due to operator learning curve and the severity of the soft tissue trauma experienced in individual cases. Importantly, the extra time spent on submental intubation is compensated for by the benefit of avoiding the long-term morbidity of tracheostomy.

Among the results of particular clinical relevance in this study is the significant difference in LOS ($p=0.008$). Patients following tracheostomy had an average hospital stay of 16.40 days, which is double that of the submental (7.48 days) and GANI (7.50 days) groups. The results reflect the general literature showing that tracheostomy is an independent factor associated with a longer LOS. This is because of the requirement for a stoma, weaning, and management of possible late complications such as

stenosis or infection [11-12]. The submental technique facilitates immediate extubation or short-term postoperative ventilation while avoiding the complications associated with tracheostomy. The lack of a significant difference between the submental and GANI groups ($p = 0.556$) supports the former as an effective bridging technique, providing surgical access comparable to tracheostomy and postoperative recovery similar to nasotracheal intubation.

A complication rate of 0% was observed with all three methods. This finding contrasts with previously reported complications, such as hemorrhage, infection, tracheal stenosis, and intracranial tube placement. Maryani and Wisudarti (2021) [13] reported significant late

complications following tracheotomy, whereas nasotracheal intubation has been associated with epistaxis and skull base injury [14]. The absence of complications may reflect rigorous patient selection and the involvement of experienced surgical and anesthesia teams. These results align with those of Kita et al. (2016) [15] and Rodrigues et al. (2017) [16] who reported minimal morbidity associated with submental intubation.

When selecting an airway management technique, a balance must be struck between the speed of intervention and the requirements for postoperative recovery. Although nasotracheal intubation remains a suitable option for many patients, it is contraindicated in cases of skull base fractures or complex naso-ethmoidal injuries—conditions frequently encountered in our patient population with panfacial fractures. In such situations, the surgeon often faces a choice between tracheostomy and submental intubation. Our data indicate that, in the absence of a foreseeable need for prolonged mechanical ventilation (e.g., in cases of severe traumatic brain injury), submental intubation is the preferred alternative to tracheostomy. This technique effectively maintains airway access for intermaxillary fixation without the prolonged hospitalization associated with a surgical tracheal approach.

This study has several limitations, including its single-center design and the relatively small sample size (n=40), particularly in the tracheostomy group. The non-randomized nature of the intervention reflects the necessity of clinical decision-making in trauma cases, which may introduce selection bias. Future multi-center studies with larger cohorts would be beneficial to further validate these findings and evaluate long-term functional outcomes such as scarring and voice quality.

Conclusion

Tracheostomy had the shortest procedural duration but resulted in a significantly longer hospital stay than submental and nasotracheal intubation (GANI). Submental intubation achieved a hospital stay comparable to GANI while avoiding the greater morbidity associated with tracheostomy. Given its favorable safety profile, submental intubation should be considered the preferred alternative for panfacial trauma when nasotracheal intubation is contraindicated.

Authors' contributions

DL: conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, validation, visualization, writing – original draft, writing – review & editing. **SRL:** conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, validation, visualization,

writing – original draft, writing – review & editing. **MIK:** conceptualization, data curation, formal analysis, investigation, methodology, resources, supervision, validation, visualization, writing (original draft), writing (review), and editing. **MF:** conceptualization, data curation, formal analysis, investigation, methodology, resources, supervision, writing – original draft, writing – review & editing.

Declaration of generative Artificial Intelligence (AI) and AI-assisted technologies in the writing process

The authors used Grammarly.com (AI tools) to improve the language and readability of the manuscript. The authors reviewed and edited the content and take full responsibility for its accuracy. No images were generated or manipulated using AI tools.

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