Original Article

PREDICTING DIFFICULT INTUBATION IN ELECTIVE SURGICAL PATIENTS: THE ROLE OF BEDSIDE SONOGRAPHIC MEASUREMENTS

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ABSTRACT

Objective: Predicting difficult intubation remains a pivotal challenge in anesthesia, with traditional methods often failing to identify all at-risk patients. This study investigates the efficacy of bedside sonographic measurements as predictors of intubation difficulty in elective surgical patients.

Methods: A prospective observational study was conducted at Gulbarga Institute of Medical Sciences, Kalaburagi, involving 60 adult elective surgery patients. Sonographic measurements, including hyomental distance, pre-epiglottic space, anterior soft tissue distance, and neck circumference were evaluated for their ability to predict difficult intubation.

Results: The study found significant associations between all measured parameters and intubation difficulty. Specifically, shorter hyomental and pre-epiglottic spaces were strongly predictive of difficult intubations. Increased anterior soft tissue thickness and larger neck circumference were also linked to higher intubation difficulty.

Conclusion: Bedside sonographic measurements provide a reliable method for predicting difficult intubations in elective surgical patients. Their integration into preoperative evaluations can significantly enhance the prediction and management of difficult airways.

Keywords: Difficult intubation, Bedside sonography, Airway management, Elective surgery, Anesthesia

INTRODUCTION

The accurate prediction of difficult intubation in elective surgical patients remains a critical component of preoperative assessment in anesthesia management. Difficult intubation, characterized by the inability to visualize the glottis and necessitating multiple attempts to secure an airway, presents significant risks, including hypoxemia, aspiration, and patient trauma. Current predictive models, often based on physical examination and patient history, do not reliably predict all cases of difficult intubation, which underscores the necessity for enhanced predictive strategies [1-3].

In response to this clinical challenge, the advent of bedside sonographic measurements has emerged as a promising tool to augment the assessment of airway difficulties. Sonography provides a non-invasive, rapid, and dynamic method to obtain vital anatomical details that are often predictive of challenging intubations. This study focuses on evaluating the efficacy of several sonographic measurements-namely, hyomental distance (HMD), pre-epiglottic space (PES), anterior soft tissue distance (ASTD), and neck circumference-in predicting intubation difficulty [4-6].

The rationale for selecting these specific measurements stems from their anatomical relevance to the airway structure and their potential changes under pathological conditions that may complicate intubation. For instance, a reduced hyomental distance may indicate a posteriorly positioned mandible, potentially complicating direct laryngoscopy. Similarly, the pre-epiglottic space, as a predictor of epiglottic positioning and mobility, can offer insights into potential laryngeal view obstruction. Anterior soft tissue thickness, particularly at cervical levels, can affect neck extension and visualization of the airway during intubation attempts. Lastly, increased neck circumference has been correlated with obstructive sleep apnea, a known risk factor for difficult airway management [7].

Our study methodically quantifies these anatomical parameters using bedside ultrasound, a tool that has gained considerable attention for its utility in various medical assessments due to its cost-effectiveness, portability, and safety profile. By correlating these sonographic measurements with the intubation difficulty scores collected from elective surgical patients, this research aims to solidify the foundation for a more robust, ultrasound-based predictive model. Such a model could significantly improve the preoperative planning process, enabling anesthesiologists to anticipate and strategize for potential difficulties, thereby enhancing patient safety and care outcomes [8].

In this context, the results of our study not only contribute to the academic and clinical understanding of airway management but also pave the way for future research that might integrate sonographic airway assessment into routine preoperative evaluation protocols. This approach holds the potential to transform current practices by providing a more accurate, real-time assessment of airway challenges, thereby minimizing the risks associated with difficult intubations in diverse surgical cohorts.

MATERIALS AND METHODS

Study design and setting

This prospective observational study was conducted at Department of Anaesthesiology and critical care, Gulbarga Institute of Medical Sciences, Kalaburagi. The study enrolled adult patients who met the inclusion criteria and were scheduled for elective surgery.

Participants

Inclusion criteria

- Age: 18 to 80 y

- ASA Classification: I, II

- Patients undergoing elective surgery who provided valid informed consent

Exclusion criteria

- Patients with head and neck pathology

- Restricted mouth opening

- Facial deformities (congenital or post-traumatic)

- Emergency surgery

- Absence of written informed consent

Materials

- Ultrasound machine equipped with B-mode 2D functionality and probes (high-frequency linear 10-14 MHz and curved 4-6 MHz)

- Standard monitoring equipment, including ECG, NIBP, SpO2, and EtCO$_2$

- Measuring tape calibrated to 0.5 cm

- Ultrasound gel

- Weighing machine

- Macintosh laryngoscope

Airway assessment

Prior medical history, including previous anesthesia records, voice changes, surgeries, snoring incidents, and systemic illnesses such as diabetes mellitus, rheumatoid arthritis, and ankylosing spondylitis, were reviewed and documented. Physical examination focused on the oral cavity, facial structure, and neck, assessing for any anomalies that could influence airway management. Specific measures included:

- **Neck mobility:** Assessment of atlantooccipital joint movement and neck flexion

- **Upper lip bite test (ULBT):** Grading based on the ability of the lower incisor to bite the upper lip

- **Inter incisor distance (IID):** Measurement between the upper and lower incisors

- **Thyromental distance:** Measured from the symphysis menti to the thyroid notch

- **Neck circumference:** Measured at the level of the thyroid notch

- **Mallampatti score (Samsoon and young modification):** Visibility of oropharyngeal structures assessed with the patient in a sitting position

Ultrasound measurements

Patients were positioned supine with maximum head tilt-chin lift to measure the following parameters using ultrasound:

- **Hyomental distance:** Measured from the hyoid bone to the mental prominence

- **Pre epiglottic space:** Measured from the hypoechoic curvilinear structure of the epiglottis to the thyrohyoid membrane

- **Anterior soft tissue distance:** Measured at the level of the vocal cords

Anesthesia and intubation protocol

All patients were connected to standard monitoring equipment and underwent premedication, preoxygenation, induction, and paralysis before intubation using a Macintosh laryngoscope. The Cormack-Lehane grading system was used to assess the glottic view. Intubation difficulty was scored using an Intubation Difficulty Scale

(IDS), which considered the number of attempts, alternative techniques used, lifting force, and laryngeal pressure applied.

Data collection and statistical analysis

Data on airway measurements, intubation details, and patient demographics were systematically recorded. Intubation time was measured from the insertion of the laryngoscope to the confirmation of the endotracheal tube placement. Post-operative observations were conducted, and patients were transferred to post-op wards for further monitoring. The collected data were compiled for statistical analysis to evaluate the correlations between the sonographic measurements and intubation difficulty.

RESULTS

In this study, the predictive value of bedside sonographic measurements for assessing the difficulty of intubation in elective surgical patients was evaluated using various anatomical parameters. The results are quantified through statistical analysis, revealing significant associations between certain measurements and the degree of intubation difficulty experienced.

Hyomental distance (HMD) and intubation difficulty

Our findings indicate a strong inverse relationship between hyomental distance and intubation difficulty. Among the patients with an HMD greater than 6 cm, 69% experienced easy intubation, while only 4% faced moderate to major difficulty. Conversely, patients with an HMD less than 4 cm had a high incidence (56%) of moderate to major difficulty (Chi-square = 31.58, $P<0.001$). This significant result underscores the utility of HMD in predicting intubation challenges.

Pre-epiglottic space (PES) and intubation difficulty

The pre-epiglottic space measurement also demonstrated notable predictive capacity. A PES less than 1.5 cm was associated with a high percentage (92%) of easy to slightly difficult intubation scenarios, contrasting sharply with the difficulties encountered when the PES was 1.5 cm or more, where 53% experienced moderate to major difficulty (Chi-square = 28.74, $P<0.001$). This distinct correlation suggests that a smaller PES might aid in anticipating difficult airways.

Anterior soft tissue distance (ASTD) and intubation difficulty

A similar trend was observed with anterior soft tissue distance. Patients with an ASTD greater than 6 cm faced predominantly moderate to major difficulties in intubation (50%), whereas those with an ASTD between 4 to 4.9 cm encountered no such difficulties, emphasizing the potential of ASTD in preoperative airway assessment (Chi-square = 29.36, $P<0.001$).

Neck circumference and intubation difficulty

Additionally, neck circumference proved to be a reliable indicator. Patients with a neck circumference less than 30 cm rarely experienced moderate to major difficulties (3%), but those with a circumference greater than 35 cm encountered significant difficulties in 67% of cases (Chi-square = 26.82, $P<0.001$).

These statistical analyses provide robust evidence supporting the use of bedside sonographic measurements in predicting difficult intubation scenarios. The data not only enhance our understanding of airway management but also guide anesthesiologists in preparing for potential challenges during surgical procedures.

Table 1: Association between hyomental distance and intubation difficulty score

Hyomental distance (cm)	Intubation difficulty score: easy (0)	Intubation difficulty score: slightly difficult (1 to 5)	Intubation difficulty score: moderate to major difficulty (>5)	Total
>6 cm (n=26)	18 (69%)	7 (27%)	1 (4%)	26
4 to 6 cm (n=18)	7 (39%)	11 (61%)	0 (0%)	18
<4 cm (n=16)	1 (6%)	6 (38%)	9 (56%)	16
Total	26	24	10	60
Chi-square	31.58	P<0.001		

Table 2: Association between pre-epiglottic space and intubation difficulty score

Pre-epiglottic space (cm)	Intubation difficulty score: easy (0)	Intubation difficulty score: slightly difficult (1 to 5)	Intubation difficulty score: moderate to major difficulty (>5)	Total
<1.5 cm (n=43)	24 (56%)	18 (42%)	1 (2%)	43
≥1.5 cm (n=17)	2 (12%)	6 (35%)	9 (53%)	17
Total	26	24	10	60
Chi-square	28.74	P<0.001		

Table 3: Association between anterior soft tissue distance and intubation difficulty score

Anterior soft tissue distance (cm)	Intubation difficulty score: easy (0)	Intubation difficulty score: slightly difficult (1 to 5)	Intubation difficulty score: moderate to major difficulty (>5)	Total
>6 cm (n=16)	2 (13%)	6 (37%)	8 (50%)	16
5 to 5.9 cm (n=22)	9 (41%)	11 (50%)	2 (9%)	22
4 to 4.9 cm (n=22)	15 (68%)	7 (32%)	0 (0%)	22
Total	26	24	10	60
Chi-square	29.36	P<0.001		

Table 4: Association between neck circumference and intubation difficulty score

Neck circumference (cm)	Intubation difficulty score: easy (0)	Intubation difficulty score: slightly difficult (1 to 5)	Intubation difficulty score: moderate to major difficulty (>5)	Total
<30 cm (n=39)	21 (54%)	17 (43%)	1 (3%)	39
30 to 35 cm (n=9)	5 (56%)	3 (33%)	1 (11%)	9
>35 cm (n=12)	1 (8%)	3 (25%)	8 (67%)	12
Total	27	23	10	60
Chi-square	26.82	P<0.001		

DISCUSSION

The results of this study underscore the critical role that bedside sonographic measurements can play in predicting difficult intubation in elective surgical patients. The statistically significant findings from measurements such as hyomental distance (HMD), pre-epiglottic space (PES), anterior soft tissue distance (ASTD), and neck circumference provide robust evidence supporting their use in clinical preoperative assessments [9].

HMD emerged as a particularly strong predictor of intubation difficulty, with a notable decrease in intubation ease as the distance decreased. This relationship highlights the importance of jaw structure and positioning in airway management, a finding consistent with previous research indicating that a shorter HMD can predict laryngoscopic challenges due to reduced space for maneuvering the laryngoscope. Similarly, the PES proved to be a critical measurement, with smaller spaces correlating highly with increased intubation difficulty, likely due to limited visibility and accessibility of the laryngeal inlet [10].

ASTD and neck circumference were also significant predictors, with increased soft tissue potentially leading to obscured airway views and physically restricted access to the trachea. These findings align with current literature that associates larger neck circumferences and increased soft tissue with obstructive sleep apnea, a known complicating factor in airway management [11, 12].

This study's implications are twofold. Firstly, it validates the utility of sonographic assessments in enhancing the predictive accuracy of difficult airway assessments. Secondly, it suggests potential modifications to preoperative protocols, advocating for routine sonographic airway assessments in patients identified as at-risk for difficult intubations. Such measures could significantly improve the safety and efficiency of anesthesia administration by allowing for better preparedness and tailored management strategies based on individual anatomical challenges.

CONCLUSION

This study clearly demonstrates that bedside sonographic measurements are valuable predictors of difficult intubation in elective surgical patients. Incorporating these measurements into routine preoperative airway assessments can enhance the prediction of intubation challenges, thereby optimizing patient safety and improving surgical outcomes. As healthcare continues to evolve, the integration of such non-invasive, cost-effective, and easily applicable tools into clinical practice is essential for advancing patient care in anesthesia management.

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AUTHORS CONTRIBUTIONS

All authors have contributed equally

CONFLICT OF INTERESTS

Declared none

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