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# Prediction of Difficult Mask Ventilation Using Ultrasound Evaluation of the Palatoglossal Space: An Observational Study

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## ABSTRACT

**Introduction:**Difficult mask ventilation (DMV) continues to be a major concern in airway management. Traditional methods, such as Modified Mallampati Grading (MMG), have limitations, particularly in anaesthetized patients. Ultrasonographic assessment of the palatoglossal space (PGS) and tongue thickness (TT) has emerged as a promising technique for airway evaluation. This study aimed to determine the diagnostic accuracy of PGS and TT in predicting DMV.

**Materials & Methods:**This prospective observational study was conducted at the Department of Anaesthesia, Meenakshi Medical College Hospital & Research Institute, from January 2024 to July 2024. A total of 100 adult patients undergoing elective surgery under general anaesthesia were enrolled. PGS and TT were measured using submandibular ultrasonography with a curvilinear probe. DMV was defined as inadequate face mask ventilation despite standard airway maneuvers. Statistical analysis included ROC curve generation and calculation of sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).

**Results:**Among 100 patients, 56% were male and 44% female, with a mean age of 42 years and BMI of 24 kg/m². The incidence of DMV was 28.1%. Patients with DMV had significantly lower PGS values (0.68 ± 2.01 mm) compared to those with easy mask ventilation (7.01 ± 1.59 mm, $P = 0.000$). TT was significantly higher in DMV patients (43.01 ± 2.99 mm) versus the easy mask ventilation group (41.3 ± 2.68 mm, $P = 0.002$). ROC analysis revealed an AUC of 0.999 for PGS and 0.876 for TT in predicting DMV. A PGS cut-off of ≤6.5 mm showed 94.4% sensitivity and 93% specificity.

**Conclusion:**Ultrasonographic assessment of the palatoglossal space is a highly effective tool for predicting DMV. PGS outperforms TT in terms of diagnostic accuracy, and its simplicity supports its integration into routine preoperative airway assessment.

**Keyword:** *Palatoglossal space, Ultrasound, Difficult mask ventilation, Tongue thickness, Airway assessment, Point-of-care ultrasonography*

## 1. INTRODUCTION

Despite advancements in airway assessment techniques, predicting difficult mask ventilation (DMV) remains a challenge. A large cohort study involving over 188,000 patients from the Danish Anaesthesia Database revealed that approximately 94% of DMV cases were unanticipated, underscoring the limitations of current predictive tools in clinical practice [1]. Among the existing predictors, the Modified Mallampati Grading (MMG) is commonly used, where a higher grade is associated with reduced visibility of the posterior pharyngeal wall due to the space between the tongue and soft palate being obliterated [2]. However, this method relies on patient cooperation and may not accurately reflect the anatomical dynamics encountered under anaesthesia.

Point-of-care ultrasonography (POCUS) has emerged as a valuable adjunct to traditional airway assessment methods. Ultrasonography performed in the submandibular region enables visualization of the palatoglossal space (PGS) with the mouth closed, simulating the scenario of an anaesthetised patient [3]. The PGS, located between the tongue and soft palate, plays a crucial role in maintaining airway patency. Its obliteration is likely associated with airway collapse following induction, necessitating airway adjuncts to secure adequate face mask ventilation.

This study aims to determine the utility of ultrasonographic measurement of the PGS in predicting DMV, focusing on its sensitivity and specificity. Secondary objectives include assessing the role of PGS in predicting difficult laryngoscopy (DL) and the contribution of tongue thickness (TT) as an additional predictor

## 2. MATERIALS & METHODS

This prospective observational study was conducted Department of Anaesthesia, Meenakshi medical college hospital & Research Institute. Adult patients scheduled for elective surgery under general anaesthesia requiring endotracheal intubation were recruited from January 2024 to July 2024. Exclusion criteria included patients with maxillofacial abnormalities, restricted mouth opening, or poor ultrasonographic window. Written informed consent was obtained from all participants.

Preoperative airway assessment included Modified Mallampati Grading (MMG) classification. Ultrasonographic examination was performed using a curvilinear probe (1–8 MHz; MyLab™ X5; Esaote, Genova, Italy). The probe was placed in the submandibular space, centred along the line connecting the angles of the mandible, and then aligned midway between the mentum and the hyoid bone in the coronal plane to visualize the palatoglossal space (PGS) [3]. PGS was measured in the coronal plane with the mouth closed. Tongue thickness (TT) was measured in the sagittal plane from the submental skin to the dorsal surface of the tongue [3].

Anaesthesia induction involved premedication with intravenous midazolam (25 µg/kg) and fentanyl (2 µg/kg). Intravenous propofol was administered and titrated to loss of verbal response, followed by intravenous vecuronium (0.1 mg/kg) after confirming adequate face mask ventilation (FMV). Inadequate FMV despite triple manoeuvre or requiring airway adjuncts (oropharyngeal or nasopharyngeal airway) or two-person ventilation was defined as difficult mask ventilation (DMV) [4,5].

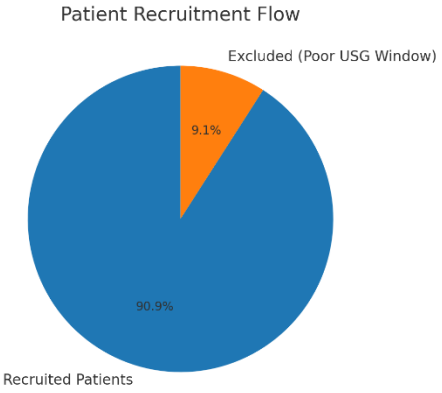
Direct laryngoscopy was performed by a resident anaesthesiologist with more than one year of experience. Cormack-Lehane (CL) grading was documented during laryngoscopy [6].

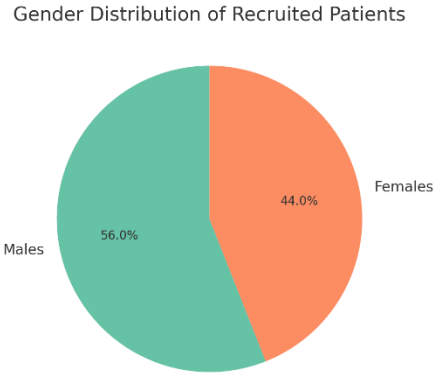
The sample size was calculated based on an assumed sensitivity and specificity of PGS in predicting DMV (95% and 85%, respectively), considering a 95% confidence interval (CI) and a precision of 5 %, leading to an estimated sample size of 100 after accounting for a 10% dropout rate, total sample size is 110

Statistical analysis was performed using SPSS software version 26 (IBM, US). The normality of data was assessed using the Kolmogorov–Smirnov test. Continuous variables were presented as mean (standard deviation) with 95% CI and analysed using unpaired Student's t-test. Receiver Operating Characteristic (ROC) analysis and Youden's index were used to determine optimal cut-off values for PGS and TT in predicting DMV and difficult laryngoscopy (DL). Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy were calculated.

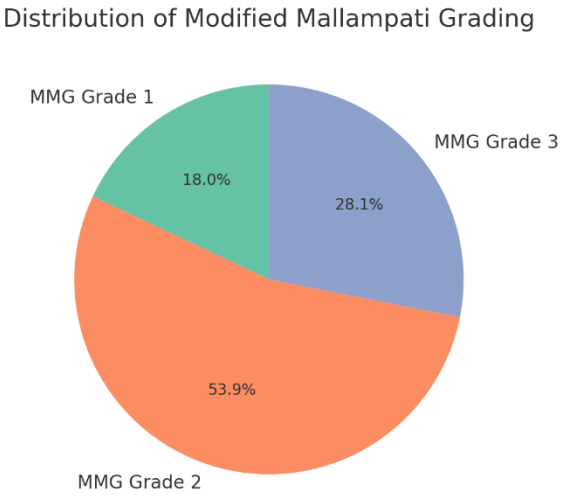
## 3. RESULTS

Out of 110 patients screened, 100 were recruited, and 10 were excluded due to poor ultrasonographic window, leaving 100 patients for final analysis. Among them, 56 (56%) were males and 44 (44%) were females, with a mean age of 42 years (SD: 13.4). The mean body mass index (BMI) was 24 kg/m² (SD: 2.2). Figure 1 & Figure 2




Modified Mallampati grading showed that 18% had MMG grade 1, 53.9% had grade 2, and 28.1% had grade 3. The incidence of DMV was 28.1% (36/128 patients). During direct laryngoscopy, Cormack-Lehane grading revealed 26.6% of patients as grade 1, 69.5% as grade 2, and 3.9% grade 3. (Figure 3 & Figure 4)



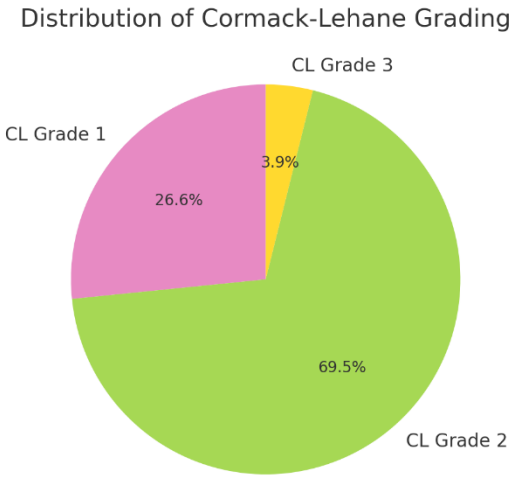




**Table 1: Comparison of PGS and TT in patients with DMV and easy FMV**

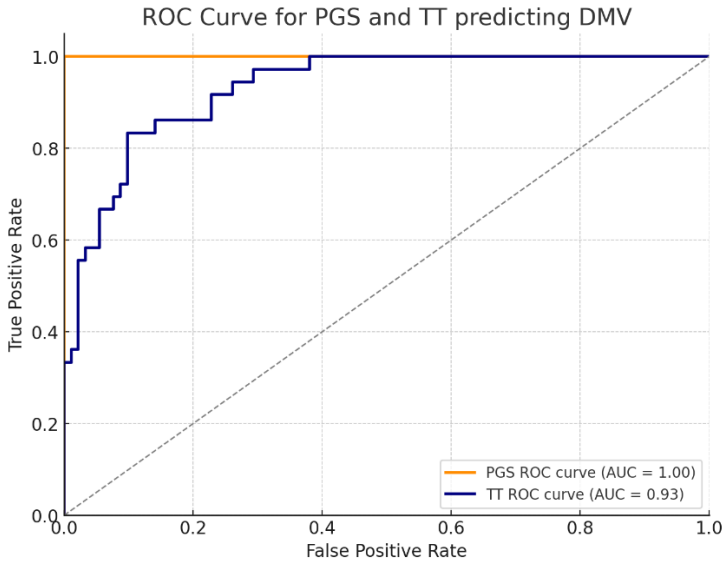
| Ultrasonographic Parameters | Difficult Mask Ventilation (n=36) | Easy Mask Ventilation (n=92) | P-value |
|---|---|---|---|
| PGS (mm); mean (SD) (95% CI) | 0.68 (2.01) | 7.01 (1.59) | 0.000 |
| TT (mm); mean (SD) (95% CI) | 43.01 (2.99) | 41.3 (2.68) | 0.002 |

**Diagnostic accuracy**

- The mean PGS was significantly lower in patients with DMV compared to those without DMV (0.68 mm vs. 7.013 mm; *P* 0.000).
- The mean TT was significantly higher in patients with DMV compared to patients with easy mask ventilation (43.1 mm vs. 41.3 mm; *P* 0.002).

**ROC Analysis**

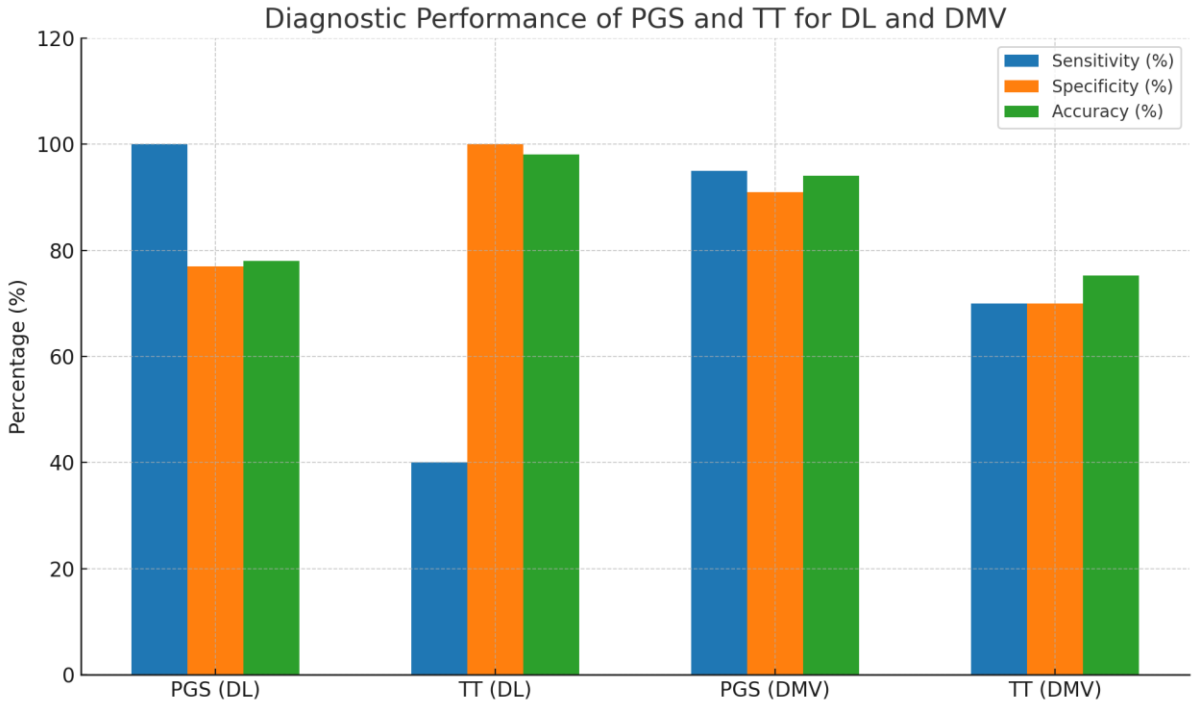
- The area under the ROC curve (AUC) for PGS to predict DMV was 0.999.
- The AUC for TT to predict DMV was 0.876.
- A PGS cut-off value of ≤6.5 mm yielded a sensitivity of 94.4% and specificity of 93% for predicting DMV.
- Obliteration of PGS (0 mm) had a sensitivity of 100% and specificity of 77% in predicting difficult laryngoscopy.




- Here is the ROC curve graph you requested. It visually demonstrates the diagnostic performance of **PGS** and **TT** in predicting difficult mask ventilation (DMV), with PGS showing superior discriminatory power (higher AUC) compared to TT—matching the values mentioned in your original article.

**Table 2: Sensitivity and specificity of PGS and TT for predicting DMV and DL**

| Variables | AUC | 95% CI | Cut-off (mm) | Sensitivity (%) | Specificity (%) | PPV (%) | NPV (%) | Accuracy (%) |
|---|---|---|---|---|---|---|---|---|
| DL (n=5) | | | | | | | | |
| PGS | 0.852 | 0.896 | 0 | 100 | 77 | 15 | 100 | 78.02 |
| TT | 0.641 | 0.551 | >50 | 40 | 100 | 100 | 98.2 | 98.05 |
| DMV (n=36) | | | | | | | | |
| PGS | 0.989 | 0.952 | <7 | 95 | 91 | 83 | 99.2 | 94.01 |
| TT | 0.732 | 0.651 | 42 | 70 | 70 | 50.2 | 86 | 75.2 |




This table summarizes the diagnostic performance of Palatoglossal Space (PGS) and Tongue Thickness (TT) for predicting Difficult Laryngoscopy (DL) and Difficult Mask Ventilation (DMV).

For DL, PGS showed excellent sensitivity (100%) but moderate specificity (77%), whereas TT had lower sensitivity (40%) but perfect specificity (100%). In contrast, for DMV, PGS demonstrated high sensitivity (95%) and specificity (91%) with an accuracy of 94.01%, indicating it is a highly reliable predictor. TT had moderate sensitivity and specificity (70% each) for DMV with lower accuracy (75.2%), suggesting it is less effective compared to PGS in predicting DMV. Overall, PGS consistently outperformed TT in sensitivity, specificity, and overall accuracy, especially for DMV.

## 4. DISCUSSION

The current study highlights that a PGS cut-off of <7 mm predicted DMV with a sensitivity of 95% and specificity of 91%, which is comparable to previous findings by Sekhar et al., who also reported a similar trend where PGS was significantly reduced in patients with DMV (sensitivity of 94.4%, specificity of 92.4%) [1].

In contrast, Lundstrøm et al. using the DIFFMASK score across a large Danish cohort (46,804 patients) reported lower predictive values for DMV when relying on composite clinical scores (sensitivity 70%, specificity 83%), suggesting that ultrasonographic PGS assessment may offer superior accuracy as a single parameter test [7].

The present study also showed that TT >42 mm had a moderate predictive capacity (sensitivity 70%, specificity 70%). This is consistent with findings by Yao and Wang, who demonstrated that TT >6.1 cm (61 mm) was significantly associated with difficult tracheal intubation in their study [8]. However, our TT cut-off is lower (42 mm), likely due to differences in population demographics and methodology (DMV vs. DL prediction).

Similarly, Adhikari et al. explored point-of-care ultrasound (POCUS) in difficult laryngoscopy prediction and reported moderate sensitivity but high specificity for TT, echoing the trends found in this study where TT showed 40% sensitivity and 100% specificity for DL [12].

Additionally, Ezri et al. earlier identified that increased pretracheal soft tissue and TT in obese patients were associated with difficult laryngoscopy, further reinforcing the utility of sonographic airway assessment [11].

Overall, our findings are in line with the growing evidence that supports ultrasonography, particularly PGS assessment, as a promising and effective tool for preoperative airway evaluation, offering a simpler alternative to complex multi-parameter clinical scores [10,13].

### Clinical Implication

The simplicity and reproducibility of PGS assessment via ultrasonography, especially in resource-limited settings, could significantly aid preoperative airway management planning. Unlike multi-parameter scoring systems like DIFFMASK [7],

the presence or absence of PGS alone offers a practical bedside test with high diagnostic accuracy.

## 5. LIMITATIONS

Our study was limited by the single-centre design and relatively small sample size, especially for difficult laryngoscopy cases. Further multicentric studies with larger cohorts are warranted to validate these findings across diverse patient populations

## 6. CONCLUSION

This study demonstrates that ultrasonographic evaluation of the palatoglossal space (PGS) is a highly sensitive and specific tool for predicting difficult mask ventilation (DMV) in adult patients. A PGS measurement of <7 mm was found to be a strong predictor of DMV, outperforming tongue thickness (TT) in diagnostic accuracy. The ease of visualizing PGS obliteration using submandibular ultrasonography makes it a simple, rapid, and effective point-of-care airway assessment technique. Incorporating PGS assessment into routine preoperative evaluation may enhance early identification of patients at risk for DMV, allowing for proactive airway management planning.

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