

Assessing the Empirical Predictive Value of the ASA-Recommended Difficult Airway Predicting Factors

Srija Konduru¹, Marilly Palettas², Haosheng Li¹, Lukas Croner¹, David Yablok², Ling-Qun Hu^{2,3}

1. The Ohio State University College of Medicine
2. The Ohio State University Wexner Medical Center – Department of Anesthesiology
3. Northwestern Memorial Hospital

Introduction

Predicting difficult airways has been an integral part of the field of Anesthesia since the conception of the Three Axis Alignment Theory in 1944[1]

The American Society of Anesthesiologists (ASA) is the overarching, trusted group of academic anesthesiologists that have defined numerous factors that may help in predicting a difficult airway[2]. However, these recommended factors have been defined subjectively or lack substantial evidence for efficacy

Known multivariate scoring systems: LEMON, Wilson's risk score, and El-Ganzouri Risk index also were analyzed and showed moderately higher specificity and sensitivity, approximately 0.82 and 0.51, respectively [3].

We undertook this study hypothesizing that there is insufficient empirical support to predict difficult airways based on the ASA-recommended factors with a goal to develop a more predictive multivariate model.

Table 1. Components of the Preoperative Airway Physical Examination	
Airway Examination Component	Nonreassuring Findings
Length of upper incisors	Relatively long
Relationship of maxillary and mandibular incisors during normal jaw closure	Prominent "overbite" (maxillary incisors anterior to mandibular incisors)
Relationship of maxillary and mandibular incisors during voluntary protrusion of mandible	Patient cannot bring mandibular incisors anterior to (in front of) maxillary incisors
Interincisor distance	Less than 3 cm
Visibility of uvula	Not visible when tongue is protruded with patient in sitting position (e.g., Mallampati class >2)
Shape of palate	Highly arched or very narrow
Compliance of mandibular space	Stiff, indurated, occupied by mass, or nonresilient
Thyromental distance	Less than three ordinary finger breadths
Length of neck	Short
Thickness of neck	Thick
Range of motion of head and neck	Patient cannot touch tip of chin to chest or cannot extend neck

Table 1: We used the 2013 ASA practice guidelines as the definitions for the predictive factors in this study. [4]

Methods

This prospective cohort observational study aimed to identify objective risk factors for difficult airways. Difficult airways in the study were categorized as:

- Difficult laryngoscopy: Inability to visualize vocal cords, Modified Cormack-Lehane Grades $\geq 2b$.
- Difficult intubation: Intubation Difficulty Scales (IDS) ≥ 5 .

660 cases at Northwestern Memorial Hospital in Chicago presented with at least one of the eleven difficult airway predictors listed in the ASA difficult airway guidelines and were analyzed

We performed univariate and stepwise multivariable logistic regression analysis to assess the association of each ASA predictive factor to either a case of (1) difficult laryngoscopy or (2) difficult intubation. The four predictive models for analysis were:

- Univariate Logistic Regression for Difficult laryngoscopy
- Stepwise Multiple Logistic Regression for Difficult laryngoscopy
- Univariate Logistic Regression for Difficult Intubation
- Stepwise Multiple Logistic Regression for Difficult Intubation

We also performed a regression analysis that included all the measurable parameters and subjective measures of a factor denoted as an eyeball examination (EE) for each ASA predictive factor.

Results & Data

Three measurable parameters—**inter-incisor distance (IID)**, **neck circumference**, **neck range of motion (ROM)**—consistently predicted difficult airways in all four models.

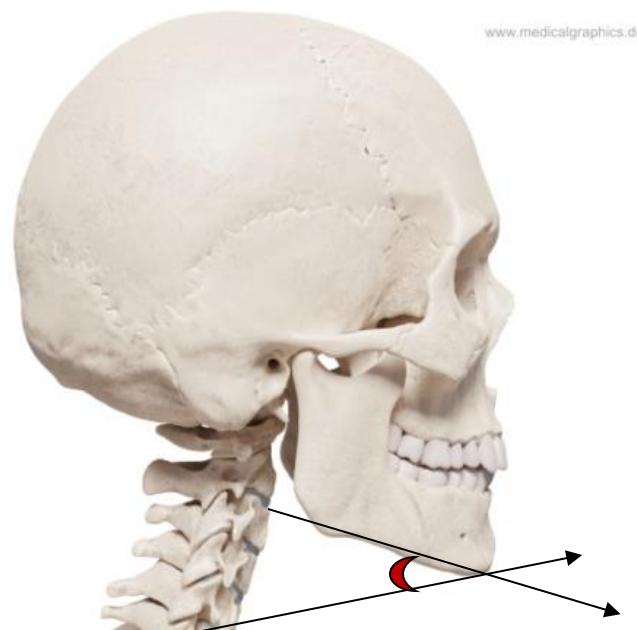
Age, **Thyromental measured distance**, and the angle difference between the Lower Incisor Mandibular Plane Angle (LIMPA) and the Lower Incisor Mandibular Body Angle (LIMBA) denoted as the **LIMPA-LIMBA angle** were all predictive except in one model.

Many predictive factors were only predictive in Univariate Logistic Regression models.

Table 2: Demographic Risk Factors Recommended in the ASA Guideline with Difficult Airway

Risk Factors of Difficult Airway	Incidences (%) or Mean (SD)	Univariate Logistic Regression for difficult laryngoscopy		Stepwise Multiple Logistic Regression for difficult laryngoscopy		Univariate Logistic Regression for difficult intubation		Stepwise Multiple Logistic Regression for difficult intubation	
		OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
		Demographics							
Age (per 10 years)	49.8 (16.1)	1.38 (1.22, 1.56)	<0.001	1.19 (1.02, 1.39)	0.03	1.37 (1.17, 1.61)	<0.001		
Female	281 (42.6%)	0.86 (0.58, 1.26)	0.45			0.71 (0.42, 1.17)	0.18		
History									
BMI ≥ 40	74 (11.2%)	0.98 (0.52, 1.74)	0.93			0.85 (0.34, 1.82)	0.69		
Obstructive Sleep Apnea (moderate & severe)	102 (15.5%)	1.67 (1.03, 2.68)	0.04			1.55 (0.81, 2.79)	0.18		

Figure 1: The LIMPA-LIMBA angle is clinically relevant for estimating amount of anterior neck soft tissue. The LIMPA-LIMBA angle is evidenced to be a positive predictor of difficult airway in this study.



Discussion

Overall, physically measurable parameters performed the best at predicting both difficulty of laryngoscopy and intubation.

The most consistent predictors:

- IID, neck circumference, and neck range of motion

The mostly reliable predicting factors

- Age, Thyromental distance, Limpa-Limba angle

Less reliable predicting factors

- Eyeball/estimating factors, required patient collaborative parameters (upper lip test), Mallampati score, "Thick neck" (neck wider than the intermandibular angle distance)

Unreliable predicting factors

- Gross assessment of "limited range of motion"

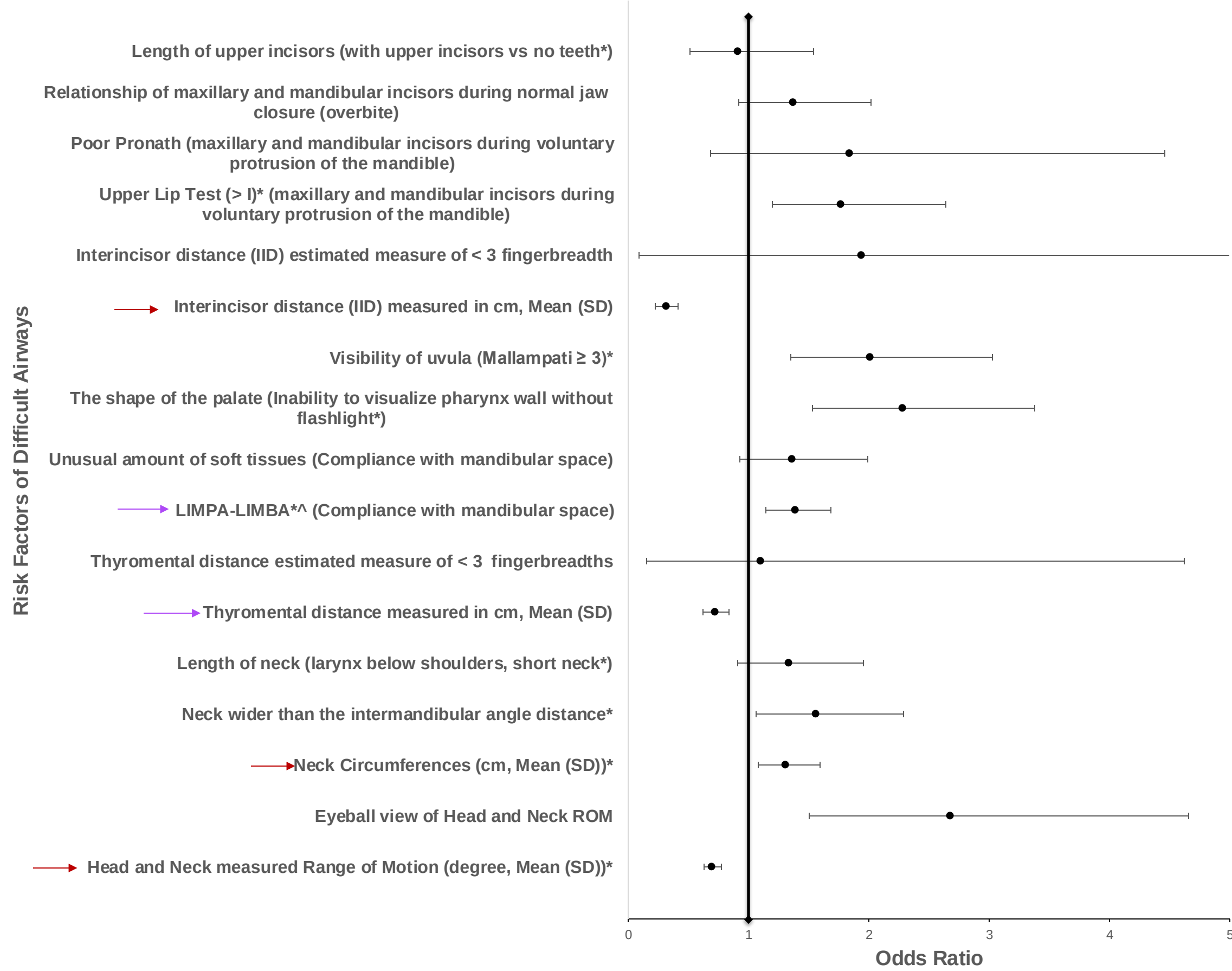
Future directions include:

- Further defining objective measures for predicting a difficult airway
- Continued statistical analysis to decide the best factors to include in multi-variable associations for predictive algorithms

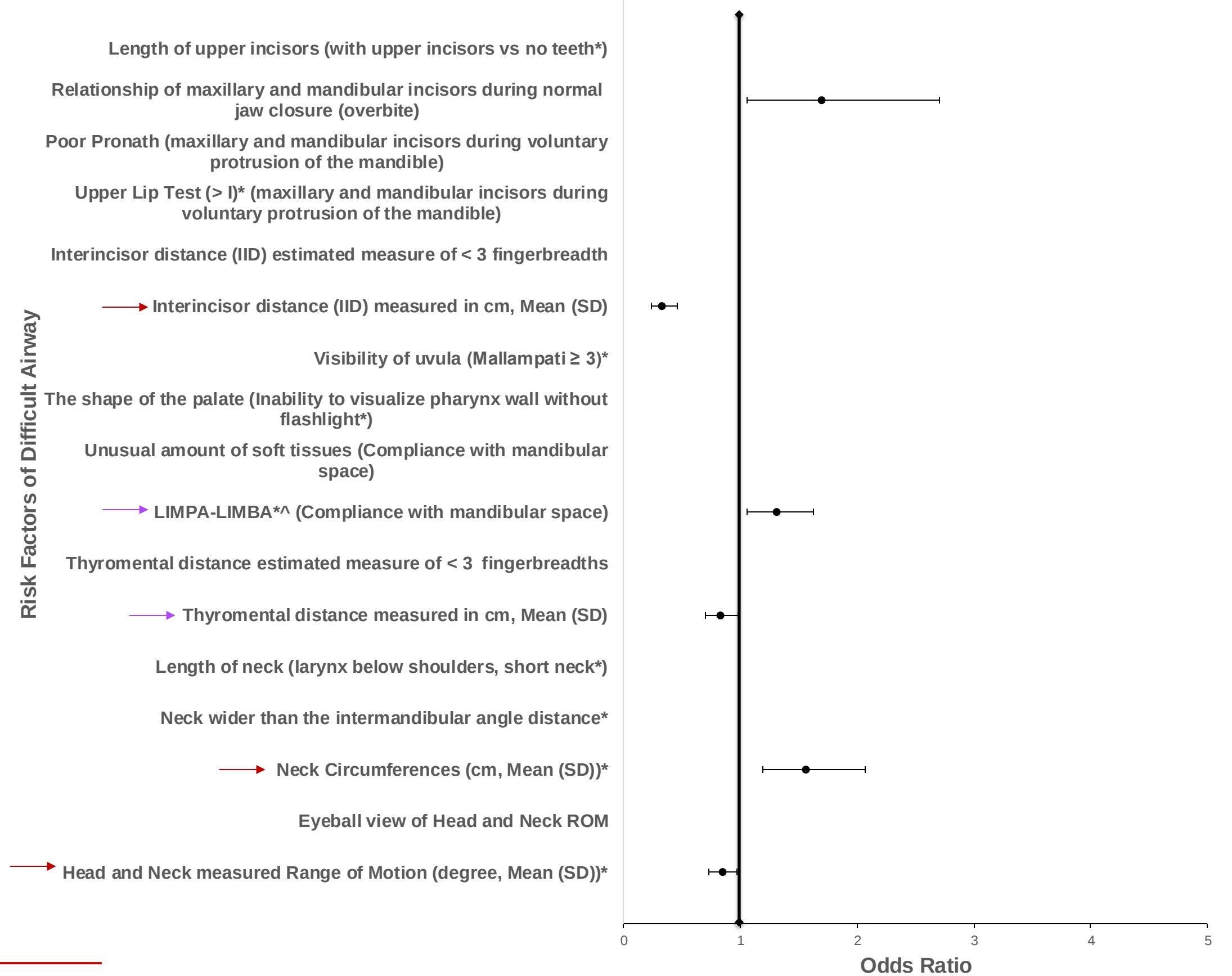
References

- Bannister FB, Macbeth RG: Direct laryngoscopy and tracheal intubation. Lancet 1944; ii: 651–4
- Apfelbaum JL, Hagberg CA, Connis RT, et al. 2022 American Society of Anesthesiologists practice guidelines for management of the difficult airway. Anesthesiology. 2022 Jan 1;136(1):31-61.
- Wang Z, Jin Y, Zheng Y, et al. Evaluation of preoperative difficult airway prediction methods for adult patients without obvious airway abnormalities: a systematic review and meta-analysis. BMC Anesthesiol 24, 242 (2024). <https://doi.org/10.1186/s12971-024-02627-1>
- Apfelbaum, J. L., Hagberg, C. A., Caplan, R. A., Blitt, C. D., Connis, R. T., Nickinovich, D. G., Hagberg, C. A., Caplan, R. A., Benumof, J. L., Berry, F. A., Blitt, C. D., Bode, R. H., Cheney, F. W., Connis, R. T., Gudivy, O. F., Nickinovich, D. G., Ovassapian, A., & American Society of Anesthesiologists Task Force on Management of the Difficult Airway (2013). Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Anesthesiology, 118(2), 251–270. <https://doi.org/10.1097/ALN.0b013e31827773b2>

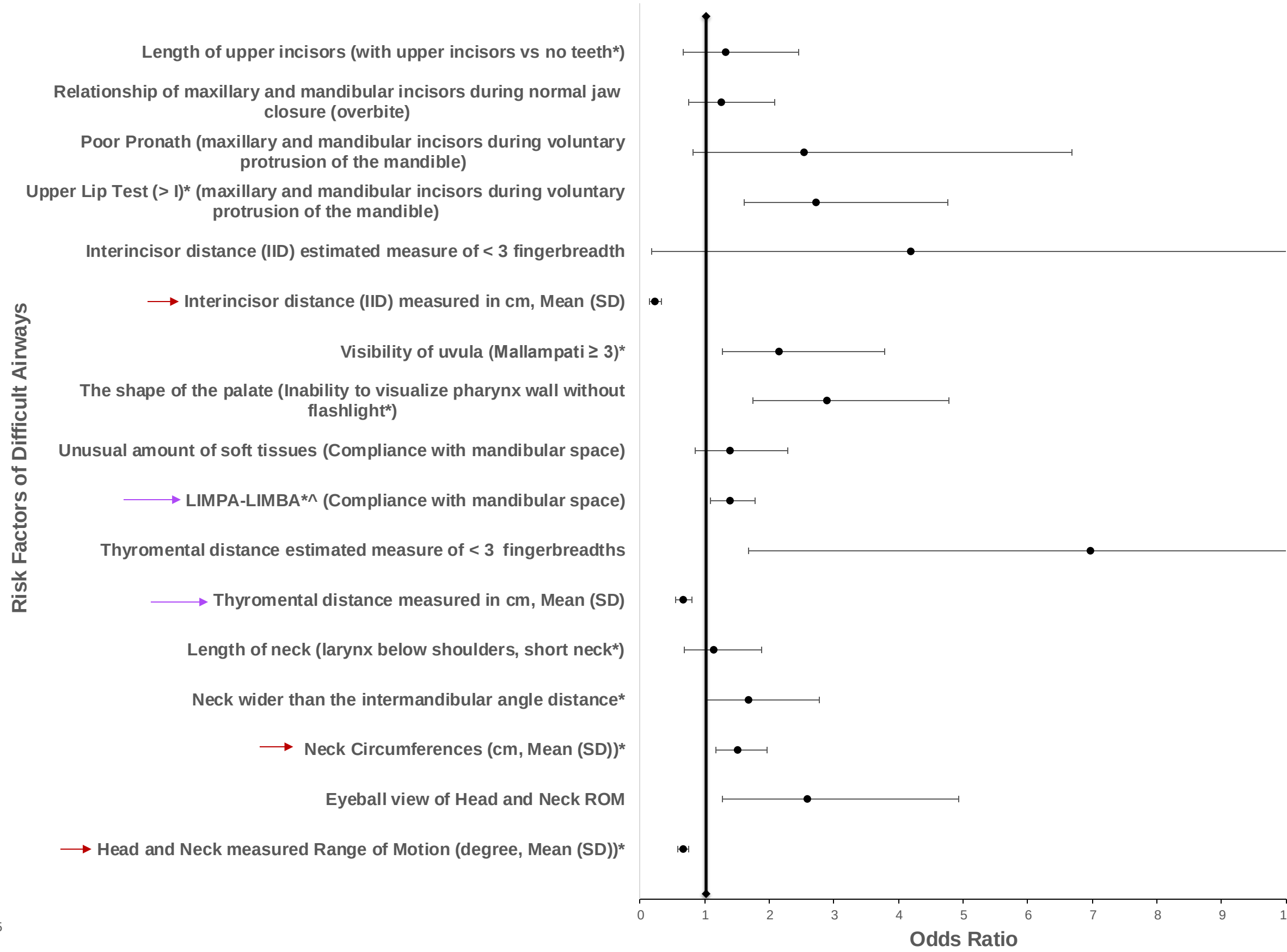
Odds Ratios of Difficult Laryngoscopy Univariate Logistic Regression



Odds Ratios of Difficult Laryngoscopy Multivariate Logistic Regression



Odds Ratios of Difficult Intubation Univariate Logistic Regression



Odds Ratios of Difficult Intubation Multivariate Logistic Regression

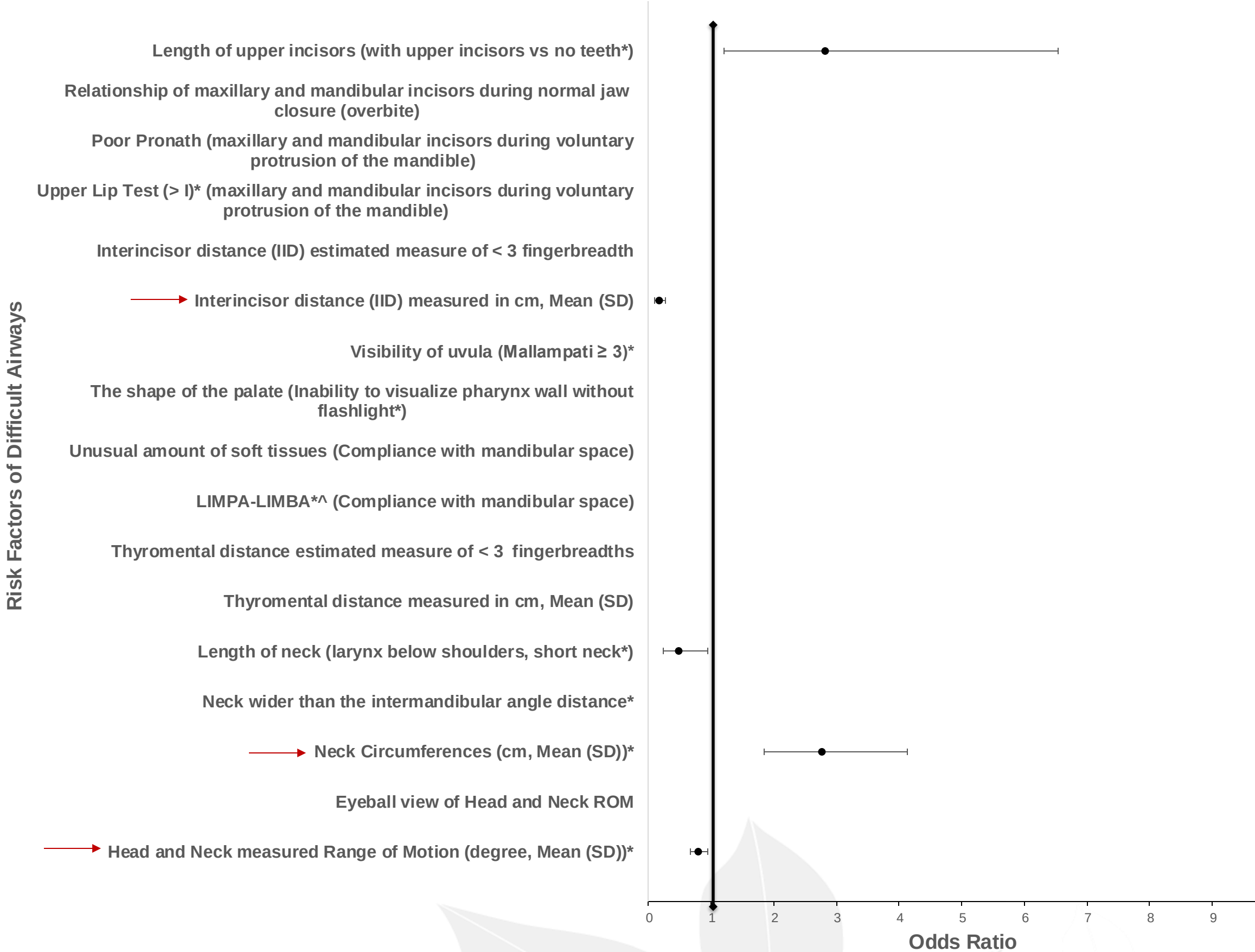


Figure 2: Forest plots of difficult airway predictive factors when compared to cases of difficult laryngoscopy and difficult intubation. Plotted are the Odds ratio with a 95% confidence interval as the error bars. The vertical line shows is plotted to show $x = 1$, where points plotted >1 or <1 show that factor was predictive of a case deemed as difficult airway. Colored arrows show significant results with $p < 0.05$.