

# Intubation Difficulty Scale and Influence of Preoperative Airway Assessment Tests in Elective Surgical Patients

Mohammad Sharif Oria MD, MPH<sup>1</sup>, Omran Omar Amarkhil MD<sup>2</sup>, Husniya Azim MD<sup>3</sup>,  
Sultan Ahmad Halimi MD, PhD<sup>4</sup>

Department of Anesthesiology, Aliabad Teaching Hospital, Kabul University of Medical Sciences, Karte Sakhi, Kabul, Afghanistan 1001

**Abstract:** ***Introduction:** The Intubation Difficulty Scale (IDS) is a method analogous to the Glasgow coma scale score. The values of the individual components may be documented to offer detail of the difficulties encountered. Preoperative airway assessment tests of patients in whom intubation is difficult would decrease the rate of anesthesia associated adverse complications. **Aim:** This study aimed to determine the prevalence difficult intubation and find out the sensitivity and specificity of the preoperative airway assessment tests among adult patients who were scheduled for elective surgery under general anesthesia patients in Aliabad Teaching Hospital, Kabul Afghanistan. **Method:** A cross sectional study was conducted among 341 patients based on the consecutive sampling. Independent variables recorded by observing preoperatively each preoperative airway assessment tests. Initial data was entered into an excel sheet and then exported to SPSS Statistics version 22 for further analysis. **Results:** A total of 341 patients were included in the study. The mean age of the participants was  $36.98 \pm 15.048$  years. The preoperative airway assessment tests associated with difficult intubation was investigated using bi-variable analysis with a  $p$ -value  $< 0.001$ . The study revealed that ability to prognath and mouth opening had poor sensitivity but good specificity in assessing negative and positive predictive values. The overall prevalence for difficult intubation were 26.7 %, 24.3% of the patients were had slight difficulty, 2.3% moderate to major difficulty in intubation, we were unable to intubate one patient using operation theatre's available instruments. **Conclusion:** The overall prevalence for difficult intubation were 26.7 %. Amongst all difficult intubation, 24.3% of the patients were had slight difficulty, 2.3% moderate to major difficulty in intubation. Combinations of independent variables add some valuable indicative importance compared to the value of each test alone.*

**Keywords:** Difficult intubation, airway assessment, anesthesia, intubation difficulty scale

## 1. Introduction

Airway management has been a remarkable contest for anesthesiologists (1). During routine anesthesia the incidence of difficult tracheal intubation has been estimated at 3 -18% (2).

Difficult tracheal intubation accounts for 17% of the respiratory related injuries and results in significant morbidity and mortality (3). There may be soft tissue injury, trauma and consequent airway edema, dental avulsion, unnecessary surgical airway, prolonged recovery, inability to maintain tissue oxygenation, brain injury, cardiorespiratory arrest, and even death (2).

Clearly, preoperative airway assessment tests of patients in whom intubation is difficult would decrease the rate of anesthesia related adverse respiratory events. If the anesthetist can predict which patients are likely to prove difficult to intubate, he may reduce the risks of anesthesia considerably (4).

The majority of difficult intubations (98% or more) may be anticipated by performing a thorough evaluation of the airway in advance. Nevertheless, many clinicians pay little attention to this important task and limit their examination of the airway to a superficial examination of the mouth and teeth (5).

The preoperative airway assessment tests included variables are gender, age, Mallampati score (MP), mouth opening (MO), thyromental distance (TMD), ability to prognath (AP)

and neck mobility and size (NM) (6).

The Intubation Difficulty Scale (IDS) is in a method analogous to the Glasgow coma scale score, the values of the individual components may be documented to offer detail of the difficulties encountered, then a composite score is summed to provide an overall assessment of difficulty. Each of these parameters has been demonstrated to contribute to the degree of difficulty of airway management by endotracheal intubation. We evaluated the IDS in a prospective investigation in operating room (7). IDS score, the operation of seven parameters, resulting in an ongoing, quantitative persistence of intubation elaboration, was used. This score was estimated by the operator instantly after intubation (6).

This study will consider the prevalence difficult Intubation during laryngoscopy for general anesthesia in adults and find out the sensitivity and specificity of the preoperative airway assessment tests which attempts to prepare a base-line data for future researches.

## 2. Methods

This research was registered in the Scientific Research Center of Kabul University of Medical Sciences review committee, and informed consent was taken from all the patients.

This was a cross-sectional study conducted in Aliabad Teaching Hospital (ATH), Kabul University of Medical

Sciences located in west of Kabul city from 28<sup>th</sup> of October 2018 to 30<sup>th</sup> of January 2019.

The patients who were admitted and scheduled for elective surgery under general anesthesia to Neurosurgery, Orthopedics, Urology and General surgery wards of ATH were selected and a verbal briefing was done to introduce the study, the objectives and methodology of the study. The informed consent form was then translated to Dari for the purpose of data collection. Once the participants agreed to take part in the study, they were asked to sign the informed consent form. The sample size estimation is based on the consecutive sampling, a common practice is to select all the cases that are available in a given period of time or to select a sample size based on a previous study (8).

All patients operated on in the specified study period were included. The study ended after successful tracheal intubation was confirmed by assessment of chest movement and auscultation.

#### Inclusion criteria:

All patients older than 18 years, ASA physical status I, II or III, both gender who required general anesthesia and orotracheal intubation.

#### Exclusion criteria:

Patients with facial abnormalities, both congenital and traumatic in whom preoperative airway assessment tests was not possible, such as comatose patients or patients requiring cervical spine immobility. Patients undergoing emergency surgery, with a full stomach, tracheostomized, and those not receiving neuromuscular blocker also American Society of Anesthesiologists Score (ASA)  $\geq$  IV.

Independent variables which were Mallampati score, Mouth opening, Thyromental distance, Ability to prognath, Neck

mobility and size variables. These variables were obtained through the data collection sheet.

#### Statistical analysis

Initial data was entered to excel data form and then exported to IBM SPSS Statistics version 22 for windows for further analysis.

The descriptive statistics, binary logistic regression and Receiver operating characteristics (ROC) curve were performed using SPSS. All variables were categorical and the significance of their correlation was studied using chi-square ( $\chi^2$ ) analysis. Pearson's ( $\chi^2$ ) test on proportion was used to examine the crude associations between binary and independent variables. However, if 20% or more cells had expected count less than 5, Fisher's exact test was used. The level of statistical significance was set as  $p < 0.05$ .

The validity of parameters such as sensitivity, specificity, odds ratio and 95% confidence intervals were performed using crosstabs on SPSS, whereas positive predictive values and negative predictive values were calculated manually from the descriptive statistics.

### 3. Results

From 28<sup>th</sup> of October 2018 to 30<sup>th</sup> of January 2019, a total of 341 patients met the conditions admitted to ATH signed the informed consent form to participate in the study. Nine patients were eliminated from consideration because of non-standardized conditions. Finally, 341 complete sets of data collection sheets were obtained. 193 (56.60%) were males and 148 (43.40%) females. The age of the subjects ranged from 18 years to 65 years with mean age of  $36.98 \pm 15.048$  years

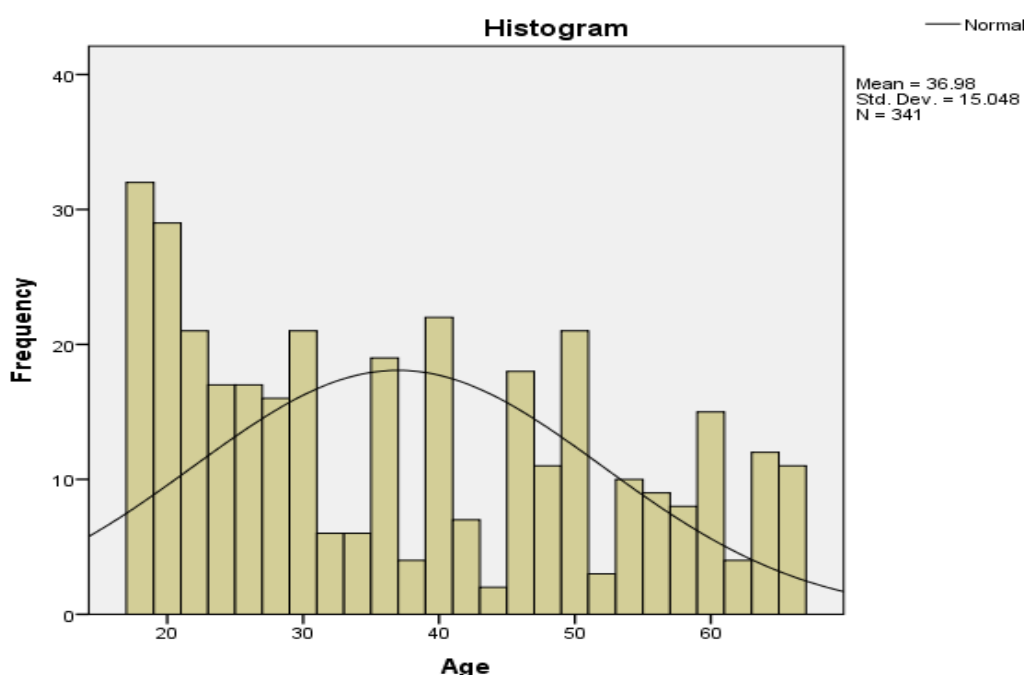


Figure 1 Age of the patients

Figure 1 describes that distribution of the age of the patients is normal.

**Table 1:** Preoperativepreoperative airway assessment tests and their distribution among surgical patients in in Aliabad Teaching Hospital

| Preoperative airway assessment tests | Classification               | Frequency | Percentage |
|--------------------------------------|------------------------------|-----------|------------|
| Mallampati classes                   | Class IV                     | 2         | 0.6        |
|                                      | Class III                    | 24        | 7          |
|                                      | Class II                     | 101       | 29.6       |
|                                      | Class I                      | 214       | 62.8       |
| Mouth opening                        | $\leq 4$ cm                  | 24        | 7          |
|                                      | $> 4$ cm                     | 317       | 93         |
| Thyromental distance                 | $\leq 6$ cm                  | 25        | 7.3        |
|                                      | $> 6$ cm                     | 316       | 92.7       |
| Ability to prognath                  | Overbite, Poor extension     | 34        | 10         |
|                                      | Normal bite, Easy to reverse | 23        | 6.7        |
|                                      | No overbite, Good extension  | 284       | 83.3       |
| Neck mobility and size category      | $< 30^\circ$ short neck      | 15        | 4.4        |
|                                      | $\geq 30^\circ$ short neck   | 9         | 2.6        |
|                                      | $\geq 30^\circ$ normal neck  | 317       | 93         |

**Prevalence of difficult intubation**

The overall prevalence of difficult intubation was 26.7 %.  
From 341 patients, 73.3% was recognized as easy

intubation. The prevalence of difficult intubation was found to be and 8/341 (2.3%).

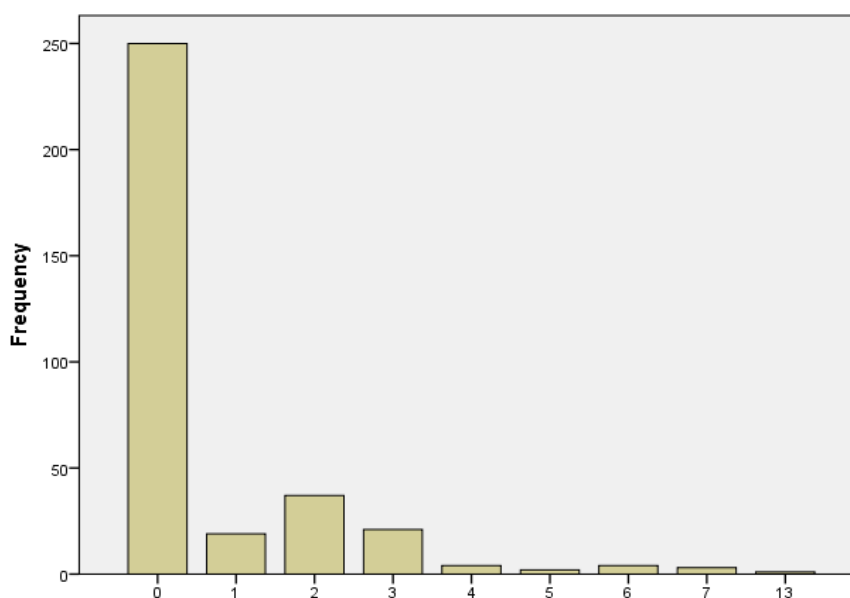
**Figure 2:** Intubation Difficulty Scale

Figure 2 describes that easy intubation detected in 250 (73.3%) patients, whereas overall prevalence of difficult Intubation were found in 91 (26.7%) number. 83 (24.3%) patients were had slight difficulty (IDS = 5), 7 (2.1%) patients were had moderate to major difficulty in intubation (IDS > 5), and only 1 patient (0.3%) detected as failed intubation (IDS > 7).

Table 2 shows significant preoperative airway assessment tests associated with difficult intubation. As the analysis indicates, patients whose in Mallampati classes III and IV had higher risk of difficult intubation compared to those were in Mallampati classes I and II, with an odds ratio of 9.2 and its correspondent 95% confidence interval (3.7-22.7). Patients whose mouth opening was less or equal to 4 cm had higher risk of difficult intubation as compared to

those with mouth opening of more than 4 cm, with an odds ratio of 10.0 and its correspondent 95% confidence interval (3.8-26.1). Patients who had thyromental distance less or equal to 6 cm getting more difficult intubation than those who had thyromental distance more than 6 cm, with an odds ratio of 4.0 and its correspondent 95% confidence interval (1.7-9.1). People who had no overbite, good extension, normal bite and easy to reverse their jaw had lower risk of difficult intubation as compared to those who had overbite and poor extension of their teeth, with odds ratio of 12.1 and its correspondent 95% confidence interval (5.2-28.0). Moreover, Patients who had limited neck mobility predisposed to difficult intubation than those who did not have any reduction in neck mobility and size, with odds ratio of 8.0 and its correspondent 95% confidence interval (3.2-20.0).

**Table 2:** Results of Chi-square analysis for preoperative airway assessment tests significantly associated with difficult intubation

| Preoperative airway assessment tests |           | Difficult intubation |                 | OR (95% CI)        |
|--------------------------------------|-----------|----------------------|-----------------|--------------------|
|                                      |           | Present<br>n (%)     | Absent<br>n (%) |                    |
| Mallampati classes                   | Difficult | 19 (73.1)            | 7 (26.9)        | 9.2<br>(3.7-22.7)  |
|                                      | Easy      | 72 (22.9)            | 243 (77.1)      |                    |
| Mouth opening                        | ≤4 cm     | 18 (75.0)            | 6 (25.0)        | 10.0<br>(3.8-26.1) |
|                                      | >4 cm     | 73 (23.0)            | 244 (77.0)      |                    |
| Thyromental distance                 | ≤6 cm     | 14 (56.0)            | 11 (44.0)       | 4.0<br>(1.7-9.1)   |
|                                      | >6 cm     | 77 (24.4)            | 239 (75.5)      |                    |
| Ability to prognath                  | Difficult | 26 (76.5)            | 8 (23.5)        | 12.1<br>(5.2-28.0) |
|                                      | Easy      | 65 (21.2)            | 242 (78.8)      |                    |
| Neck mobility and size               | Difficult | 17 (70.8)            | 7 (29.2)        | 8.0<br>(3.2-20.0)  |
|                                      | Easy      | 74 (23.3)            | 243 (76.7)      |                    |

### Measures of preoperative airway assessment tests' Sensitivity, Specificity, PPV and NPV for difficulty in intubation

Table 3 shows that Mallampati classes (MP), Mouth opening (MO), Ability to prognath (AP) and Neck mobility and size

(NM) were statistically significant ( $P < 0.05$ ), only Thyromental distance (TMD) was not statistically significant ( $P = 0.121$ ).

**Table 3:** Sensitivity, Specificity, Positive Predictive Values and Negative Predictive Values for preoperative airway assessment tests related to overall difficulty in intubation among surgical patients undergoing general surgery in Aliabad Teaching Hospital

| Predictors | Sn. (%) | Sp. (%) | PPV (%) | NPV (%) | Area  | Accuracy (%) | p-value | 95% C.I       |
|------------|---------|---------|---------|---------|-------|--------------|---------|---------------|
| MP         | 20.8    | 97.2    | 73      | 77.1    | 0.590 | 59.0         | 0.011   | 0.518 - 0.668 |
| MO         | 19.7    | 97.6    | 75      | 76.9    | 0.587 | 58.7         | 0.014   | 0.514 - 0.660 |
| TMD        | 15.3    | 96.5    | 56      | 75.6    | 0.555 | 55.5         | 0.121   | 0.483 - 0.627 |
| AP         | 28.5    | 96.8    | 76.4    | 78.8    | 0.674 | 67.4         | 0.000   | 0.554 - 0.700 |
| NM         | 18.6    | 97.2    | 70.8    | 76.6    | 0.579 | 57.9         | 0.025   | 0.507 - 0.651 |

\*Sn = sensitivity, Sp = specificity, PPV = positive predictive value, NPV = negative predictive value, C.I = confidence interval.

As the table illustrates, the ability to prognath showed upper accuracy (67.4%) followed by Mallampati classes (59%), mouth opening (58.7%), neck mobility and size (57.9%) and

thyromental distance (55.5%). Based on this table, the study model is acceptable.

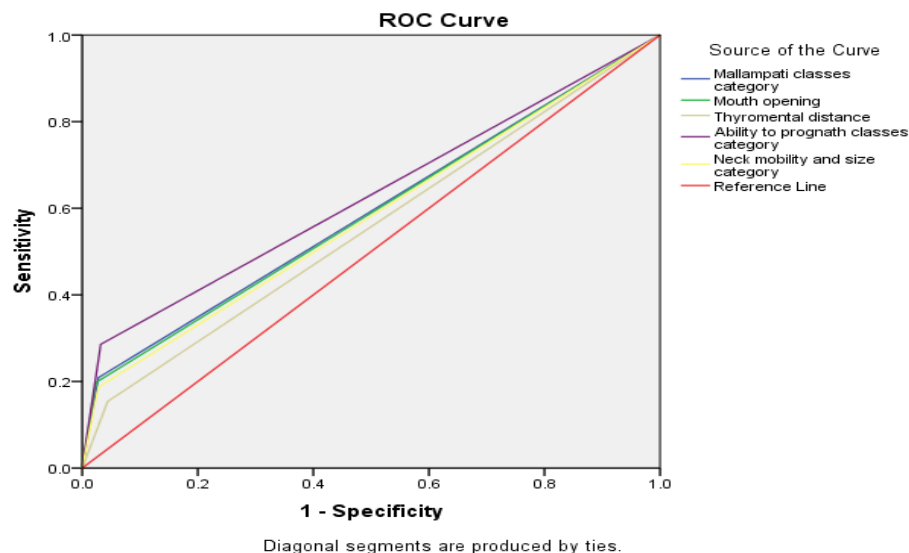
**Figure 3:** Receiver operating characteristics curve for preoperative airway assessment tests related to overall difficulty in intubation within the study population

Figure 3 shows that the receiver operating curve of the preoperative airway assessment tests for overall difficulty in intubation were above the reference line (0.5) with the area under the curve, this means that the correlation between a preoperative predictors and overall difficulty in intubation is positive.

When the measure of existence of at least one preoperative airway assessment tests was considered. For this risk category, the sensitivity is 35.1%, with a specificity of 86.8%. We also tried to find the best possible combination in order to increase the sensitivity without much changing the specificity. The results are presented in Table 4.

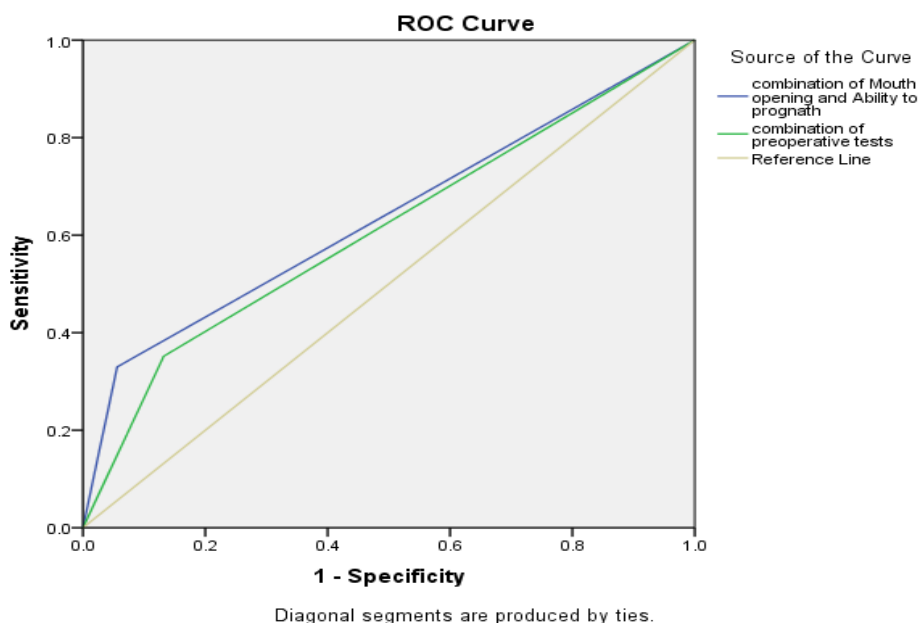
**Table 4:** Sensitivity, Specificity, Positive Predictive Values and Negative Predictive Values for included preoperative airway assessment tests in different combinations related to overall difficulty in intubation

| Preoperative airway assessment tests | Sn. (%) | Sp. (%) | PPV (%) | NPV (%) | Area  | p-value | 95% C.I       |
|--------------------------------------|---------|---------|---------|---------|-------|---------|---------------|
| MO + AP                              | 32.9    | 94.4    | 68.1    | 79.4    | 0.637 | 0.000   | 0.565 – 0.709 |
| MP+ TMD +MO+ AP+ NM                  | 35.1    | 86.8    | 49.2    | 78.6    | 0.610 | 0.002   | 0.538 – 0.681 |

\*Sn = sensitivity, Sp = specificity, PPV = positive predictive value, NPV = negative predictive value, C.I = confidence interval.

Combination of mouth opening and ability to prognath appeared to be more sensitive and best combinations for prediction of overall difficult intubation within the study population, because of combinations (MO and AP) showed good sensitivity and specificity. When these two were studied together as a combination, the sensitivity improved to 32.9 %. However, there was no significant improvement in sensitivity and specificity when other variables were

included in different combinations. But when all the five variables were included, the sensitivity slightly increased from 32.9 % to 35.1%, with a decrease in specificity from 94.4 % to 86.6%. We notice that independent preoperative airway assessment test had very high specificity but a lower sensitivity, as compared to preoperative airway assessment tests when combined together.

**Figure 4:** Receiver operating characteristics curve for included preoperative airway assessment tests in different combinations related to overall difficulty in intubation within the study population

#### 4. Discussion

Airway management has been a remarkable urge for anesthesiologists (1). The role of anesthetist assistant is important in influencing the outcome of an airway crisis. All the decisions about alternative options in case of difficulty should be done with the anesthetic assistant before induction of anesthesia (9).

The overall prevalence of difficult intubation was found 26.7 %, while 24.3% had slight difficulty (IDS = 5), 2.3% moderate to major difficulty (IDS > 5) in intubation, which were in line with the study conducted by Garg & Dua in overall prevalence of difficult intubation and lower than what were reported by Smita *et al.*, Schmitt *et al.* and Adnet *et al.*, they reported slight intubation difficulty in 48.5%, 37% and 37.3%, also moderate to major difficulty in 4.5%, 8% and 7.7% of patients (1, 6, 7, 10).

The study outcomes by Crosby *et al.*, showed the incidence of difficult intubation as 1.5 - 8.5% (11). Our findings on the subject of difficult intubation prevalence (IDS > 5) 2.3%, were to be lesser compared to studies by Savva D. *et al.* (12), Khan ZH *et al.*, (13), Bilgin H, Ozyurt G, Yildiz TS *et*

*al.*, (14), Keyvan *et al.*, (15), Bhavdip *et al.*, (16) and Tse *et al.*, (17) who reported as 4.9%, 5% & 4.8% %, 8.24%, 8.1%, 13.1% respectively. This may be because of differences on the definition of difficult intubation, for instance Tse *et al.*, (17) and Shiga *et al.*, (18) were defined difficult intubation as laryngoscopy grade III & IV. But, in our study, we defined difficult intubation as more than three attempts or more than 10 minutes to complete tracheal intubation based on ASA definition (11), also whenever IDS score were more than five, considered as difficult intubation (1). Differences in the definition of difficult intubation may contribute to the difference in the extent of difficult intubation, this intern may play a role for the variation of predictive values of preoperative tests among different studies as we have seen from the above findings. In addition, this might be again because of the effect of physical characteristics of the study population, sample size and cut off point values.

With regard to preoperative airway assessment tests of difficult intubations among the study population, Chi-square analysis revealed that Mallampati classes, mouth opening, thyromental distance, ability to prognath and neck mobility and size had higher risks of difficult intubation. Garg & Dua have reported similarly (6). Besides, Brodsky *et al.*, have

assessed with a number of preoperative airway assessment tests methods including Mallampati, neck circumference, mouth opening and thyromental distance (19). Class III upper lip bite test (similar to AP in our cases), IID <4.5 cm (similar to MO in our cases), TMD <6.5 cm, and SMD <13 cm were defined as predictors of difficult intubation in the study conducted by Khan ZH *et al.*, (13). Furthermore, Sileshi Abiy Workeneh *et al.*, indicates that mouth opening and Mallampati classes III and IV are the most sensitive assessments for predicting difficult intubation (20).

Concerning to sensitivity, specificity, PPV and NPV of the independent variables for overall difficult intubation, our study showed that poor sensitivity and but good specificity, negative predictive, positive predictive values, which were in line to the study by Garg & Dua specificity and positive predictive values for difficult intubation (6). Combination of mouth opening and ability to prognath appeared to be more sensitive and best combinations for prediction of overall difficulty in intubation which were in difference to Garg & Dua finding, they reported Mallampati classes and ability to prognath as a best combinations for prediction of overall difficult intubation (6). We recognize sensitivity 35.1%, specificity = 86.6%, PPV 49.2 % and NPV 78.6 % measures being all of the five preoperative airway assessment tests in use. Besides sensitivity 32.9 %, specificity 94.4 %, PPV 68.1 % and NPV 79.4 % measures being for mouth opening and inability to prognath. Conversely Johom *et al.*, had reported that the validity of positive predictive value of MP increased from 27 to 100% after combining other preoperative airway assessment tests (21).

## 5. Conclusions and Recommendations

The overall prevalence for difficult intubation were 26.7 %. Amongst all difficult intubation, 24.3% of the patients were had slight difficulty, 2.3% moderate to major difficulty in intubation, and 1 patient detected as failed intubation. Currently existing preoperative tests for difficult intubation have only poor to moderate inconsistent power when used alone. Therefore, combinations of independent variables add some valuable indicative importance compared to the value of each test alone. Literatures have also recommended that the use of combined preoperative tests in predicting difficult intubation. The descriptive information can be used in describing the pattern of the difficult intubation that lead to preventive and control program, therefore required further investigation.

## 6. Limitations of the study

The findings of this study may not reflect the prevalence of difficult intubation in afghan population. However, these 341 samples are representative of patients admitted to the surgical wards of Aliabad Teaching Hospital. A larger sample size with more widespread preoperative airway assessment tests would have provider more information.

## Authors' Contributions

Mohammad Sharif Oria: Writing draft of the paper, data collection and data analysis.

Omran Omar Amarkhil: Data entry, data collection and literature review.

Husniya Azim: Data collection, data entry and drafting the table and figures.

Sultan Ahmad Halimi: Idea of the paper, data collection and results description.

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