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POSITIVE PREDICTIVE VALUE OF RESTRICTED NECK MOVEMENT IN ASSESSING DIFFICULT INTUBATION TAKING INTUBATION DIFFICULTY SCALE AS GOLD STANDARD

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Abstract:
Introduction: *Airway maintenance during anesthesia is crucial for adequate oxygenation and ventilation and failure to secure airway can lead to tissue hypoxia and ultimately death. The three main causes of respiratory related injuries of anesthesia are inadequate ventilation, esophageal intubation and difficult tracheal intubation. 17% of all respiratory related injuries are due to difficult intubation and it accounts for 28% of anesthesia related deaths'.*
Subjects and Methods: *This study involved 126 patients of both genders, aged between I8-70 years undergoing general anesthesia with endotracheal intubation on elective lists Difficult intubation was predicted on restricted neck movement (<80°) and was confirmed on IDS. IDS diagnosis was taken as gold standard and results of restricted neck movement were evaluated accordingly. Written informed consent was taken from every patient.*
Results: *The age of the patients ranged from 18 years to 70 years with a mean of 42.49 ± 14.56 years. There were 64 (50.8%) male and 62 (49.2%) female patients in the study group. There were 52 (41.3%) obese patients. Difficult intubation was confirmed in 90 (71.4%) patients on intubation difficulty scale (as per operational definition). 1'he frequency of difficult intubation was higher among obese patients (80.8% vs. 64.9%; p 0.052) however the difference was insignificant. There were 90 (71.4%) true positive patients with 36 false positive patients. It yielded a positive predictive value of 71.4% for restricted neck movement in the prediction of difficult intubation taking IDS as gold standard. Similar positive predictive value was observed across age, gender and obesity groups.*
Conclusion: *The positive predictive value of restricted neck movement (<80°) was found to be 71.4% in predicting difficult intubation among patients undergoing general anesthesia with endotracheal intubation on elective list while taking intubation difficulty scale as the gold standard.*
Keywords: *Difficult Intubation. Intubation Difficulty Scale. Restricted Neck Movement.*

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INTRODUCTION:

Airway maintenance during anesthesia is crucial for adequate oxygenation and ventilation and failure to secure airway can lead to tissue hypoxia and ultimately death [1]. The three main causes of respiratory related injuries of anesthesia are inadequate ventilation, esophageal intubation and difficult tracheal intubation. 17% of all respiratory related injuries are due to difficult intubation and it accounts for 28% of anesthesia related deaths'. Precise pre-operative assessment of airway is therefore extremely important to identify high risk patients and adopt appropriate measures to reduce the morbidity) and mortality in patients with difficult intubation [2]. Such a tool should have high positive predictive value so that normal patients are not wrongly subjected to high risk protocols thus avoiding wastage of resources and manpower'. Until now a number of pre-operative screening tests have been devised with variable positive predictive value (PPV); Mallampati score (59.3%), Cormack-Lehane score (78.6%), short thyromental distance (81.6%)4 and upper lip bite test (72.8%) But all these tests have their own limitations and demerits particularly the interobserver reliability [3, 4]. Thus, there has always been a need for simple, pre-operative screening test which is reproducible with acceptable positive predictive value [5].

Nasa el al. in 2014 reported the positive predictive value of neck extension test (neck extension < 80°) to be 76% in predicting difficult intubation taking intubation difficulty scale (IDS) as gold standard 6. Similar acceptable positive predictive value for neck extension was previously reported by Orozco-Diaz et al. in 2010 (67%) However, there has been a discrepancy between the results where Srinivasa et al. in 2014s and Cattano et al. in 20049 reported it to be 40% and 9% respectively. Considering the results of Nasa et al. and Orozco-Diaz et al. neck extension test carries positive predictive value which is comparable to those of other screening tests mentioned above [4]. It also offers the advantage of being simple, non-invasive and cost-effective6. However, there is controversy surrounding its positive predictive value (9%9 - 76% 6). Moreover, as the positive predictive value varies with prevalence and to the best of candidate's knowledge no such local published material exists, there is need for the present study to confirm the positive predictive value of neck extension in determining the difficult intubation in local population. The results of this study may thus provide a quick and easy to perform screening test to identify high risk patients in future practice [6, 7].

LITERATURE REVIEW

The primary purpose of airway management is to oxygenate the patient, as loss of the airway is associated with hypoxemia causing significant morbidity and mortality. Patients need successful airway management as part of a general anesthetic or for resuscitation when a patient is in extremis. Difficulty achieving satisfactory ventilation and oxygenation is a medical emergency, where prevention is better than the cure, and adverse outcomes follow rapidly with unprepared attempts by unskilled practitioners. Since the ASA closed claims studies [10], the critical importance of recognizing the difficult airway and preventing hypoxia has been a primary aspect of airway training. The advent of neuromuscular relaxants in the 1950s ushered in an era of tracheal intubation as this was considered the most effective way to ensure adequate ventilation during surgery. As a result, the vast majority of published literature looks at prediction of difficult tracheal intubation. However, mask ventilation is an equally critical component of successful airway management. Successful mask ventilation provides practitioners with a rescue technique during unsuccessful attempts at laryngoscopy and unanticipated difficult airway situations.

Difficulty with both tracheal intubation and mask ventilation is associated with increased risk of patient injury. Several clinical models and tests have been described for the prediction of difficult intubation and mask ventilation. These screening tests use history elements and quantitative or estimated measures of various aspects of the face, upper airway, and neck to ascribe either high or low risk of an expected difficult airway. In order to better understand the performance and accuracy of these tests, a working understanding of the anatomy of the structures of interest is essential [12]. A variety of systemic and local tissue factors impact the ease of tracheal intubation and mask ventilation. While the elective situation permits a rigorous examination of the airway, certain urgent and emergent clinical scenarios preclude a complete and thorough airway examination, making difficult airway situations more likely but less predictable. Irrespective of the urgency of airway instrumentation, clinical suspicion of a difficult airway helps prepare the practitioner for backup airway management strategies that often require additional personnel, equipment, and techniques for successful tracheal intubation. The purpose of this chapter is to describe the clinical features associated with the difficult airway and explore the clinical utility of these features on prediction of difficult mask ventilation and difficult tracheal intubation [13].

2.1 The Difficult Airway

Considerable variability exists in the literature definition of the difficult airway (DA) has not been clearly established in the literature. Differences in study design, assessment tools, operator skill, and relevant metrics tor defining difficulty have contributed to this lack of consensus. Most studies have divided the difficult airway into two components: difficult mask ventilation (DMV) and difficult intubation. A difficult airway may then involve either component or both. Definitions for DMV. for example, may range from subjective anesthesiologist assessment to a need for four-hand ventilation1 or alternative intervention and additional personne [11].

Other metrics have included the presence of a clinically relevant gas leak during ventilation, a need for increased fresh gas flows above 15 L/min or use of oxygen flush valve more than twice12, lack of perceptible chest movement12, SpO2 <92% 12. and need for a different operator12. One recent classification of mask ventilation has been developed by Han and consists of 5 grades (Table 2.1).

Table 2.1 Classification of difficulty of mask ventilation

Grade 0	Ventilation by mask not attempted
Grade 1	Readily able to ventilate by mask
Grade 2	Able to ventilate by mask with oral airway or another adjuvant
Grade 3	Difficult mask ventilation (inadequate, unstable, or requiring two practitioners)
Grade 5	Unable to mask ventilate

Similarly, published metrics tor difficult intubation include requiring more than two attempts or more than 10 min with conventional laryngoscopy, requiring more than three or four attempts to successfully intubate, a perceived need for a stylet, and inability to intubate the trachea alter at least three unsuccessful attempts with stylet or by an experienced stall anesthesiologist1'. Adnet and coworkers proposed a continuum of difficulty based upon several parameters referred to as the Intubation Difficulty Scale (IDS), assigning numerical values to parameters such as number of attempts, number of operators, number of alternative techniques. Cormack and Lehanc laryngoscopic grade, increased lifting force, application of laryngeal pressure, and vocal cord mobility13.

OBJECTIVES

The objective of this study was to determine the positive predictive value of restricted neck movement in predicting difficult intubation taking intubation difficulty scale as gold standard.

MATERIALS AND METHODS:

Study Design: It was a cross-sectional survey.

Setting: Research was conducted at Department of Anesthesiology. Sir Ganga Ram Hospital, Lahore.

Duration of Study: Duration of study was 6 months after the approval of synopsis from 28/03/2016 to 27/09/2016.

Sample Size: Sample size of 126 cases was calculated with 95% confidence level and 5% margin of error while taking expected percentage of positive predictive value of restricted neck movement (<80°) to be 76% in the diagnosis of difficult intubation taking intubation difficulty scale as gold standard.6

Sampling Technique: Patients were selected by Non-probability. Consecutive Sampling.

Sample Selection 5.6.1 Inclusion criteria: Patients of both genders, aged between 18-70 years undergoing general anesthesia with endotracheal intubation on elective list.

- Patients who exhibited restricted neck movement (as per operational definition).
- Patients who signed written informed consent to participate in the study.

Exclusion criteria: • Patients with a mass in front of the neck e.g. goiter (clinical examination).

- Patients with previous surgical scar or contracture on neck (clinical examination).
- Patients with nasopharyngeal growth (history and clinical record).

DATA COLLECTION PROCEDURE

Alter approval from hospital's ethical review committee. 126 patients admitted at Sir Ganga Ram Hospital Lahore undergoing surgical procedure under general anesthesia with endotracheal intubation on elective list meeting the inclusion criteria were included into this study Detailed history and written informed consent was obtained. Restricted Neck Movement (Neck extension < 80 degree) was assessed on pre-operative evaluation day before surgery. Per-operatively difficult intubation was confirmed on IDS (as per operational definition) and the results of restricted neck movement were judged accordingly. Patient s demographic details along with presence (true positive) or absence (false positive) of difficult intubation on IDS was noted in the attached proforma. All the pre- operative patients' examinations were done by a single resident (candidate herself) and all the operative table assessments were done by a single consultant to eliminate bias. Confounding variables were controlled by exclusion.

DATA ANALYSIS PROCEDURE

All the collected data was entered and analyzed through SPSS version 20

1 Numerical variables; age has been presented by mean ± SD.

2. Categorical variables, gender, difficult intubation on IDS have been presented by frequency and percentage.

3. Data has been stratified for age. gender and obesity (BMI > 30Kg m2) to address effect modifiers. Post-stratification chi-square test has been applied taking p-value <0.05 as significant.

4 A 2x2 contingency table has been generated to calculate positive predictive value of restricted neck movement in the diagnosis of difficult intubation while taking intubation difficulty scale as gold standard.

RESULTS:

The age of the patients ranged from 18 years to 70 years with a mean of 42.49 + 4.56 years. There were 64 (50.8%) male and 62 (49.2%) female patients in the study group. There were 52 (41.3%) obese patients. These findings have been summarized in Table 8.1.

Difficult intubation was confirmed in 90 (71.4%) patients on intubation difficulty scale (as per operational definition). The frequency of difficult intubation was higher among obese patients (80.8% vs. 64.9%; p 0.052) however the difference was insignificant as shown in Table 8.2 There were 90 (71.4%) true positive patients with 36 false positive patients. It yielded a positive predictive value of 71.4% for restricted neck movement in the prediction of difficult intubation taking IDS as gold standard as shown in Table 8.3. Similar positive predictive value was observed across age, gender and obesity groups as shown in Tables 8.4 - 8.6.

Table 8.1 Baseline Characteristics of Study Population

Characteristics	Participants (n - 126)
Age (Years)	42.49 + 14.56 (18 - 70)
Gender	
Male	64 (50.8%)
Female	62 (49.2%)
Obese	
Yes	52 (41.3%)
No	74 (58.7%)

Table 8.2 Frequency of Difficult Intubation on IDS

Characteristics	n	Participants (n - 126)	P-Value
Overall	126	90 (71.4%)	-
Age Groups			
18 - 44 Years	74	52 (70.3%)	0.731
45 - 70 Years	52	38 (73.1%)	
Gender			
Male	64	46 (71.9%)	0.91
Female	62	44 (71.0%)	
Obese			
Yes	52	42 (80.8%)	0.052
No	74	48 (64.9%)	

Table 8.3 Stratification of Positive Predictive Value of restricted neck movement in predicting difficult intubation (n - 126)

Difficult intubation on RNM	Difficult intubation on IDS		Total	P-value
	Yes (90)	No (36)		
Yes	90 (71.4%)	36 (28.6%)	126 (100%)	N/A
No	0 (0%)	0 (0%)	0 (0%)	
Total	90 (71.4%)	36 (28.6%)	126 (100%)	

Chi-square test, N/A: No statistics are completed because Difficult Intubation on RNM is a constant.
True Positive = 90
False Positive = 36
Positive Predictive Value = 90 / 90 + 36 X 100 = 71.4%

Table 8.4 Stratification of Positive Predictive Value Across Age (n - 126)

Age	Difficult intubation on RNM	Difficult intubation on IDS		Total	P-value	PPV
		Yes (90)	No (36)			
18 - 44 (74)	Yes	52 (70.3%)	22 (29.7%)	74 (100%)	N/A	70.3%
	No	0 (0%)	0 (0%)	0 (0%)		
	Total	52 (70.3%)	22 (29.7%)	74 (100%)		
45 - 70 (52)	Yes	38 (73.1%)	14 (26.9%)	52 (100%)	N/A	73.1%
	No	0 (0%)	0 (0%)	0 (0%)		
	Total	38 (73.1%)	14 (26.9%)	52 (100%)		

Chi-square test, N/A: No statistics are completed because Difficult Intubation on RNM is a constant.

Table 8.5 Stratification of Positive Predictive Value Across Gender (n - 126)

Gender	Difficult intubation on RNM	Difficult intubation on IDS		Total	P-value	PPV
		Yes (90)	No (36)			
Male (64)	Yes	46 (71.9%)	18 (28.1%)	64 (100%)	N/A	71.9%
	No	0 (0%)	0 (0%)	0 (0%)		
	Total	46 (71.9%)	18 (28.1%)	64 (100%)		
Female (62)	Yes	44 (71.0%)	18 (29.0%)	62 (100%)	N/A	71.0%
	No	0 (0%)	0 (0%)	0 (0%)		
	Total	44 (71.0%)	18 (29.0%)	62 (100%)		

Chi-square test, N/A: No statistics are completed because Difficult Intubation on RNM is a constant.

Table 8.6 Stratification of Positive Predictive Value Across Obesity (n - 126)

Obesity	Difficult intubation on RNM	Difficult intubation on IDS		Total	P-value	PPV
		Yes (90)	No (36)			
Yes (52)	Yes	42 (80.8%)	10 (19.2%)	52 (100%)	N/A	80.80%
	No	0 (0%)	0 (0%)	0 (0%)		
	Total	42 (80.8%)	10 (19.2%)	52 (100%)		
No (74)	Yes	48 (64.9%)	26 (35.1%)	74 (100%)	N/A	64.90%
	No	0 (0%)	0 (0%)	0 (0%)		
	Total	48 (64.9%)	26 (35.1%)	74 (100%)		

Chi-square test, N/A: No statistics are completed because Difficult Intubation on RNM is a constant.

DISCUSSION:

I he foremost responsibility of an anesthesiologist is to maintain patency of the airway to allow oxygen to move down into the lungs to ensure adequate gas exchange. Inability to maintain ventilation and oxygenation for several minutes alter the patient is rendered apneic following induction of anesthesia results in catastrophic complications including death. Such problems account for 30 % of deaths occurring during anesthesia1. The difficult airway can be represented by difficulty with laryngoscopy, intubation and mask ventilation. Before an anesthetic is administered, it is of paramount importance to correctly diagnose and clinch potential airway problems to choose alternative modalities of airway management1'5'6. It is a kind of dress rehearsal before a potentially hazardous march on the enemy and should under no circumstances be under estimated. Approximately half of all cases of Dl are not predicted and this is particularly alarming as it can potentially turn into a life threatening event1.

Precise pre-operative assessment of airway is therefore extremely important to identify high risk patients and adopt appropriate measures to reduce the morbidity and mortality in patients with difficult intubation 2. Until now a number of pre-operative screening tests have been devised with variable positive predictive value (PPV); Malampati score (59.3%), Cormack-Lchane score (78.6%), short thyromental distance (81.6%)4 and upper lip bite test (72.8%)3. But all these tests have their own limitations and demerits particularly, the interobserver reliability.

Restricted neck movement has been shown to be a reliable pre-operative predictor of difficult intubation. It also has the advantage of being simple, non-invasive and cost-effective tool. However, the available evidence contained conflicting results (Table 9.1) while no such local published material was available.

The objective of this study was to determine the positive predictive value of restricted neck movement in predicting difficult intubation taking intubation difficulty scale as gold standard. It was a cross-sectional survey conducted at Department of Anesthesiology, Sir Ganga Ram Hospital Lahore over 6 months after the approval of synopsis from 28/03/2016 to 27/09/2016.

Table 9.1 PPV of Restricted Neck Movement in Existing Literature

Author	Year	Population	PPV
Karakus et al. 65	2015	Turkish	75.80%
Bhatnagarct al. 66	2005	Indian	77.00%
Nasa et al 6	2012	Indian	76.00%
Orozco-Diaz et al. 7	2010	Mexican	67.00%
Wong et al. 67	2016	Singapore	46.70%
Srinivasa et al. 8	2014	Indian	40.00%
Ciupta er al. 68	2010	Indian	34.60%
Cattano et al. 9	2004	Italian	9.00%
Present Study	2016	Pakistani	71.40%

In the present study, the positive predictive value of restrict neck movement was found to be 71.4%. Our results are in line with those of Karakus et al. 65 (2015) who reported similar PPV of 75.8% in Turkish population. Nasa et, al. 6 in 2012 (76%) and Bhatnagar e, al.66 in 2005 (77%) reported similar positive predictive value of restricted neck movement in Indian population while Orozco-Diaz et al. in 2010 reported relatively lower PPV of 67% in Mexican such patients.

The present study is first of its kind in local population and has found the positive predictive value of restricted neck movements to be 71.4% which is comparable to other preoperative predictors currently in practice; Mallampati score (59.3%), Cormack-Lehane score (78.6%). short thyromental distance (81.6%)4 and upper lip bite test (72.8%)3. However, compared to these methods, this new predictor is easy to perform, non-invasive and has high inter-observer reproducibility which makes it more ideal. On the basis of the results of the present study, it can be advocated that future patients who are planned for general anesthesia with endotracheal intubation should be assessed pre-operatively for restricted neck movements to identify patients who are high risk for difficult intubation. So that optimum measures can be undertaken to avoid failed intubation with consequent hypoxia and morbidity.
A very strong limitation to the present study was that we didn't consider the interobserver reproducibility of this clinical pre-operative predictor. Future studies addressing this aspect are therefore strongly recommended.

CONCLUSIONS:

The positive predictive value of restricted neck movement (<80°) was found to be 71.4% in predicting difficult intubation among patients undergoing general anesthesia with endotracheal intubation on elective list while taking intubation difficulty scale as the gold standard.

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