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Original Article

Neck Circumference as Sole Predictor of Cormack-Lehane Score and Difficult Intubation

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ABSTRACT

Objective: To determine if higher neck circumference correlates with greater Cormack-Lehane score and difficulty in intubation among patients undergoing orthopaedic surgery under general anaesthesia.

Study Design: Prospective longitudinal study

Place and Duration of Study: Combined Military Hospital, Rawalpindi, Pakistan from April to July, 2021.

Methodology: ASA I and II adult patients undergoing elective orthopaedic surgery planned under general anaesthesia who had a neck circumference greater than 40 cm were included in the study. Non-randomized, consecutive sampling was used and all eligible patients during the study period were included. Neck circumference at the level of the thyroid cartilage was measured by the resident during pre-anaesthesia assessment. Modified Cormack-Lehane Score (MCLS) for each patient was determined either by the senior (third or fourth year) resident or the consultant on duty. All intubations were performed either by a senior resident or the consultant. Intubation Difficulty Scale (IDS) score of 5 or more was considered a difficult intubation.

Results: 55 patients, of which 28(50.9%) were female, were included in the study. Mean age was 36.89±14.08 years. Mean neck circumference was 43.14±1.63 cm. 37(67.3%) had MCLS grade 2b or higher while 20(36.4%) had IDS score of 5 or higher. Greater neck circumference was found to be significantly associated with a higher MCLS grade (p=0.012) but not with a higher IDS score (p=0.055).

Conclusion: Neck circumference could have predictive value for MCLS grade but not directly for IDS score. Further studies are needed to determine utility of NC as sole predictor of difficult intubation.

Keywords: Neck circumference; endotracheal intubation; Intubation Difficulty Scale.

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INTRODUCTION

Tracheal intubation difficulties contribute significantly to the morbidity and death associated with anaesthesia. Identifying situations and patients who are at risk for airway management issues is critical to providing the best possible care, and it has been the subject of numerous studies.[1-8] Effective methods to predict problematic intubation are needed to avoid development of a disastrous situation where oxygenation and ventilation are compromised. If a difficult intubation happens suddenly in a patient after general anaesthesia has been induced and the patient's lungs cannot be effectively ventilated by mask or an endotracheal tube cannot be correctly inserted with other procedures, the patient's result may be catastrophic.[2,3] An unexpected difficult intubation is much harder to manage and is more likely to lead to morbidity and mortality than a planned difficult intubation.4 Inadequate preoperative examination of the airway and a lack of good prognostic testing for difficult intubation are most likely to blame for unexpected difficult intubations.[5] It is of vital importance to develop and employ methods that can effectively predict a difficult intubation. The vocal cords are made visible during direct laryngoscopy by placing the head in the "sniffing" position (extension of the head at the atlanto-occipital joint and upper part of the cervical spine, with flexion of the neck at the lower cervical spine). Several characteristics have been shown to predict the level of difficulty of visualization of the vocal cords and endotracheal intubation. History of obstructive sleep apnoea syndrome, a high Mallampati score, higher age, male sex, short neck, and atypical upper teeth are all suggested indicators of difficult endotracheal intubation as described in the literature.[9-13] In general, endotracheal intubation is considered to be more difficult in obese patients than in non-obese patients.[14] Obesity-related airway and respiratory alterations create challenges in airway management in obese patients. Excess fatty tissue can be found

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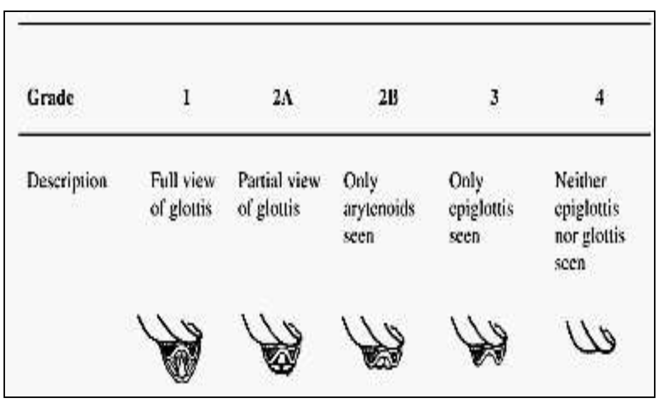
outwardly on the breast, neck, thoracic wall, and belly, as well as internally in the mouth, pharynx, and abdomen in obese patients. This extra tissue makes access to and patency of the upper airway (during sedation or mask ventilation) as well as lung function (decreased residual capacity and worsened ventilation perfusion mismatch) more difficult than in lean patients. However, it remains very difficult to predict if an obese patient will have a difficult laryngoscopy. Despite the fact that obesity is expected to increase the likelihood of difficult intubation, a high Body Mass Index (BMI) does not seem to predict difficult laryngoscopy.[15] Another marker of obesity, high neck circumference, has also been studied as a predictor of difficult laryngoscopy and difficult intubation.[16] In terms of the link between problematic intubation and high neck circumference, studies have discovered that none of the traditional indicators for difficult intubation are satisfactory in obese patients. Therefore it is important to study the association of neck circumference, being a marker of obesity, with difficult laryngoscopy and with endotracheal intubation, and its potential of being an independent predictor of both. Level of difficulty of direct laryngoscopy is generally measured in the literature by the Modified Cormack-Lehane Score (MCLS), with higher grades representing a more difficult direct laryngoscopy. MCLS is based on the proportion of the laryngeal inlet visualized after direct laryngoscopy and is a 5-point grading system.16 (Figure-1). Intubation Difficulty Scale (IDS) is a validated measure of intubation difficulty and is a seven-parameter function that yields a progressive, quantitative assessment of intubation complexity and a score of 5 or more is considered a difficult intubation.[17] (Figure-2).

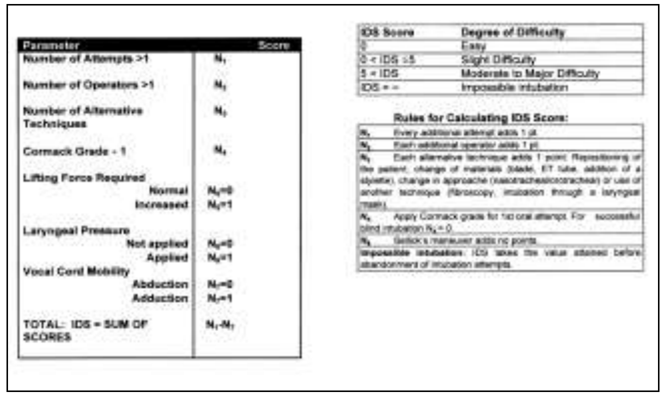


Grade	1	2A	2B	3	4
Description	Full view of glottis	Partial view of glottis	Only arytenoids seen	Only epiglottis seen	Neither epiglottis nor glottis seen

Figure-1: Modified Cormack-Lehane Scoring16

OBJECTIVE

The objective of this study was to determine if higher neck circumference correlates with difficult direct laryngoscopy (as measured by MCLS) and increased difficulty in intubation (as measured by IDS) among patients undergoing orthopaedic surgery under general anaesthesia.



Parameter	Score
Number of Attempts >1	N_1
Number of Operators >1	N_2
Number of Alternative Techniques	N_3
Cormack Grade - 1	N_4
Lifting Force Required	
Normal	$N_5=0$
Increased	$N_5=1$
Laryngeal Pressure	
Not applied	$N_6=0$
Applied	$N_6=1$
Vocal Cord Mobility	
Abduction	$N_7=0$
Adduction	$N_7=1$
TOTAL: IDS = SUM OF SCORES	N_1-N_7

IDS Score	Degree of Difficulty
0	Easy
0 < IDS ≤5	Slight Difficulty
5 < IDS	Moderate to Major Difficulty
IDS = ∞	Impossible intubation

Rules for Calculating IDS Score:

N_1	Every additional attempt adds 1 pt.
N_2	Each additional operator adds 1 pt.
N_3	Each alternative technique adds 1 point: Repositioning of the patient, change of materials (blade, ET tube, addition of a stylette), change in approache (nasotracheal/orotracheal) or use of another technique (fibroscopy, intubation through a laryngeal mask).
N_4	Apply Cormack grade for 1st oral attempt. For successful blind intubation N_4 = 0.
N_5	Sellick's maneuver adds no points.
Impossible intubation: IDS takes the value attained before abandonment of intubation attempts.	

Figure-2: Intubation Difficulty Scale (IDS)17

METHODOLOGY

This was Prospective longitudinal studyconducted at Department of Anaesthesiology, Combined Military Hospital Rawalpindi, Pakistan. The study was initiated after approval from Ethics Committee vide IERB no 224. Non-probability, consecutive sampling was used in this pilot study with convenience sampling and non-experimental design.

Inclusion Criteria: All subjects treated at the study centre during the study duration who met the eligibility were included. A total of 55 subjects were included after taking and documenting informed consent. Patients of either sex, 18 years of age or older, presenting in the Operation Theatres for elective orthopaedic surgery under general anaesthesia who had neck circumference greater than 40 cm (measured horizontally just below the thyroid cartilage) were included in the study.

Exclusion Criteria: Pregnant females, patients falling into an ASA category greater than II, patients needing emergency surgery, patients with known history of previous failed intubation, and patients with obvious mouth, neck and/or palate deformity were excluded.

Baseline demographics, vital signs, date, time, ASA score and type of surgery were recorded. Neck circumference at the level of the thyroid cartilage was measured by the resident during pre-anaesthesia assessment. MCLS for each patient was determined either by the senior (third or fourth year) resident or a consultant. All intubations were performed either by

a senior resident or a consultant. Data was analysed in Statistical Package for the Social Sciences (SPSS) version 23.00. For each group, descriptive statistics (frequency and percentages) were computed for categorical variables like ASA score and type of surgery. Mean ± Standard Deviation (SD) were calculated for quantitative variables like age, duration of surgery, and neck circumference. Level of difficulty of direct laryngoscopy was determined by MCLS, with higher grades representing a more difficult direct laryngoscopy. IDS score of 5 or more was considered a difficult intubation, as described in the literature.[17] Figure 2 shows the procedure for IDS scoring and interpretation of the score.

RESULTS

55 patients, of which 28(50.9%) were male, were included in the study. Mean age was 36.89±14.08 years. Demographic variables were not found to be significantly associated with IDS scores and difficult intubation (Table I). Mean neck circumference was 43.14 ± 1.63 cm. Median MCLS score was 2b and of the 55 subjects, 37(67.3%) had MCLS grade 2b or higher. Endotracheal intubation was accomplished for all study subjects (failure rate 0%). Correlation between neck circumference and MCLS grade was found to be statistically significant at the 0.05 level (p = 0.012), with higher neck circumference being associated with a higher MCLS grade. Median IDS score was 5 (Min 2; Max 8). Of the 55 subjects, intubation was determined to be difficult for 20(36.4%) since their IDS score was 5 or higher. A higher neck circumference was associated with a higher IDS score, but the association was not found to be statistically significant (p=0.055). A higher MCLS grade was significantly associated with a difficult intubation (p=0.010).

Table-I: Baseline Characteristics and Their Association with Difficult Intubation

			Difficult Intubation (IDS ≥ 5)				p-value
			Yes		No		
Baseline Characteristics	n(%)		n (%)		n (%)		
Sex	Male	Female	Male	Female	Male	Female	
	27(49.1%)	28(50.9%)	9(16.4%)	10(18.2%)	18(32.7%)	18(32.7%)	0.921
ASA Category	ASA I	ASA II	ASA I	ASA II	ASA I	ASA II	
	24(43.6%)	31(56.4%)	9(16.4%)	10(18.2%)	15(27.3%)	21(38.2%)	0.880
	Mean±SD		Mean±SD		Mean ± SD		
Age (Years)	36.89±14.08		37.42 ± 12.57		36.61 ± 14.98		0.903
Neck Circumference (cm)	43.14±1.63		44.03 ± 1.27		42.67 ± 1.62		0.055

Table-II: Correlation between Neck Circumference and MCLS Grade

	Neck Circumference (cm)								p-value
	≥40 - <41	≥41 - <42	≥42 - <43	≥43 - <44	≥44 - <45	≥45 - <46	>46	Total	
MCLS	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	
1	1(1.8%)	1(1.8%)	1(1.8%)	2(3.6%)	1(1.8%)	0(0.0%)	0(0.0%)	6(10.9%)	0.012
2A	2(3.6%)	4(7.3%)	1(1.8%)	3(5.5%)	1(1.8%)	1(1.8%)	0(0.0%)	12(21.8%)	
2B	0(0.0%)	3(5.5%)	3(5.5%)	5(9.1%)	0(0.0%)	9(16.4%)	1(1.8%)	21(38.2%)	
3	1(1.8%)	0(0.0%)	2(3.6%)	3(5.5%)	2(3.6%)	3(5.5%)	0(0.0%)	11(20.0%)	
4	0(0.0%)	0(0.0%)	0(0.0%)	2(3.6%)	1(1.8%)	2(3.6%)	0(0.0%)	5(9.1%)	
Total	4(7.3%)	8(14.5%)	7(12.7%)	15(27.3%)	5(9.1%)	15(27.3%)	1(1.8%)	55(100.0%)	

DISCUSSION

Obesity and difficult tracheal intubation have been linked in the literature, but there have been inconsistent findings. Obesity or morbid obesity has been linked to intubation difficulties in a number of studies but despite the fact that obesity is assumed to increase the likelihood of difficult intubation, a higher BMI has not been found to consistently predict difficult laryngoscopy or intubation. According to a meta-analysis, the risk of difficult intubation is three times higher in morbidly obese patients than in normal-weight people.[18] Authors used BMI>30 as the definition of obesity. Authors discovered that the rate of difficult intubation in obese patients was more than three times higher than in normal patients. Obese patients with a 15% pre-test probability of difficult intubation had a 34% chance of difficult intubation after a positive Mallampati test result, more than double the risk of the normal population with a 5% pre-test probability. In authors' opinion, obese people with excess soft tissue in the velopalate, retropharynx, and submandibular regions may have trouble with laryngoscopy. Some other studies, on the other hand, discovered no link between morbid obesity and difficult intubation while using BMI as the marker of obesity. In one study,

authors wanted to see if obesity, obstructive sleep apnoea, and neck circumference were linked to a higher risk of difficult intubation in individuals undergoing bariatric surgery.[19] There was no correlation between the existence and severity of obstructive sleep apnoea, BMI, or neck circumference and difficulty of intubation or laryngoscopy grade and only Mallampati scores of 3 or 4 or male gender were the only factors that predicted difficult intubation. Another study that explored the subject of obesity and difficult intubation did not find a correlation between the two.[20] The authors looked at morbidly obese patients (BMI >40) to see whether characteristics made direct laryngoscopy and tracheal intubation more difficult. The Mallampati score and preoperative measurements (height, weight, neck circumference, mouth opening, sternomental distance, and thyromental distance) were taken. The number of attempts at tracheal intubation was recorded, and the vision during direct laryngoscopy was assessed. Intubation difficulties were not found to be linked to absolute obesity or BMI. The only predictors of probable intubation issues were a large neck circumference and a high Mallampati score. The authors concluded that obesity alone did not predict tracheal intubation difficulties, but neck circumference could. It is therefore difficult to predict whether an obese patient will have a difficult laryngoscopy using BMI. Neck circumference has been used as an alternative to BMI as the predictor of a difficult laryngoscopy. On the link between neck circumference and difficult intubation, there is also scant literature and contradictory evidence. Some studies did not discover a predictive relationship between neck circumference and difficult intubation, but some other recently published studies did observe that a higher neck circumference indicated an increased risk of difficult intubation. One such study of morbidly obese patients undergoing general anaesthesia found that neck circumference more than 42 cm was an independent predictor of difficult intubation.[21] The main goal of the non-interventional, prospective study was to see if neck circumference and obesity were factors in difficult intubation in morbidly obese surgery patients. Difficult mask ventilation was one of the secondary outcomes. The study's primary outcome was difficult tracheal intubation defined as IDS of at least 5. Difficult intubation was linked to neck circumference, males with a BMI more than 50, ASA status, and waist circumference, while difficult mask ventilation was linked to neck circumference, males with a BMI greater than 50, ASA status, and thyromental distance. Neck circumference greater than 42 cm (p=0.044) and BMI greater than 50 (p = 0.017) were found to be independent predictors of difficult intubation in a multiple logistic regression analysis. Another study found that in obese patients, thyromental distance, higher neck circumference, higher BMI, and a Mallampati score of 3 were all related with a difficult intubation (IDS >5).[22] The authors wanted to confirm that obese patients were more difficult to intubate than lean patients using IDS. They looked at traditional bedside examinations as well as neck circumference, and evaluated the incidence of difficult tracheal intubation in obese (BMI ≥ 30] and lean patients (BMI < 30) in a prospective study. The findings showed that obese patients were more likely than lean patients to have difficult tracheal intubation (p=0.03). The only predictors of probable intubation issues in individuals with IDS > 5 were thyromental distance, BMI, higher neck circumference, and a higher Mallampati score. In this study, using logistic regression, researchers discovered that higher neck circumference was independently associated with both difficult laryngoscopy and difficult intubation and recommended that preoperatively, neck circumference should be measured to forecast problematic intubation. In another study, authors found that the most reliable and safest bedside test for predicting difficult laryngoscopy is a combination of sternomental distance measurement and neck circumference.[23] When studying neck circumference as a sole predictor of difficult laryngoscopy, they set the critical value of neck circumference to 35 cm and above. With this criterion, the sensitivity was 74% and the positive predictive value was 53%, depicting that neck circumference was not a strong predictor of difficult laryngoscopy below the value of 40 cm. In our study, we used 40 cm as the critical value of neck circumference which was the likely reason we found significant correlation between neck circumference and difficult laryngoscopy. In another study, neck circumference alone was found to be a "fair predictor" of difficult laryngoscopy.[24] In this study of adult obese patients (BMI ≥ 35) scheduled for elective surgery under general anaesthesia difficult laryngoscopy view was defined as Cormack–Lehane grade ≥ 3. Patients who had difficult laryngoscopy had a significantly larger neck circumference than those who had easy laryngoscopy group (45.1±3.2 cm vs. 41.2±2.2 cm; p=0.001). These findings are consistent with our study in that we also found that higher neck circumference was significantly associated with difficult laryngoscopy. We, however, used MCLS rather

than the simple Cormack Lehane scoring used in this study. Our study has several limitations including lack of an experimental design, small sample size, and single study centre. However, the study findings are important because there is limited information on predictors of difficult intubation in our local population. Further investigation adds to the body of knowledge about the issue and results of this study will help anaesthesiologists in selecting patients who are difficult to intubate.

Table-III: Distribution of MCLS and Association with Difficult Intubation

		Difficult Intubation (IDS ≥ 5)		*p*-value
		Yes	No	
MCLS Grade	n(%)	n(%)	n(%)	
1	6(10.9%)	1(1.8%)	5(9.1%)	0.010
2A	12(21.8%)	2(3.6%)	12(18.2%)	
2B	21(38.2%)	8(14.5%)	13(23.6%)	
3	11(20.0%)	5(9.1%)	6(10.9%)	
4	5(9.10%)	4(7.3%)	1(1.8%)	
Total	55(100.0%)	20(36.4%)	35(63.6%)	

CONCLUSION

Neck circumference has predictive value for difficult laryngoscopy and difficult endotracheal intubation. Further studies are needed to determine wider clinical applications of using neck circumference as sole predictor of difficult intubation.

Conflict of Interest: None.

Funding Source: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

MAS: & SAK: Study design, drafting the manuscript, data interpretation, critical review, approval of the final version to be published.

SQAS: & BY: Data acquisition, data analysis, approval of the final version to be published.

AHB: & HMM: Critical review, concept, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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