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Magnitude and Predictive Factors of Difficult Airway in Patients Undergoing Thyroid Surgery, From a Goiter Endemic Area

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Abstract

The role of an enlarged goiter for the airway management in patient populations undergoing thyroidectomy has rarely been studied. The main objective of this study was to assess the incidence and predictive factors of difficult airway in patients undergoing thyroidectomy. The study was designed as a prospective observation carried out to determine the incidence of difficult mask ventilation, difficult laryngoscopy, difficult intubation and failed intubation. Association of goiter related variables and demographic characteristics association with difficult airway was analyzed using chi-square, fisher's exact taste and binary logistic regression with odds ratio and 95% CI in the univariate analysis. Sensitivity, specificity positive predictive value and negative predictive value for bedside airway parameters were calculated. For the preoperative bedside airway parameters Roc analysis with a CI of 95% and p-value 40 years), deviation of the trachea (>1 cm on chest x-ray), jaw slide (B or C), mouth opening (<3 cm) were identified as a potential risk factors in the univariate analysis. With multivariate analysis tracheal deviation was identified as the only independent risk factor for DL or DI. Patients with DL (CL III/IV) required repeated attempts of laryngoscopy (≥ 3) for intubation. The use of smaller size endotracheal tubes was helpful in managing patients in who calculated size ETT were difficult to pass through a narrowed or deviated trachea. We conclude that thyroid enlargement accompanied by airway deformity constitutes a risk factor for both difficult laryngoscopy and intubation. Preparation of different size endotracheal tubes as well as ordering a preoperative chest x-ray is recommended.

Keywords: Difficult mask ventilation; Difficult laryngoscopy; Difficult intubation; Failed intubation; Thyroidectomy; Goiter

Background

Airway management is very vital for good patient care and is an important skill for every clinical anesthetist dealing with the airway in their daily activity. Despite this, Management of the airway is not always straight forward. According to the American Society of Anesthesiologists (ASA), difficult airway is defined as the clinical situation in which a conventionally trained anesthesiologist experiences difficulty with face mask ventilation of the upper airway, difficulty with tracheal intubation, or both [1]. Difficult airway management can result in patient harm from relatively minor problems such as oral trauma up to an increased risk of aspiration and eventually hypoxia, cerebral damage and death from inability to oxygenate.

The difficulty of achieving a patent airway varies with anatomical and other individual patient factors. Identification of the patient with a difficult airway is vital in planning anesthetic management, so that endotracheal intubation and positive pressure ventilation can be achieved safely. Management of the difficult airway in the general surgical population has been widely investigated [2]. However, the incidence of the difficult airway in the patient population undergoing thyroid surgery has been studied rarely and the published series are relatively small [3].

In general it is estimated that about 4-15% of the world's population is affected by goiter making it the second leading endocrine disorder [4]. The common management of such patients is thyroidectomy (total or partial removal of the enlarged gland) which is one of the most frequent operations performed in iodine-deficient regions [5].

In Ethiopia, there is insufficient data about the general prevalence of goiter in the country. A few surveys have been done to estimate its prevalence. The most recent was a survey conducted for the distribution of iodide salt in 1988 by the Ethiopian Nutrition Institute. According to this systematic survey which covered randomly selected areas in around 70% of the country and was stratified for region and altitude, the incidence of goiter ranges from 0.4%-66.3% with a mean of 25%. The prevalence was highest in altitudes >2000 m (33.9%) compared with 19.2% incidence rate at altitudes <2000 m. There were also differences among residency between urban ranging from 1.93% to 58.89% and rural 1.16% to 73.55% [6].

In addition to this, there are different individual studies. One such study was done in Addis Ababa by Mengistu M, about the pattern of thyroid diseases in adult Ethiopians and experience in management between February 1989 and July 1991 incorporating 373 thyroid patients. This study concluded that, 68.3% of the total endocrine cases are patients with thyroid disease, of which thyrotoxicosis was seen in 43.7% of the patients, followed by euthyroid solitary nodules (23.6%) and simple goitres (22.3%). Euthyroid multinodular goiter was seen in 6.7% while hypothyroidism and thyroiditis were less frequent. Graves' disease was the main cause (41.7%) of thyrotoxicosis, followed by toxic multinodular goiter (31.9%), toxic solitary nodule (22.1%), Jodbasedow phenomenon (3.1%) and thyroiditis (1.2%) [7].

Another cross-sectional study done in Sekota, Ethiopia district (North of Ethiopia) stated that the prevalence of goiter varies with geographic areas of the country and came up with the overall prevalence goiter in the region of 22.8% [8]. A similar study carried out in the south western part of the country in school children and household members showed a prevalence of 30.6% and 18.7% respectively [9].

Specific to our study area (North-west Ethiopia) there are not enough studies done beyond one retrospective review aimed at determining the incidence, pathology and postoperative complications of 137 cases of thyroid operations at Gondar university hospital. In this study Abebe et al. concluded that the female to male ratio was two to one, with a mean age of 32.3 years and duration of illness was around 8.8 years. In addition they also reported the commonest reasons for seeking medical attention being bulk of the mass (82%) and rapid growth (9.5%). Furthermore, 10.2% of the cases were thyroid carcinomas, Follicular carcinoma was the most common type of malignancy and the overall postoperative mortality was 1.5%, additionally 59.9% patients came from rural areas [10].

Apart from these incidence and prevalence studies there are no studies found about the impact of goiter on the airway in our country (Ethiopian Journal of Medical Sciences and other data bases searched).

An enlarged thyroid gland may cause tracheal deviation, compression, or both, leading to DI [11]. A more reliable prediction of this possible event could be helpful to the attending anesthesiologists/anesthetists.

Around 28% of all anesthesia related deaths are due to difficult airway caused by either inability to mask ventilate or intubate [12]. It is claimed that thyroid surgery is associated with difficult airway and according different studies, from 5.3% to 11.6% of tracheal intubations for thyroid surgery will be difficult [3,13-16].

Published data on catastrophic outcomes like brain damage or death indicates that the majority (85%) of airway related events are due to inability to secure the airway [17,18].The maximum risk of airway problems is associated with the so called "cannot intubate cannot ventilate" situation [19,20].

Preoperative identification of patients with difficult airway or impossible airway is of vital importance in order to avoid unnecessary risks posed on to patients, but there is no ideal or precise scoring system or means by which difficulty of ventilation, laryngoscopy or intubation can be predicted.

Apart from mentioning the presence of goiter as a potential problem for difficult airway, there are only a few published studies on difficult airway in patient populations undergoing thyroid surgery [3]. The role of enlarged goiter in complicating the airway remains controversial [21].

In an investigation of the ease of endotracheal intubation in the presence of goiter against well-established predictive factors, Voyagis et al. concluded that when accompanied by airway deformity, thyroid surgery constitutes an aggravating factor for difficult intubation [3]. However, another study by Bouaggad et al found no association between solitary and nodular goiter and difficult intubation in patients undergoing thyroidectomy but came up with the conclusion that only malignant goiter is associated with DI [22].

A study incorporating 2000 patients with goiter was performed in Serbia. The study concluded that DI was highest in patients with polynodal goiter but extreme DI was present mostly in patients with hyperthyroidism and men seem to be at higher risk for DI than women [15].

A contradicting result published two years later by Amathieu et al. concluded that neither presence of goiter nor the type of thyroid disease is associated with difficult intubation and the overall incidence of DI for patients with goiter was 11.1% [14].

Most of the above articles focus on identifying the overall incidence of difficult intubation in thyroid patient and some predictive factors of difficult intubation. However, there is a huge inconsistency among these papers.

This study investigates the incidence of difficult airway and its predictive factors using the preoperative airway parameters and the intubation difficulty scale as a tool for assessment of difficult intubation.

Methodology

Prospective observational study conducted in Gondar University hospital and Bahir Dar Felege Hiwot referral hospitals North West Ethiopia by taking 50 and 41 consecutive patients with goiter to assess the incidence and predictive factors of difficult airway for patients scheduled to undergo thyroidectomy from beginning of January 2015 up to 30 April 2015. Studies have shown that the North-western part of Ethiopia is one of the highly endemic regions for goiter.

A pretested and structured questionnaire was prepared to collect data from the patient immediately before and during induction of Anesthesia. All of the socio-demographic variables along with the preoperative airway assessment values were collected the day before surgery. Variables related to goiter are evidence of tracheal compression, thyroid enlargement (palpable or non-palpable), size of the goiter (cm^2, median size were taken as a cut point to classify in two groups), evidence of tracheal deviation and intubation requiring smaller size endotracheal tube than calculated. Airway parameters (Jaw slide (JSD), tyro-mental distance (TMD), sterno-mental distance (TMD), Inter incisor gap (IIL), neck range of motion (NRM), and Mallampati score or Oropharyngeal view (OPV)) are collected preoperatively before induction of anesthesia. The data for dependent variables were collected during induction of anesthesia.

An Intubation difficulty scale, defines difficulty of intubation when IDS score is greater than 5, is widely used in most of literatures. There is wide variety of definition of IDS among studies on difficult intubation is due to using different parameters and their inconsistency in pointing out the boundary to say difficult. It has been shown that different weight given for each parameter used in IDS to increase its predictability value according to the type of patient and surgeries. The intubation difficult scale used in this study is number of attempt, operators, alternative techniques used and airway trauma scored from 0 to 2. The other IDS parameters scored from 0 and 1 labeled as present or not respectively are laryngoscopy grade (Grade I & II/Grade III & IV), laryngeal manipulation (yes or not) and time taken for intubation (<30/>30 sec). Difficult intubation is operationalized as Cormack and Lehane laryngoscopic grade of III & IV

Data was checked, coded and entered to SPSS version 20 statistical package and analysis is done using SPSS version 20. Analytic statistics were calculated for most variables in the study. Association of goiter related variables and demographic characteristics with difficult airway were analyzed using chi-square, fisher's exact test and binary logistic regression with odds ratio and 95% CI in the univariate analysis. Sensitivity, specificity positive predictive value and negative predictive value for bedside airway parameters were calculated.

Additionally for bedside airway parameters area under the curve of a receiver-operator curve analysis with a confidence interval of 95% and p-value <0.05 were checked for association between airway parameters with dependent variables.

A forward stepwise logistic multivariate regression analysis was used to determine association of combination of risk factors for difficult intubation (defined as IDS>5) and difficult laryngoscopy (defined as CL III/IV). All variables with a p<0.20 in the univariate analysis were entered in the logistic regression model. Odds ratios (OR) and 95% confidence intervals were then calculated. A p value less than 0.05 were considered significant.

This study was performed after obtaining an agreement letter for approval from an institutional ethics committee. Informed consent was offered to all study patients after brief explanation and full disclosure of the benefit or risk they will get from participation. Patients were well informed that they would receive no harm or benefit by not consenting to participating in this study. The will of patients to participate or resign from the study was respected and treatment without any difference from other patients. All data collectors were trained about informed consent process. Confidentiality was ensured at all time.

Result

Socio demographic data

Data were collected from 91 consecutive patients undergoing thyroidectomy. There were no cases with either difficult mask ventilation or failed intubation (Table 1).

Variable	Frequency n (%)	Difficult airway n (%)	
		IDS>5	CL III/IV
Age			
Under 20	13 (14.3)	0	0
21 – 40	51 (56.0)	5 (9.8)	4 (7.8)
41 & above	27 (29.7)	8 (29.6)*	8 (29.6)*
Sex			
Male	12 (13.2)	2 (16.7)	2 (16.7)
Female	79 (86.8)	11 (13.9)	10 (12.6)
BMI			
Under wt. (BMI<18kg/m^2)	15 (16.5)	2 (13.3)	2 (13.3)
Normal (18kg/m^2>BMI<23kg/m^2)	68 (74.7)	9 (13.2)	8 (11.8)
Over wt. (BMI>23kg/m^2)	8 (8.8)	2 (25)	2 (25)
*p-value<0.05, numbers in parenthesis are percentages. BMI: Body Mass Index			

Table 1: socio demographic characteristics and distribution of difficult airway of the study participants from January 2015-April 2015.

The incidence of difficult laryngoscopy (Cormack & Lehane III, IV) was 13.2%. The incidence of intubation with an IDS (intubation difficulty scale)>5 (moderate to major difficulty of intubation) was 14.3% (13 of 91), while the rate of easy tracheal intubation (IDS=0) and minor difficulty with intubation (IDS 1-5) were 39.6% and 46.2% respectively.

Patients between the ages of 21-40 years contribute 56% of the total population. Association of age with difficult airway was found in the age groups above 40 (P=0.011, OR=4.968 for DI & P=0.006, OR=6.316 for DL).

Majority of the patients were females (86.8%) who contributed for 84.6 % of difficult intubation and 83.3% of difficult laryngoscopy.

Preoperative airway parameters and their distribution with difficult airway

The number and percentage of patients falling in each preoperative bedside airway parameters and their distribution with DI as well as DL is shown in the following Table 2.

Variable	Frequency n (%)	Difficult airway n (%)	
		IDS>5	CL III/IV
OPV			
I + II	81 (89)	11 (13.6)	9 (11.1)
III + IV	10 (11)	2 (20)	3 (30)
TMD			
≥ 6.5 cm	50 (54.9)	5 (10)	6 (12)
<6.5 cm	39 (42.9)	7 (58.3)	5 (45.5)
NRM			
≥ 90 Degrees	54 (59.3)	8 (14.8)	9 (16.7)
<90 Degrees	37 (40.7)	5 (13.5)	3 (13.5)
JSD			
JSD A	64 (70.3)	6 (9.4)	5 (7.8)
JSD B & C	27 (29.7)	7 (25.9)*	7 (25.9)*
SMD			
≥ 12.5 cm	69 (75.8)	9 (13)	7 (10.1)
<12.5 cm	22 (24.2)	4 (18.2)	5 (22.7)
IIL			
≥ 3 cm	82 (90.1)	10 (12.2)	9 (10.9)
<3 cm	9 (9.9)	3 (33.3)	3 (33.3)
*p-value<0.05, numbers in parenthesis are percentages			

Table 2: Distribution of bedside airway parameters against difficult airway among study participants from January 2015 up to 30 April 2015.

From bedside airway parameters only a jaw slide of B & C was found to be associated with difficult intubation and laryngoscopy (p=0.047, OR=3.383 for DI & p=0.027, OR=4.130 for DL).

Variables related to goiter and difficult airway

In all of the patients the thyroid gland was palpable manually. X-ray report of tracheal deviation>1cm (14 out of 33) was found to be a statistically significant determinant factor of both difficult laryngoscopy and intubation ($p<0.001$, OR=14.4 for DL and $p<0.001$, OR=11.833 for DI). Neither specific diagnosis nor the size goiter seems to have association with the outcome variables (DI & DL) (Table 3).

Variable	Frequency n (%)	Difficult airway n (%)	
		IDS>5	CL III/IV
Diagnosis			
Nodular/Multinodular goiter	78 (85.7)	10 (12.8)	9 (11.5)
Cancerous goiter	13 (14.3)	3 (23.1)	3 (23.1)
Compressive symptoms (present)			
Dyspnea	13 (14.3)	3 (23.1)	3 (23.1)
Dysphagia	2 (2.2)	0	0
Voice change	4 (4.4)	1 (25)	1 (25)
Tracheal deviation			
Deviation>1cm	14 (15.4)	7 (50)*	7 (50)*
No deviation & No CXR	77 (84.6)	6 (7.8)	5 (6.5)
Size of goiter (cm², median)			
≤ 25	48 (52.7)	6 (12.5)	6 (12.5)
>25	43 (47.3)	7 (16.3)	6 (13.9)

*p-value<0.05, numbers in parenthesis are percentages. Size of goiter (cm^2)-width multiplied by length of the mass in centimeter.

Table 3: Distribution goiter related variables with difficult airway.

Difficult laryngoscopy and airway parameters (predictive factors)

Sensitivity, specificity, positive and negative predictive values for specific and nonspecific difficult laryngoscopy predictive factors is shown in the following table (Table 4).

The figures in the above table used to produce the receiver operating curve for the parameters (Figure 1).

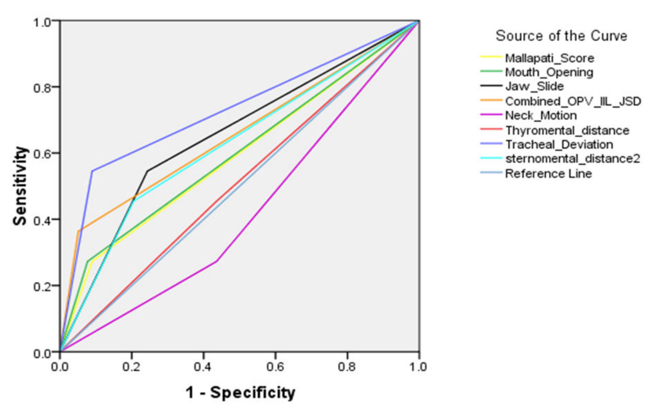

Figure 1: ROC curve for DL against predictive risk factors. Diagonal segments are produced by ties.

Variable	Sensitivity	Specificity	PPV	NPV	Area	P-value	95% C.I	
							Lower	Upper
OPV	25%	91.10%	30%	88.90%	0.591	0.328	0.396	0.787
IIL	25%	92.40%	33.30%	89%	0.598	0.295	0.401	0.795
JSD	58.30%	76.70%	25.90%	92.20%	0.651	0.106	0.467	0.835
Combined (OPV, IIL, JSD)	33.30%	95%	50%	90.40%	0.656	0.095	0.458	0.855
NRM	25%	57%	8.10%	83.30%	0.418	0.383	0.244	0.593
TMD	45.50%	56.40%	12.80%	88%	0.509	0.921	0.326	0.693
SMD	41.70%	78.50%	22.70%	89.90%	0.625	0.182	0.436	0.814
Deviation	58.30%	91.10%	50%	93.50%	0.728	0.015*	0.541	0.915

*p<0.05, CI: Confidence Interval; PPV: Positive Predictive Value; NPV: Negative Predictive Value

Table 4: Sensitivity, specificity positive predictive and negative predictive values for airway parameters against difficult laryngoscopy for patients' data collected from January 2015 up to 30 April 2015.

All the airway parameters along with deviation of the trachea are above the reference line except neck motion (<90°). In the above table JSD, TMD and SMD seem to have better sensitivity. Above all deviation of the trachea was found to be a good predictor with area under the curve 0.728, followed by combined (OPV, IIL & JSD) and JSD.

Difficult intubation and airway parameters (predictive factors)

Table below shows sensitivity, specificity, positive and negative predictive values of airway parameters for difficult intubation (Table 5).

Variable	Sensitivity	Specificity	PPV	NPV	Area	P-value	95% C.I	
							Lower	Upper
OPV	15.40%	89.70%	20%	86.40%	0.531	0.728	0.349	0.713
IIL	23.10%	87.80%	33.30%	87.80%	0.586	0.34	0.398	0.774
JSD	53.80%	74.40%	25.90%	90.60%	0.627	0.16	0.448	0.806
Combined (OPV, IIL, JSD)	23.10%	93.60%	37.50%	87.90%	0.593	0.304	0.403	0.782
NRM	38.50%	58.90%	13.50%	82.20%	0.501	0.995	0.324	0.677
TMD	58.30%	58.40%	18%	90%	0.584	0.352	0.41	0.758
SMD	30.80%	77%	18.20%	87%	0.556	0.532	0.374	0.738
Deviation	53.80%	91%	50%	92%	0.705	0.023*	0.522	0.888

*p<0.05, CI: Confidence Interval; PPV: Positive Predictive Value; NPV: Negative Predictive Value

Table 5: Sensitivity, specificity positive predictive and negative predictive values for airway parameters against difficult intubation for patients' data collected from January 2015 up to 30 April 2015.

The actual figures of table 6 were used to produce a ROC curve for airway parameters and predictive factors for difficult intubation as follows (Figure 2).

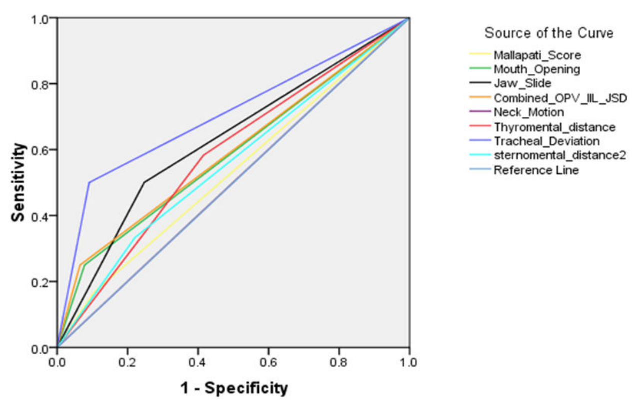

Figure 2: ROC curve for DI against predictive risk factors. Diagonal segments are produced by ties.

All preoperative airway parameters were found to be above the reference line. Still deviation of the trachea is a good predictor of difficult intubation with the area under the curve being 0.705, followed by JSD & combined (0.627 & 0.593 respectively). Compared to others a thyromental distance followed by jaw slide and deviation were found to have highest sensitivity with values 58.3%, 53.8% & 53.8% respectively. Combination of airway parameters was found to increase specificity (93.6%) and positive predictive value (37.5), but still sensitivity is low (23.1%).

False negative rate (FNR)

The false negative rate tells us the percentage of patients who have difficult airway, but who incorrectly receive a negative test result.

Figure below shows distribution of FNR percentages among preoperative bedside airway parameters (Figure 3).

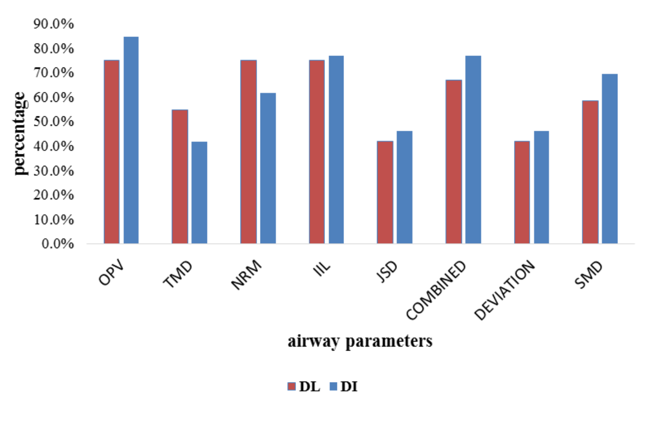

Figure 3: Percentages of false negative rate for airway parameters against difficult airway. DI: Difficult Intubation, DL: Difficult Laryngoscopy.

Above graph demonstrated OPV, NRM and IIL were tests with high FNR values in predicting difficult laryngoscopy all having a 75% FNR percentage. In comparison to this tracheal deviation and jaw slide have lower FNR percentages of 41.7% & 41.7% respectively.

Whereas, the percentage of false negative rate was highest for OPV (84.6%), followed by IIL and combined (OPV, IIL & JSD) with FNR values 76.9%, 76.9% respectively in predicting difficult intubation. Similar to false negative rates for predicting DL, jaw slide and tracheal deviation have lower FNR percentage values of 46.2% & 46.2% respectively.

Risk factors against DL

Table below shows the adjusted odds ratio for risk factors for difficult laryngoscopy along with specific management strategies.

Initially all the variables with a p-value<0.20 computed in the univariate analysis were entered in to the logistic regression model to compute the adjusted odds ratio (Table 6).

Variable	Odds ratio (95% CI)	p-value
Deviation (>1 cm)	0.069 (0.017-0.0.278)	<0.001

Table 6: Risk factors for DL and other variables with multivariate analysis. CI: Confidence Interval.

Above table shows some predisposing factors along with management strategies for difficult laryngoscopy. In the univariate analysis all variables with a p-value<0.2 were included to run for forward conditional binary logistic to get the adjusted odds ratio.

Age (>40 years), tracheal deviation>1cm on chest x-ray, a jaw slide of grade B or C, mouth opening of<3cm and mallapati score of III or IV were included for multivariate analysis.

The multivariate analysis shows deviation of the trachea to be a strong predictor of Cormack & Lehane III/IV (P<0.001, OR=0.069). From bedside preoperative airway parameters only a jaw slide of B or C has correlation with difficult laryngoscopy in the univariate analysis.

Management and risk factors for DI

Adjusted odds ratio for difficult intubation associated factors along with some specific management strategies carried out (Table 7).

Variable	Odds ratio (95% CI)	p-value
Deviation (>1 cm)	11.833 (3.10 – 45.13)	<0.001

Table 7: Risk factors for difficult intubation multivariate analysis. CI: Confidence Interval.

In the univariate analysis same variables as that of difficult laryngoscopy were found to have p-value<0.2 except mallapati score, which were insignificant even in the univariate analysis. The significant variables were included in the logistic model for forward stepwise regression.

In the multivariate analysis only deviation of the trachea found to be strong predictor of difficult intubation (p ≤ 0.001, OR=11.8). Similar to difficult laryngoscopy only a jaw slide of B or C is found to have association with difficult intubation in the univariate analysis only (p=0.047, OR=3.38).

Discussion

The major findings of this study were; DI in the presence of goiter was 14.3% and the incidence of difficult laryngoscopy in the presence of goiter was 13.2%. Tracheal deformity (deviation of the trachea>1cm on chest x-ray) were the only independent predictive risk factors for difficult airway in the presence of goiter. Neither the size nor the presence of malignant goiter is associated with difficult airway. Pre anesthetic bedside airway parameters can't be relied upon on deciding the difficulty of an airway in thyroid patients.

The incidence of difficult airway in thyroid surgery has rarely been studied in studies related to airway management. Published studies show a great discrepancy in the incidence of difficult airway ranging from 5.3% to 11.6% [3,13-16].

We chose IDS, a quantitative scale of intubation difficulty based on variables (objective and subjective criteria) associated with DI & Comark Lehane direct laryngoscopic view of the glottis for grading DL. The major limitation of the IDS was it does not include the difficulty of passing a tracheal tube. Articles published suggest that goiter, when accompanied with tracheal deformity, constitutes an aggravating factor for difficult airway, but no resistance has been encountered in the passage of the ETT through the compressed or narrowed portion of the trachea [3,11,13,16,23]. In contrast to this our experience in this study shows goiter when accompanied with tracheal deformity is associated with difficulty of passing the calculated size (subjective) of ETT through the deformed or narrowed portion of the trachea and this was managed with a smaller sized ETT (at least 0.5mm less). In our study 8 of 14 (57.1%) patients with tracheal deviation need smaller size ETT for intubation and this was statistically significant (p=0.003, OR=5.429).

In a prospective study of 324 patients undergoing thyroidectomy in France, Amathieu et al reported the incidence of DI (IDS>5) as 11.1%. In this particular study preoperative bed side airway parameters for difficult intubation, unrelated to the thyroid gland itself, such as Mallampati class III or IV, decreased mouth opening, decreased neck movement (<90°), short thyromental distance (<6.5 cm), Sternomental distance (<12.5 cm) and a retrognathic mandible showed a statistically significant correlation. But our findings are different and only a jaw slide other than A (B & C) is associated with difficult intubation and difficult laryngoscopy in univariate analysis. The interpersonal difference in the assessment of these airway parameters may have contributed for this difference.

In addition the sensitivity and specificity of the pre-operative airway parameters in our ROC curve analysis shows OPV, JSD, IIL, (combined OPV, JSD, and IIL) and TMD found to be above the reference line. But accuracy of these tests as measured by the area under the ROC curve shows the area under the curve to be well above 0.5 (cut point) but below 0.7 indicating the poor ability of these tests to predict the presence of difficult airway.

With a sample of 320 patients undergoing thyroidectomy Bouaggad et al. found the incidence of difficult intubation being 5.3% [22]. In this study Bouaggad et al. found no association between size of goiter (measured along the main straight line of the goiter, with the head fully extended) and difficult intubation. However, they found an increased incidence of difficult intubation when malignant thyroid was present. Although there is a claim that big goitres are associated difficult airway [15] based on the assumption that, big goitres dislocate the trachea. Our conclusion is in line with that of Bouaggad et al. in that presence of big goitres is not always associated with deformity leading to difficult airway. Rather than dislocating the trachea or larynx, they wrap the trachea and larynx diffusely leaving the position of the neck structures unaffected.

In contrary to Bouaggad et al, our data does not support their conclusion that the presence of malignant goiter is associated with increased incidence of difficult airway. The sounding explanation for this may be that carcinomatous infiltration and invasion of tissues may lead to fibrosis. This fibrosis may in turn reduce the mobility of laryngeal structures and make the laryngoscopic view difficult.

A similar incidence of difficult intubation to Bouaggad et al. was reported from Serbia (5.5%).in this study involving 2000 patients, Kalezic N et al, concluded the incidence of DI being highest in patients with polynodal goiter and extremely DI was present mostly in patients with hyperthyroidism. Additionally they found out that Men have higher risk for DI than Women. The explanation for the polynodal goiter association with difficult airway might be size related. In our data we showed that size did not affect the outcome variables. But they fail to explain the extreme difficulty faced in their patient groups with hyperthyroidism. Furthermore, our study reveals the incidence of DI were more in women than men (84.6% vs 15.4%), but these numbers does not reach statistical difference favouring either sex. Both male sex and hyperthyroidism were underrepresented in our data and this might have contributed to the difference.

In a prospective study of patients undergoing thyroidectomy, the incidence of DI, defined as Cormack Lehane grade III or IV on direct laryngoscopy was 8.5% [3]. Still this number is far below our finding of DI & DL (14.3% & 13.2 respectively). This was consistent with our finding that 75% (9 of 12) patients with difficult laryngoscopy end up being difficult to intubate ($p \leq 0.001$, OR=56.25). However, studies have found a very strong discrepancy between DI & DL [24].

A more recent paper from New York, USA by Loftus et al found a higher incidence of difficult intubation. Although they do not have explanation for the higher incidence, Loftus et al. [16] found the general incidence difficult intubation being 11.6% from a retrospective data of 112 patients. They also found that patient age was significantly associated with difficult intubation (60 ± 3.7). We found an incidence of 61.5% (for both DI & DL) in patient age groups above 40. This was statistically significant in the univariate analysis only (p=0.017, OR=4.95). There is a physiologic and anatomic explanation for this is that Increasing age is a known risk factor for difficult intubation secondary to decreases in cervical joint mobility, head and neck movement, thyromental distance, and Interincisor gap, making our findings consistent with this and other the established literature [25]. Additionally Loftus et al suggested that the use of fiber optic intubations in patients with goiter should be refined. In our data all of 91 patients were managed safely with oral intubations. Trans-oral intubations are safe and effective.

In most of the papers from the westerns the degree of difficulty with intubation is more or less in similar frequency between thyroid surgery and the general surgical population (5.3 % vs 5.5%) [22]. This might probably be because of the current surgery is early in the developed world and the thyroid related complications are less. However, our findings are consistent with the findings of unpublished paper by Amare & his colleagues at Gondar university hospital. In this study Amare et al concluded the incidence of DI & DL in the general population being 12.9% & 9% respectively.

All in all our finding of difficult airway was higher than the figures mentioned in most papers, but given the fact that the study was done in tertiary hospitals where training is given to undergraduate and postgraduate students it is not surprising compared to the ones where most of the intubations were done by experienced anesthesiologists and senior residents. The other way, this higher incidence of DI & DL in patients with goiter in these segment of the population may be contributed by the fact that most of our patients came from the rural area (59.1%), where bulk of the mass is an issue for seeking medical attention (81.8%) and longer periods of time (8.8 years, mean duration of illness) for seeking medical attention [10]. This may have some contribution to the anatomic disfigurements seen in our patient population.

The limitations of this study are; small sample size since we get only 91 patients coming for thyroidectomy in the study period. Determining the size of the goiter was difficult. The easiest way of assessing the volume of goiter is by using echography which is not done for all of our patients. As an alternative we used the palpability and measuring external size of goiter as a determinant, and we evaluated this as a predictive factor for difficult airway. We know that this was not the best way of doing so, because goiter usually grows internally and we can't determine the correct size. Another limitation was that chest x-ray reports were only about whether there is tracheal deviation or not. Evidence of tracheal narrowing (stenosis) was not reported. So we were forced to use tracheal deviation as a predictor of difficult airway. The best way of determining tracheal stenosis was by using a CT scan, which is not available in our data collection periods. Additional limitation was most of our intubations were performed by undergraduate and postgraduate students. This might have contributed to the intubation difficulty score. And finally, the assumption of use of smaller size endotracheal tube has interred individual variability.

Conclusion

We conclude that thyroid enlargement accompanied by airway deformity is a risk factor for both difficult laryngoscopy and intubation. Usual pre-anesthetic airway parameters cannot be relied upon to rule out difficulty in these segments of population.

Recommendation

We recommend the inclusion of chest x-ray as a preoperative investigation modality in thyroid patients.

Preparation of different size endotracheal tubes (0.5 mm below calculated size) before any anesthetic is performed for operation including thyroidectomy. Still preoperative airway parameters have to be performed for every patient.

Competing Interests

The authors declare that they have no competing interests.

Authors' Contributions

Sleshi Abiy with Amare Hailekiros and Habtamu Getinet initiated the idea to investigate the magnitude and predictive factors of the difficult airway and all authors contributed to the data analysis, read and approved the final manuscript.

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