Prediction of Difficult Endotracheal Intubation in Thyroid Surgery

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Abstract: *Background*: Thyroid surgery is usually considered as difficult airway and a risk factor for intubation. *Methods*: All adult patients who were undergoing thyroid surgery under general anaesthesia were prospectively included in this study over a period of eighteen months to determine the incidence of difficult intubation using the intubation difficulty scale (IDS) and to assess whether features related to goitre were associated with increased risk of difficult intubation. Depending upon the IDS score calculated, two groups were formed as Group 1→IDS ≤ 5, Group 2 → IDS > 5. The association between different variables and difficult intubation was evaluated using the chi-square test for qualitative data and the Student's t test for quantitative data. *Results*: The numbers of patients in Group 1 were 156 and those in Group 2 were 31. The incidence of difficult intubation was 16.5%. The highest IDS value attained was 11. Mallampati classification III or IV, thyromental distance < 65 mm. Interincisor gap < 35 mm, neck mobility < 80° and prognathic or retrognathic mandible were statistically significant risk factors for difficult intubation. Malignant goitre was found to be associated with difficulty in intubation. *Conclusions*: Except for malignant goitre no other goitre related specific risk factors were associated with increased incidence of difficult intubation. The classical risk factors for difficult intubation such as Mallampati grade III or IV, interincisor gap less than 35 mm, thyromental distance less than 65 mm, neck mobility less than 80° and mandibular abnormality were reliable predictors.

Keywords: Airway, endotracheal, intubation, thyroid.

INTRODUCTION

Airway management is an important aspect during induction of general anaesthesia. Tracheal intubation of a patient for thyroid surgery is usually considered difficult [1]. The initial preliminary step of basic life support system includes adequate airway control.

The incidences of difficult laryngoscopy (DL), difficult intubation (DI), difficult mask ventilation (DMV) are not well defined and are subject to physician variability, but they occur in 1.5%-13%, 1.2%-3.8% and 0.01%-0.5% of patient's, respectively [2]. Progressive nature of thyroid gland disease can lead to compression and deformity of airway. Difficulty with intubation may be caused by an enlarged thyroid gland producing tracheal deviation or compression or both [3, 4]. Preoperative detection of patients or procedures at risk for difficult intubation is essential [5]. However, the evaluation of factors linked to DI in thyroid surgery is limited to very few studies.

MATERIALS AND METHODS

The approval of this prospective observational study was provided by the Institutional Ethics Committee. All adult patients who were undergoing thyroid surgery under general anaesthesia were prospectively included over a period of eighteen months. A written valid informed consent was obtained from the patient.

The aims and objectives of this study were to determine the incidence of difficult intubation in adults using the intubation difficulty scale (IDS) in patients undergoing thyroid surgery and to assess whether presence of goitre was associated with increased risk of difficult intubation. Details of goitre noted were compressive symptoms (dyspnoea, dysphagia, and hoarseness), thyroid enlargement, and X-Ray neck findings: deviation of trachea ≥ 1 cm from midline, surgical diagnosis (toxic multinodular goitre, /malignant goitre, simple or multiple thyroid nodules). Preoperative airway assessment included assessment of classical risk factors for difficult intubation like body mass index (BMI) (<30 kg/m^2 or ≥30 kg/m^2), Mallampati classification, mouth opening as interincisor gap (< 35 mm or ≥ 35 mm), thyromental distance (< 65 mm or ≥ 65 mm), neck mobility (< 80 degree or ≥ 80 degree), mandibular abnormality (appearance of a retrognathic midface and prognathic mandibular profile), impression of short neck and dentition.

On the day of surgery, patients were wheeled to operation theatre after suitable premedication. General anaesthesia was given with intravenous fentanyl 2μg/kg, midazolam 0.02mg/kg, propofol 2mg/kg. Neuromuscular blockade was given with intravenous vecuronium 0.1mg/kg. Patient's trachea was orally intubated using a laryngoscope with Macintosh blade size 3 with head in sniffing position by experienced

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E-ISSN: 2310-9394/14

anaesthesiologists. The thyroidectomy was performed with patients in the supine position, with the head slightly hyper extended. The patient was extubated after the end of the surgery.

The primary outcome measured was degree of difficulty during endotracheal intubation on the basis of IDS. The IDS is a combination of seven criteria:

If the intubation is successful in first attempt or by the first operator, N1 or N2 is 0.

N1: Number of attempts: Every additional attempt adds 1 point.

N2: Number of operators: Every additional operator adds 1 point

N3: Number of alternative techniques: Every alternative technique adds 1 point

N4: Cormack Lehane grade: Apply Cormack grade for 1st oral attempt. For successful blind intubation N4=0:

Cormack grade

I: full vocal cord seen N4=0,

II: partial vocal cord seen N4=1

III: only epiglottis seen N4=2

IV: neither glottis nor epiglottis seen N4=3

N5: Lifting force required Normal N5=0, Increased N5=1

N6: Laryngeal pressure Not applied N6=0, Applied N6=1

N7: Vocal cord mobility Abduction N7=0, Adduction N7=1

Degree of Difficulty: IDS Score

0 Easy

0 – 5 slightly difficult

> 5 moderate to severely difficult

∞ Impossible intubation

Depending upon the IDS score calculated after intubation two groups were formed

Group 1→IDS ≤ 5 (easy intubation)

Group 2 → IDS > 5 (difficult intubation)

The distribution of the IDS score was non-Gaussian. Thus, we used non-parametric tests for comparisons and correlations among the variables. The association between different variables and difficult intubation was evaluated using the chi-square test for qualitative data and the Student's t test for quantitative data. A p value of < 0.05 was considered to be statistically significant.

RESULTS

In our hospital, a total of 187 patients underwent thyroidectomy during the study period. No patients were excluded from our study.

The numbers of patients in Group 1 were 156 and those in Group 2 were 31. The incidence of difficult intubation was 16.5%. The highest IDS value attained was 11. There were no patients in whom both tracheal intubation and mask ventilation were impossible. Also there was no incidence of any complication such as fall in oxygen saturation, bradycardia, laryngospasm, or any trauma to soft tissue.

The patients were demographically similar in both groups as shown in Table **1**.

Table **2** summarizes the results of classical risk factors. Mallampati classification III or IV, thyromental distance < 65 mm, interincisor gap < 35 mm, neck mobility $< 80^{o}$ and prognathic or retrognathic mandible were statistically significant risk factors for difficult intubation. However, BMI > 30 kg/m^2, gender and protruding teeth were not associated with increased risk of difficult intubation.

As shown in Table **3**, goitre related factors such as tracheal deviation; tracheal compression and the size of goitre were not associated with increased risk of difficult intubation. Malignant goitre was found to have associated with difficult intubation.

There was no significant difference between Group 1 and Group 2.

DISCUSSION

Maintenance of the airway patency and oxygenation are main objectives to reduce respiratory catastrophes during anaesthesia management.

Table 1: Demographical Data

Parameters		Group 1 n=156	Group 2 n=31	P value
Age (year)	Mean ± SD	42.00 ± 12.6	44.50 ± 11.4	NS
	Range	18 - 88	19 – 67	
Weight (kg)	Mean ± SD	58.6 ± 9.1	59.2 ± 8.1	NS
	Range	32 – 81	40 – 60	
Height (cm)	Mean ± SD	158.2 ± 6.0	155.1 ± 4.5	NS
	Range	145 - 177	146 – 166	
BMI (kg/m^2)	Mean ± SD	23.3 ± 2.9	22.4 ± 2.6	NS
	Range	13 - 31	13 – 30	
Gender	Male	25	20	NS
	Female	131	11	

BMI: Body Mass Index; NS: Not Significant

Table 2: Classical Risk Factors

Risk factors (%)	Group 1 n=156	Group 2 n=31	P value
Gender (Male/Female)	35/121	10/21	NS
BMI > 30 kg/m^2	3 (1.9%)	0	NS
MPC III or IV	8 (5.1%)	18 (58.1%)	P < 0.05
Interincisor gap < 35 mm	20 (12.8%)	25 (80.6%)	P < 0.05
Thyromental distance < 65 mm	20 (12.8%)	20 (64.5%)	P < 0.05
Neck mobility < 80^o	14 (8.9%)	16 (51.3%)	P < 0.05
Dentition abnormality	21 (13.5%)	11 (35.5%)	NS
Mandibular abnormality	16 (10.2%)	19 (61.2%)	P < 0.05

BMI: Body Mass Index; MPC: Mallampati Classification

Table 3: Goitre Related Specific Factors

Goitre related specific factors (%)	Group 1 (n = 156)	Group 2 (n = 31)	P value
Tracheal deviation	35 (22.4%)	14 (45.2%)	NS
Tracheal compression	40 (25.6%)	11 (35.5%)	NS
Goitre palpable	75 (48.1%)	13 (41.9%)	NS
Multinodular goitre	78 (50%)	13 (41.9%)	NS
Toxic goitre	30 (19.2%)	1 (3.2%)	NS
Malignant goitre	20 (12.9%)	15 (48.6%)	P < 0.05
Thyroid nodule	28 (18.6%)	2 (6.5%)	NS

NS - not significant

The study by D Cattano *et al.* [2] correlated the Mallampati modified score and several other indexes with the laryngoscopic view to identify anatomical and clinical risk factors related to difficult airway. Difficult intubation occurred in 28 patients as measured by operator intubation difficulty score. Mallampati classification grade III or IV, thyromental distance < 65mm and interincisor gap < 35mm were considered significant predictors for difficult intubation whereas obesity and reduced neck mobility were considered insignificant.

The IDS does not include the difficulty in passing a tracheal tube. This is a major and probably the only limitation of IDS.

The incidence of difficult intubation with IDS score > 5 was 16.5% in our study. Bouaggad *et al.* [6] reported an incidence 5.3% (17 out of 324 patients) while Voyagis *et al.* [7] reported an incidence rate of 8.5% in patients undergoing thyroidectomy. Lower rate was observed due to difference in definition of difficult intubation which was defined as inadequate exposure of glottis.

In our study, gender was not a predictive factor for difficult intubation. But Bouaggad *et al.* [6] reported higher incidence of difficult intubation in males. R Amatheiu *et al.* [8] also reported higher incidence of difficult intubation among females. Rose and M. Cohon [9] have found male gender as predictive factor for difficult intubation with a predictive value of 0.01.

Higher BMI causes difficulty in airway management by reducing posterior airway space behind the base of the tongue causing impaired airway patency. In our study, the incidence of difficult intubation in patients with BMI > 30 kg/m^2 was 0. We had only 3 patients out of 187 with a BMI more than 30kg/m^2. All three of them were easily intubated. Langeron *et al.* [10] proved BMI > 26kg/m^2 was a risk factor for difficult intubation. R Amatheiu *et al.* [8] also reported an incidence of only 22.2% of difficult intubation in patients with BMI >30kg/m^2. Also J Arne *et al.* [11] reported that there was no statistical significance in the height and weight between patients without difficult intubation and those with difficult intubation.

Our study showed a statistical significance for difficult intubation with Mallampati Classification (MPC) class III or IV. Bouaggad *et al.* [6] reported incidence of difficult intubation in 7 out of 15 patients with MPC grade III or IV. R Amatheiu [8] *et al.* had incidence rate of 36.5% with MPC grade III or IV.

T. Randell [12] found that the probability of difficult intubation was highest in patients with a Mallampatti class II, III, IV together with short neck, protruding

maxillary incisors and receding mandible, with a positive predictive value of 64%. Similarly, K. Rose and M.Cohen [9] also observed increasing MPC as a predictor of difficult intubation with statistical significance. El.Ganzouri [13] had concluded a very low 21% positive predictive value (PPV) of MPC grade III and 4% of MPC grade IV when used alone.

In our study, the incidence of difficult endotracheal intubation in patients having interincisor gap < 35 mm was 80.6%. Voyagis *et al.* [7] reported an incidence of 75% patients with interincisor gap < 35 mm having difficult intubation. R Amatheiu *et al.* [8] also mentioned the statistical significance of interincisor gap < 35 mm in predicting difficult intubation. However D Cattano *et al.* [2] reported that interincisor gap has a low PPV (13%) in predicting difficult intubation. According to the study by Langeron *et al.* [10], study this factor was not significant.

Thyromental distance (TMD) determines the space anterior to larynx. So short thyromental distance means relatively anterior larynx. In our study, 20 out of 31 patients had difficult intubation with TMD < 65 mm. R Amatheiu *et al.* [8] also mentioned TMD to be significant in predicting difficult intubation. Bouaggad *et al.* [6] also concluded that TMD < 65 mm had statistical significance. According to Rose and Cohen [9], decreased thyromental distance was one of the best predictors of difficult intubation. El.Ganzouri [13] illustrated decreased thyromental distance of < 6 cm, as a predictive factor of difficult intubation with the sensitivity of 16.8% and specificity of 99%. Tse *et al.* [14] concluded that TMD had a very low sensitivity 5% and a low positive predictive value (PPV) of 21% when used alone. D Cattano *et al.* [2] also mentioned a very low PPV for thyromental distance.

In our study, out of 156 patients who could be easily intubated, only 14 had neck mobility < 80^{o}. In difficult intubation group, the incidence was 51.3%; R Amatheiu *et al.* [8] also mentioned an incidence rate of 41.5% of difficult intubation in patients with neck mobility of < 80^{o}. Bouaggad *et al.* [6] also concluded this factor to be statistically significant. D Cattano *et al.* [2] mentioned in their study that neck mobility < 80^{o} had a low PPV of 9% with sensitivity of 25%.

The incidence of difficult intubation in patients having abnormal dentition was 35.8%. Also 21 patients could be easily intubated out of 32 patients having abnormal dentition. R Amatheiu *et al.* [8] did not include this factor in their study. Bouaggad *et al.* [6] also concluded that protruding teeth was not a significant factor in difficult intubation. Langeron *et al.* [10] concluded that protruding teeth was responsible for difficult mask ventilation but was not significant for difficult intubation.

Abnormality in mandible results in posterior placement of tongue making laryngoscopy and intubation difficult. In our study the incidence of difficult intubation in patients having mandibular abnormality was 19 out of 31 patients. Retrognathic mandible was reported in 11 patients whereas 8 patients had protruding mandible. This was statistically significant when compared to only 16 patients out of 156 having no problems with intubation with mandibular abnormality. Bouaggad *et al.* [6] mentioned this as non significant factor in their study. R Amatheiu *et al.* [8] mentioned retrognathic mandible as a significant factor in prediction of difficult intubation in their study with incidence of 16.6%. D Cattano *et al.* [2] mentioned that the negative predictive value of retrognathic mandible was 97% in their study.

With respect to specific goitre related variables in our study, 14 out of 49 (28.7%) patients had signs of tracheal deviation. Bouaggad *et al.* [6] also reported a high incidence of tracheal deviation having difficult intubation 14 out of 17 patients. But R Amatheiu *et al.* [8] reported a low incidence of 16.5% of tracheal deviation with difficult intubation.

In our study, only 11 out of 51 patients with tracheal compression had difficult intubation. Bouaggad *et al.* [6] found incidence of 70.6% difficult intubation in 12 out of 17 patients having tracheal compression. R Amatheiu *et al.* [8] also reported a low incidence of 2.7% of compression signs with tracheal intubation.

In our study, the incidence of difficult intubation with palpable goitre was 13 out of 88 patients. Also 18 patients having difficult intubation had no increase in size of goitre. Bouaggad *et al.* [6] also concluded that goitre size was not a significant predictive factor. Amatheiu *et al.* [8] also proved that goitre size was not related to difficult intubation, with an incidence rate of 5.3%.

Also in our study, we concluded that malignant goitre was associated with difficult intubation. 15 out of 35 cases of malignant goitre reported of difficulty in intubation. The mechanism for this DI could be an advanced stage of cancerous goitre. The patients usually have consultations at an advanced stage of this

disease, when compressive signs are present. DI is caused by tracheal invasion and tissue infiltration by the carcinoma associated with fibrosis. Fibrosis may reduce the mobility of laryngeal structures and make the laryngoscopy more difficult. However, 78 out of 91 patients having multinodular goitre had no problems in intubation. Also only 2 patients in solitary thyroid nodule had difficult intubation and one patient in toxic goitre group had difficult intubation which was not significant. Bouaggad *et al.* [6] also proved that cancerous goitre is associated with difficult endotracheal intubation with an odds ratio of 1.95 and p value < 0.001. However Amatheiu *et al.* [8] concluded that presence of thyroid malignancy was not related to increased intubation difficulty with incidence of 3 out of 36 cases of difficult intubation.

Thus we identified MPC III or IV, short interincisor gap, short thyromental distance, decreased neck mobility, mandibular abnormalities and malignant goitre as risk factors for difficult intubation. However gender, BMI > 30kg/m^2, protruding teeth, tracheal deviation, tracheal compression and palpable goitre were statistically non significant for prediction of difficult intubation. Preoperative anticipation of difficult intubation and evaluation of risk factors for difficult intubation is of vital importance so that alternative approach is kept ready to avoid any complication during intubation.

CONCLUSION

In conclusion we found that thyroid surgery was associated with increased incidence of difficult intubation. In these selected population of patients, except for malignant goitre, we could not find any other goitre related specific risk factors associated with increased incidence of difficult intubation. In contrast the classical risk factors for difficult intubation which were commonly used in general population such as MPC grade III or IV, interincisor gap less than 35 mm, thyromental distance less than 65 mm, neck mobility less than 80^o and mandibular abnormality were reliable predictors.

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Received on 27-03-2014 Accepted on 09-04-2014 Published on 05-09-2014

DOI: http://dx.doi.org/10.14205/2310-9394.2014.02.01.2