ORIGINAL ARTICLE

Goitre-Related Factors for Predicting Difficult Intubation in Patients Scheduled for Thyroidectomy in a Resource-Challenged Health Institution in North Central Nigeria

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ABSTRACT

BACKGROUND: *Airway management problems may arise when intubating patients with goitre scheduled for thyroidectomy. Goitres are not uncommon in sub-Saharan Africa, thyroidectomy being the main treatment. The aim of this study was to determine incidences of difficult intubation (DI), failed intubation (FI)and predictors of DI using a modified intubation difficulty score (IDS).*

METHODS: *One hundred and twenty-five consenting patients with goitre scheduled for thyroidectomy were recruited. Goitre-related factors (GRF) of duration of illness, diagnosis, neck circumference, tracheal deviation and narrowing and retrosternal extension were recorded as well as Mallampati classification and BMI. At intubation, modified IDS was determined for each patient. Patients with modified IDS ≤ 5 were categorized as easy intubation group (E), and those with modified IDS >5 were categorized as difficult intubation group (D). The GRF of all patients in group D were compared with matched patients in group E.*

RESULTS: *Incidence of DI was 13.6% with 2 (1.6%) cases of failed intubation. Comparing groups D and E, duration of illness was 4.28 ± 3.78 years in group D versus 7.44 ± 7.63 years group E, p = 0.1353. Neck circumference was 41.42 ±5.30 cm in group D versus 37.43±2.68 cm in group E, p = 0.0200. Tracheal deviation, narrowing and retrosternal extension, and surgical diagnosis were not significantly different among both groups.*

CONCLUSION: *Incidence of DI was 13.6% and that of FI was 1.6%. Neck circumference was found to be a predictor of difficult intubation in goitre patients scheduled for thyroidectomy using the modified IDS.*

KEYWORDS: *Goitre, thyroidectomy, difficult intubation, predictive factors, modified intubation difficulty score*

INTRODUCTION

Problems with airway management are the main concern of the anesthetist when intubating the trachea of patients with goiter due to distortion of the airway by the enlarged thyroid gland. Difficult or failed intubation may result in serious morbidity such as hypoxic brain damage or even mortality. Amathieu et al (1) reported that the overall incidence of DI in thyroidectomy surgeries was 11.1%.

Iodine deficiency which promotes the development of goitre is widespread in sub-Saharan Africa and it is a public health concern (2). In our environment, many goiters are neglected and patients sometimes present with enlarged glands reaching enormous sizes (3). Famuyiwa (4) reported that thyroidectomy was the most common treatment for goitre in Nigeria**.** Despite these facts, a search in the literature revealed paucity of discourse on specific risk assessment of DI in patients scheduled for thyroidectomy in our environment.

Traditionally, tracheal intubation is described as difficult when proper insertion of the tracheal tube with conventional laryngoscopy requires more than three attempts or more than 10 minutes for a successful endotracheal intubation (5). An intubation difficulty scale (IDS) described by Adnet et al (6) uses seven variables to characterize DI: intubation attempts, number of operators, alternative techniques, laryngoscopic grade, lifting force at laryngoscopy, external pressure and position of vocal cords.

Classical risk factors which have been used to predict DI are: the Body Mass Index (BMI), Mallampati classification, inter-incisor gap, thyromental distance, neck mobility, gender, dentition and mandibular abnormalities (7). For goitre patients, in addition to the classical risk factors, there are goiter-related factors that may predict DI. Indirect laryngoscopy by the otorhinolaryngologist and Chest X-Ray showing tracheal narrowing, deviation and retrosternal extension may suggest higher probability of DI (8).These tests are routinely requested in the preoperative assessment of goitre patients. Khan *et al* (9) concluded, in a study, that neck thickness measured as neck circumference in goitre patients was a significant predictor of DI.

The aim of this study was to use preoperative goitre-related factors to predict DI in goiter patients scheduled for thyroidectomy under general anaesthesia. The factors considered were duration of illness, surgical diagnosis, neck circumference and radiological tracheal abnormalities using a modified IDS.

PATIENTS AND METHODS

Institutional ethics approval was obtained for the study. Consecutive and consenting 125 patients with goitre scheduled for elective thyroidectomy over a 3-year period were recruited into this prospective observational study. The exclusion criteria were history of previous difficult or failed intubation, recognized airway pathological (apart from goitre) or anatomical abnormality, recurrent goitre and patient refusal. Other exclusion criteria were the classical risk factors of difficult intubation (inter-incisor gap <3.5 cm, thyromental distance <6.5 cm, short neck and limited neck mobility < 80^{o}).

Patients were reviewed a day before their scheduled surgery. The nature of the study was explained to the patients and written informed consent obtained. The records of sex and age of the patients, height (cm) and weight (kg) were obtained. Goitre-related data recorded included the following: duration of illness, surgical diagnosis, Mallampati classification (10), presence or absence of radiological features of tracheal deviation, tracheal narrowing and retrosternal extension of the goitre. Neck circumference (cm) was taken at the point of maximum bulge on the goitre using a measuring tape. Patients had other standard preoperative anaesthetic preparations such as premedication, blood grouping and cross-matching for the procedure. Pre-treatment with intravenous atropine at induction of anaesthesia was not routinely administered to the patients. However, it was administered if the heart rate was low (< 60 bpm) or if administration of further doses of suxamethonium became necessary in the event of multiple attempts at intubation. Atropine was also given when inhalational induction with

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halothane was done in cases of anticipated difficulty.

In the operating room, Mallampati classification (10) was repeated by any of the 3 anaesthetist investigators. Blood pressure, arterial oxygen saturation (SpO_2), pulse rate, temperature and electrocardiogram were monitored using a DASH 4000 multi-parameter modular monitor (GE Medical Systems, Wisconsin, USA). Venous access was secured with either size 16 or 18 gauge intravenous canula on the forearm or dorsum of the hand.

The anaesthesia workstation was checked to be functional while various sizes of cuffed endotracheal tubes, and functional laryngoscopes with various sizes of blades were made available. Available intubation aids such as gum elastic bougies, laryngeal mask airways and stylets were provided.

As the IDS allows for multiple operators for scoring, only experienced residents and consultants performed endotracheal intubation. Pre-induction dose of atropine 0.04 mg/kg was administered intravenously as required. Induction technique of anaesthesia depended on whether or not DI was anticipated. Where difficulty was anticipated, induction was done by inhalational method using halothane in 0.5% increments up to 3% until hypnosis was achieved. The patient was thereafter test-ventilated manually and gentle laryngoscopy carried out. If the larynx was visualized and intubation was adjudged possible, the patient was given intravenous suxamethonium 1.0 - 1.5 mg/kg to facilitate endotracheal intubation.

Where difficulty was not anticipated, induction of anaesthesia was achieved with iv fentanyl 1-3 µg/kg and iv propofol 2.5-3.5 mg/kg. Following loss of verbal contact, iv suxamethonium 1.0-1.5 mg/kg was given to facilitate endotracheal intubation.

At laryngoscopy, the following were noted: a) laryngoscopic view as described by Cormack and Lehane (11), b) lifting force to expose the glottis whether normal or more than normal, c) the use of external laryngeal pressure to expose the glottis, d) position of vocal cords. The number of intubation attempts, the number of operators to achieve intubation and the alternative techniques used were all recorded.

The intubation difficulty score (IDS) (6) (Table 1) uses 7 parameters, namely, intubation attempts, number of operators, number of alternative techniques, laryngoscopic grade, lifting force at laryngoscopy, external laryngeal pressure and position of vocal cords at laryngoscopy. For the goitre patients, the larynx may not be visible even with maximal external laryngeal manipulation. Also, the vocal cords may not be wholly visible, and intubation may be done blindly advancing the tube under the tip of the epiglottis. The 7th parameter of the IDS, position of the vocal cords is scored as follows: Abduction = 0; Adduction = 1, and there is no score when vocal cords are not visible and intubation done blindly using the tip of the epiglottis as guide. Therefore, for the purpose of this study, a score was added: vocal cords not visible = 2. Once the patient's trachea was successfully intubated, the patient was connected to the anaesthesia machine via a closed circuit or Bain breathing system. Further intra-operative anaesthetic and postoperative management of the patient followed standard protocols.

The modified IDS for each patient was calculated. Patients were classified into two groups based on their modified IDS score as follows: Easy intubation (Group E), modified IDS $\leq$ 5, Difficult intubation (Group D), modified IDS > 5. The incidence of difficult intubation was determined from the modified IDS grouping.

Each patient with difficult intubation (D) was matched with a patient with easy intubation (E) using age, sex and BMI. Subsequently, the goitre-related predictive risk factors (duration of illness, neck circumference, tracheal deviation, narrowing, retrosternal extension and surgical diagnosis) were compared between the two groups.

Using Fishers' formula (12,13) for descriptive study, it was determined that a minimum number of 96 patients were needed for the study. The primary outcome measure was the incidence of difficult intubation. Other outcome measures were incidence of failed intubation and goitre-specific predictive factors for difficult intubation.

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Data were analyzed using Epi Info version 7.2 (Centre for Disease Control and Prevention, Atlanta, Georgia, USA). Parametric data were presented in means and standard deviations and the Student's t test was used for test of significance. Non-parametric data were presented in proportions and frequencies and Chi square test was used for test of significance or Fisher's exact test where appropriate. A p-value less than 0.05 was considered significant.

RESULTS

One hundred and twenty-five (125) consecutive consenting patients scheduled for elective thyroidectomy were prospectively recruited into this observational study. There were 9(7.2%) males and 116(92.8%) females. The age range of all the patients was from 22-80 years, mean 45.76 ± 12.66 years. The BMI ranged from 16.18 - 44.61 kg/m^2, mean 25.84 ± 4.76 kg/m2.

The modified intubation difficulty score (modified IDS) ranged from 0 to 17. Table 1 shows the distribution of the modified IDS among patients. There were 108(86.4%) patients with easy intubation (score ≤ 5), with patients of score 0 constituting the majority, 48(38.4%). There were 17(13.6%) patients with difficult intubation (score > 5). Among the patients that had modified IDS > 5, 9(7.2%) had score of 6, 2(1.6%) each had scores of 7 and 9 respectively, while 1(0.8%) each had scores of 11, 12, 13 and 17 respectively. Two (1.6%) patients with scores of 13 and 17 respectively eventually had failed intubation.

Table 1: Modified IDS of patients with goitre (n = 125)

Modified IDS	Number (%)
0	48 (38.4)
1	22 (17.6)
2	9 (7.2)
3	9 (7.2)
4	9 (7.2)
5	11 (8.8)
>5	17 (13.6)
Total	125 (100.0)

Tables 2 and 3 show demographic data and goitre-specific characteristics respectively of the 17 difficult intubation patients (D) matched with 17 easy intubation patients (E). The demographic data between the two groups were comparable: mean age p = 0.7275, mean weight p = 0.7087, mean height p = 0.9532 and mean BMI p = 0.7652 (Table 2). Table 3 shows that there was no significant difference in mean duration of illness between the two groups, 4.28 ± 3.78 years in Group D versus 7.44 ±7.63 years in Group E, p = 0.1353 (95% CI -7.372 to 1.043). There were also no significant differences in tracheal deviation (p = 0.2587), tracheal narrowing (p = 1.0000), retrosternal extension (p = 0.1175) and surgical diagnoses of simple, toxic and malignant goitre (p = 0.3353, 0.3353 and 1.0000 respectively) between the two groups. Neck circumference was significantly greater in Group D than Group E, 41.42 ± 5.30cm versus 37.43 ± 2.68 cm, p = 0.0200 (95% CI -6.415 to -0.562).

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Table 3: Demographic data of Difficult intubation (Group D) patients matched with Easy intubation (Group E) patients.

Parameter	Group D (IDS > 5) n = 17	Group D (IDS ≤ 5) n = 17	p value
Mean age (years)	51.35 ± 13.11	49.94 ± 10.11	0.7275
Mean weight (Kg)	64.88 ± 13.13	66.07 ± 9.56	0.7087
Mean height (m)	1.64 ± 0.06	1.64 ± 0.06	0.9532
Mean BMI (kg/m^2)	25.01 ± 4.90	24.57 ± 3.53	0.7652

Table 3: Duration of illness, neck circumference and radiological features of Difficult intubation (Group D) patients matched with Easy intubation (Group E) patients

Parameter	Group D n =17	Group E n= 17	p value
Mean duration of illness(years)	4.28±3.78	7.44±7.63	0.1353*
Mean neck circumference(cm)	41.4±5.3	37.43±2.68	0.0200*
Tracheal deviation(no of patients)	14	10	0.2587**
Tracheal narrowing(no of patients)	5	4	1.0000**
Retrosternal extension (no of patients)	7	2	0.1175**
Simple goiter	13	16	0.3353**
Toxic goiter	4	1	0.3353**
Malignant goiter	0	0	1.0000**

*student's t test, **Fisher's exact test

DISCUSSION

We found the incidence of difficult intubation in 125 goitre patients scheduled for thyroidectomy using the modified Intubation Difficulty Score (IDS) to be 13.6%. However, there were 2 cases of failed intubation giving an incidence of 1.6%. A previous retrospective study in our centre which agrees with our results found incidences of DI in goitre patients to be 13.2% and failed intubation 1.3% (14). Amathieu et al (1) reported that the incidence of difficult intubation in 223 goitre patients was 11.7% using the IDS. The slightly higher incidence in our series may be due to the additional point when the vocal cord was not visible in the IDS scale. The IDS scale introduced by Adnet et al (6) had 2 scores for position of the vocal cords, 0 for abduction and 1 for adduction. In our practice, some goitres distorted airway anatomy such that only the epiglottis is seen even with maximal external laryngeal manipulation. In such situations, a good operator used the tip of the epiglottis as a guide to pass the endotracheal tube or a bougie into the trachea without visualizing the vocal cords. For such cases, the position of the vocal cord was scored 2 in our study. A levering laryngoscope such as the McCoy would probably have added an advantage of visualizing the vocal cords and using the original score for position of the vocal cords. However, this instrument was not available at the time of this study.

Shah et al (15) reported difficult intubation in 36 out of 187 patients scheduled for thyroid surgery with an incidence of 16.5% using the IDS. However, there were no exclusion criteria in their study which may give a high incidence of difficult intubation. In the study by Amathieu

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et al (1), the only exclusion criterion was previous difficult intubation. Bouaggad et al (16) reported a lower incidence of difficult intubation of 5.3% in 320 patients. In the Bouaggad et al (16) study, all the patients were successfully intubated, with no cases of failure. Khan et al (9) reported difficult intubation of 12.9% in 139 patients scheduled for elective surgery to treat euthyroid goitre. However, in their study, they used Cormack and Lehane grades III and IV to define difficult intubation.

In our study, the only goitre-related specific risk factor that was associated with difficult intubation (DI) was neck circumference. Neck circumference is an indirect measure of the size of the gland, and a larger size is more likely to cause airway deformity, hence difficult intubation. Khan et al (9) reported that neck thickness measured as neck circumference in goitre patients was a significant predictor of difficult intubation. While Khan et al (9) measured neck circumference at the level of the thyroid cartilage, we measured neck circumference at the level of the maximal bulge of the gland. It is noteworthy that in some huge goitres, it is difficult to palpate the laryngeal prominence, thus any measurement using this landmark may be difficult or impossible. Kalezic et al (7) singled out circumference and length of the neck as the two most important risk factors for DI which partly agrees with our study that found only neck circumference as a predictor of DI. The limitation of using neck circumference is that it does not accurately represent the size of the gland. A better way of assessing size is to determine the volume using ultrasound.

Shah et al (15) showed that malignant goitre was associated with DI. However, in their study, they compared all patients with difficult intubation (n = 31) with those that had easy intubation (n = 156) whereas we compared equal number of both groups having matched those with DI (n = 17) with those that had easy intubation (n = 17). Although the sample size of the two groups compared was small, they were well matched for sex, BMI and age. In the study by Bouaggad et al (16), the presence of a cancerous goitre was the only predictor of difficult intubation in thyroid surgery, and it was attributed to tracheal invasion, tissue infiltration and fibrosis of the trachea. The diagnosis was made by fine needle aspiration cytology prior to surgery. In our study, only surgical diagnosis of the goitre was made, and there was no recorded case of cancerous goitre.

Interestingly, tracheal deviation and narrowing were not found to be predictors of DI in this study. However, in a previous retrospective study in this centre, it was found that goitres producing annular luminal tracheal narrowing less than 7 mm was associated with DI and failed intubation when less than 5 mm (14). That study considered only radiological tracheal configuration in predicting DI (14). In the study by Kalezic et al (17), tracheal deviation and stenosis were shown to be significant but not independent predictors of DI in thyroid surgery. The observed difference from our study may be due to our smaller sample size and the duration of study which was three years. Their study had a total sample size of 2,379 patients who had surgery over a period of five years in a centre dedicated to endocrine surgery. Kalezic et al (17) reported that tracheal dislocation and/or stenosis was more present in the group with DI. The authors gave this as the reason for preoperative x-ray before thyroid surgery in their centre. Pre-thyroid surgery x-ray of the neck and thoracic inlet are mandatory in our centre. On the contrary, Hong et al (18) showed, in a retrospective analysis of records of 1,000 thyroid patients, that there was no correlation between a finding of tracheal deviation on preoperative chest–ray (CXR) and DI. They concluded that CXR for the sole purpose of identifying tracheal deviation in thyroid surgery was not warranted.

In our study, patients with obvious classical risk factors for difficult intubation were excluded from participating as these factors were regarded as confounders. Rather, we evaluated risk factors that were specific to patients with goitre. Workers that evaluated the classical risk factors in addition to the goitre-related specific factors found that all the classical risk factors were significant for predicting DI in goitre patients (1,15). Since the classical risk factors apply to all patients

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scheduled for surgery in predicting difficult intubation, using these in our study would not add new knowledge to what is already known.

In conclusion, we found the incidence of DI in goitre patients scheduled for thyroidectomy to be 13.6% while that of failed intubation was 1.6% in our study. We also found that neck circumference, which is an indication of goitre size, is a significant risk for DI in these patients. However, abnormal radiological features of tracheal deviation, narrowing and retrosternal extension were not significant risks for DI in our patients. We recommend that all goitre patients scheduled for thyroidectomy have complete airway assessment, including the classical risk factors for successful airway management.

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