



## SCIENTIFIC ARTICLE

## Does ultrasonographic volume of the thyroid gland correlate with difficult intubation? An observational study<sup>☆</sup>



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### KEYWORDS

Ultrasonography;  
Airway management;  
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### Abstract

**Background and objectives:** Preoperative ultrasonographic evaluation of the thyroid gland done by surgeons could let us foresee airway management challenges. The aim of this observational study was to evaluate the effects of thyroid-related parameters assessed preoperatively by surgeons via ultrasonography and chest X-ray on intubation conditions.

**Methods:** Fifty patients undergoing thyroid surgery were enrolled. Thyromental distance, Mallampati score, neck circumference and range of neck movement were evaluated before the operation. Thyroid volume, signs of invasion or compression and tracheal deviation on chest X-ray were also noted. The intubation conditions were assessed with Cormack and Lehane score and the intubation difficulty scale. Statistical analyses were done with SPSS 15.0 software.

**Results:** The mean thyroid volume of the patients was  $26.38 \pm 14$  mL. The median intubation difficulty scale was 1 (0–2). Thyromental distance ( $p = 0.011$ ;  $r = 0.36$ ; 95% CI 0.582–0.088), Mallampati score ( $p = 0.041$ ;  $r = 0.29$ ; 95% CI 0.013–0.526), compression or invasion signs ( $p = 0.041$ ;  $r = 0.28$ ; 95% CI 0.006–0.521) and tracheal deviation on chest X-ray ( $p = 0.041$ ;  $r = 0.52$ ; 95% CI 0.268–0.702) were correlated with intubation difficulty scale. Also patients were classified into two groups related to their intubation difficulty scale (Group I,  $n = 19$ : intubation difficulty scale = 0; Group II,  $n = 31$ :  $1 < \text{intubation difficulty scale} \leq 5$ ) and difficult intubation predictors and thyroid-related parameters were compared. Only Mallampati score was significantly different between groups ( $p = 0.025$ ).

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**PALAVRAS-CHAVE**

Ultrassonografia;  
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aéreas;  
Glândula tireoide

**Conclusion:** The thyroid volume is not associated with difficult intubation. However clinical assessment parameters may predict difficult intubation.

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### Existe correlação entre o volume ultrassonográfico da glândula tireoide e intubação difícil? Um estudo observacional

**Resumo**

**Justificativa e objetivos:** A avaliação ultrassonográfica pré-operatória da glândula tireoide feita por cirurgiões pode prever desafios no manejo das vias aéreas. O objetivo deste estudo observacional foi avaliar os efeitos de parâmetros relacionados à tireoide investigados pré-operatoriamente por cirurgiões mediante ultrassonografia e radiografia de tórax em condições de intubação.

**Métodos:** Cinquenta pacientes submetidos à cirurgia de tireoide foram inscritos. Distância tireoentoniana (DTM), escore de Mallampati, circunferência do pescoço e amplitude de movimento do pescoço foram avaliados antes da operação. Volume da tireoide, sinais de invasão ou compressão e desvio da traqueia na radiografia de tórax também foram registrados. As condições de intubação foram avaliadas com o escore de Cormack e Lehane (CL) e a escala de intubação difícil (EID). Análises estatísticas foram realizadas com o software SPSS 15.0.

**Resultados:** A média do volume da tiroide dos pacientes foi de  $26,38 \pm 14$  mL. A mediana da EID foi 1 (0-2). DTM ( $p=0,011$ ;  $r=0,36$ , IC 95% 0,582-0,088); escore de Mallampati ( $p=0,041$ ;  $r=0,29$ , IC 95% 0,13-0,526); sinais de compressão ou invasão ( $p=0,041$ ;  $r=0,28$ ; IC 95% 0,006-0,521) e desvio da traqueia na radiografia de tórax ( $p=0,041$ ;  $r=0,52$ , IC 95% 0,268-0,702) foram correlacionados com a EID. Os pacientes foram classificados em dois grupos também relacionados à EID (Grupo I,  $n=19$ : EID=0; Grupo II,  $n=31$ :  $1 < \text{EID} \leq 5$ ), e os preditivos de intubação difícil e os parâmetros da tiroide relacionados foram comparados. Apenas o escore de Mallampati foi significativamente diferente entre os grupos ( $p=0,025$ ).

**Conclusão:** O volume da tireoide não está associado à intubação difícil. Contudo, os parâmetros de avaliação clínica podem prever intubação difícil.

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**Introduction**

Airway management is one of the most important first concern in the operating room not only for anesthesiologists but also for surgeons who are going to operate close to the airway, as failed intubation is associated with severe morbidity and mortality. Preoperative evaluation of the airway by physicians with objective parameters is therefore essential in all cases. Thyroid surgery is a common surgical procedure of the neck region and an enlarged thyroid gland could yield a risk factor for difficult airway management.<sup>1</sup> However routine physical examination fails to predict actual size of the enlarged thyroid gland. On the other hand ultrasound provides relatively more accurate size estimation and patients who will undergo a thyroidectomy are almost always preoperatively examined by ultrasonography of the thyroid gland and chest X-ray by their respective surgeons. Thus, at the time of preoperative evaluation for thyroid surgery results of these examinations are already available for almost every patient. Considering this, some objective data from these already obtained preoperative investigations could also be used by the interdisciplinary physician

team for the preoperative risk calculation of difficult airways among this group of patients.

As the ultrasonographic volume of the enlarged thyroid gland and its impact on the airway management is still not truly appraised, the primary aim of this study was to evaluate the impact of the thyroid gland volume estimated by ultrasonography on the endotracheal intubation conditions. Nearby, the secondary aim was to correlate these parameters with classical indicators like Mallampati classification, thyromental distance (TMD), neck circumference and movements for predicting difficult endotracheal intubation.

**Methods**

After the approval of the University Research Ethics Committee and after obtaining informed consent from every individual patient, fifty consecutive ASA physical status I and II female patients undergoing thyroid surgery were enrolled to this study. Patients with history of difficult intubation, Body Mass Index more than 35 and having malformation of the airway (not due to thyroid enlargement),

younger than 18 and older than 75 were excluded from the study. Preoperative airway assessment consisting of TMD (>70 mm or <70 mm), Mallampati classification, Cormack and Lehane (CML) score, range of neck movement (>80° or <80°) and neck circumference (>43 cm or <43 cm) was performed by an attending anesthesiologist. Thyroid volume, signs of invasion or compression and tracheal deviation on chest X-ray were noted. Detection of dysphonia, change in voice quality, dyspnea, stridor, hoarseness and/or cough during the preoperative evaluation was considered as signs of invasion or compression. Thyroid volumes were calculated via ultrasonographic measurement. The volume of each thyroid lobe was calculated with ellipsoid formula (height × width × depth × 0.524) and the total volume of the thyroid was obtained as the sum of two thyroid lobes.<sup>2</sup> Direct X-ray examination of the neck and chest were also done to assess the tracheal deviation defined as 1 cm deviation of trachea from the midline. Additionally histopathological diagnosis of each patient was recorded as malignant or benign disease.

All patients were premedicated with intravenous (iv) midazolam (0.01 mg/kg). The ASA monitoring consisting of noninvasive blood pressure, pulse oximetry, electrocardiogram, and measurement of end-tidal carbon dioxide was done. Dexketoprofen trometamol 50 mg iv was given for postoperative pain medicine. Anesthesia was induced with lidocaine (1 mg/kg) and propofol (3 mg/kg). Tracheal intubation was facilitated by the administration of iv rocuronium (0.6 mg/kg). Patient were intubated 90s after rocuronium administration by a certified anesthesiologist with a Macintosh laryngoscope (Blade 3 or 4) and the laryngeal view was assessed according to the Cormack Lehane Score (CMS) grading system defined as: grade 1 = complete visualization of the vocal cords; grade 2 = visualization of the inferior portion of the glottis; grade 3 = visualization of only the epiglottis; and grade 4 = no visualized epiglottis.<sup>3</sup> Intubation difficulty was assessed using the intubation difficulty scale (IDS). The IDS is a combination of seven criteria that have been associated with difficult intubation: (1) number of intubation attempts; (2) number of operators; (3) number of alternative techniques; (4) Cormack Grade minus 1; (5) lifting force required to make laryngoscopy; (6) necessity of laryngeal pressure; and (7) position of vocal cords. A score of 0 indicates easy intubation, a score from 1 to 5 indicates a slightly difficult intubation, and a score more than 5 indicates moderate to major difficulty.<sup>4</sup> The intubation time (the time interval between the first contact of the laryngoscope and the successful endotracheal intubation and inflation of the cuff) was also recorded. Furthermore number of intubation attempts was recorded. After tracheal intubation, the correct positioning of the endotracheal tube was confirmed by the auscultation of both hemithorax. Sevoflurane concentration that adjusts to 1 MAC with 50% nitrous oxide in oxygen was used for the anesthesia maintenance.

The thyroidectomy was performed with patients in the supine position, with the head slightly hyperextended. Side effects related to intubation such as bleeding, sore throat or hoarseness were evaluated after extubation and noted.

A power analysis was performed before the initiation of the study. The results of the previous study of Amathieu et al. were used to calculate the number of patients needed to enroll into the study to find a statistically significant

correlation between the enlarged thyroid gland and IDS score.<sup>1</sup> According to the calculation 50 patients were needed to calculate the correlation between the thyroid gland volume and IDS score. The statistical analyses were done with SPSS 15.0 software (SPSS Inc., Chicago, IL, USA). Demographic data and predictors of difficult intubation were presented as mean ± SD and number of patients. Correlation analysis of IDS with predictors of difficult intubation (TMD, Mallampati score, compression or invasion signs, tracheal deviation on chest X-ray, neck mobility and neck circumference), thyroid gland volume and diagnosis were done with Pearson's correlation analysis. The results of the correlation analysis were presented as *r* (correlation coefficient) and *p* value with the confidence interval. The patient population was divided into two groups according to the IDS value (Group I *n* = 19; IDS = 0 and Group II *n* = 31; 1 < IDS ≤ 5). Predictors of difficult intubation, number of intubation attempts, intubation time and the presence of compression signs were further analyzed with Student's *t*-test, Mann-Whitney *U* test and Chi-square test as where indicated, and presented as mean ± SD, median and quartiles and number of patients. A *p* value of <0.05 was accepted as significant.

## Results

Demographic and surgical data of the patients are presented in Table 1. The mean thyroid volume of the patients was 26.38 ± 14 mL. The numbers of patients who have predictors of difficult intubation (thyromental distance <7 cm, Mallampati score III–IV, neck movement <80° or neck circumference >43 cm) are presented in Table 2. Six patients out of 50 had compression or invasion signs and 6 had tracheal deviation on chest X-ray. In 4 patients those findings were concomitant. All patients were intubated at the first attempt without any significant difficulty. The median IDS was 1 (0–2) and the overall incidence of difficult intubation defined as IDS > 5 was 0%. Thirty-eight percent of the intubations (*n* = 19) were performed without difficulty (IDS = 0) while 62% (*n* = 31) had minor difficulty (1 < IDS ≤ 5). Three patients had IDS of 5. The median and quartiles of Cormack and Lehane score was

**Table 1** Demographic and surgical data.

Age (year)	47 ± 9
Height (cm)	162 ± 6
Weight (kg)	78 ± 13
Anesthesia time (min)	143.8 ± 33
Surgery time (min)	134 ± 36
Diagnosis (malign/benign) ( <i>n</i> )	6/44

Data are mean ± SD or numerical value.

**Table 2** Predictors of difficult intubation.

Variables	Number of patients
Mallampati III–IV	7
Neck movement <80	26
Neck circumference >43 cm	11
Thyromental distance <7 cm	1

Data are numerical value.

**Table 3** Correlation analysis of IDS with predictors of difficult intubation.

Variables	p-Value	r-Value	95% CI
Thyromental distance <7 cm	0.011	0.36	0.582–0.088
Mallampati III–IV	0.041	0.29	0.013–0.526
Compression or invasion signs	0.041	0.28	0.006–0.521
Tracheal deviation on chest X-ray	0.041	0.52	0.268–0.702
Diagnosis (malign/benign)	0.28	0.15	–
Neck mobility <80	0.25	0.17	–
Neck circumference >43 cm	0.21	0.18	–
Thyroid gland volume	0.85	–0.03	–

CI, confidence interval; IDS, intubation difficulty scale.

2 (1–2). The median number of intubation attempt was 1 (1–1) and the median time to intubate was 85 (48–98) s.

The correlation analyses of IDS with predictors of difficult intubation and thyroid volume are shown in Table 3. Furthermore no significant correlation was observed between IDS and postoperative side effects such as hoarseness and sore throat at rest and with swallowing.

Patients were classified into two groups related to their IDS (Group I: IDS = 0; Group II: 1 < IDS ≤ 5). Demographic data were similar among groups. Routine predictors for difficult intubation and thyroid-related parameters were compared between these groups and Mallampati score was significantly different between groups (Table 4).

### Discussion

The primary findings of this study were that IDS was not correlated with thyroid-related parameters such as volume and malignancy, but it was correlated with tracheal deviation, compression signs and with routine difficult intubation

predictors such as TMD and Mallampati score. The secondary findings were the difference between IDS groups related to Mallampati score.

Amathieu et al., with a very similar study design without the ultrasonographic calculation of the enlarged thyroid gland volume, showed that the presence of a goiter or goiter-associated airway deformities, compressive symptoms or endo-thoracic position were not associated with difficult intubation.<sup>1</sup> In contrast with these results, in our study, tracheal deformity related to thyroid gland and compression signs were correlated with intubation score. When enlarged, the thyroid gland may exert a pressure on the trachea and adjacent tissues and this pressure may deviate the trachea and cause some compression signs. These changes in the tissue anatomy may render intubation more difficult and lower the quality of the intubation. In concordance to our study, Voyagis et al. demonstrated that when thyroid enlargement was accompanied by an airway deformity it constituted an aggravating factor for difficult intubation.<sup>5</sup>

In another study, Bouaggad et al. demonstrated that in 320 patients undergoing thyroidectomy the difficulty of intubation was increased only with malignant thyroid diseases.<sup>6</sup> The mechanism for difficult intubation is explained with an advance stage of the disease, which leads to tracheal invasion and tissue infiltration. In our study, the presence of thyroid malignancy was not related to an increased intubation difficulty. This discrepancy may be explained by the time of diagnosis. All of our patients with malignancy were early stage diseases.

In our study group only 6 patients had invasion and compression signs and 6 had tracheal deviation on chest X-ray. In 4 patients those findings were concomitant, thus actually 8 patients had them. Additionally and interestingly, the diagnosis of all the patients with compression signs and tracheal deviation was benign. Also in this study group thyroid gland volume was 20.21 ± 13 mL in malign group and 27.70 ± 15 in benign group. Although statistically non-significant, patients with benign diseases had bigger thyroid gland which may explain the incidence of compression signs and tracheal deviation. Furthermore Bouaggad et al. measured the size of the thyroid gland in millimeters along the main straight line of the gland and did not find any

**Table 4** Comparison of predictors and expressions for difficult intubation between groups.

Variables	IDS = 0 (n = 19)	1 < IDS ≤ 5 (n = 31)	p-Value
Thyromental distance <7 cm	0	1	NS
Mallampati score	1.5 ± 0.6	2 ± 0.6	0.025
Mallampati III–IV	1	6	NS
Cormach and Lehane score	1 (1–1)	2 (1–4)	<0.001
Neck mobility <80	8	16	NS
Neck circumference >43 cm	2	9	NS
Diagnosis (malign/benign)	0/19	6/25	NS
Thyroid gland volume	27.20 ± 12.21	25.74 ± 16.77	NS
Compression signs	2	4	NS
Tracheal deviation on chest X-ray	1	5	NS
Number of intubation attempt	1 (1–1)	1 (1–5)	0.026
Intubation time	81.93 ± 34.55	80.21 ± 38.74	NS

Data are presented as mean ± SD, median (minimum-maximum) or numerical value. NS, not significant; IDS, intubation difficulty scale.

correlation between thyroid size and intubation difficulty.<sup>6</sup> This measurement is in correlation with our results related to the volumetric measurements of the thyroid.

Seker and Tas had evaluated 251 healthy volunteers and defined the mean thyroid volume of Turkish population as  $13 \pm 6.27$  mL.<sup>7</sup> Also Erbil et al. reported in a population of 402 patients, that the thyroid volume in patients with thyroid carcinoma was  $38 \pm 18$  mL and in patients with benign diseases it was  $73.3 \pm 48$  mL.<sup>8</sup> The mean thyroid volume of our study group was  $26.38 \pm 14$  mL, which is higher than the healthy population but still lower than Erbil's results. These findings may explain the fact that in our study this volume did not have any effect on intubation condition. Bigger thyroid gland might have had some different effect on intubation conditions.

The analysis of routine predictors of difficult intubation revealed that more frequently used TMD and Mallampati score were correlated with IDS but neck circumference and motility were not. These results are partly in concordance with Amathieu et al. results, which stated that usual preoperative predictors for difficult intubation such as mouth opening, Mallampati score, TMD and neck mobility were reliable parameters also in thyroid surgery patients.<sup>1</sup>

Also, when dividing patients into 2 groups according to their IDS, there was only a significant difference between Mallampati score, which is similar to the previous results of the study.

Taking into account that none of our patients were difficult to intubate, it is difficult to correlate thyroid-related parameters with difficult intubation. Although this might seem like a limitation in this study, it actually reflects that in our daily clinical practice and patient population, thyroid-related parameters do not really increase the risk of difficult intubation in our setting. Nevertheless, bigger patient series are probably needed to come to more comprehensive conclusions, especially taking more specific groups into account like malignant disease or giant thyroid masses.

In such occasions, findings of the thyroid USG and chest X-ray already ordered preoperatively by the surgeons could reveal valuable information to the anesthesiologist to assess better risk analysis.

In conclusion, the volume of the thyroid gland is not correlated with the intubation difficulty score. As the signs of tracheal deviation on the chest X-ray and compression or invasion signs represent a moderate correlation with IDS, special care should be taken in patients with tracheal deviation and compression signs.

## Conflicts of interest

The authors declare no conflicts of interest.

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