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PREDICTORS OF DIFFICULT AIRWAY MANAGEMENT IN THYROID SURGERY: A FIVE-YEAR OBSERVATIONAL SINGLE-CENTER PROSPECTIVE STUDY

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SUMMARY – Difficult tracheal intubation (DI) is more common in thyroid than in other surgical branches due to thyromegaly. Proper preoperative airway evaluation is necessary in order to reduce the potential numerous complications. The study examined the incidence of DI in thyroid surgery and the influence of tracheal dislocation and other risk factors on DI. A prospective study was conducted on 2379 patients who underwent thyroidectomy at the Center for Endocrine Surgery, Clinical Center of Serbia, from 2007 to 2012. Patients were divided into groups with (n=162) and without DI (n=2217). Besides tracheal dislocation, another 13 risk factors contained in 13 screening tests and three additional factors of gender, age and diagnosis were defined. The incidence of DI in our study was 6.81%. The presence of tracheal dislocation was statistically significant, but not an independent predictor of DI. The diagnosis, large circumference and small neck length, previous DI, recessive mandible, tooth characteristics and oral anomalies were the most significant and independent predictors of DI. Neck circumference and small neck length had highest sensitivity. Previous DI had highest specificity. Thyromegaly, if causing tracheal dislocation and/or stenosis, represents a significant DI predictor, not individually, but in combination with other factors.

Key Words: *Airway Management; Intubation, Intratracheal – Methods; Thyroid Diseases - Surgery; Tracheal Dislocation*

Introduction

It is well known that the causes of difficult intubation (DI) of the trachea can be congenital and acquired anomalies, especially anomalies of the head and neck. Among the acquired causes, endocrine disorders including thyroid gland diseases occupy an important place[1,2]. Thyroid gland diseases often are associated with thyromegaly, which, on the one hand, leads to increased neck size, especially its circumference, which is a known predictor of DI in other branches of surgery. On the other hand, enlarged thyroid can compress the trachea and lead to its deviation (dislocation) and/or stenosis. Although trachea dislocation (deviation of the trachea from the midline by more than 1 cm) has always been associated with DI, a small number of published papers confirm this assertion. In more severe cases, compression of the trachea may lead to its stenosis, if the lumen narrowing is greater than 30%. Severe tracheal stenosis (over 70% of its normal lumen width) results in progressive steady-state dyspnea and such patients are at greatest risk of various complications during airway management, including total airway obstruction[3,4]. The existence of tracheal dislocation and stenosis at the same time certainly represents the most difficult clinical

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scenario. Unfortunately, this scenario is often seen precisely in thyroid surgery and requires vast knowledge and experience of the anesthesiologist.

Numerous studies showed a high incidence of DI in thyroid surgery, ranging from 5.3% to 16.5%[5-7]. However, we still cannot certainly claim which methods of preoperative evaluation of the airway have the highest predictive value in assessing possible DI because there are not enough well-documented studies.

The aim of our study was to investigate the incidence of DI in thyroid surgery, the influence of tracheal dislocation and/or stenosis on DI, and to analyze other risk factors for DI that were part of the scoring scale created in our Center and adapted to our patients.

Patients and Methods

We conducted a prospective study on 2379 patients undergoing surgery of the thyroid gland at the Center for Endocrine Surgery, Clinical Center of Serbia, during the period from 2007 to 2012. Patients were divided into groups with DI (162 patients) and without DI (2217 patients). In addition to tracheal dislocation/stenosis, we defined another 13 risk factors that were part of 13 screening tests used in the prediction of difficult intubation and three additional factors of gender, age and diagnosis: nodular goiter, multinodular goiter, toxic adenoma, hyperthyroidism, papillary cancer, medullary cancer, anaplastic cancer, postoperative hematoma, Hashimoto thyroiditis, recurrent goiter, struma permagna, retrosternal goiter and multinodular toxic goiter.

Difficult intubation was defined as tracheal intubation without visualization of the glottis during laryngoscopy (grade III or IV according to Cormac-Lehane laryngoscopy classification)[8]. Several maneuvers if applied during intubation were taken into account (external pressure on the larynx, use of intubation stylet). Also, the number of attempts and duration of intubation were taken into account, which is consistent with the criteria of the American Society of Anesthesiologists[9]. Intubation was performed by four experienced anesthesiologists and anesthesiology residents.

Table 1. Potential predictors of difficult intubation (DI)

Potential predictors of DI	No risk 0 points	Moderate risk 1 point	High risk 2 points
History of previous DI	No/not known	-	Positive
Tracheal dislocation and/or stenosis (according to neck and chest x-ray)	No	Moderate	Significant
Larynx/vocal cords/airway (according to ENT examination)	No	Paresis/paralysis	Dislocation
Anatomic deformities of bones and joints	No	-	
Retrognathic ('recessive') mandible	No	-	
Size, layout and position of teeth (incisors)	Normal	Long	Asymmetric
Oral anomalies (small mouth, macroglossia, tumors)	No	-	Macroglossia, tumor
Body mass index	20-25 kg/m^2	25-30 kg/m^2	>30 kg/m^2
Degree of neck mobility (maximum extension)	>90°	80-90°	<80°
Thyromental distance (distance from the tip of the chin to Adam's apple)	>6.5 cm	6-6.5 cm	<6 cm
Interincisor gap (distance upper/lower incisors) M F	 >5 cm >4 cm	 4-4.5 cm 3.5-4 cm	<3.5 cm
Maximum protrusion of the mandible over the maxilla	>0 cm	=0 cm	<0 cm
Neck circumference and length	Normal	Short or wide	Short and wide
Mallampati score	I+II	III	IV
Maximal score R=28			

In order to predict DI, 14 parameters, i.e. potential risk factors were used and scored with 0-2 points (0 no risk, 1 moderate risk, and 2 high risk), with maximum score of 28. A total score higher than 5 was considered as a predictor of DI occurrence (Table 1). Three additional potential risk factors of gender, age and surgical diagnosis were included.

Statistics

Data collected through preoperative evaluation of the airway were entered into the electronic database. Statistical analysis was performed with SPSS 18.0 for Windows (SPSS Inc., Chicago, IL, USA). The methods of descriptive and analytical statistics evaluated the specificity and sensitivity of each risk factor. Data were presented as mean, standard deviation and median. For comparison of characteristics between the study groups we used *Pearson's* χ^2*-test* (contingency tables). Selection of tests for the analysis of numerical variables depended on the nature of their distribution, which was evaluated using Kolmogorov-Smirnov test. To test for differences between patients with and without DI with nonparametric data, Mann Whitney U test was used. Logistic regression was used to determine differences between the groups of patients with and without DI, as well as to determine odds ratio for the observed risk factors and the probability of the occurrence of DI. The level of statistical significance was set at $p<0.05$.

Results

The incidence of DI in our study was 6.81%. Gender, age and surgical diagnosis were significantly different between the two study groups (Table 2). All 14 potential risk factors/tests for assessing the airway were statistically significantly different between the two patient groups (Table 3). Since the univariate

Table 2. General characteristics of patients with and without difficult intubation

		Difficult intubation		Significance
		Yes	No	
Number of patients (n)		162	2216	
Age (Mean±SD (Med, min-max))		54.10±11.81 (55; 19-82)	50.77±14.41 (52.50; 20-90)	[a]p=0.006*
Gender, n (%)	Male	32 (19.8%)	307 (13.8%)	[b]p=0.038*
	Female	130 (80.2%)	1910 (86.2%)	
Diagnosis, n (%)	Nodular goiter	14 (8.6%)	488 (22.0%)	[b]p=0.000*
	Multinodular goiter	63 (38.9%)	788 (35.5%)	
	Toxic adenoma	1 (0.6%)	87 (3.9%)	
	Hyperthyroidism	25 (15.4%)	385 (17.4%)	
	Papillary cancer	8 (4.9%)	125 (5.6%)	
	Medullary cancer	2 (1.2%)	80 (3.6%)	
	Anaplastic cancer	1 (0.6%)	11 (0.5%)	
	Postoperative hematoma	20 (12.3%)	0 (0%)	
	Hashimoto thyroiditis	4 (2.5%)	64 (2.9%)	
	Recurrent goiter	3 (1.9%)	88 (4.0%)	
	Follicular carcinoma	0 (0%)	11 (0.5%)	
	Struma permagna	7 (4.3%)	20 (0.9%)	
	Retrosternal goiter	6 (3.7%)	20 (0.9%)	
	Multinodular toxic goiter	8 (4.9%)	38 (1.7%)	
	Thyroid cyst	0 (0%)	12 (0.5%)	

*statistically significant; [a]Mann Whitney U-test; [b]χ^2-test

Table 3. Predictive value of tests – parameters used to predict difficult intubation (DI)

		Difficult intubation		Significance
		Yes	No	
History of previous DI	No/noUnavailable	148 (91.4%)	2206 (99.5%)	[b]p=0.000*
	Positive	14 (8.6%)	11 (0.5%)	
Dislocation and/or stenosis of the trachea (according to neck and chest x-ray)	No	50 (30.9%)	1114 (50.2%)	[b]p=0.000*
	Moderate	75 (46.3%)	918 (41.4%)	
	Significant	37 (22.8%)	185 (8.3%)	
Larynx/vocal cords/ airway (according to ENT examination)	No	142 (87.6%)	2104 (94.9%)	[b]p=0.000*
	Paresis/paralysis	15 (9.3%)	95 (4.3%)	
	Dislocation	5 (3.1%)	17 (0.8%)	
Anatomic deformities of bones and joints	No	132 (81.5%)	1995 (90.0%)	[b]p=0.001*
	Moderate	24 (14.8%)	196 (8.8%)	
	Significant	6 (3.7%)	26 (1.2%)	
Retrognathic ('recessive') mandible	No	116 (71.6%)	2012 (90.8%)	[b]p=0.000*
	Moderate	25 (15.4%)	162 (7.3%)	
	Significant	21 (13.0%)	43 (1.9%)	
Size, layout and position of teeth (incisors)	Normal	113 (69.8%)	1771 (79.9%)	[b]p=0.000*
	Long	33 (20.4%)	359 (16.2%)	
	Asymmetric	16 (9.9%)	87 (3.9%)	
Oral anomalies (small mouth, macroglossia, tumors)	No	99 (61.1%)	1820 (82.1%)	[b]p=0.000*
	Small mouth	60 (37.0%)	379 (17.1%)	
	Macroglossia, tumors	3 (1.9%)	17 (0.8%)	
Body mass index	<25	39 (24.1%)	1057 (47.7%)	[b]p=0.000*
	25-30	71 (43.8%)	806 (36.4%)	
	>30	52 (32.1%)	354 (16.0%)	
Degree of neck mobility (maximum extension)	>90°	59 (36.4%)	1319 (59.5%)	[b]p=0.000*
	80-90°	82 (50.6%)	800 (36.1%)	
	<80°	21 (13.0%)	98 (4.4%)	
Thyromental distance (tip of the chin-Adam's apple distance)	>6.5 cm	72 (44.4%)	1475 (66.5%)	[b]p=0.000*
	6.5-6 cm	75 (46.3%)	707 (31.9%)	
	<6 cm	15(9.3%)	35 (1.6%)	
Interincisor gap (upper/lower incisors distance)	M >5 cm F >4 cm	108 (66.7%)	1841 (83.0%)	[b]p=0.000*
	M 4-4.5 cm F 3.5-4 cm	44 (27.1%)	364 (16.4%)	
	<3.5 cm	10 (6.2%)	12 (0.5%)	
Maximum protrusion of the mandible over the maxilla	>0 cm	134 (82.7%)	1982 (89.4%)	[b]p=0.027*
	=0 cm	27 (16.7%)	221 (10.0%)	
	<0 cm	1 (0.6%)	14 (0.6%)	
Neck circumference and length	Normal	62 (38.3%)	1578 (71.2%)	[b]p=0.000*
	Short or wide	47 (29.0%)	503 (22.7%)	
	Short and wide	53 (32.7%)	136 (6.1%)	
Mallampati score	I+II	94 (58.0%)	1667 (75.2%)	[b]p=0.000*
	III	45 (27.8%)	414 (18.7%)	
	IV	23 (14.2%)	136 (6.1%)	

*statistically significant; [b]χ^2-test

logistic regression analysis showed statistical significance for all 14 tests, three additional variables that were examined (gender, age and surgical diagnosis) and overall maximum value risk score (R >5), multivariate logistic regression analysis was performed, which showed that thyroid gland disease, previous DI, recessed (retrognathic) mandible, size, appearance and position of teeth, oral anomalies, and neck circumference and length were the strongest predictors of DI (Table 4).

The highest sensitivity was recorded for neck circumference and length, and highest specificity for positive history of previous DI (Fig. 1).

The number of attempts of intubation, duration and method of intubation are shown in Table 5. The prevalence of subjects with DI methods (using standard Macintosh blade or fiber optic) was also statistically significantly different (p<0.001).

Discussion

We analyzed 2379 patients undergoing elective surgical treatment of the thyroid. The incidence of DI was 6.81%. In our previous study[10] on 2000 patients undergoing thyroid surgery, the incidence was 5.5%. A similar incidence (5.3%) was demonstrated in a study by Bouaggad *et al*.[5]. The study by Adnet *et al*.[11] showed the incidence of DI of 8%, and the study by Ammatei *et al*. of 11.1%[6]. Shah and Gupta in their recent study showed the incidence of DI in thyroid

Table 4. Univariate and multivariate logistic regression analysis of the impact of observed factors on the occurrence of difficult intubation (DI)

Risk factor	Univariate		Multivariate	
	RR (95%CI)	Significance	RR (95% CI)	Significance
Gender	1.531 (1.021-2.296)	p=0.039*	1.003 (0.989-1.018)	p=0.665
Age	0.983 (0.972-0.995)	p=0.004*	1.192 (0.699-2.031)	p=0.519
Thyroid disease	0.935 (0.913-0.957)	p=0.000*	0.946 (0.921-0.972)	p=0.000*
History of previous DI	0.230 (0.153-0.344)	p=0.000*	0,403 (0.221-0.732)	p=0.003*
Dislocation and/or stenosis of the trachea	0.481 (0.382-0.606)	p=0.000*	0.743 (0.505-1.093)	p=0.132
Larynx/vocal cords/airway	0.456 (0.310-0.671)	p=0.000*	0.856 (0.481-1.523)	p=0.596
Anatomic deformities of bones and joints	0.538 (0.385-0.751)	p=0.000*	0.834 (0.501-1.388)	p=0.485
Retrognathic ('recessive') mandible	0.351 (0.273-0.451)	p=0.000*	0.420 (0.279-0.634)	p=0.000*
Size, layout and position of teeth (incisors)	0.620 (0.482-0.798)	p=0.000*	0.661 (0.441-0.992)	p=0.046*
Oral anomalies (small mouth, macroglossia, tumors)	0.388 (0.288-0.524)	p=0.000*	0.596 (0.371-0.958)	p=0.033*
Body mass index	0.505 (0.409-0.622)	p=0.000*	0.967 (0.622-1.503)	p=0.881
Degree of neck mobility	0.451 (0.353-0.575)	p=0.000*	0.678 (0.448-1.026)	p=0.066
Thyromental distance	0.395 (0.301-0.517)	p=0.000*	0.810 (0.525-1.250)	p=0.341
Interincisor gap	0.387 (0.287-0.521)	p=0.000*	0.747 (0.455-1.226)	p=0.249
Protrusion of the mandible over the maxilla	0.623 (0.422-0.920)	p=0.017*	0.793 (0.468-1.342)	p=0.387
Neck circumference and length	0.324 (0.263-0.399)	p=0.000*	0.562 (0.378-0.835)	p=0.004*
Mallampati score	0.563 (0.451-0.702)	p=0.000*	0.965 (0.653-1.428)	p=0.859
Maximum score	0.704 (0.667-0.742)	p=0.000*	1.005 (0.752-1.343)	p=0.974

*statistically significant; #RR = relative risk

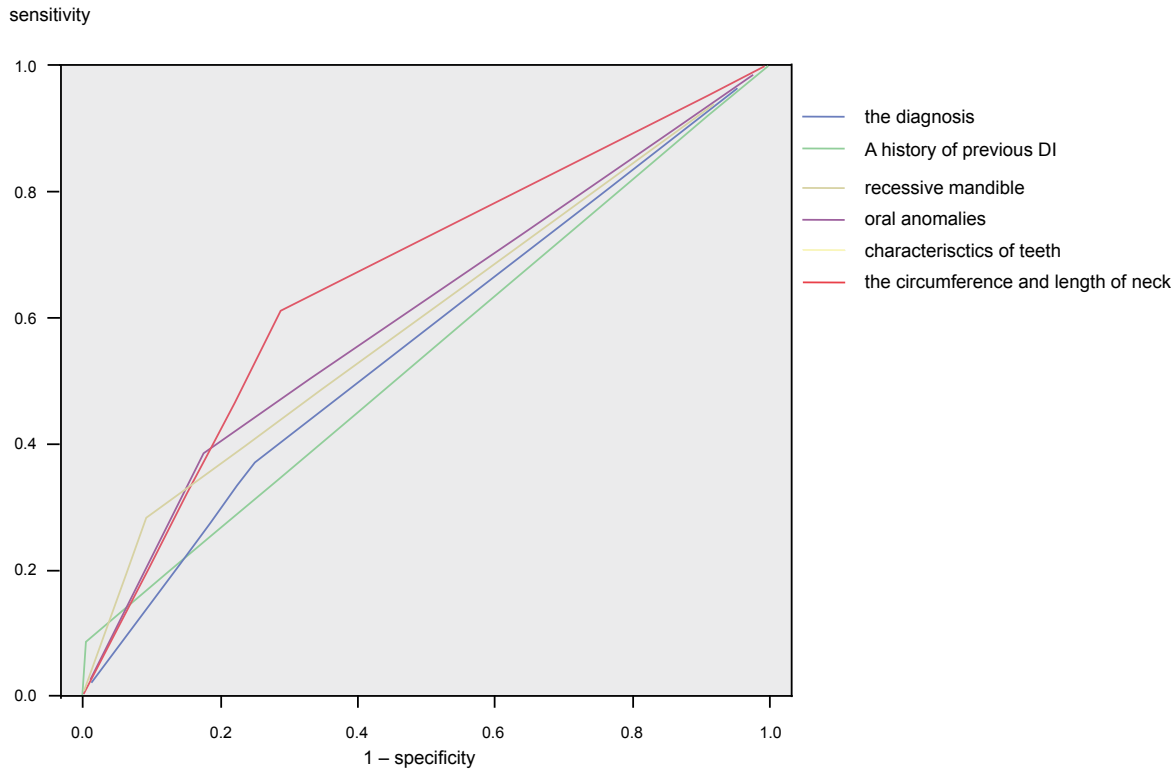

Fig. 1. Sensitivity and specificity of individual risk factors for difficult intubation (DI).

surgery of 16.5%[7]. Given that the incidence of DI in other branches of surgery in patients with no anatomic anomalies of the head and neck was about 1% in most studies[12,13], it is clear that the risk of DI in thyroid surgery is several times higher than in other subpopulations of patients. On the other hand, the wide range of the incidence of DI in thyroid surgery (from 5.3% to 16.5%) can be explained by different definitions of DI, but also there is an important question how many anesthesiologists were included in these studies and how experienced they were, which was not clearly defined in most studies. In our previous study, all 2000 patients were intubated by two experienced anesthesiologists, and in the second study more anesthesiologists were involved, including younger anesthesia residents, which may explain the higher incidence of DI in the second study.

Table 5. Intubation techniques applied in patients with difficult intubation

		Number (%) of patients
Number of attempts to intubate	Once	37 (22.8%)
	Once with pressure	23 (14.2%)
	Two times with pressure	64 (39.5%)
	Three times with pressure	30 (18.5%)
	More than three times with pressure	8 (4.9%)
Duration of intubation	Standard	30 (18.5%)
	Prolonged	98 (60.5%)
	Longer than 10 minutes	34 (21.0%)
Method of intubation	Using standard Macintosh blade	122 (75.3%)
	Fiberoptic	40 (24.7%)

Our study showed DI to be more common in older patients, although age was not an independent risk factor. This is consistent with the results reported by Loftus *et al.*, who showed that older age was a risk factor for DI[14]. It is assumed that poor dentition and osteoarthritic changes, often seen in this subpopulation of patients, may be a contributing risk factor for DI.

Although both study groups included more females, DI was significantly more prevalent in men, which is consistent with the results of our previous study[10]. Results reported by Bouaggad *et al.*[5] are in accordance with our results. However, some studies have shown that the incidence of DI is higher in women[6], while others showed the incidence of DI to be similar in both genders[7].

Dislocation and/or stenosis of the trachea were significantly more present in the group with DI in our study. This is the reason why in our Center, an x-ray is required prior to thyroid surgery. Some studies dispute the importance of dislocation of the trachea as a risk factor for DI in thyroid surgery. In the study by Hong *et al.*, it was shown that the incidence of DI was 7% in patients with tracheal deviation and 5% in patients without tracheal deviation, which was not statistically significantly different, and the authors concluded that preoperative x-ray was not necessary[15].

Our study showed that one of the independent predictors of DI is surgical diagnosis, i.e. thyroid gland disease (with a sensitivity of 37%). The analysis of primary diagnosis in the group of patients with DI showed that the highest number of DI were present in the group of patients with multinodular goiter, followed by the group with hyperthyroidism and those with cancers, and the least in the group with nodular goiter. Since patients with multinodular goiters, as a rule, have maximum dimension of goiter, and those with nodular goiters the least thyroid size, this indirectly proves that the size of goiter has the largest share in DI occurrence, as shown by the results of a recent study by Agarwal *et al.*[16].

The circumference and length of the neck in our study were singled out as one of the most important risk factors for DI and as an independent predictor of DI in thyroid surgery. The highest sensitivity was observed precisely with this test, while the specificity of this test was (not surprisingly) the lowest. This test was expected to be one of the most powerful predictors of DI in this branch of surgery, since extremely enlarged thyroid gland (which also leads to dislocation of the larynx and/or trachea) certainly contributes to the high neck circumference. Similar results have also been reported by other authors; among all risk factors that were evaluated in the study by Khan *et al.*, neck circumference and Mallampati score greater than 3 were the most important predictors of difficult intubation[17]. Studies by Lacoste *et al.*[18] and Voyagis *et al.*[19] also demonstrated that a large neck circumference (as a result of thyromegaly) significantly influenced the occurrence of DI in thyroid surgery. Increased neck circumference, whether as a result of thyromegaly, obesity or other reasons, causes DI as an independent risk factor or associated with other factors, as shown by numerous reports[20,21]. Furthermore, it has been found that circumference of the neck has a predictive value even in lean patients[22].

A history of previous DI was an independent risk factor for DI in our study and had the highest specificity of 95%. The study by De Jong *et al.* demonstrated a significant relationship between the history of previous DI and the occurrence of DI[23]. Lundstrøm's study supports the fact that previous DI represents a significant risk factor for DI, but the author did not show that it was an independent predictor of DI[24], as it was the case in our study.

Recessive mandible in our study was also an independent predictor of DI. Bouaggad *et al.* in the study conducted on 320 patients observed no statistically significant difference in the prevalence of patients with recessive mandible between the groups with and without DI[5]. However, recessive mandible in that study was noted in only 3.4% of the total number of patients, while in our study recessive mandible was present in 10.5% of patients. In addition, Bouaggad *et al.*[5] excluded patients with anomalies of the upper airways and for defining DI, they used the Intubation Difficulty Scale, which minimally takes into account the characteristics of patients. These differences may be the reasons for different results of our study and those by these authors.

Patients with long and asymmetric teeth were significantly more present in the group with DI. Tooth characteristics were also an independent risk factor for DI in our study. Results of the prospective study conducted by Eberhart *et al.*[25] showed a statistically significant association between the existence of protruding front teeth of the upper jaw, Mallampati score and the possibility of mouth opening with the occurrence of DI. The authors demonstrated the significance of the examined parameters individually and their combination in predicting DI. Dentition

abnormalities have been shown to pose a significant risk factor for DI[26].

Oral anomalies exerted significant influence on the incidence of DI in our study. Macroglossia was identified as an independent risk factor in other studies as well[27].

Many studies indicate the necessity of additional equipment besides the standard Macintosh laryngoscope, primarily fiber optic bronchoscope in order to resolve a problematic airway[28-30].

In all patients, including those who had a very high-risk score and where it was almost certain that DI would occur, we primarily tried to intubate in a conventional manner, using Macintosh laryngoscope. The inability of glottis visualization and of intubation in 1-3 attempts was considered as impossible intubation, and then we intubated using fiber optic bronchoscope. This scenario occurred in nearly 25% of DI cases. Although Maldini *et al*.[31] presented advantages of the Bonfils Retromolar Fiberscope usage in the cases of anticipated difficult airway, we had no possibility of this device application in our Institution. The incidence of impossible tracheal intubation varies from 1 to 2000 cases in elective surgery, more than 1 in 250 in obstetrics, and up to 1% in emergency states[32,33].

Conclusion

Dislocation and/or tracheal stenosis represent a significant risk factor for DI, not individually, but in combination with other factors. Evaluation of the airway prior to thyroid surgery should include a larger number of examinations including preoperative x-ray of the neck and chest. Our study found that the strongest predictors of DI were history of previous DI, thyroid gland disease, size of the neck (circumference and length), recessive (retrognathic) mandible, teeth (irregular, large) and oral anomalies (small mouth, macroglossia).

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References

1. Barash PG, Cullen BF, Stoelting RK. Airway management. In: Barash PG, Cullen BF, Stoelting RK, editors. Clinical Anesthesia,. 5th ed. United States: Lippincott Williams & Wilkins; 2006; p.440-56.
2. Miller R. Evaluation of the airway. In: Miller RD, editor. Miller's Anesthesia, 6th ed. Philadelphia: Churchill Livingstone; 2004. p. 1621-3.
3. Dy B, Wise K, Farley D, McGlinch B. Extreme tracheal compression due to substernal goiter: surgical and anesthetic management. World J Endocr Surg. 2012;4(2):71-3.
4. Piao M, Yuan Y, Wang Y, Feng C. Successful management of trachea stenosis with massive substernal goiter *via* tracheobronchial stent. J Cardiothorac Surg. 2013;15(8):212. doi: 10.1186/1749-8090-8-212.
5. Bouaggad A, Nejmi SE, Bouderka MA. Prediction of difficult tracheal intubation in thyroid surgery. Anaesth Analg. 2004;99:603-6.
6. Amathieu R, Smail N, Catineau J, Poloujadoff MP, Samii K, Adnet F. Difficult intubation in thyroid surgery: myth or reality? Anesth Analg. 2006;103:965-8.
7. Shah PN, Gupta G. Prediction of difficult endotracheal intubation in thyroid surgery. Int J Anesth Res. 2014;2(1):6-10.
8. Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia. 1984;39(11):1105-11.
9. A report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Practice guidelines for management of the difficult airway. Anesthesiology. 1993;78(3):597-602.
10. Kalezić N, Milosavljević R, Paunović I, Živaljević V, Diklić A, Matić D, *et al*. The incidence of difficult intubation in 2000 patients undergoing thyroid surgery: single center experience. Vojnosanit Pregl. 2009;66(5):377-82.
11. Adnet F, Borron SW, Racine SX, Clemessy JL, Fournier JL, Plaisance P, *et al*. The intubation difficulty scale (IDS): proposal and evaluation of a new score characterizing the complexity of endotracheal intubation. Anesthesiology. 1997;87;1290-7.
12. Yentis SM, Hirsch NP, James K. Anaesthesia and intensive care AZ: an encyclopaedia of principles and practice. Elsevier Health Sciences. 2013; p. 324.
13. Savva B. Prediction of difficult tracheal intubation. Br J Anaesth. 1994;73:149-53.
14. Loftus PA, Ow TJ, Siegel B, Tassler AB, Smith RV, Schiff BA. Risk factors for perioperative airway difficulty and evaluation of intubation approaches among patients with benign goiter. Ann Otol Rhinol Laryngol. 2014;123(4):279-85. doi: 10.1177/0003489414524171.
15. Hong BW, Mazeh H, Chen H, Sippel R. Routine chest x-ray prior to thyroid surgery: is it always necessary? World J Surg. 2012;36(11):2584-9. doi: 10.1007/s00268-012-1720-z

16. Agarwal A, Agarwal S, Tewari P, Gupta S, Chand G, Mishra A, *et al*. Clinicopathological profile, airway management, and outcome in huge multinodular goiters: an institutional experience from an endemic goiter region. World J Surg. 2012;36.4:755-60. doi: 10.1007/s00268-012-1447-x.
17. Khan MN, Rabbani MZ, Qureshi R, Zubair M, Zafar MJ. The predictors of difficult tracheal intubations in patients undergoing thyroid surgery for euthyroid goitre. J Pak Med Assoc. 2010;60(9):736-8.
18. Lacoste L, Montaz N, Bernit AF, Gineste D, Lehuede MS, Barbier J, *et al*. Airway complications in thyroid surgery. Ann Otol Rhinol Laryngol. 1993;102(6):441-6.
19. Voyagis GS, Kyriakos KP. The effect of goiter on endotracheal intubation. Anesth Analg. 1997;84(3):611-2.
20. Brodsky JB, Lemmens HJ, Brock-Utne JG, Vierera M, Saidman LJ. Morbid obesity and tracheal intubation. Anesth Analg. 2002;94:732-6.
21. Kim WH, Ahn HJ, Lee CJ, Shin BS, Ko JS, Choi SJ, *et al*. Neck circumference to thyromental distance ratio: a new predictor of difficult intubation in obese patients. Br J Anaesth. 2011;106(5):743-8. doi: 10.1093/bja/aer024.
22. Gonzalez H, Minville V, Delanoue K, Mazerolles M, Concina D, Foucade O. The importance of increased neck circumference to intubation difficulties in obese patients. Anesth Analg. 2008;106:1132-6. doi: 10.1213/ane.0b013e3181679659.
23. De Jong A, Molinari N, Terzi N, Mongardon N, Arnal JM, Guitton C, *et al*. Early identification of patients at risk for difficult intubation in the intensive care unit: development and validation of the MACOCHA score in a multicenter cohort study. Am J Respir Crit Care Med. 2013;187(8):832-9. doi: 10.1164/rccm.201210-1851OC.
24. Lundstrøm LH. Detection of risk factors for difficult tracheal intubation. Dan Med J. 2012;59(4):B4431.
25. Eberhart LHJ, Arndt C, Aust HJ, Kranke P, Zoremba M, Morin A. A simplified risk score to predict difficult intubation: development and prospective evaluation in 3763 patients. Eur J Anaesthesiol. 2010;27(11):935-40. doi: 10.1097/EJA.0b013e328338883c.
26. Naithani U, Gupta G, Gupta GM, Meena K, Sharma CP, Bajaj P. Predicting difficult intubation in surgical patients scheduled for general anaesthesia: a prospective study of 435 patients. JEMDS. 2013;2(14):2270-86.
27. Shah PN, Sundaram V. Incidence and predictors of difficult mask ventilation and intubation. Anaesthesiol Clin Pharmacol. 2012;28(4):451-5. doi: 10.4103/0970-9185.101901.
28. Mazères JE, Lefranc A, Cropet C, Steghens A, Bachmann P, Perol O, *et al*. Evaluation of the Bonfils intubating fiberscope for predicted difficult intubation in awake patients with ear, nose and throat cancer. Eur J Anaesthesiol. 2011;28:646-50. doi: 10.1097/EJA.0b013e3283495b85.
29. Kovacs G, Law J. A, Petrie D. Awake fiberoptic intubation using an optical stylet in an anticipated difficult airway. Ann Emerg Med. 2007;49:81-3.
30. Kim SH, Woo SJ, Kim JH. A comparison of Bonfils intubation fiberscopy and fiberoptic bronchoscopy in difficult airways assisted with direct laryngoscopy in difficult airways assisted with direct laryngoscopy. A comparison. Korean J Anesthesiol. 2010;58:249-55. doi: 10.4097/kjae.2010.58.3.249.
31. Maldini B, Goranović T, Vučić M, Kovač J, Baranović S, Letica-Brnadić R. Difficult airway management at Sestre milosrdnice University Hospital Center. Acta Clin Croat. 2012;51:473-6.
32. Cook TM, MacDougall-Davis SR. Complications and failure of airway management. Br J Anaesth. 2012;109(1):68-85. doi: 10.1093/bja/aes393.
33. Bokhari A, Benham SW, Popat MT. Management of unanticipated difficult intubation: survey of current practice in the Oxford region. Eur J Anaesth. 2004;21:123-7.

Sažetak

PREDIKTORI ZBRINJAVANJA OTEŽANOG DIŠNOG PUTA U KIRURGIJI ŠTITNJAČE: PETOGODIŠNJA OPSERVACIJSKA PROSPEKTIVNA STUDIJA U JEDNOM CENTRU

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Otežana intubacija (OI) traheje je češća u kirurgiji štitnjače nego u drugim kirurškim granama zbog tireomegalije. Pravilna prijeoperacijska evaluacija dišnoga puta je neophodna za smanjenje brojnih potencijalnih komplikacija. Ispitivali smo učestalost OI u kirurgiji štitnjače, utjecaj dislokacije traheje i drugih čimbenika na OI. Provedena je prospektivna studija na 2379 bolesnika podvrgnutih operacijama štitne žlijezde u Centru za endokrinu kirurgiju Kliničkog centra Srbije u Beogradu u razdoblju od 2007. do 2012. godine. Bolesnici su bili podijeljeni u skupine s OI (n=162) i bez OI (n=2217). Uz dislokaciju i/ili stenozu traheje definirano je još 13 čimbenika rizika sadržanih u 13 probirnih testova i 3 dodatna čimbenika – spol, životna dob i dijagnoza. Učestalost OI u našoj studiji iznosila je 6,81%. Prisutnost dislokacije traheje bila je statistički značajan, ali ne i nezavisni prediktor OI. Kao najznačajniji i nezavisni prediktori OI izdvojili su se: dijagnoza, veliki obim i mala dužina vrata, prethodna OI, recesivna mandibula, karakteristike zuba i oralne anomalije. Najveću osjetljivost imali su obim i dužina vrata, a najveću specifičnost prethodna OI. Ako dovodi do dislokacije i/ili stenoze traheje, tireomegalija je značajan prediktor OI, ne samostalno, nego u kombinaciji s drugim čimbenicima.

Ključne riječi: *Dišni put, zbrinjavanje; Intubacija, intratrahealna; Tireoidne bolesti – kirurgija; Dislokacija traheje*