



An evaluation score of the difficulty of thyroidectomy considering operating time and preservation of recurrent laryngeal nerve

Salvatore Vieni¹ · Giuseppa Graceffa¹ · Giacomo E. M. Rizzo¹ · Federica Latteri¹ · Mario A. Latteri¹ · Calogero Cipolla¹ 

Received: 9 February 2018 / Accepted: 8 November 2018 / Published online: 15 November 2018
© Italian Society of Surgery (SIC) 2018

Abstract

The purpose of this study was to edit a renovated thyroidectomy difficulty scale (rTDS) in order to identify underlying thyroid diseases with a longer operative time and higher technical difficulty, also considering preservation of recurrent laryngeal nerve. We developed a renovated scale with a maximum score of 20 points by creating a form in which five variables were considered: vascularity, friability, mobility/fibrosis, gland size and difficulty in preservation of the recurrent laryngeal nerve. Two surgeons separately evaluated each of these. Through a simple linear regression analysis, we have analyzed the relationship between rTDS score and operative times, and between rTDS score and preservation of recurrent nerve. Eventually, Spearman's rank correlation coefficient has been used in order to evaluate our double-blind study. Our cohort included 131 patients undergoing total thyroidectomy. The mean of the rTDS was 9.00 ± 3.67 for Surgeon A and 8.31 ± 3.42 for Surgeon B, with Spearman's rank correlation coefficient between surgeons of 0.85 ($p < 0.0001$). We have shown that the rTDS score significantly influences the operating times ($R^2 = 0.44$ for surgeon A, $R^2 = 0.46$ for B, $p < 0.0001$ for both). Moreover, we can say that the rTDS score significantly influences preservation of the recurrent nerve ($R^2 = 0.37$, Beta 0.61, 8.84 *t* test, $p < 0.0001$). Our rTDS is a useful tool and, thanks to it, we identified hyperthyroidism and goiter as the hardest underlying disease for surgery. Thus our scale could change operative approach, resulting in better surgeries' scheduling and identification of pathologies that require higher attention.

Keywords Total thyroidectomy · Operative time · Difficulty scale

Introduction

Surgeons have identified an association among underlying thyroid diseases and the degree of surgical difficulty of thyroid removal, which often correlates with a higher complication rate [1]. Editing a scale of difficulty is not new in the modern history of surgery: other evaluations of difficulty have been developed for different types of procedures, such as in laparoscopic colorectal surgery, in phacoemulsification cataract surgery, and yet in the surgical technique implanting the collum femoris preserving (CFP) hip arthroplasty [2–5].

Thyroidectomy is a surgical technique that has been perfected in the last centuries with an initial high mortality due

to hemorrhage, infections and thyroid storm. Later Kocher, changed the approach to thyroidectomy and was able to bring the percentage of mortality down to less than 1% [6]. Nowadays, total thyroidectomy has virtually 0% mortality rate and an extremely low morbidity, when performed by experienced surgeons and in specialized centers [7–11]. Nevertheless, thyroid surgery retains a modest incidence of complications, such as a 0–15% of hypoparathyroidism, which could be transient or permanent, approximately 1% of dysphonia due to recurrent laryngeal nerve injury and a 0.1–2% of post-operative bleeding [12–17].

Few studies focused on identifying underlying diseases that can give a harder surgery. The present study focuses on editing a renovated thyroidectomy difficulty scale (rTDS) considering the most important parameters of difficulty while performing surgery with the main outcome to identify through these the harder underlying diseases for thyroidectomy. Some author has already showed that patients with hyperthyroidism, thyroglobulin greater

✉ Calogero Cipolla
calogero.cipolla@unipa.it

¹ Department of Surgical Oncological and Oral Sciences, University of Palermo, Via del Vespro 129, 90127 Palermo, Italy

than 150 ng/ml and positive anti-thyroglobulin antibodies, may have a difficulty thyroidectomy associated with longer operative times and increased complications [18]. Then, the identification of parameters of harder surgery and high risk underlying diseases becomes a primary objective for a surgeon and it is our main goal. Quantifying the difficulty of a thyroidectomy remains complicated, even because the literature is lacking of big studies and it is limited to case reports, opinions and technical-scientific articles [19–23]. Hence, we renovated a previously developed thyroidectomy difficulty scale through the assessment of more variables, including recurrent laryngeal nerve isolation and preservation, based even on the degree of agreement between the two main surgeons and furthermore correlated with the operative time, in order to have a useful and relevant tool to identify high risk diseases for thyroidectomy.

Materials and methods

This prospective study was carried out on 131 patients who underwent total thyroidectomy in our Division of Oncological and General Surgery in the period between January 2016 and July 2017. The preoperative diagnosis comprised of multi-nodular goiter (both toxic and non-toxic), Graves' disease, Hashimoto's thyroiditis, benign thyroid neoplasms and differentiated thyroid carcinoma. Exclusion criteria were any case of retrosternal goiter, considering the possibility of performing sternotomy, any re-operative thyroidectomy and any patients undergoing concomitant lymph nodes dissection, since procedures have longer operative times.

The indication for an elective total thyroidectomy was at all times discussed and established with the referring endocrinologist after an accurate preoperative workup, which included interview and clinical examination, thyroid ultrasound and scintigraphy, cytological sampling with fine needle aspiration biopsy, and thyroid hormone assay. The major indications for a total thyroidectomy included an increase in glandular volume causing compressive symptoms, a hyperthyroidism not responsive to anti-thyroid drugs and, above all, a chronic thyroiditis with suspected neoplastic degeneration of one or more nodules. The evaluation of hyperthyroidism was made by laboratory tests evaluating serum levels of TSH, and it was diagnosed to those who had values under 0.4 $\mu\text{U}/\text{mL}$ or undetectable. Physical examination and ultrasound examination were used as basic tools in the diagnosis of goiter, while the final diagnosis of the diseases with surgical indication have been waiting for confirmation or revision by the histology post-surgery of the gland, in order to be correctly integrated into the scale.

Renovated Thyroidectomy Difficulty Scale (rTDS)

A scale of difficulty was developed (rTDS) with a maximum score of 20 points by creating a form in which four variables were considered: vascularization, friability, mobility/fibrosis and gland size. Each of them had been evaluated through the use of a Likert scale with scores from 1 to 5. In particular, friability was considered as the break-up of the gland while it is pulled or held by an instrument or surgeon's hands. In addition to them, the difficulty of identification and preservation of the recurrent laryngeal nerve was considered and evaluated with a score from 1 to 3, with 1 meaning that surgeon took less than 5 min to identify every nerve (easy), 2 meaning that he took between 5 and 15 min (moderate), and 3 that he spent more than 15 min to identify and preserve every nerve (severe) (Fig. 1).

Each operation was separately evaluated by the main operator (Surgeon A) and by the assistant surgeon (Surgeon B). The two graphs illustrating the scale show the distribution of operations in our rTDS, using the four groups of diagnosis as a criterion of division of the cases (Fig. 2).

Considering the importance of the surgeons' experience, all operations were performed by the same surgeons, Surgeon A who has over 25-years of surgical experience and by a Surgeon B, an expert in thyroid surgery, with over 15-years surgical experience. All the involved surgeons regularly perform more than one hundred thyroidectomies per year. In order to gain a greater objectivity through a double-blind method both surgeons filled out a form, at the end of the surgery, with the scores for rTDS and transcribed the scores. Thus, this inter-rater agreement was developed in order to analyze the correlation between the values of the surgeons in each parameter. rTDS forms for surgeons are identical, except for the variable "isolation and preservation of recurrent laryngeal nerve" that was the only one given by the main surgeon (Surgeon A), mostly involved in the research and preservation of this nerve.

Furthermore, while taking data and considering post-surgery histological diagnosis, the pathologies were divided into four big groups: hyperthyroidism, thyroiditis, goiter, neoplasias. Also taking into consideration that these diseases are not mutually exclusive as they could coexist in many groups, therefore some of them were added to more groups whenever needed (Table 1).

Statistical analysis

The statistical analysis aims to validate the renovated scale of difficulty. To this aim, the following hypothesis was

Renovated Thyroidectomy difficulty scale (rTDS)

Surgeon A

Patient's name _____

Surgeon _____

Diagnosis _____

Date _____

Operative time **Start:** _____ **End:** _____ **Total:** _____

Gland size	1 Normal	2	3 Bigger than normal	4	5 Goiter over average
Mobility / Fibrosis	1 Easy to lift	2	3 Difficulty to move	4	5 Blocked and extremely difficult to pull
Friability	1 Easy to pull	2	3 It sometimes lacerates while pulling	4	5 Extremely hard to hold/pull
Vascularity	1 Normal	2	3 Moderate	4	5 Severe

Total: _____ / 20

Isolation and preservation of the recurrent laryngeal nerve	1 Easy	2 Moderate	3 Severe
--	------------------	----------------------	--------------------

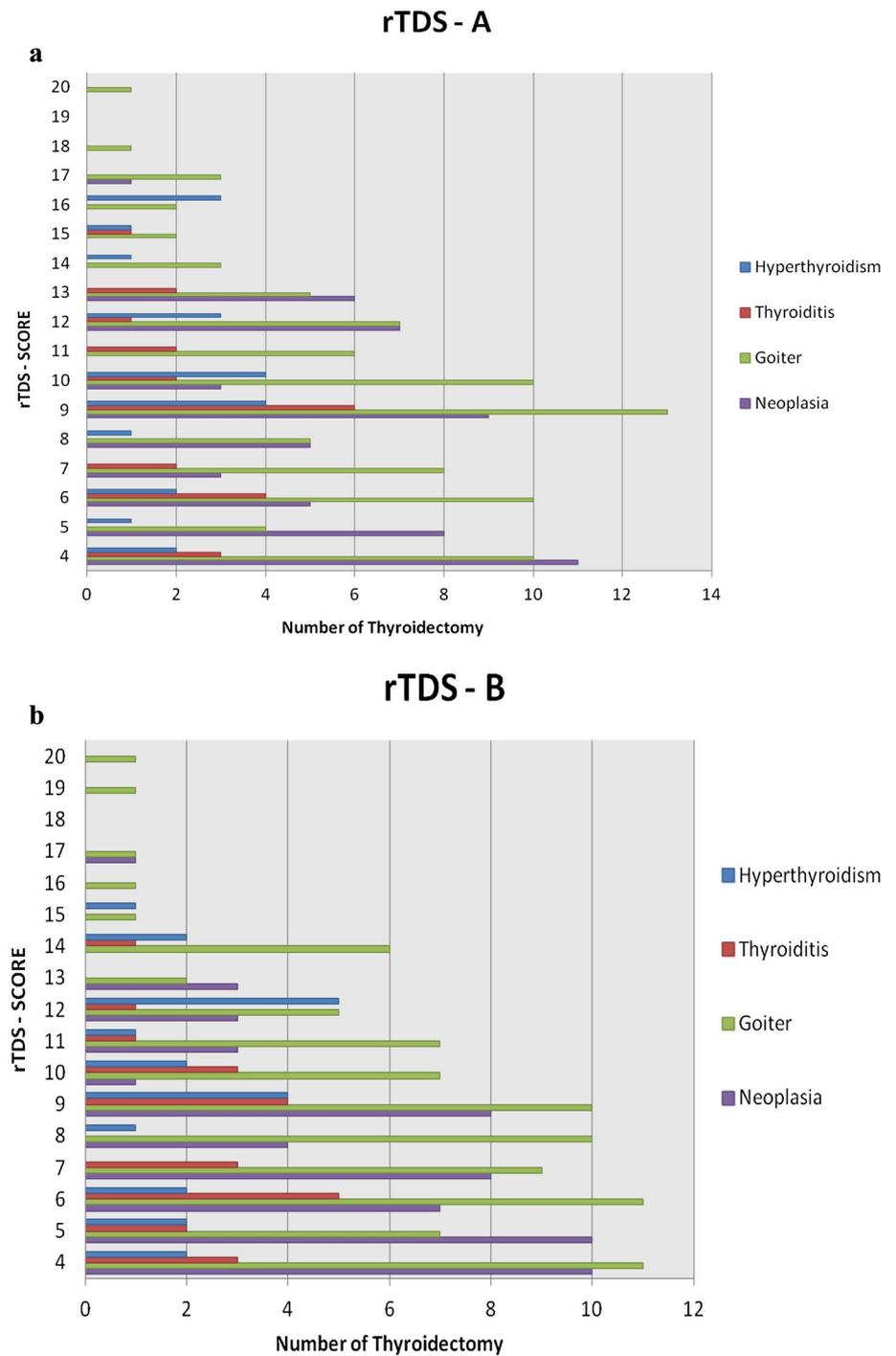
Notes:

Fig. 1 Model form to gather data post-surgery

established to evaluate whether rTDS score influences significantly operative time, whether and how the rTDS scale can influence isolation and preservation of recurrent laryngeal nerve, and to check which among the four parameters of rTDS can influence operative times. Therefore,

simple linear regression analysis was performed in order to analyze the relationship between rTDS score and operative time, and between rTDS score and the isolation and preservation of recurrent laryngeal nerve. On the other hand, a multiple regression model was used to evaluate

Fig. 2 **a** Distribution of diseases in rTDS according to surgeon A's score. **b** Distribution of diseases in rTDS according to surgeon B's score



the relationship among the four components of the rTDS score and the operative time. Finally, Spearman's rank correlation coefficient was used in order to evaluate the inter-surgeons agreement. The analysis of data was performed by using the software S.P.S.S. v.20 (Statistical Package for Social Science).

Results

There were 131 patients included in the study, the mean age of the patients was 51.82 years (range 22–85), 99 were female (75.57%) and 32 males (24.43%). In the sample, the

Table 1 Cases grouped by diagnosis, considering also histological diagnosis

Group of diagnosis	No. cases per group (%)	Pathology	No. cases (%)
Hyperthyroidism	22 (16.79%)	Graves' disease	7 (31.81%)
		Toxic multinodular goiter	14 (63.63%)
		Toxic adenoma	1 (4.54%)
Thyroiditis	23 (17.56%)	Hashimoto's thyroiditis	23 (100%)
Goiter	90 (68.7%)	Non-toxic multinodular goiter	68 (75.55%)
		Toxic multinodular goiter	14 (15.55%)
		Colloid nodular goiter	8 (8.88%)
		Follicular nodule	21 (37.5%)
Neoplasia	56 (42.75%)	Papillary thyroid carcinoma	35 (62.5%)
		Medullary thyroid carcinoma	1 (1.78%)
		Follicular thyroid carcinoma	2 (3.57%)

Table 2 Results about linear relation between rTDS score and operative time

Variable	Beta	<i>t</i> test	<i>p</i> value	<i>R</i> ²
rTDS-A	0.67	10.15	<0.0001	0.44
rTDS-B	0.68	10.49	<0.0001	0.46

percentage of manifestation of disease according to final histopathological examination and considering that these diseases are not mutually exclusive as they could coexist in many groups, was as follows: hyperthyroidism was shown on 22 cases (16.79%), and even within this group the toxic multinodular goiter was the predominant diagnosis with 63.64%; thyroiditis with indication for thyroidectomy was shown in 23 patients (17.56%) out of the total number, considering the whole sample; nodular goiter occurred on 90 cases (68.7%) with a clear majority of goiter (75.56%); malignancies occurred in 56 patients (42.75%), the predominant diagnosis was of papillary carcinoma (62.5%) followed by follicular nodule (37.5%), follicular carcinoma (3.57%) and medullary carcinoma (1.79%).

The average of rTDS among cases was 9.00 ± 3.67 according to Surgeon A and 8.31 ± 3.42 according to Surgeon B. Referring to the first research hypothesis, it emerged that rTDS score significantly influences operative times with a *p* < 0.0001 in both surgeons' score (Table 2), scatter plots were reported showing existence of a positive linear relationship among variables (Fig. 3a, b). Regarding the second research objective, it can be asserted that rTDS score significantly influences the time of isolation and preservation of the recurrent laryngeal nerve (Table 3) and, moreover, data show that 73 out of 131 surgeries (55.73%) had 1 as score in isolation and preservation of RLN score, while 40 surgeries (30.53%) had 2 and only 18 out of 131 (13.74%) had 3 (simultaneously to surgeries with the highest rTDS-score). Concerning the third hypothesis of this study, it was shown that only two among the four items considered in the rTDS

have a significant impact on the operative time; they are vascularity (*p* < 0.0001 for Surgeon A; *p* = 0.005 for Surgeon B) and size of the gland (*p* = 0.003 for Surgeon A; *p* = 0.004 for Surgeon B), while the influence of friability (*p* = 0.113 for Surgeon A; *p* = 0.018 for Surgeon B) and mobility/fibrosis (*p* = 0.786 for Surgeon A; *p* = 0.184 for Surgeon B) is irrelevant.

As a result, the study found that the two most important features of the gland which correlate with the difficulty of the thyroidectomy are vascularity and gland size. Moreover, concerning gland size, a conversion table was developed and used to find gland size-score before surgery (Table 4). Furthermore, inter-rater agreement was calculated by the Spearman's rank correlation coefficient in order to verify the degree of agreement between the two surgeons; it was equal to 0.85 (*p* < 0.0001), then it showed an overall high degree of agreement in the assessment of the characteristics detected during surgery. Through the drafting of the scale and its application, it has also been shown that thyroidectomy, which appear to have a longer operative time and greater difficulties, are those in which the diagnosis is hyperthyroidism (average of rTDS score ~ 10 and operative time of 141.36 ± 27.65 min) or goiter (average of rTDS score ~ 9 and operative time of 138.17 ± 38.30 min) (Fig. 4 and Table 5).

Discussion

rTDS is an updated tool, which improves previous attempts to stratify patients undergoing this procedure. Moreover, the scale evaluates some parameters that change according to the underlying thyroid diseases on the one hand, and the close relationship that this gland possesses with the recurrent laryngeal nerve on the other. Our study considered 131 patients, which is one of the most numerous samples in the literature. A previous study had already identified similar parameters in order to edit a difficulty scale [1], but it did not consider the tight relationship between gland and recurrent

Fig. 3 a Scatter plot showing existence of a positive linear relationship between variables rTDS score-operative time of surgeon A. **b** Scatter plot showing existence of a positive linear relationship between variables rTDS score-operative time of surgeon B

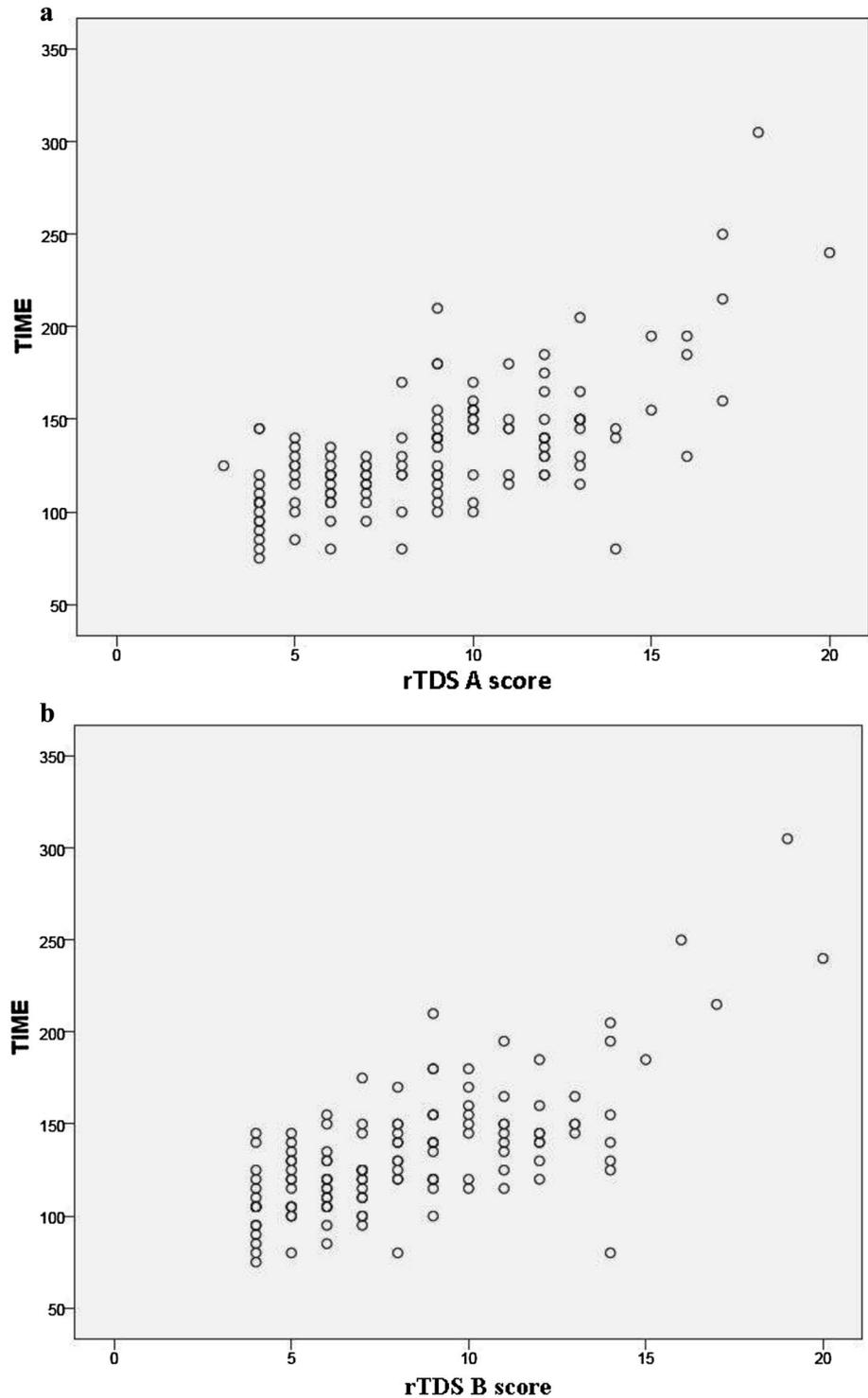


Table 3 Results of linear regression analysis on rTDS score and variable “isolation and preservation of RLN”

Variable	Beta	<i>t</i> test	<i>p</i> value	R^2
rTDS-A	0.61	8.84	<0.0001	0.37
rTDS-B	0.53	7.01	<0.0001	0.27

laryngeal nerve, which was added to the present study, as it is considered fundamental with regards to the difficulty of the operation and variation of operative time. Furthermore, it does not focus on grading underlying thyroid pathologies.

The present rTDS starts from a minimum value of 4 until it reaches the maximum value of 20, according to scores given by sum of four items: vascularity, friability, mobility/

Table 4 This converter table shows the equivalent gland size’s rTDS-score of gland’s volume during US-examination, based on our data’s study

Gland size’s rTDS-score	Equivalent gland’s volume at US-examination
1	< 15 cc
2	16–21 cc
3	22–28 cc
4	29–40 cc
5	> 41 cc

fibrosis and gland size, present in the form which surgeon fill. The choice of these parameters depends on some issues still debated such as the increased incidence of complications associated, for example, with vascularity and friability of the gland in Graves’ disease, with fibrosis in Hashimoto’s thyroiditis and large gland size in some thyroid pathologies. This study used histological diagnosis after surgery, in order to confirm or inspect diagnostic indication for surgery given by admission diagnosis. This was done in order to make association between rTDS scores and characteristics of the

pathological gland as meaningful as possible. To ensure the validity of this scale, it was correlated to the degree of agreement between the two surgeons and related to the operating time. This gives rise to this research hypotheses, which have by far been confirmed by the results obtained.

It is worth noting that this study acquired further statistical significance and a greater acquisition of objectivity due to the high degree of agreement among surgeons (Spearman correlation of 0.85 with $p < 0.0001$). In addition, regarding the first hypothesis of this study, it has been shown that rTDS score significantly influences operative time ($p < 0.0001$), then a high score of rTDS is associated with a longer operative time, thus allowing to designate rTDS as a useful tool to be used in the future in the pre-operative management. In agreement with this analysis, this study has a higher statistical impact than previous studies, because it shows a p-value and other statistical indicators extremely more significant ($p < 0.0001$ vs $p < 0.01$ in previous studies). The results relative to the second hypothesis is even more satisfactory, since it indicates that rTDS score significantly influences time of isolation and preservation of the recurrent laryngeal nerve ($p < 0.0001$), therefore gain of rTDS-score increases the degree of difficulty in isolation and

Fig. 4 Scatter plot reporting the correspondence between operative time and average rTDS score for each group of diagnosis. It shows that the most difficult thyroidectomy is performed on patients suffering from hyperthyroidism, followed by thyroiditis, goiter and neoplasia

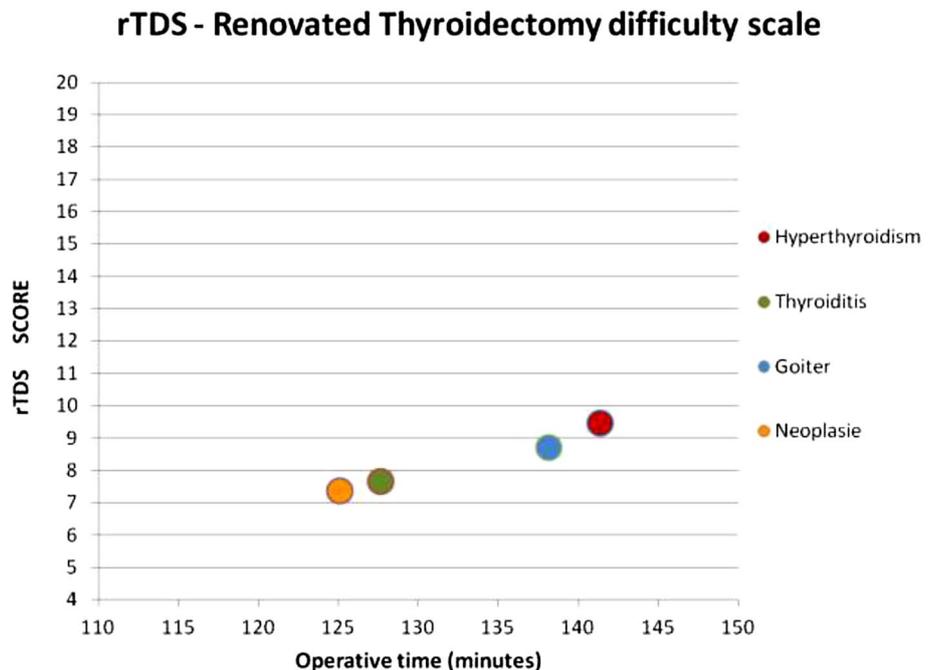


Table 5 Average and Dev. St. of operative time and rTDS score for every diagnosis

	Hyperthyroidism	Thyroiditis	Goiter	Neoplasia
rTDS—A	10.09 ± 3.77	8.70 ± 3.14	9.44 ± 3.74	8.02 ± 3.34
rTDS—B	9.45 ± 3.33	7.65 ± 2.72	8.69 ± 3.60	7.36 ± 2.98
Average RTDS A/B	~ 10	~ 8	~ 9	~ 8
Time (min)	141.36 ± 27.65	127.61 ± 20.27	138.17 ± 38.30	125.09 ± 25.47

preservation of the recurrent laryngeal nerve. For this reason, by considering that this parameter has never been used in the literature on thyroidectomy difficulty scale, this study is the first one affirming this relationship (LRN and operative time) as fundamental in thyroidectomy. Hence, it can be stated that, in the future, the use of rTDS could increase the likelihood of early identification of operations with a higher degree of difficulty in isolation and preservation of the laryngeal nerve, thanks to the parameters included in the scale (like fibrosis and mobility) which are more related to it. The third hypothesis allows us to highlight how, ultimately, the two relevant parameters useful to identify an operation with a prolonged operative time (so more difficult) are identified with vascularity and size gland, eventually allowing for a focus on these parameters during diagnosis and preoperative management. Therefore, focusing on gland size, a converter table was developed in order to take advantage of these findings. This tool was edited comparing surgeons' scores with the volume of the gland after surgery, so a volume range was assigned to every score in order to use it during preoperative US's examination and finding the expected rTDS-gland sizes before surgery. This specific tool was truly considered useful for the final goal, that means stratifying patients before surgery according to their feasible difficulty in thyroidectomy. Moreover, we are truly sure that it would be possible to identify preoperatively rTDS parameters using imaging instruments such as us-doppler for vascularity and elastosonography for fibrosis, in order to have an rTDS score.

In addition, it should be noted that during the analysis of data, changes to every item's score were comprehended according to underlying pathologies. Thus, it has been shown that hyperthyroidism patients tended to have a higher score in the vascularity item (2.73 ± 1.20); those with goiter had an average score of the parameter gland size significantly higher than the others (2.71 ± 1.22), while patients with a diagnosis of cancer showed a higher score in the mobility/fibrosis parameters (2.07 ± 1.04) and gland size (2.16 ± 1.07). Thanks to this, gland size-score using preoperative US-examination can be predicted, taking advantage of the equivalent volume based on our study. Finally, following the positive results obtained in the processing of our research hypotheses, the data have been grouped and summarized with regard to the operative time and rTDS score, according to diagnosis with surgical indication, as shown in Table 5. Our data show that diagnosis such as hyperthyroidism and goiter are at the top of our scale because they have a mean rTDS score, considering both of the surgeons, respectively of ~ 10 and ~ 9 , and that this average is correlated in our sample with an operative time (in minutes) of 141.36 ± 27.65 for hyperthyroidism and 138.17 ± 38.30 for goiter, so they are high risk diseases for a difficult thyroidectomy. Furthermore, according to our data, thyroiditis and cancer have a lower rTDS score than the previous diagnoses (both

diagnoses ~ 8), so in these cases operative time is shorter (127.61 ± 20.27 min for thyroiditis, and 125.09 ± 25.47 min for neoplasia), so they get an easier thyroidectomy. Hypothetically, based on the disease, these times may be used to identify patients who require a greater demanding of the staff in the operating theatre and more attention during the operation.

Conclusions

The rTDS that we propose, has been a valuable tool to identify the most difficult thyroid surgery-related diseases (Fig. 4), indeed it has shown that hyperthyroidism (rTDS score ~ 10 , of 141.36 ± 27.65) and goiter (rTDS score ~ 9 , of 138.17 ± 38.30) are the hardest underlying diseases for thyroid surgery. Moreover, the intervention approach could change resulting in an improvement in preoperative management and in a better surgical scheduling, considering operating times. In addition, this study shades light on identification of parameters that can predict the difficulty of surgery and a higher operating time, such as high vascularity and gland size.

The goals of this study have been achieved and, subsequently, a useful specific tool (our converter table for thyroid size) has been developed, which can be used before surgery to find gland's size rTDS score. Next step will be to create other tools to identify preoperatively other important parameters of our renovated thyroidectomy difficulty scale, such as vascularity through US color Doppler and fibrosis through elastosonography. In the future, preoperative identification of our rTDS parameters will make the identification of operative time more accurate through the developed relationship between rTDS-score and operative time.

Finally, this study intends to attain a confirmation of the results got through a re-evaluation after its application on a larger sample on the one hand, and to assess whether rTDS can be an important predictive tool for the development of post-surgery complications on the other. Beyond that, the next step will also be to identify pre-operative laboratory values, treatment and comorbidities that can be integrated to the rTDS, helping to predict a greater difficulty of thyroidectomy.

Funding No funding has been received for this study.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Research involving human participants and/or animals The study has been approved by the Institutional ethic committee of our university hospital.

Informed consent A detailed informed consent has been obtained by each patient involved in the study.

References

- Schneider DF, Mazeh H, Oltmann SC, Chen H, Sippel RS (2014) Novel thyroidectomy difficulty scale correlates with operative times. *World J Surg* 38:1984–1989
- Jamali FR, Soweid AM, Dimassi H, Bailey C, Leroy J, Marescaux J (2008) Evaluating the degree of difficulty of laparoscopic colorectal surgery. *Arch Surg* 143:762–767
- Dooley JJ, O'Brien PD (2006) Subjective difficulty of each stage of phacoemulsification cataract surgery performed by basic surgical trainees. *J Cataract Refract Surg* 32:604–608
- van Oldenrijk J, Schafroth MU, Bhandari M, Runne WC, Poolman RW (2008) Time-action analysis (TAA) of the surgical technique implanting the collum femoris preserving (CFP) hip arthroplasty. TAASTIC trial identifying pitfalls during the learning curve of surgeons participating in a subsequent randomized controlled trial (an observational study). *BMC Musculoskelet Disord* 9:93
- Ahanchi SS, Carroll M, Almaroof B, Panneton JM (2011) Anatomic severity grading score predicts technical difficulty, early outcomes, and hospital resource utilization of endovascular aortic aneurysm repair. *J Vasc Surg* 54:1266–1272
- Giddings AE (1998) The history of thyroidectomy. *J R Soc Med* 91(suppl. 33):3–6
- Gurrado A, Bellantone R, Cavallaro G, Citton M, Constantinides V, Conzo G, Di Meo G, Docimo G, Franco IF, Iacobone M, Lombardi CP, Materazzi G, Minuto M, Palazzo F, Pasculli A, Raffaelli M, Sebag F, Tolone S, Miccoli P, Testini M (2016) Can total thyroidectomy be safely performed by residents? A comparative retrospective multicenter study. *Medicine (Baltimore)* 95:e3241
- Adam MA, Thomas S, Youngwirth L, Hyslop T, Reed SD, Scheri RP, Roman SA, Sosa JA (2017) Is there a minimum number of thyroidectomies a surgeon should perform to optimize patient outcomes? *Ann Surg* 265:402–407
- Sosa JA, Bowman HM, Tielsch JM, Powe NR, Gordon TA, Udelsman R (1998) The importance of surgeon experience for clinical and economic outcomes from thyroidectomy. *Ann Surg* 228:320–330
- Duclos A, Peix JL, Colin C, Kraimps JL, Menegaux F, Pattou F, Sebag F, Touzet S, Bourdy S, Voirin N, Lifante JC, CATHY Study Group (2012) Influence of experience on performance of individual surgeons in thyroid surgery: prospective cross sectional multicentre study. *BMJ* 10:344
- Snyder SK, Hamid KS, Roberson CR, Rai SS, Bossen AC, Luh JH, Scherer EP, Song J (2010) Outpatient thyroidectomy is safe and reasonable: experience with more than 1,000 planned outpatient procedures. *J Am Coll Surg* 210:575–582
- Hallgrimsson P, Nordenström E, Bergenfelz A, Almquist M (2012) Hypocalcaemia after total thyroidectomy for Graves' disease and for benign atoxic multinodular goitre. *Langenbecks Arch Surg* 397:1133–1137
- Glinoe D, Andry G, Chantrain G, Samil N (2000) Clinical aspects of early and late hypocalcaemia after thyroid surgery. *Eur J Surg Oncol* 26:571–577
- Sukumaran V, Teli B, Avula S, Pavuluru J (2016) Effect of dissection of the recurrent laryngeal nerves on parathyroid insufficiency during total thyroidectomy for multinodular goitre. *J Clin Diagn Res* 10:PC01–PC03
- Thomusch O, Machens A, Sekulla C, Ukkat J, Brauckhoff M, Dralle H (2003) The impact of surgical technique on postoperative hypoparathyroidism in bilateral thyroid surgery: a multivariate analysis of 5846 consecutive patients. *Surgery* 133:180–185
- Samona S, Hagglund K, Edhayan E (2016) Case cohort study of risk factors for post-thyroidectomy hemorrhage. *Am J Surg* 211:537–540
- Wagner HE, Seiler C (1994) Recurrent laryngeal nerve palsy after thyroid gland surgery. *Br J Surg* 81:226–228
- Mok VM, Oltman SC, Chen H, Sippel RS, Schneider DF (2014) Identifying predictors of a difficult thyroidectomy. *J Surg Res* 190:157–163
- Gil-Carcedo E, Menendez ME, Vallejo LA, Herrero D, Gil-Carcedo LM (2013) The Zuckerkandl tubercle: problematic or helpful in thyroid surgery? *Eur Arch Otorhinolaryngol* 270:2327–2332
- Upile T, Jerjes W, Mahil J, Tailor H, Balakumar R, Rao A, Qureshi Y, Bowman I, Mukhopadhyay S (2011) How to do it: the difficult thyroid. *Head Neck Oncol* 3:54
- Agarwal A, Agarwal S, Tewari P, Gupta S, Chand G, Mishra A, Argawal AG, Verna AK, Mishra SK (2012) Clinicopathological profile, airway management, and outcome in huge multinodular goiters: an institutional experience from an endemic goiter region. *World J Surg* 36:755–760
- Shindo ML (1996) Considerations in surgery of the thyroid gland. *Otolaryngol Clin N Am* 29:629–635
- O'Sullivan MD, McAnena KS, Egan C, Waters PS, McCann PJ, Kerin MJ (2013) Enlarging neck masses in the elderly—histological and surgical considerations. *Int J Surg Case Rep* 4:378–381