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SURGICAL MEDICAL SCIENCES / CERRAHİ TIP BİLİMLERİ

The Role of Clinical Factors in the Development of Loss of Signal During Thyroid Surgery

Tiroid Cerrahisi Sırasında Sinyal Kaybı Gelişiminde Klinik Faktörlerin Rolü

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Abstract

Objectives: This study aims to identify clinical parameters beyond recurrent laryngeal nerve (RLN) anatomy contributing to loss of signal (LOS) during thyroid surgery.

Materials and Methods: We retrospectively analyzed the records of 171 initial thyroid surgery patients under intraoperative nerve monitoring (IONM) by a single surgeon. Patient characteristics, surgical details, and LOS data were recorded. All surgical procedures were performed using intermittent IONM in accordance with international guideline statements. Patients were categorized according to the presence of LOS (LOS+ and LOS-), and logistic regression analysis was used to identify LOS-related factors.

Results: Among 171 patients, 8 (4.7%) experienced LOS. LOS+ cases showed significantly lower tumor/nodule size and thyroid volume. No significant differences were observed in other variables between the LOS+ and LOS- groups. Logistic regression analysis identified tumor/nodule size ≤10 mm (p=0.006) and thyroid volume ≤12 mL (p=0.013) as significant factors. In 8 LOS+ patients, traction injuries were prevalent (87.5%), mainly at the level of Berry's ligament, left-sided, and single-branch nerve anatomy in 87.5%. Complete recovery of LOS occurred in 37.5% of LOS+ cases after the termination of traction.

Conclusion: Small thyroid volume increases the risk of the development of LOS, due to excessive RLN stretching during surgery. Our findings highlight the importance of minimizing traction and using continuous IONM to prevent LOS and subsequent vocal cord paralysis.

Key Words: Thyroidectomy, Electromyography, Vocal Cord Paralysis, Loss of Signal, Intraoperative Neuromonitoring

Öz

Amaç: Bu çalışma, tiroid cerrahisinde sinyal kaybının (LOS) gelişiminde etkili olan rekürren laringeal sinir (RLN) anatomisi dışındaki klinik parametreleri belirlemeyi amaçlamaktadır.

Gereç ve Yöntem: Tek bir cerrah tarafından intraoperatif sinir monitörizasyonu (IONM) altında ilk defa ameliyat edilen 171 hastanın kayıtları retrospektif olarak incelenmiştir. Hastaların özellikleri, cerrahi detaylar ve sinyal kaybı ayrıntıları kaydedilmiştir. Tüm cerrahi işlemler aralıklı IONM ile uluslararası kılavuz önerilerine uygun olarak gerçekleştirilmiştir. Hastalar LOS gelişimine göre iki gruba ayrılmıştır (LOS+ ve LOS-) ve LOS ile ilişkili risk faktörlerini belirlemek için lojistik regresyon analizi kullanılmıştır.

Bulgular: Çalışmada yer alan 171 hastanın %4,7'sinde (8 hasta) LOS geliştiği belirlenmiştir. LOS+ hastalarda tümör/dominant nodül boyutu ve tiroid hacmi istatistiksel olarak anlamlı şekilde daha düşük bulunmuştur. LOS+ ve LOS- grupları arasında diğer değişkenlerde anlamlı fark saptanmamıştır. Lojistik regresyon analizinde, tümör/dominant nodül boyutunun ≤10 mm (p=0,006) ve tiroid hacminin ≤12 mL (p=0,013) olmasının LOS gelişme riskinde etkili olduğunu belirlemiştir. LOS gelişen 8 hastanın ayrıntıları incelendiğinde, traksiyon yaralanmasının yaygın olduğu (%87,5), hasarın büyük çoğunluğunun (%87,5) Berry ligamenti bölgesinde, sol taraflı ve tek dal sinir anatomisinde gerçekleştiği görülmüştür. LOS gelişen hastaların %37,5'inde traksiyon sonlandırıldıktan sonra intraoperatif tam iyileşme gözlemlenmiştir.

Sonuç: Küçük tiroid hacmi, cerrahi sırasında RLN'nin aşırı gerilmesine bağlı olarak LOS gelişimi riskini artırmaktadır. Bulgularımız, intraoperatif sinyal kaybını ve bunun sonucunda oluşabilecek vokal kord paralizisini önlemek için diseksiyon sırasında traksiyonu minimize etmenin ve sürekli IONM kullanımının önemini vurgulamaktadır.

Anahtar Kelimeler: Tiroidektomi, Elektromiyografi, Vokal Kord Paralizisi, Sinyal Kaybı, İntraoperatif Sinir Monitörizasyonu

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Introduction

In thyroid surgery, understanding the significance of recurrent laryngeal nerve (RLN) injury is crucial. Complications such as dysphonia and aspiration pneumonia may occur in unilateral nerve palsy. If the paralysis is bilateral, it may progress to severe respiratory distress and even mortality (1,2). Traditionally, RLN injury assessment was primarily based on intraoperative visual observations of nerve integrity. However, the incorporation of intraoperative nerve monitorization (IONM) provides a significant advantage by providing real-time information on the occurrence of nerve injury (3). This innovative approach empowers surgeons with real-time predictive capabilities for postoperative nerve function and offers a robust strategy to mitigate the risk of bilateral RLN palsy (4). The detection of loss of signal (LOS) during the surgical procedure is crucial for this method. When identified through IONM, LOS signifies dynamic neurophysiological changes occurring within anatomically intact nerves. Furthermore, it serves as an early predictive marker for postoperative vocal cord dysfunction, prompting a comprehensive re-evaluation of surgical strategies, particularly in the context of a staged thyroidectomy (2,4).

The LOS in thyroid surgery is the result of a multifaceted process influenced by numerous factors and complex mechanisms. Injury during identification and dissection of the RLN may occur due to traction, thermal injury, clamping, mechanical trauma, or transection. Traction injury is the mechanism that occurs most frequently among these, accounting for about 80% of cases (3,5). In this regard, the most essential step of the surgical technique is the medialization of the thyroid lobe. At this stage, the Berry's ligament and/or adjacent blood vessels may cause excessive strain on the RLN, resulting in its injury (5,6). Consequently, understanding the various causes and mechanisms of LOS in thyroid surgery is essential to develop prevention strategies.

Studies examining the factors that contribute to the development of LOS have focused predominantly on the anatomical characteristics of the nerve (7,8). However, clinical characteristics that may have anatomical reflections cannot be evaluated independently from anatomical characteristics. So, the clinical factors that may cause traction are just as significant as the nerve anatomy, and these factors are not adequately described in the literature (4,5). The aim of this study is to identify clinical factors that are responsible for the development of LOS.

Materials and Methods

The IONM records of 173 patients who underwent their initial thyroid surgery with IONM by a single surgeon at the Department of General Surgery, Faculty of Medicine, Ankara University, between February 2020 and May 2022 were retrospectively analysed. Two patients with preoperative tumor invasion of the RLN were excluded from the study due to the absence of an intraoperative initial electromyography (EMG) signal. The demographic data of the patients, indication for surgery, presence of compression symptoms, tumor/dominant nodule size, tumor/dominant nodule location, thyroid nodularity characteristics, thyroid volumes, and the type of thyroid and lymphatic surgery performed were recorded. In addition, information on multifocality, capsular invasion, extrathyroidal extension (ETE), and central lymph node metastases was collected in patients with a malignant diagnosis. For the patients with intraoperative LOS, the nerve anatomy and injury characteristics were also examined.

All thyroid surgeries were performed by a single surgeon (C.K.), who predominantly utilized the superior approach for RLN dissection. To assess the functional integrity of the RLN, intermittent intraoperative nerve neuromonitorization (iIONM) was applied to all cases using the NIM 3.0® monitor manufactured by Medtronic, USA. The iIONM strategy followed the recommendations outlined in the international standards guideline statement of the International Neural Monitoring Study Group (9). The definition of LOS in patients was also in accordance with the international standards guideline statement, which considered the detection of an EMG signal below 100 μV, with a suprathreshold stimulation level of either 1 mA or 2 mA, following a satisfactory baseline vagal and RLN EMG amplitude in the dry surgical field (9).

Using the collected data, patients were categorized into two groups based on the occurrence of LOS during surgery: those with signal loss (LOS+) and those without (LOS-). Information from both groups was compared to identify factors contributing to LOS development, followed by logistic regression analysis for associated risk factors.

This study has been approved by the Ankara University Faculty of Medicine, Human Research Ethics Committee (decision no: İ07-506-23, date: 21.08.2023).

Statistical Analysis

Descriptive statistics are summarized as counts and percentages for categorical variables and median (interquartile range) for non-normally distributed continuous variables. The differences in proportions between groups were compared by using the Fisher's exact test. Difference between two groups for non-normally distributed continuous variables was assessed by the Mann-Whitney U test. Multiple logistic regression analysis was used to define risk factors of outcome variable (LOS). Receiver operating characteristic curves were used to describe the diagnostic performance of variables predicting LOS. The

Youden index was used to determine the most appropriate cut-off value. Prior to multiple logistic regression analysis, a univariate logistic regression analysis was performed to evaluate the association of each independent variable with the outcome variable. Variables with p-value less than 0.25 following univariate analysis were included to the multiple logistic model along with variables of known clinical importance. P-value less than 0.05 was considered significant.

Results

The study included 171 patients, with LOS observed in 8 (4.7%). Comparisons based on variables of all patients, categorized by LOS development, are presented in Table 1. In terms of age, gender, body mass index (BMI), surgical indication, Graves' disease, Hashimoto's disease, compressive symptoms, gland nodularity, tumor/dominant nodule lateralization and localization, both groups were similar. Statistically significant lower values of tumor/dominant nodule size and thyroid volume were identified in LOS+ patients. Regarding the surgical procedures, total thyroidectomy was more frequent than lobectomy in both groups, while the distribution of central lymph node dissection was similar. Cancer patients in both groups had similar multifocality, capsular invasion, ETE, and central lymph node metastases (Table 1).

Table 1: Clinical characteristics of the patients grouped on the basis of loss of signal

	LOS- (n=163)	LOS+ (n=8)	p-value
Age (years)	46 (18)	39 (18)	0.179
Gender (Female/Male)	133 (81.6)/30 (18.4)	8 (100.0)/0 (0.0)	0.353
BMI (kg/m^2)	27.13 (7.57)	25.00 (4.59)	0.101
Indication for surgery			0.712
Benign	64 (39.3)	2 (25.0)	
Malignant	99 (60.7)	6 (75.0)	
Presence of Graves' disease	14 (8.6)	1 (12.5)	0.528
Presence of Hashimoto's disease	63 (38.7)	4 (50.0)	0.713
Presence of compressive symptoms	47 (28.8)	1 (12.5)	0.444
Nodularity			0.513
None	42 (25.8)	2 (25.0)	
Ipsilateral	22 (13.5)	0 (0.0)	
Bilateral	99 (60.7)	6 (75.0)	
Dominant nodule size (mm)	22.00 (25.00)	15.00 (12.04)	**0.027**
Tumor size (mm)*	11.00 (11.00)	7.00 (13.13)	0.516
Tumor/dominant nodule lateralization			0.924
None	3 (1.8)	0 (0.0)	
Right lobe	79 (48.5)	5 (62.5)	
Left lobe	63 (38.7)	2 (25.0)	
Isthmus	17 (10.4)	1 (12.5)	
Pyramidal Lobe	1 (0.6)	0 (0.0)	
Tumor/dominant nodule localization			0.306
None	3 (1.8)	0 (0.0)	
Superior	31 (19.0)	0 (0.0)	
Medial	77 (47.2)	7 (87.5)	
Inferior	35 (21.5)	0 (0.0)	
Isthmus	16 (9.8)	1 (12.5)	
Pyramidal	1 (0.6)	0 (0.0)	
Presence of multifocality*	43 (43.4)	1 (16.7)	0.397
Presence of capsular invasion*	26 (26.3)	1 (16.7)	1.000
Presence of ETE*	6 (6.1)	1 (16.7)	0.346
Presence of central lymph node metastasis*	43 (43.4)	0 (0.0)	0.079

Table 1: Continued

	LOS- (n=163)	LOS+ (n=8)	p-value
Thyroid surgery			**0.046**
Lobectomy	16 (9.8)	3 (37.5)	
Total thyroidectomy	147 (90.2)	5 (62.5)	
Central lymphatic dissection			0.977
None	63 (38.7)	3 (37.5)	
Unilateral	76 (46.6)	4 (50.0)	
Bilateral	24 (14.7)	1 (12.5)	
Lateral lymphatic dissection			0.836
None	156 (95.7)	8 (100.0)	
Unilateral	6 (3.7)	0 (0.0)	
Bilateral	1 (0.6)	0 (0.0)	
Thyroid volume (mL)	23.00 (36.00)	10.50 (29.50)	**0.031**

*: Calculated only for patients with malignant diagnosis
All data presented as either number (percentages) or median (interquartile range)
BMI: Body mass index, ETE: Extrathyroidal extension, LOS: Loss of signal

In order to identify the risk factors influencing the development of LOS, a logistic regression analysis was performed on clinical characteristics. For the analysis of continuous variables, the areas under the ROC curve were 0.732±0.100 for dominant nodule/tumor size (p=0.027) and 0.725±0.101 for thyroid volume (p=0.032). The most appropriate cutoff values were 10 mm and 12 mL, respectively. Gender, the presence of a central metastatic lymph node and lateral lymphatic dissection variables could not be included in the univariate logistic regression analysis due to zero cell problem. The results of the univariate logistic regression analysis suggest that tumor/dominant nodule size of ≤10 mm (p=0.006) and thyroid volume of ≤12 mL (p=0.013) were found to be statistically significant. On the other hand, according to multiple logistic regression analysis, only tumor/dominant nodule size ≤10 mm was found to be statistically significant (p=0.006) (Table 2).

When the anatomical details and nerve injury patterns of 8 patients with intraoperative LOS were examined, it was observed that traction injuries developed in all patients (87.5%), except for one patient who had an injury due to instrumentation. While segmental injuries occurred in all patients, the injury site in traction-related cases was consistently found at the level of Berry's ligament. Lateralization of LOS was on the left side in 75% of the patients, and the nerve anatomy was observed as a single branch in 87.5%. In three (37.5%) patients with LOS, complete intraoperative recovery was observed after traction was terminated. As a result, only 37.5% of the patients required a staged thyroidectomy. In the postoperative clinical evaluation, only one patient with traction injury-related LOS experienced deterioration in sound quality, which was recovered within one month, and hoarseness was found in one patient with instrumentation injury-related LOS that recovered after 3 months (Table 3).

Table 2: Analysis of relationship between clinical characteristics and development of loss of signal by logistic regression

	OR (95% CI)	p-value
Age (years)	0.966 (0.914-1.020)	0.212
BMI (kg/m^2)	0.886 (0.754-1.042)	0.144
Malignant diagnosis	1.939 (0.380-9.907)	0.426
Presence of Graves' disease	1.520 (0.174-13.260)	0.705
Presence of Hashimoto's disease	1.587 (0.383-6.575)	0.524
Presence of compressive symptoms	0.353 (0.042-2.945)	0.336
Presence of nodularity	1.041 (0.202-5.359)	0.961
Tumor/dominant nodule size ≤10 mm	8.036 (1.814-35.587)	**0.006**
Tumor/dominant nodule lateralization		0.719
Right lobe	1.329 (0.147-11.999)	0.800
Left lobe	0.667 (0.057-7.731)	0.746
Presence of medial tumor/nodule localization	7.818 (0.941-64.987)	0.057
Presence of multifocality*	0.227 (0.029-2.312)	0.227
Presence of capsular invasion*	0.562 (0.063-5.034)	0.606
Presence of ETE*	3.100 (0.311-30.929)	0.335
Central lymphatic dissection		0.977
Unilateral	1.105 (0.238-5.123)	0.898
Bilateral	0.875 (0.087-8.828)	0.910
Thyroid volume ≤12 mL	6.566 (1.492-28.885)	**0.013**

*: Calculated only for patients with malignant diagnosis
BMI: Body mass index, ETE: Extrathyroidal extension, OR: Odds ratio, CI: Confidence interval

Table 3: Anatomical and injury characteristics of the nerves and clinical information of the patients with loss of signal

Patient	Necessity of staged thyroidectomy	LOS lateralization	Type of LOS	Intraoperative LOS recovery	Intraoperative LOS recovery time(min)	Segmental injury zone	Type of injury	RLN branching anatomy	RLN branching zone	Postoperative paralysis symptoms	Postoperative symptomatic recovery time (months)
1	-	Left	Segmental	-	-	Berry's Ligament	Traction	Single	-	Deterioration in sound quality	1
2	+	Right	Segmental	-	-	Berry's Ligament	Traction	Single	-	-	-
3	-	Left	Segmental	+	20	Berry's Ligament	Traction	Single	-	-	-
4	-	Left	Segmental	+	10	Berry's Ligament	Traction	Single	-	-	-
5	-	Left	Segmental	-	-	Berry's Ligament	Traction	Single	-	-	-
6	+	Right	Segmental	-	-	Berry's Ligament	Traction	Single	-	-	-
7	+	Left	Segmental	-	-	Proximal	Instrumental Trauma	Single	-	Hoarseness	3
8	-	Left	Segmental	+	10	Berry's Ligament	Traction	Double	Distal 2 cm	-	-

LOS: Loss of signal, RLN: Recurrent laryngeal nerve

Discussion

In the results of our study investigating the effect of non-anatomical factors on the development of intraoperative LOS in thyroid surgery, it was found that tumor/dominant nodule size of ≤10 mm and thyroid volume of ≤12 mL, which can be considered clinically as small volume indicators, are effective risk factors for the development of intraoperative LOS. When the risk factors for the development of intraoperative LOS or vocal cord paralysis are searched in the literature, the studies have mainly focused on the anatomical features of the nerve. However, considering that most nerves are injured due to traction, especially near the Berry's ligament, clinical factors that may cause an increase in the need for anteromedial stretching of the thyroid lobe during dissection are thought to be at least as important as RLN anatomy.

When the studies that evaluated clinical characteristics were reviewed in the literature; Wu et al. (10), in a study comparing intraoperative complete and incomplete LOS, found that the distribution of age, gender, diagnosis, and procedure in patients with and without LOS was similar. In a retrospective study of 2,350 patients, the rate of LOS near the laryngeal entry point of the RLN was found to be 5.1%. While age, gender, procedure, side, the presence of Hashimoto's disease, and the weight of the thyroid lobe were not significant in the development of RLN injury, the presence of extralaryngeal bifurcation of the RLN substantially increased the risk (6). Other studies in the literature have evaluated RLN injury or paralysis, which can be considered a clinical reflection of LOS. In a study by Wojtczak et al. (11), retrosternal goiter, gender, diagnosis, and thyroid volume were found to increase the risk of RLN injury in thyroidectomies performed using only visual identification of the RLN, whereas only surgical experience affected the risk of RLN injury in thyroidectomies performed using IONM. In addition, Moreira et al. (12) identified male gender and longer operation times as independent risk factors for RLN palsy. In another study investigating the effect of nimodipine on the recovery of RLN injury, age, number of comorbidities, lymph node metastasis, tumor size, presence of intraoperative and pathological ETE were identified as significant risk factors for RLN palsy. Only age (≥55 years) and the presence of intraoperative ETE were identified as independent risk factors for RLN injury (13). In one of the largest series in the literature, analysing RLN injury in 11,230 patients by Gunn et al. (14), age (≥65 years), total thyroidectomy, and malignant diagnosis were determined to be

independent risk factors by multivariate analysis. In a study by Aygun et al. (15), in which the effect of clinical and anatomical factors on RLN palsy in 871 patients was investigated, Berry's ligament entrapment of the RLN, nerve branching, RLN-inferior thyroid artery relationship, and recurrent surgical procedures were found to be significant, whereas other clinical factors, including BMI, gender, diagnosis, thyroid weight, and side of surgery, were not. In addition, only anatomical features were reported to be effective factors in RLN injury in multivariate analysis. In another study on multinodular goiter patients, thyroid tissue heavier than 100 g was found to increase the risk of early postoperative vocal cord paralysis (16). According to a study evaluating the safety of the preferred dissection techniques in the approach to the RLN, nerve injury at the level of Berry's ligament was substantially less frequent with the superior approach than with the lateral approach (7). When the results of these studies are evaluated, it can be summarized that the anatomical characteristics of the nerve are the most significant risk factors for RLN injury, whereas advanced age and a cancer diagnosis are the most influential clinical features. In our study, univariate logistic regression analysis revealed that tumor/dominant nodule size ≤10 mm and thyroid volume ≤12 mL were significant factors in the development of LOS, while other clinical characteristics did not affect LOS risk. Although it was hypothesized that the medial location of the tumor/dominant nodule in the thyroid lobe might increase the risk due to its potential to predispose the RLN to traction, particularly around Berry's ligament, this was found to be marginally insignificant (p=0.057). In the multivariate analysis, only tumor/dominant nodule size ≤10mm was found to be independently associated with an increased risk. While advanced age and cancer diagnosis are apparent as important clinical factors in RLN injury in the literature, their lack of influence on LOS development in our study could be primarily attributed to the exclusion of patients with preoperative RLN injury, such as RLN invasion. Secondly, the patients in our study reflected data from a standardized dissection technique performed by a single surgeon under IONM. This consistency in surgical approach could potentially have a favourable effect on preventable factors during surgery, thereby influencing the observed outcomes. While existing literature suggests that a larger thyroid volume increases the risk of RLN injury, our study revealed the opposite trend regarding LOS development. We attribute this divergence to our use of IONM and meticulous dissection technique that reduce the risk of traction-related injury. This implies that with careful precautions, we can minimize preventable traction injuries. The varied impact of dissection techniques could be associated with the development of LOS or RLN injuries, particularly in proximity to Berry's ligament. In this specific region, the RLN is exposed to significant stretching during the medial traction of the thyroid lobe. Moreover, in cases of larger thyroid tissues, the presence of more prominent and elongated vessels and fibrous bands is notable. These structures' increased longevity potentially enhances flexibility, and consequently reducing the transmission of traction/compression forces onto the RLN during dissection. In addition, for smaller thyroid tissues, the medial stretching might result in less controlled traction on the RLN compared to larger tissues. Furthermore, the earlier release of structures that may cause traction or compression during a superior approach, in contrast to a lateral approach, may result in a shorter and less intense traction force on the RLN. Despite the limited number of LOS patients in our study, we believe that these factors indicate an increased risk of LOS development in thyroidectomies involving smaller gland volumes, particularly those less than 12 mL.

In our study, a LOS rate of 4.7% was observed among the patients. When the details of LOS cases were examined, it was observed that all injuries were segmental, and apart from one patient, they all manifested as traction-related injuries (87.5%) within or around Berry's ligament. Among the traction injuries, complete intraoperative recovery in LOS was observed in 37.5% of patients when traction was terminated during the dissection. At postoperative evaluation of the patients with traction-related LOS, only one patient exhibited symptomatic deterioration in sound quality, which resolved by the 30th postoperative day.

Several studies reviewed the characteristics of LOS in the literature. In a study by Dionigi et al. (1), a classification of severity for RLN injury was proposed. This study examined 281 cases of RLN injury among 6093 nerves. According to their findings, traction-related injuries were reported as the most frequent type of injury, accounting for 71% of cases. In cases of traction-related injuries, it was observed that recovery occurred in an average of 7 days, which was the shortest compared to other types of injuries. The severity of the traction-related injury was classified as "mild" (1). In a study that focused on RLN injuries at the level of Berry's ligament and highlighted the difficulty in distinguishing between compression and traction injuries, it was found that injuries around Berry's ligament accounted for 91.4% of RLN injuries, with traction or compression as the primary causes. In addition, an average recovery period of 35.8 days for RLN injuries was reported (6). In a study examining intraoperative electromyographic alterations, a 4.0% risk of LOS development was discovered. During thyroid medialization, it was also noted that vagus EMG amplitudes decreased significantly compared to baseline values (5). In another investigation on intraoperative EMG recovery patterns in LOS, patients with complete recovery demonstrated normal postoperative vocal cord function. According to the findings, early detection of traction could potentially prevent irreversible LOS (3). Liu et al. (8) found the incidence of LOS to be 8.6% and stated that injured nerves were recovered within the intraoperative period in 70% of cases, specifically within

a maximum of 20 minutes after intraoperative traction was terminated. Similarly, Schneider et al. (17) reported that in cases of LOS detected under continuous IONM, observing ≥50% intraoperative recovery according to the baseline amplitude value indicated normal early postoperative vocal cord functions.

Our study's findings align with the existing literature in terms of the characteristics of nerve injury. According to these findings, it becomes evident that traction and compression injuries occurring at the level of Berry's ligament during thyroid medialization should be comprehensively evaluated as a whole. This primary cause of injury necessitates intraoperative early detection to increase the likelihood of recovery. To achieve this goal, a technique that minimizes stretching and avoids traction or compression should be preferred in dissection. In this regard, a superior approach is believed to be advantageous for RLN dissection. In addition, because a significant proportion of nerve injuries occur in nerves with intact morphology, IONM-guided functional evaluation of the RLN has become an unquestionable necessity. When compared to intermittent IONM, continuous IONM is thought to be more effective in facilitating the early identification of traction-related EMG amplitude decreases throughout the intraoperative period. This methodical shift is thought to have significant advantages for protecting nerve integrity.

Study Limitations

Among the limitations of this study, several factors should be mentioned. Due to the limited number of patients with LOS, the impact of all variables could not be examined in the statistical analysis. Secondly, it was not possible to investigate the duration of the onset of traction-related nerve injury because of the data obtained from operations with intermittent IONM. Additionally, since a single surgeon carried out the surgical procedures, it is impossible to generalize the findings to all RLN dissection techniques.

Conclusion

The findings of our study suggest that among the clinical characteristics of patients undergoing thyroid surgery, a smaller thyroid volume is associated with an increased risk of LOS. This consideration is believed to result in excessive RLN stretching during surgery. Therefore, opting for surgical techniques with minimal traction and utilizing continuous IONM for early damage detection is advisable. This strategy is believed to effectively prevent the development of complete LOS and, consequently, postoperative vocal cord paralysis.

Ethics

Ethics Committee Approval: This study has been approved by the Ankara University Faculty of Medicine, Human Research Ethics Committee (decision no: İ07-506-23, date: 21.08.2023).

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Concept: C.K., Design: C.K., Data Collection and Processing: C.K., A.H.E., Analysis or Interpretation: C.K., A.H.E., Literature Search: C.K., Writing: C.K., A.H.E.

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