TOTAL THYROIDECTOMY FOR MALIGNANCY - IS CENTRAL NECK DISSECTION A RISK FACTOR FOR RECURRENT NERVE INJURY AND POSTOPERATIVE HYPOCALCEMIA? A TERTIARY CENTER EXPERIENCE IN ROMANIA

C. Giulea¹, O. Enciu^{1*}, E.A. Toma¹, S. Martin², S. Fica², A. Miron¹

Elias University Emergency Hospital - ¹Department of Surgery, ²Department of Endocrinology, "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania

Abstract

Introduction. Surgery for thyroid cancer carries a higher risk of morbidity given the region's complicated anatomy, the setting of malignancy and extent of the surgery.

Aim. To investigate the rate of complications related to the recurrent nerve and parathyroid glands lesions in patients with thyroid carcinoma that undergo thyroid surgery and lymph node dissection.

Patients and Methods. The data of 71 patients who underwent total thyroidectomy and 19 patients who underwent total thyroidectomy and central neck dissection with various associated neck dissection techniques were investigated using appropriate statistical tests.

Results. As expected, the rate of recurrent nerve injury observed in the neck dissection group was higher than in the total thyroidectomy group (15.7% vs. 2.8%, $p=0.05$). As for postoperative hypocalcemia, the rate observed in the neck dissection group, both for postoperative day 1 ($p<0.0001$) and day 30 ($p=0.0003$) was higher than in the total thyroidectomy group (68.4% vs. 19.7% postoperative day 1, 31.5% vs. 4.2% postoperative day 30).

Conclusions. The risk of morbidity concerning the recurrent nerve injury and postoperative hypoparathyroidism increases with the extent of surgery. Extensive surgery may achieve proper oncologic outcomes but increases the risk of postoperative morbidity and decreases quality of life. In deciding for extensive surgery, both patient and medical team need to understand these risks.

Key words: thyroid cancer, thyroid surgery, recurrent nerve injury, postoperative hypocalcemia.

INTRODUCTION

Thyroid cancer incidence has increased all over the world, being the 18th most common cancer in Europe. After thyroid surgery, general complications include bleeding and wound related complications (infection and keloid formation) while specific complications

are related to recurrent and superior laryngeal nerve injuries and postoperative hypocalcemia. In extreme cases, the esophagus, the large vessels of the neck and the cervical sympathetic trunk may be involved. Still, the most frequent and dreaded complications regard the temporary and permanent paralysis of the recurrent nerve and hypocalcemia induced by postoperative hypoparathyroidism (1-3).

Acquired hypoparathyroidism is a consequence of inadequate resection or injury to the parathyroid glands or to their blood supply during thyroidectomy, parathyroidectomy and/or neck dissection. It is estimated that permanent postoperative hypoparathyroidism results in 0.5-6.6% of all thyroidectomies with wide ranges in different series but specialized centers report 0.9-1.6% (2-4). Neck surgery represents the most frequent cause of hypoparathyroidism with tetany being observed in the first two postoperative days but more than 50% of patients experience satisfactory recovery without the need for long term substitution (6).

Injury to the recurrent laryngeal nerve leads to dysphonia, dysphagia and aspiration problems. The clinical signs depend on the position of the paralyzed cord and patients may be asymptomatic. The reported rate of recurrent nerve paralysis varies widely. While most authors report a rate of temporary paralysis lower than 5.1% and permanent paralysis around 2%, injury rates of up to 38% have been reported (7, 8). The superior laryngeal nerve has recently gained attention because the injury of its external branch can cause significant voice changes such as vibratory phase asymmetry in the vocal cords and reduction in fundamental frequency range (9-11). It is recommended that it should also be preserved (12).

Postoperative hypoparathyroidism and recurrent nerve paralysis depend on the extent of the thyroid resection, neck dissection for malignancy, reoperation,

*Correspondence to: Octavian Enciu MD, "Carol Davila" University of Medicine and Pharmacy, Dept. of Surgery, Str. Dionisie Lupu 37 Bucharest, 030167, Romania, E-mail: esoctavian@gmail.com

underlying thyroid disorder and not least the experience of the surgeon. Thyroid malignancy and Graves' disease also increase the risk of complications (2, 3).

The current study aims to compare outcomes of total thyroidectomy with and without neck dissection concerning the function and mobility of the vocal cords and postoperative hypocalcemia in patients with thyroid cancer.

METHODS

During the last 15 years in the Elias Surgery Department more than 1500 interventions for thyroid and parathyroid disorders were performed. These operations consisted of total thyroidectomies, thyroid lobectomies or parathyroidectomies. The cases that were managed included thyroid disorders (multinodular goiter, Graves' disease, thyroid cancer, thyroiditis ecc) and primary hyperparathyroidism (parathyroidectomies per se or concomitant with thyroidectomy).

We retrospectively analyzed the files of 493 patients that underwent thyroidectomies in our Surgery Department between 2012 and 2015. Anthropometric, biologic and imagistic data, indications of thyroid surgery, types of surgical procedures, pathology results and the presence of complications after surgery were recorded.

The postoperative complications of interest were recurrent nerve injury and postoperative hypocalcemia. According to our protocol, patients with voice changes are scheduled for follow up at 30 days after surgery in close collaboration with our ENT department. Patients with postoperative hypocalcemia will be followed up by the endocrinologist that referred them for surgery.

For recurrent nerve complications, temporary paralysis was defined as occurring in the first postoperative day when it was diagnosed by fiberscope examination and with complete remission in 6 months. Paralysis was considered permanent when remission failed to be complete by 6 to 12 months. The clinical evaluation followed voice changes in the first postoperative day and postoperative day 30, and in cases with persistent dysphonia, persistent vocal cord immobility or loss of mobility the patients were reevaluated within 6 – 12 months. Patients with voice alteration and those with suspected nerve injury without obvious voice alteration but with difficult dissection or suspected nerve damage underwent fiberscope examination in the first postoperative day.

When regarding parathyroid failure,

postoperative hypocalcemia was defined as postoperative day 1 calcemia below 8 mg/dL ($s-Ca < 8 \text{ mg/dL}$), with or without clinical symptoms. If this persisted longer than 30 days it was defined as protracted hypoparathyroidism in correlation with determined iPTH values, while after one year it was considered permanent (13).

Out of the 493 patients that were reviewed, 90 patients with thyroid cancer that underwent surgery were studied in order to establish if neck dissection increases the risk of postoperative complications. The patients were studied in two groups: group A – patients that underwent total thyroidectomy and group B – patients that underwent total thyroidectomy with central neck dissection with or without associated neck dissection techniques (selective neck dissection – SND or modified radical neck dissection – MRND).

Central neck dissection (CND) implies the removal of clinically involved prelaryngeal, pretracheal and bilateral paratracheal lymph node basins (14). The superior limit of dissection is a horizontal line at the inferior border of the cricoid cartilage, the inferior limit is formed by the innominate artery while the lateral is formed by the common carotid artery (15).

Selective neck dissection (SND) was carried out when suspicious lymph nodes were detected both on ultrasound or during the intervention outside the borders of compartment VI and was carried out on the side of the diagnosed thyroid malignant mass. The procedure involves the removal of lymphatic tissue along the internal jugular vein – compartments IIa, III and IV, seldom Vb (15-17).

Modified radical neck dissection (MRND) was used for grossly enlarged palpable lymph nodes that were proven malignant and involves the removal of lymphatic tissue from compartments I, IIb and V in addition to our SND protocol. A similar hockey stick incision in continuity with the horizontal incision for thyroidectomy was used for MRND as for SND (15, 17, 18).

All patients with thyroid cancer operated on during this period were included in the study and the indication for surgery was established by the endocrinologist that referred the patient.

A complete and detailed database was obtained and Pearson's tests were performed to certify significant correlations.

RESULTS

Out of 493 patients that underwent thyroid

surgery between 2012 and 2015, 90 patients (19.06%) underwent surgery for primary thyroid cancer. CND with or without SND or MRND was carried out in selected cases: lymph nodes suspected of malignancy during preoperative ultrasound, high suspicion of malignancy after fine needle aspiration, suspected malignancy confirmed during surgery by frozen section and obviously pathological lymph nodes observed during surgery.

Most patients were diagnosed with a form of differentiated thyroid cancer. Four cases of medullary thyroid cancer, two in each group, and two cases of anaplastic thyroid cancer were discovered after histopathological examination.

The clinical details, diagnosis, malignancy characteristics, surgical intervention, types of neck dissection and postoperative complications are presented in Table 1.

Recurrent nerve complications

Out of the 90 patients that underwent surgery, recurrent nerve complications occurred in 5 patients but none showed signs of glottis insufficiency.

In Group A, two patients were diagnosed with

unilateral paralysis in postoperative day 1. At 30 day follow up, one patient fully recovered clinically while the other patient recovered partially but the fiberscope examination diagnosed loss of motility in the cord.

In Group B, three patients displayed voice changes after surgery and after ENT examination, all three patients were diagnosed with unilateral recurrent nerve paralysis. At 30 day follow up, two recovered fully, while one patient had persistent voice changes and fiberscope examination diagnosed complete loss of motility in the cord.

Total thyroidectomy with central neck dissection is associated with increased risk of recurrent nerve injury ($r=0.2015$, $p=0.05$) with increased statistic relevance for specific types of dissection.

Postoperative hypocalcemia and hypoparathyroidism

In the first postoperative day, 14 patients in Group A and 13 patients in Group B had hypocalcemia ($s\text{-Ca}<8\text{mg/dL}$), with or without clinical symptoms. Follow up at 30 days showed that only 3 patients without lymph node dissection and 6 patients with lymph node

Table 1. Patient, Diagnosis, Intervention and Complications Summary

Parameter	Group A Total Thyroidectomy (71 patients)	Group B Total Thyroidectomy and CND (19 patients)	p-value
Age (years)	56.4 (25-83)	52.6 (27-76)	0.29
Gender female/male	58 (82%)/13 (18%)	15 (79%)/4 (21%)	0.039
Diagnosis (malignancy)			
PTC	20 (28.1%)	13 (68.4%)	
PTC-F	33 (49.2%)	1 (5.2%)	
PTC-S	10 (14.1%)	2 (10.5%)	
FTC	4 (5.6%)	1 (5.2%)	
MTC	2 (2.8%)	2 (10.5%)	
Anaplastic	2 (2.81%)	0	
Capsular invasion	24 (33.8%)	16 (84.2%)	<0.0001
Extracapsular extension	10 (14.1%)	15 (78.9%)	<0.0001
Neck dissection	0	19	N/A
CND	0	3 (15.7%)	N/A
CND + MRND	0	6 (31.4%)	N/A
CND + SND	0	10 (52.6%)	N/A
Calcemia, day POD1			
>8 mg/dL (normal)	57 (80.2%)	6 (31.5%)	
<8 mg/dL	14 (19.7%)	13 (68.4%)	0.005
Calcemia, day POD30			
>8 mg/dL (normal)	68 (95.7%)	13 (68.4%)	
<8 mg/dL	3 (4.2%)	6 (31.5%)	0.15
RLN injury	2 (2.8%)	3 (15.7%)	<0.0001
Transient	1 (1.4%)	2 (10.5%)	N/A
Permanent	1 (1.4%)	1 (5.2%)	N/A

*Mean comparison and single and two-factor ANOVA

*CND – central neck dissection; SND – selective neck dissection; MRND – modified radical neck dissection; PTC – papillary thyroid carcinoma; PTC-F – papillary thyroid carcinoma follicular variant; PTC-S – papillary thyroid carcinoma diffuse sclerosing form; FTC – follicular thyroid carcinoma; MTC – medullary thyroid carcinoma; POD – postoperative day; RLN – recurrent laryngeal nerve.

dissection were hypocalcemic. All patients continued calcium supplementation and none of the patients had permanent hypothyroidism as shown by normal iPTH values determined during follow up as outpatients.

Highly significant correlations are demonstrated between both postoperative day 1 ($r=0.4337$, $p<0.0001$) and day 30 ($r=0.3721$, $p=0.0003$) and central neck dissection.

We found significant differences ($p<0.0001$) when comparing postoperative hypocalcemia and recurrent nerve injuries within the two groups. Both POD 1 and 30 s-Ca levels over 8 mg/dL were positively correlated with total thyroidectomy ($p=0.0003$) while recurrent nerve injury was negatively correlated ($p=0.05$).

DISCUSSION

Comprehensive preoperative examination before thyroid surgery should begin with patient history, from the overall status to acute symptoms (both general and specific to the pathology in question), genetic anomalies, chronic disease and previous surgical interventions followed by careful examination of the cervical region and voice assessment. Prior to surgery, patients with voice change – and more importantly recent voice alterations and patients diagnosed with malignant thyroid disease – large tumors and enlarged central lymph nodes undergo complete routine ENT evaluation.

For patients with thyroid nodules, fine-needle aspiration (FNA) is the most important study, determining the nature of the nodule (solid or cystic) and should be considered in cases with singular or dominant nodules (19). FNA should be an important factor in the preoperative planning of the extent of surgery and it is very important when discussing this with the patient. Preoperative and postoperative evaluation of the larynx should be performed by an ENT doctor, but many surgeons ask for a consult only in cases where changes

are found in tone or voice characteristics, or when the patient has had relevant previous surgeries (20). The most valuable finding in a routine examination would be vocal cord paralysis in otherwise asymptomatic patients. A swift check of the status of the vocal cords should also be performed by the anesthesiologist after the removal of the endotracheal tube as an early indicator of typical movement and function (21,22).

Patient positioning is an important first step for the surgeon, insuring a proper surgical field through sufficient neck extension using special pillows or silicone bags that are placed beneath the shoulders. Suitable exposure also depends on making a proper skin incision, both in terms of placement and length in order to operate safely (23).

Although constantly underrated, less than 2% of patients who undergo total thyroidectomy suffer permanent recurrent laryngeal nerve damage, while transient injuries are reported around 5%. (8,24,25) The rate of recurrent injury also varies on the method of laryngeal examination. Thorough observation during surgery and careful dissection significantly reduce the risk of injury considering the anatomic variability of the nerve (26, 27). Nerve exposure in the operative field has been shown to reduce the rate of damage, which is why, after a long debate regarding the premeditated identification of the RLN, a consensus has been reached. Exposure can be achieved in multiple ways – after the mobilization of both thyroid poles or even at the beginning of dissection, after the ligation of the inferior thyroid artery (28-31). Another strategy to avoid nerve injury is the vascular ligation medially so that the sutures do not include the RLN or its branches.

Transient postoperative hypocalcemia is a very variable complication, observed in 1% to 50% of patients, but with less than 2% of them experiencing prolonged dysfunction. Hypocalcemia due to hypoparathyroidism is especially seen in patients who undergo total thyroidectomies, the risk of injury when dissecting both lobes being obviously higher.

Table 2. Recurrent Nerve Injury

Intervention	RLN Injury	Pearson (r)	(p)
Total Thyroidectomy	1.4%	0.2015	0.05
Total Thyroidectomy + CND	5.2%		

Table 3. Postoperative Calcemia

Intervention	Postoperative Calcemia		Pearson (r)	(p)
Total Thyroidectomy	Calcemia POD1	19.7%	0.4337	<0.0001
	Calcemia POD30	4.2%	0.3721	0.0003
Total Thyroidectomy + CND	Calcemia POD1	68.4%	-0.4337	<0.0001
	Calcemia POD30	31.5%	-0.3721	0.0003

Damage to the parathyroid glands can be avoided by carefully observing the branches of the inferior thyroid artery as they enter the thyroid capsule and correctly identifying the end-arteries that supply the four glands. If even following these steps, injury occurs, the gland should be transplanted either to a pocket in the sternocleidomastoid muscle, the forearm or subcutaneously, where its function can be restored. (31-33).

Both complications of total thyroidectomy regarding the injury of the recurrent nerve and postoperative hypoparathyroidism can be avoided with satisfactory results employing the technique of capsular dissection. There is no compelling evidence that nerve monitoring can help prevent complications better than careful meticulous dissection of the thyroid gland in the space between the thyroid capsule and the proper capsule of the gland (34).

One cannot argue that hemostasis, during or after the resection steps, is very important. Unsatisfactory hemostasis is yet another factor to consider because during hasty hemostasis maneuvers for an important bleeding the risk of laryngeal or parathyroid lesion is higher.

For patients with diagnosed differentiated thyroid cancer total thyroidectomy is recommended (grade A recommendation) while resection of regional lymph nodes should minimize the rate of recurrence. Central compartment neck dissection is recommended for papillary carcinoma and suspected Hurtle carcinoma (grade B recommendation) while for follicular total thyroidectomy should suffice (35).

The risk of increased rate of postoperative complication with neck dissection and efficient oncologic treatment for residual disease in metastatic lymph nodes leads to concept of minimizing treatment-related morbidity – the extent of surgery should be determined by the experience of the surgeon (36). We emphasize that all details of the planned surgery and after the intervention, the intraoperative findings were communicated to the patient.

The present study demonstrates that neck dissection increases morbidity when concerning recurrent nerve injury and postoperative hypocalcemia.

The rate of recurrent laryngeal nerve injury is correlated with neck dissection ($p=0.05$). In Group A, 2 out of 71 patients (2.81%) were diagnosed with recurrent nerve injury while in the neck dissection group 3 out of 19 patients suffered nerve injury (15.5%). None of the patients displayed postoperative glottis insufficiency and one patient in each group had permanent paralysis at

1 year follow up. Similar results were reported by other authors within larger cohorts. (37).

Postoperative transient hypocalcemia was observed in both groups but with a higher rate among patients that suffered neck dissection, both in postoperative day 1 ($p<0.0001$) and day 30 ($p=0.0003$). This may be explained by ample manipulation of tissue during neck dissection and increased extent of surgery. As a remark, the pathology reports did not show signs of parathyroid tissue in the resection specimens. All patients followed a protocol plan of postoperative calcium supplementation in accordance with the endocrinologist's prescription: calcium/cholecalciferol, alfacalcidol, magnesium and calcium gluconate with gradual reduction and calcemia control. None of the patients in either group was diagnosed with permanent postoperative hypoparathyroidism.

In conclusion, the dissection of the central compartment alone or associated with or other types of neck dissection has been shown to increase postoperative morbidity regarding recurrent nerve injury and postoperative hypocalcemia. Understanding of the relationship between extensive surgery and the increased risk for postoperative complications that may decrease the patient's quality of life is the sum and substance of thyroid surgery for cancer.

Conflict of interest

The authors declare that they have no conflict of interest.

References

1. Mitchell I, Livingston EH, Chang AY, Holt S, Snyder WH, Lingvay I, Nwariaku FE. Trends in thyroid cancer demographics and surgical therapy in the United States. *Surgery*. 2007;142(6):823-828.
2. Zambudio AR, Rodríguez J, Riquelme J, Soria T, Canteras M, Parrilla P. Prospective study of postoperative complications after total thyroidectomy for multinodular goiters by surgeons with experience in endocrine surgery. *Annals of surgery*. 2004;240(1):18-25.
3. Rosato L, Avenia N, Bernante P, De Palma M, Gulino G, Nasi PG, Pelizzo MR, Pezzullo L. Complications of thyroid surgery: analysis of a multicentric study on 14,934 patients operated on in Italy over 5 years. *World Journal of Surgery*. 2004;28(3):271-276.
4. Thomusch O, Machens A, Sekulla C, Ukkat J, Brauckhoff M, Dralle H. The impact of surgical technique on postoperative hypoparathyroidism in bilateral thyroid surgery: a multivariate analysis of 5846 consecutive patients. *Surgery*. 2003;133(2):180-185.
5. Asari R, Passler C, Kaczirek K, Scheuba C, Niederle B. Hypoparathyroidism after total thyroidectomy: a prospective study. *Archives of Surgery*. 2008;143(2):132-137.
6. Miron A, Martin S, Giulea C, Fica S. Postoperative hypoparathyroidism, an assumed risk in total thyroidectomy for Graves disease(Romanian). *Chirurgia*. 2009;104 (6): 749-752.

7. Giulea C, Martin S, Safta D, Miron A. Evaluation of recurrential complications after total thyroidectomy. *Acta Endocrinologica (Buc)*. 2015;11(1):124-129.
8. Jeannon JP, Orabi AA, Bruch GA, Abdalsalam HA, Simo R. Diagnosis of recurrent laryngeal nerve palsy after thyroidectomy: a systematic review. *International journal of clinical practice*. 2009; 63(4):624-629.
9. Mattsson P, Hydman J, Svensson M. Recovery of laryngeal function after intraoperative injury to the recurrent laryngeal nerve. *Gland surgery*. 2015;4(1):27-35.
10. Orestes MI, Chhetri DK. Superior laryngeal nerve injury: effects, clinical findings, prognosis, and management options. *Current opinion in otolaryngology & head and neck surgery*. 2014;22(6):439-443.
11. Roy N, Smith ME, Dromey C, Redd J, Neff S, Grennan D. Exploring the phonatory effects of external superior laryngeal nerve paralysis: an *in vivo* model. *The Laryngoscope*. 2009;119(4):816-826.
12. Chandrasekhar SS, Randolph GW, Seidman MD, Rosenfeld RM, Angelos P, Barkmeier-Kraemer J, Benninger MS, Blumin JH, Dennis G, Hanks J, Haymart MR. Clinical practice guideline: improving voice outcomes after thyroid surgery. *Otolaryngology—Head and Neck Surgery*. 2013;148(6_suppl):S1-37.
13. Lorente-Poch L, Sancho JJ, Muñoz-Nova JL, Sánchez-Velázquez P, Sitges-Serra A. Defining the syndromes of parathyroid failure after total thyroidectomy. *Gland surgery*. 2015;4(1):82-90.
14. Stack BC Jr, Ferris RL, Goldenberg D, Haymart M, Shaha A, Sheth S, Sosa JA, Tufano RP; American Thyroid Association Surgical Affairs Committee. American Thyroid Association consensus review and statement regarding the anatomy, terminology, and rationale for lateral neck dissection in differentiated thyroid cancer. *Thyroid*. 2012; 22(5): 501-508.
15. R. Tufano, Central compartment neck dissection. In: Myers EN, Ferris R (Eds). *Master Techniques in Otolaryngology - Head and Neck Surgery: Thyroid, Parathyroid, Salivary Glands, Paranasal Sinuses and Nasopharynx*, Philadelphia, Wolters Kluwer Health, 2014:161-168.
16. Robbins KT, Clayman G, Levine PA, Medina J, Sessions R, Shaha A, Som P, Wolf GT. Neck dissection classification update: revisions proposed by the American Head and Neck Society and the American Academy of Otolaryngology–Head and Neck Surgery. *Archives of otolaryngology–head & neck surgery*, 128(7): 751-758.
17. Stack BC Jr, Ferris RL, Goldenberg D, Haymart M, Shaha A, Sheth S, Sosa JA, Tufano RP. American Thyroid Association consensus review and statement regarding the anatomy, terminology, and rationale for lateral neck dissection in differentiated thyroid cancer. *Thyroid*. 2012; 22(5): 501-508.
18. Sitges-Serra A, Lorente L, Sancho JJ. Technical hints and potential pitfalls in modified radical neck dissection for thyroid cancer. *Gland surgery*. 2013; 2(4): 174-179.
19. Werga P, Wallin G, Skoog L, Hamberger B. Expanding role of fine-needle aspiration cytology in thyroid diagnosis and management. *World journal of surgery*. 2000;24(8):907-912.
20. Järhult J, Lindestad PÅ, Nordenström J, Perbeck L. Routine examination of the vocal cords before and after thyroid and parathyroid surgery. *British Journal of Surgery*. 1991;78(9):1116-1117.
21. Chiang FY, Lee KW, Chen HC, Chen HY, Lu IC, Kuo WR, Hsieh MC, Wu CW. Standardization of intraoperative neuromonitoring of recurrent laryngeal nerve in thyroid operation. *World Journal of Surgery*. 2010;34(2):223-229.
22. Reeve T, Thompson NW. Complications of thyroid surgery: how to avoid them, how to manage them, and observations on their possible effect on the whole patient. *World Journal of Surgery*. 2000;24(8):971-975.
23. Bliss RD, Gauger PG, Delbridge LW. Surgeon's approach to the thyroid gland: surgical anatomy and the importance of technique. *World Journal of Surgery*. 2000;24(8):891-897.
24. Chiang FY, Wang LF, Huang YF, Lee KW, Kuo WR. Recurrent laryngeal nerve palsy after thyroidectomy with routine identification of the recurrent laryngeal nerve. *Surgery*. 2005;137(3):342-347.
25. Lo CY, Kwok KF, Yuen PW. A prospective evaluation of recurrent laryngeal nerve paralysis during thyroidectomy. *Archives of Surgery*. 2000;135(2):204-207.
26. Hunt PS, Poole M, Reeve TS. A reappraisal of the surgical anatomy of the thyroid and parathyroid glands. *British Journal of Surgery*. 1968;55(1):63-66.
27. Ardito G, Revelli L, D'Alatri L, Lerro V, Guidi ML, Ardito F. Revisited anatomy of the recurrent laryngeal nerves. *The American Journal of Surgery*. 2004;187(2):249-253.
28. Songun I, Kievit J, van de Velde CJH. Complications of thyroid surgery. In: *Textbook of Endocrine Surgery*, Clark, O.H., Duh, Q.Y. Philadelphia: Saunders. 1997: 167–173.
29. Hayward NJ, Grodski S, Yeung M, Johnson WR, Serpell J. Recurrent laryngeal nerve injury in thyroid surgery: a review. *ANZ Journal of Surgery*. 2013;83(1-2):15-21.
30. Reeve TS, Delbridge L, Cohen A, Crummer P. Total thyroidectomy. The preferred option for multinodular goiter. *Annals of Surgery*. 1987;206(6):782-786.
31. Olson Jr JA, DeBenedetti MK, Baumann DS, Wells Jr SA. Parathyroid autotransplantation during thyroidectomy. Results of long-term follow-up. *Annals of Surgery*. 1996;223(5):472-480.
32. Lo CY, Lam KY. Routine parathyroid autotransplantation during thyroidectomy. *Surgery*. 2001;129(3):318-323.
33. Walker RP, Paloyan E, Kelley TF, Gopalsami C, Jarosz H. Parathyroid autotransplantation in patients undergoing a total thyroidectomy: a review of 261 patients. *Otolaryngology-Head and Neck Surgery*. 1994;111(3P1):258-264.
34. Pisanu A, Porceddu G, Podda M, Cois A, Uccheddu A. Systematic review with meta-analysis of studies comparing intraoperative neuromonitoring of recurrent laryngeal nerves versus visualization alone during thyroidectomy. *Journal of Surgical Research*. 2014; 188(1): 152-161.
35. Cooper DS, Doherty GM, Haugen BR, Kloos RT, Lee SL, Mandel SJ, Mazzaferri EL, McIver B, Sherman SI, Tuttle RM. Management guidelines for patients with thyroid nodules and differentiated thyroid cancer: The American Thyroid Association Guidelines Taskforce. *Thyroid*. 2006;16(2):109-142.
36. Haugen BR, Alexander EK, Bible KC, Doherty GM, Mandel SJ, Nikiforov YE, Pacini F, Randolph GW, Sawka AM, Schlumberger M, Schuff KG, Sherman SI, Sosa JA, Steward DL, Tuttle RM, Wartofsky L. American Thyroid Association management guidelines for adult patients with thyroid nodules and differentiated thyroid cancer: The American Thyroid Association guidelines task force on thyroid nodules and differentiated thyroid cancer. *Thyroid*. 2015; 26(1): 1-133.
37. Lee YS, Nam KH, Chung WY, Chang HS, Park CS. Postoperative complications of thyroid cancer in a single center experience. *Journal of Korean Medical Science*. 2010;25(4):541-545.