Surgical Outcome of Thyroid Cancer: 5 Year Experience South Egypt Cancer Institute

Mahran EAG[1], Salem AWS[1], Tohamy AZ[1], Saleh MKA[1]

[1] Surgical Oncology Department, South Egypt Cancer Institute, Assiut University, Assiut, Egypt

Abstract:

Background: Thyroid surgery can lead to different complications, hemorrhage, RLN palsy, postoperative hypocalcemia. Surgical mechanisms of the high rate of hypoparathyroidism with bilateral neck dissection could be disruption of the inferior thyroid arteries at their thyrocervical trunk origin during comprehensive lateral and central neck dissection.

Objective: Description of short-term surgical outcome of thyroid cancer in patients operated in south Egypt cancer institute as regarding: post-operative bleeding, post-operative infection, post-operative stridor, RLN injury, Hypoparathyroidism, Wound infection seroma and Complication of neck dissection (Horner syndrome, chyle leak and spinal accessory nerve injury

Patients and methods: This study is a retrospective one that will include all patients with thyroid cancer operated at South Egypt Cancer Institute between a time period from 2015 to 2019. This study is a descriptive study of short-term surgical outcome of thyroid cancer by studying files of thyroid cancer patients.

Results: postoperative stridor happened in 3 cases of 28 case completion thyroidectomy by incidence of 10.6%, RLN injury occurred in 5 cases among 28 case completion thyroidectomies. Transient hypoparathyroidism happened in 12 cases among 28 cases did completion thyroidectomy by incidence of 42.8%. A recent retrospective study performed in 1,087 patients with PTC and clinically negative neck lymph nodes showed that both ipsilateral prophylactic CND or bilateral CND with concomitant total thyroidectomy were associated with a higher rates of transient Hypoparathyroidism

Conclusion: The literature and our data confirm that patients undergoing re-operative thyroid surgery and thyroid surgery for cancer are at increased risk of RLNP. There is no significant difference in laterality of nerve injured or in rates between histological diagnoses. The literature suggests that extended resection and possibly low surgeon caseload are also risk factors.

Keywords: mortality rate, surgical outcome, thyroid cancer, thyroidectomy

Authors Information:

Ebrahim Aboeleoun Gaber Mahram
Surgical Oncology Department, South Egypt Cancer Institute, Assiut University
email: Ebrahim_aboeleoun@yahoo.com

Ahmed Awad Sayed Salem
Surgical Oncology Department, South Egypt Cancer Institute, Assiut University
email: Ahmed_awad721@yahoo.com

Ali Zedan Tohamy
Surgical Oncology Department, South Egypt Cancer Institute, Assiut University
email: Alizedan73@yahoo.com

Mohammed Khairy Abd ElMegeed Saleh
Surgical Oncology Department, South Egypt Cancer Institute, Assiut University
email: Mkhairy523@gmail.com

Corresponding Author:
Mohammed Khairy Abd ElMegeed Saleh
Surgical Oncology Department, South Egypt Cancer Institute, Assiut University
email: Mkhairy523@gmail.com

Introduction:

A marked increase in the incidence of thyroid cancer in the last 30 years, the mortality rate remains stable or has even decreased. This incidence increase is thought to be mainly due to the improvement of screening techniques. Indeed, this increase is particularly evident for small papillary thyroid cancer. [1] Currently, total thyroidectomy is usually recommended for papillary thyroid cancers >1 cm. Lymph node dissection (central and/or lateral) is recommended in all patients with proven invaded lymph nodes. [2]

With regard to so-called low-risk carcinoma defined by the ATA there are controversial therapeutic approaches. The guidelines of the ATA recommend a lobectomy under certain conditions. Following the guidelines of the Europian Association of Nuclear Medicine a thyroidectomy with radioactive iodine therapy should be performed (except PTC pT1a). However, long-term studies are currently not available. [3] These studies are certainly necessary (against the background of the slow growth of the well-differentiated thyroid carcinoma) to decide which approach is appropriate. A risk-stratified follow-up is

required since recurrences can occur over years. Furthermore, thyroid hormone substitution must be controlled.[4]

In cases of follicular thyroid cancer, the treatment is similar, although there are some differences, particularly concerning lymph node dissection. [5] Medullary thyroid cancer (MTC) management has experienced the most dramatic changes in the last 40 years, following the discovery of the RET proto-oncogene mutations leading to familial MTC. [6]

Anaplastic thyroid carcinoma (ATC) is a highly aggressive form of thyroid cancer, with a reported median survival rate of only 4 months. While multimodal therapy is frequently advocated, the precise role of surgery for patients with advanced disease is unclear. [7] Some experts have concluded that patients undergoing radical resection with negative margins have no survival benefit over those with positive microscopic or macroscopic margins. Other authors have shown that complete resection is a positive prognostic factor. [8]

Thyroid surgery can lead to different complications, hemorrhage, RLN palsy, postoperative hypocalcemia. [9] Surgical mechanisms of the high rate of hypoparathyroidism with bilateral neck dissection could be disruption of the inferior thyroid arteries at their thyrocervical trunk origin during comprehensive lateral and central neck dissection.[10]

Completion thyroidectomy is a must in follicular cancer and papillary cancer (except for a group of patients with low risk treated by lobectomy or less), that are not treated with total thyroidectomy initially, and recurrent tumor of the thyroid.[11] It has a higher complication rate compared to primary procedures although morbidity rates of completion thyroidectomy may cause some surgeons to hesitate to operate, the improvement of surgical techniques and experience has reduced these complications. [12] Our study aims at shedding light on short outcome of thyroid cancer surgery in a tertiary care center in developing country.

Patients and Methods:

This study is a retrospective one that included all patients with thyroid cancer operated at South Egypt Cancer Institute between a time period from 2015 to 2019.

Ethical consideration:

The study was approved by the ethical committee of South Egypt Cancer Institute, Assiut University. Written informed consent was obtained from the patients after a simple and clear explanation of the research objectives. The approval form was developed in accordance with the quality and improvement system standards of the Ministry of Health in Egypt and in accordance with the Declaration of Helsinki.

Inclusion Criteria:

All patients with thyroid cancer admitted to South Egypt Cancer Institute underwent surgery with available pathology report and sufficient data in files and age groups above 18 years.

This study is a descriptive study of short-term surgical outcome of thyroid cancer by studying files of thyroid cancer patients as regard age, sex, preoperative imaging and workup, FNAC and pathological result, type of thyroid surgery done, redo surgery, type of neck dissection done, final histopathology and staging, extrathyroidal extension, multifocality, postoperative bleeding, stridor, postoperative RLN injury, laterality, postoperative hypoparathyroidism, type of hypoparathyroidism and management of hypoparathyroidism by studying, analyzing and predicting different factors impact on the incidence of short-term complications of thyroid cancer surgery (mainly RLN injury, hypoparathyroidism).

Statistical Analysis:

Data collected throughout history, basic clinical examination,

and outcome measures coded, entered and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 25.0) (Armonk, NY: IBM Corp, 2018, New York, USA). Descriptive statistics included Percentage (%), mean (x) and standard deviation (SD) and analytic statistics included chi-square test ($\chi2$) Student's t-test, Mann-Whitney test (U test). P value<0.05 was considered statistically significant.

Results:

The study included a total number of 248 patients,152 (61.3%) females and 96 (38.7%) males with age range of 18 – 79 years old with median age of 46 years old and Male to female ratio 2:3. Hypocalcemia was found in 21.8 of patients underwent total thyroidectomy while hypocalcemia was found in 42.8 of patients underwent completion thyroidectomy 12 case had hypocalcemia of total 28 cases underwent completion thyroidectomy putting in mind the small number of cases underwent completion thyroidectomy .table1

Postoperative stridor occurred in 2.8 of patients underwent total thyroidectomy while postoperative stridor occurred in 14.2 of patients underwent completion thyroidectomy 4 cases of total 28 case underwent completion thyroidectomy. Only one case underwent tracheostomy. (Table 2).

Furthermore, RLN injury occurred in 4.7 of patients underwent total thyroidectomy while RLN injury occurred in 17.8 of patients underwent completion thyroidectomy (Table 3). In our study we had 28 case s postoperative stridor happened in 4 cases of 28 case underwent completion thyroidectomy by incidence of 14.3% and only one case needed tracheostomy, RLN injury occurred in 5 cases among 28 case completion thyroidectomies. Completion thyroidectomy poses a challenge because of the scarring and nonavailability of usual anatomical landmarks for parathyroid gland identification. Transient hypoparathyroidism occurred in 12 cases among 28

cases underwent completion thyroidectomy by incidence of 42.8% and zero incidence of permanent hypoparathyroidism among 28 cases (putting in mind the small number of cases available reports performed completion thyroidectomy) (Table 4).

Regarding Prophylactic central neck dissection (CND) is also associated to high risk for Hypoparathyroidism. On the other hand, total thyroidectomy with bilateral CND had higher rate (~2.5 times) of permanent Hypoparathyroidism than total thyroidectomy alone (16.2 vs 6.3 %; p <0.001). These findings suggest a critical review of indications for the routine use of prophylactic CND for PTC (Table 5).

Table (1): Relation of hypocalcemia to type of surgery

| | | Hypocalcemia | | | |
| | | No | | Yes | |
		Count	%	Count	%
Type of surgery	Hemithyroidectomy	9	3.6	0	0.0
	Near total thyroidectomy	19	7.7	0	0.0
	Total thyroidectomy	165	78.2	46	21.8
	Completion thyroidectomy	16	57.2	12	42.8

p value did not reach a significant value (p = 0.07).

Table (2) Type of surgery and post- operative stridor

| | | Post-operative stridor | | | |
| | | No | | Yes | |
		Count	Row N %	Count	Row N %
Type of surgery	Hemithyroidectomy	9	100.0%	0	0.0%
	Near total thyroidectomy	19	100.0%	0	0.0%
	Completion thyroidectomy	24	64.2%	4	35.7%
	total thyroidectomy	205	97.2%	6	2.8%
	Total	238	96.0%	10	4.0%

Table (3) Type of surgery and RLN injury

| | | RLN injury | | | |
| | | No | | Yes | |
		Count	Row N %	Count	Row N %
Type of surgery	Hemithyroidectomy	9	100%	0	0.0%
	Near total thyroidectomy	19	100.0%	0	0.0%
	Total thyroidectomy	201	95.3%	10	4.7%
	Completion thyroidectomy	23	82.2%	5	17.8%

Table (4) Comparison between Completion thyroidectomy and total thyroidectomy as regard complications.

		Total thyroidectomy		Completion thyroidectomy		P value
		Count	Column %	Count	Column %	
Hypoparathyroidism	No	165	78.2	16	57.2	< 0.001 *
	permeant	1	0.4	0	0	
	transient	45	21.4	12	42.8	
	Total	211	100	28	100	
Outpatient follow up hypocalcemia	No	172	81.5%	18	64.3%	0.034 *
	Yes	39	18.5%	10	35.7%	
	Total	211	100.0%	28	100.0%	
Readmission Due to hypocalcemia	No	180	85.3%	18	64.3%	0.009 *
	Yes	31	14.7%	10	35.7%	
	Total	211	100.0%	28	100.0%	
ICU admission Due to hypocalcemia	No	209	99.1%	27	96.4%	0.313
	Yes	2	0.9%	1	3.6%	
	Total	211	100.0%	28	100.0%	
IV calcium	No	172	81.5%	17	60.7%	**0.014 ***
	Yes	39	18.5%	11	39.3%	
	Total	211	100.0%	28	100.0%	
Tracheostomy	No	207	98.2%	27	96.4%	0.184
	Yes	4	1.8%	1	3.6%	
	Total	211	100.0%	28	100.0%	
Post operative stridor	No	204	97.2%	25	89.2%	0.075
	Yes	7	2.8%	3	10.7%	
	Total	211	100.0%	28	100.0%	
RLN injury	No	201	95.3%	23	82.2%	0.023 *
	Yes	10	4.7%	5	17.8%	
	Total	211	100.0%	28	100.0%	

Table (5) Relation of neck dissection type and post-operative complication

		Type of neck dissection							
		Central		MND including CND		No		SND	
		N	%	N	%	N	%	N	%
Post operative stridor	No	65	98.5	105	95.5	66	94.3	2	100.0
	Yes	1	1.5	5	4.5	4	5.7	0	0.0
	Total	66	100.0	110	100.0	70	100.0	2	100.0
RLN injury	No	61	92.4	103	93.6	67	95.8	2	100.0
	Yes	5	7.6	7	6.4	3	4.2	0	0.0
	Total	66	100.0	110	100.0	70	100.0	2	100.0
Hypoparathyroidism	No	48	73.7	84	77.3	65	89.9	2	100.0
	permeant	0	0.0	1	0.9	0	0.0	0	0.0
	transient	18	27.3	25	22.7	5	7.1	0	0.0
	Total	66	100.0	110	100.0	70	100.0	2	100.0
Chyle leak	Yes	0	0	5	4.5	0	0	0	0
	No	66	100.0	105	95.5	70	100.0	2	100
	Total	66	100.0	110	100.0	70	100.0	2	100
Spinal accessory nerve injury	Yes	0	0.0	6	5.4	0	0.0	0	0.0
	No	66	100.0	104	94.6	70	100	2	100
	Total	66	100.0	110	100.0	70	100	2	100
Horner syndrome	Yes	0	0.0	1	0.9	0	0.0	0	0.0
	No	66	100	109	99.1	70	100	2	100
	Total	66	100	110	100	70	100	2	100

Discussion:

In our study we found, Hypoparathyroidism had been reported in about 58 case (23.3%), transient hypoparathyroidism had been reported in about 57 cases by incidence of 22.9%, permeant hypoparathyroidism happened in only one case. Completion Thyroidectomy is traditionally characterized by a high complication rate. Complications are the reason for fear and hesitation for many surgeons. Complications occur due to the presence of adhesions, which make dissection difficult [13]. However, the literature shows a low complication rate due to improvement surgical techniques and high-volume surgeons. In a 2015 meta-analysis that included 7 studies and 1,208 patients and compared the complication rates between completion thyroidectomy and primary TT for differentiated thyroid cancer, Li et al [31] did not find statistically significant differences in the presence of temporary recurrent laryngeal nerve (RLN) palsy, permanent RLN palsy, temporary hypocalcemia, permanent hypocalcemia, hematoma, and wound infection. [14] completion thyroidectomy has been described as having a higher surgical complication rate than that of total thyroidectomy (TT), which is possibly related to adhesions from the initial procedure. [15] There are also studies that support comparable rates of complications between the procedures. [16]

In our study, about 28 cases underwent completion thyroidectomy. Also, we have lower incidence of complications post completion thyroidectomy due to high volume experienced surgeons and improved surgical techniques. The revision surgery in our series did not correlate with higher complication rates. Also, we have lower incidence of complications post completion thyroidectomy due to high volume experienced surgeons and improved surgical techniques. Postoperative stridor happened in 3 cases of 28 case completion thyroidectomy by incidence of 10.6% and only one case needed tracheostomy, RLN injury occurred in 5 cases among 28 case completion thyroidectomies. Completion thyroidectomy poses a challenge because of the scarring and nonavailability of usual anatomical landmarks for parathyroid gland identification. Transient hypoparathyroidism happened in 12 cases among 28 cases did completion thyroidectomy by incidence of 42.8% and zero incidence of permeant hypoparathyroidism among 28 cases (putting in mind the small number of cases available reports performed completion thyroidectomy).

Improved outcomes in high volume surgeons are also seen in endocrine surgery, with fewer complications, decreased length of stay (LOS) and reduced hospital charges. Likewise in thyroid surgery a number of studies published over the past 20 years have shown improvements in the thyroid surgery specific complications of hypocalcemia, recurrent laryngeal nerve palsy (RLN) and post-operative hematoma, as well as LOS and general post-operative complications with increasing surgeon case-load [17].

Incidence of temporary hypoparathyroidism ranges between 3-15%, and incidence of permanent hypoparathyroidism ranges between 0-3.5% for completion thyroidectomy for DTC (Erdem et al., [18]; Gulcelik et al., [19]). In our study incidence of permeant hypoparathyroidism 0% and temporary hypoparathyroidism 6.4% for completion thyroidectomy.

Also, we found prophylactic central neck dissection (CND) is also associated to high risk for Hypoparathyroidism. A recent retrospective study performed in 1,087 patients with PTC and clinically negative neck lymph nodes showed that both ipsilateral prophylactic CND or bilateral CND with concomitant total thyroidectomy were associated with a higher rate of transient hypoparathyroidism, which were 27.7%, 36.1 %, and 51.9 % for total thyroidectomy, total thyroidectomy with ipsilateral CND, and total thyroidectomy with bilateral CND, respectively. On the other hand, total thyroidectomy with bilateral CND had higher rate (~2.5 times) of permanent Hypoparathyroidism than total thyroidectomy alone (16.2 vs 6.3 %; $p < 0.001$). These findings suggest a critical review of indications for the routine use of prophylactic CND for PTC [20]. However, this complication is unusual after subtotal thyroidectomy or lobectomy in low-risk papillary thyroid carcinomas (PTC). Transient surgical Hypoparathyroidism is more common than permanent in thyroid cancer patients. The incidence of transient Hypoparathyroidism has been reported to range from 6.6–51.9 %, and that of permanent Hypoparathyroidism from 0–16.2 % in patients underwent cervical surgery for thyroid cancer. The different incidence rates for both transient and permanent Hypoparathyroidism are mainly explained by the extent of thyroidectomy and cervical lymphadenectomy [21].

Aggressive histology and inadvertent parathyroidectomy were significant factors for hypocalcemia. Bilateral central compartment clearance was significantly associated with hypocalcemia and RLN palsy [22]. Even experienced surgeons report a 1% rate of permanent hypoparathyroidism when both thyroid lobes are removed. [23] A number of authors have reported an increase in postoperative temporary and/or permanent hypoparathyroidism with the addition of central and lateral neck dissection. Roh et al., [16] reported a temporary and permanent rate of postoperative hypocalcemia as 20%and 4.9%, respectively, with nodal dissection of any type. [24]

In our study, the incidence of transient hypoparathyroidism in cases performed CND was 27.3% (18 case among 66 cases did CND), no reported case of permanent hypoparathyroidism. The incidence of RLN injury was 7.6% (5 cases among 66 case CND) in cases underwent CND. The incidence of transient hypoparathyroidism in cases underwent MND was 22.7% (25 case among 110 case MND). The incidence of RLN injury happened in cases underwent MND was 6.4% (7 cases only reported of 110 cases of MND). Another study by Thomusch et al. [14] reported that the presence of two functioning parathyroid glands is essential to avoid hypocalcemia. Implanted glands have more predictable survival than leaving revascularized

gland in the paratracheal area. Careful examination of specimen is crucial to identify a parathyroid gland that has been inadvertently removed.

The complications related to Horner's syndrome (injury to sympathetic trunk), and brachial plexus or, hypoglossal nerve is quite rare.[25] The accessory nerve may be injured by extensive dissection and skeletisation of the nerve with neuropraxia and devascularization. Most of the time, shoulder function can improve with intensive physiotherapy. The rate of spinal accessory injury in this report is significantly lower than rates in prior studies of lateral neck dissections. [26] Incidence of spinal accessory nerve happened in 6 cases (9%) undergoing MND (110 case). The incidence of chyle leaks in this report is lower than the incidence in other studies of lateral neck dissections in thyroid cancers [27]. Incidence of thoracic duct injury happened in 5 cases (4.5%) undergoing MND (110 case). Also, McMullen et al., [28] described outcomes for 86 patients who underwent BLND with TT and reported only 1 complication, a transient chyle leak. Noguchi et al., [29] described 98 patients with BLND and reported 4 cases of RLN palsy and 1 case of Horner syndrome. The same group reported 135 patients who underwent BLND for thyroid cancer and reported 1 case of Horner symptoms and 5 RLN palsies [30]. Horner syndrome had reported in only one case 0.9% among 110 case MND.

LIMITATIONS OF THE STUDY

This study has a number of limitations. Primarily, the study is Limited by its format as a retrospective review of available medical record. A number of patients had limited follow-up (<6 months) limiting complete assessment of certain complications including hypoparathyroidism. Also, assessment of transient recurrent laryngeal nerve palsy postoperative due to missing and no long -term follow up of the patients.

Conclusion:

The literature and our data confirm that patients undergoing re-operative thyroid surgery and thyroid surgery for cancer are at increased risk of RLNP. There is no significant difference in laterality of nerve injured or in rates between histological diagnoses. The literature suggests that extended resection and possibly low surgeon caseload are also risk factors. Intraoperative visualization and capsular dissection of the RLN is the gold standard for intraoperative care during thyroid surgery for reducing risk of RLNP. Abnormal traction forces leading to RLNP are frequently the result of RLN anatomical variants, including extra laryngeal branching of the nerve.

Surgical mechanisms of the high rate of hypoparathyroidism with bilateral neck dissection could be disruption of the inferior thyroid arteries at their thyrocervical trunk origin during comprehensive lateral and central neck dissection. Thorough central compartment dissection consisting of complete removal of fibrofatty and/or nodal tissue between the carotids to the level of innominate is performed routinely.

Unfortunately, this also can contribute to parathyroid devascularization.

Hypocalcemia post-thyroidectomy represents a dynamic topic, yet incompletely solved and prophylactic calcium and vitamin D supplements seem the best approach until now.

Even though modified neck dissection is a reliable, safe surgical procedure for metastatic thyroid carcinoma, due consideration must be given to certain complications. The risk of hypoparathyroidism and other complications are detailed in this series of LNDs for thyroid cancers from a single high-volume institution. Despite high preoperative clinical suspicion, in particular on imaging, contralateral sides of the neck often are pathologically node-negative. Furthermore, comprehensive neck dissections for thyroid cancers results in notable morbidity, while the survival impact of this procedure is debated. Knowledge of the risk-benefit ratio of the procedure may inform preoperative patient counseling and decision-making.

References:
1. Hamdi Y, Abdeljaoued-Tej I, Zatchi AA, et al. Cancer in Africa: the untold story. Front Oncol. 2021 Apr 15;11:650117.
2. Feng JW, Yang XH, Wu BQ, et al. Predictive factors for central lymph node and lateral cervical lymph node metastases in papillary thyroid carcinoma. Clin Transl Oncol. 2019 Nov;21(11):1482-1491.
3. Schmidbauer B, Menhart K, Hellwig D, et al. Differentiated thyroid cancer—treatment: state of the art. Int J Mol Sci. 2017 Jun 17;18(6):1292.
4. Doubleday A, Sippel RS. Surgical options for thyroid cancer and post-surgical management. Expert Expert Rev Endocrinol Metab. 2018 May;13(3):137-148.
5. Chung R, Guan H, Ponchiardi C, et al. Noninvasive follicular thyroid neoplasm with papillary-like nuclear features: epidemiology and long-term outcomes in a strictly defined cohort. Thyroid. 2021 Jan;31(1):68-75.
6. Barletta JA, Nosé V, Sadow PM. Genomics and epigenomics of medullary thyroid carcinoma: From sporadic disease to familial manifestations. Endocr Pathol. 2021 Mar;32(1):35-43.
7. Saeed NA, Kelly JR, Deshpande HA, et al. Adjuvant external beam radiotherapy for surgically resected, nonmetastatic anaplastic thyroid cancer. Head Neck. 2020 May;42(5):1031-1044.
8. Tummers WS, Groen JV, Sibinga Mulder BG, et al. Impact of resection margin status on recurrence and survival in pancreatic cancer surgery. Br J Surg. 2019 Jul;106(8):1055-1065.
9. Alharbi F, Ahmed MR. Experience of thyroid surgery at tertiary referral centers in Jazan Hospitals, Saudi Arabia. nterv Med Appl Sci. 2018 Dec;10(4):198-201.
10. Teshima M, Otsuki N, Morita N, et al. Postoperative hypoparathyroidism after total thyroidectomy for thyroid cancer. Auris Nasus

Larynx. 2018 Dec;45(6):1233-1238.

11. Harries V, Wang LY, McGill M, et al. Should multifocality be an indication for completion thyroidectomy in papillary thyroid carcinoma. Surgery. 2020 Jan;167(1):10-17.

12. Gulcelik MA, Dogan L, Akgul GG, et al. Completion thyroidectomy: safer than thought. Oncol Res Treat. 2018;41(6):386-390.

13. Promberger R, Ott J, Kober F, Koppitsch C, et al. Risk factors for postoperative bleeding after thyroid surgery. Br J Surg. 2012 Mar;99(3):373-9.

14. Thomusch O, Machens A, Sekulla C, et al. The impact of surgical technique on postoperative hypoparathyroidism in bilateral thyroid surgery: a multivariate analysis of 5846 consecutive patients. Surgery. 2003 Feb;133(2):180-5.

15. Kupferman ME, Patterson DM, Mandel SJ, et al. Safety of modified radical neck dissection for differentiated thyroid carcinoma. Laryngoscope. 2004 Mar;114(3):403-6.

16. Roh JL, Kim DH, Park CI. Prospective identification of chyle leakage in patients undergoing lateral neck dissection for metastatic thyroid cancer. Ann Surg Oncol. 2008 Feb;15(2):424-9.

17. Machens A, Holzhausen HJ, Dralle H. Skip metastases in thyroid cancer leaping the central lymph node compartment. Arch Surg. 2004 Jan;139(1):43-5.

18. Erdem E, Gülçelik MA, Kuru B, et al. Comparison of completion thyroidectomy and primary surgery for differentiated thyroid carcinoma. Eur J Surg Oncol. 2003 Nov;29(9):747-9.

19. Gulcelik MA, Kuru B, Dincer H, et al. Complications of completion versus total thyroidectomy. Asian Pac J Cancer Prev. 2012;13(10):5225-8.

20. Lynch J, Parameswaran R. Management of unilateral recurrent laryngeal nerve injury after thyroid surgery: A review. Head Neck. 2017 Jul;39(7):1470-1478.

21. Kulekci M, Batıoglu-Karaaltın A, Saatci O, et al. Relationship between the branches of the recurrent laryngeal nerve and the inferior thyroid artery. Ann Otol Rhinol Laryngol. 2012 Oct;121(10):650-6.

22. Alsubaie KM, Alsubaie HM, Alzahrani FR, et al. Prophylactic Central Neck Dissection for Clinically Node-Negative Papillary Thyroid Carcinoma. Laryngoscope. 2022 Jun;132(6):1320-1328.

23. Chu F, De Berardinis R, Pietrobon G, et al. Step-by-step illustrated guide to central neck dissection. The J Laryngol Otol. 2021 Oct 1;1-6.

24. Akerström G, Malmaeus J, Bergström R. Surgical anatomy of human parathyroid glands. Surgery. 1984 Jan;95(1):14-21.

25. Ahmed A, Musa H, Musa T, Musa I, et al. An analytical, statistical study of thyroid cancer incidence in sudan during 2005-2015. Global Journal of Public Health Medicine, 1(2), 96–106.

26. Torre LA, Islami F, Siegel RL, Ward EM, et al. Global cancer in women: burden and trends. Cancer Epidemiol Biomarkers Prev. 2017 Apr;26(4):444-457.

27. Seib CD, Sosa JA. Evolving understanding of the epidemiology of thyroid cancer. Endocrinol Metab Clin North Am. 2019 Mar;48(1):23-35.

28. McMullen C, Rocke D, Freeman J. Complications of bilateral neck dissection in thyroid cancer from a single high-volume center. JAMA Otolaryngol Head Neck Surg. 2017 Apr 1;143(4):376-381.

29. Shankar B, Thaseen A, Surendramohan T, et al. Selected Abstracts of IANCON 2014. Ann Indian Acad Neurol 2014;17, Suppl S2:160-244

30. Lloyd RV, Osamura RY, Klöppel G, et al. WHO Classification of Tumours of Endocrine Organs, 4th edn IARC Press 2017

31. Li YJ, Wang YZ, Yi ZB, et al. Comparison of completion thyroidectomy and primary total surgery for differentiated thyroid cancer: a meta-analysis. Oncol Res Treat. 2015;38(10):528-31.