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ORIGINAL ARTICLE

Evaluation of thyroid Zuckerkandl tubercle by computed tomography

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Abstract

Purpose This study investigated the incidence of thyroid Zuckerkandl Tubercle (ZT) using a computed tomography (CT) scan of the neck with contrast to identify the typologies in ZT-positive CT scans, investigate the presence of nodules located in that area, and compare the results with the relevant literature.

Methods We selected and retrospectively examined the CT scan images of patients who presented to our clinic with CT scans of the neck with contrast that clearly showed thyroid tissue and boundaries. Patients were evaluated based on age, gender, and presence of thyroid ZT. Patients with thyroid ZT were further investigated for localization and type of tubercles as well as for presence of nodules at the tubercle level.

Results A total of 1000 patients (mean age: 48.4 ± 19.1) were included in the study. Out of the total 222 (22.2%) patients who had thyroid ZT, 134 (60.4%) patients had unilateral thyroid ZT on the right side and 29 (13.1%) patients had unilateral thyroid ZT on the left side; 59 (26.6%) patients had bilateral thyroid ZT. In addition, nodules at the ZT level were observed in 13 (1.3%) of the patients. A review of all cases with ZTs indicated that 63% were Type 1, 31% were Type 2, and 5% were Type 3.

Conclusion During the thyroid operations, ZT is essential for locating the recurrent laryngeal nerve. Reporting the presence of ZTs based on CT scans is crucial because it can prevent unnecessary interventional procedures, misdiagnoses, and likely complications in patients with planned thyroid operations.

Keywords Thyroid · Zuckerkandl tubercle · Recurrent laryngeal nerve · Computed tomography

Introduction

Zuckerkandl tubercle (ZT) is a protrusion induced by the lateral or posterior thyroid lobe. It is mostly manifested in the form of a thyroid parenchyma, which is located in the cricothyroid compound. It is a point that can be used during thyroid surgery to locate the recurrent laryngeal nerve (RLN) owing to its adjacency to the recurrent laryngeal nerve [3, 5].

It is critical to locate and protect the RLN during thyroid surgery. Unilateral injuries may be associated with hoarseness and difficulty in swallowing, where bilateral injuries may urge the need for an emergency tracheostomy procedure and induce life-threatening situations. Although the rate of unilateral injury is higher in thyroid surgery, the rate of laryngeal nerve injury can reach up to 10% [3, 5, 9]. Emil Zuckerkandl first identified thyroid ZT [13] in 1902 as the processus posterior glandulae thyroidea, or thickening or nodule originated from the most posterior side of the thyroid lobes. Due to its adjacency to the parathyroid gland and RLN, its importance has increased over time and has been used as a reference point to facilitate the location and protection of the RLN during thyroid surgery [7, 12].

This study investigated the incidence of thyroid ZT by a computed tomography (CT) scan of the neck with contrast, to find the typologies in ZT-positive CT scans, to investigate the presence of nodules located in that area, and to compare the results with the relevant literature.

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Materials and methods

This study was designed as a retrospective archival research. The scan images of approximately 1,000 patients, who presented to our clinic between January 2010 and September 2021 with CT scans of the neck with contrast where thyroid tissue and boundaries were clearly shown were selected and retrospectively examined. Patients were investigated by age, gender, and presence of thyroid ZT. Patients with thyroid ZT were further investigated for localization and type of tubercles and presence of nodules at the tubercle level.

According to the exclusion criteria of the study, the scans without contrast due to unclear parenchymal contours or with artifacts; a history of thyroid operation; and patients with tracheostomy due to intense artifact formation, multinodular goiter due to impaired thyroid boundaries, and compressive mass or lymphadenopathy adjacent to thyroid were excluded from the study.

All the scans were carried out by a 64 detector BT (Philips Brilliance 64 Channel, Philips Healthcare, Eindhoven, the Netherlands) device. Scanning parameters are: 120 kVp, 300 mAs, 1 mm slice section thickness, 0.5 pitch, and 220 mm scan area. The patients received 100 ml of contrast material intravenous at the upper extremity (antecubital vein) using an automatic injector and 20-gauge cannula at a speed of 5 ml/s.

All images were uploaded to the Radiological Imaging and Archiving System (Picture Archiving and Communication system) and multiplanar images were created and examined. All the images were examined by two radiologists with at least 10 years of experience in head and neck imaging. Where there was no consensus, the images were re-examined together with a third radiologist to reach an agreement. Thickening or nodular appearance in the lateral thyroid tissue or posterior to the tracheoesophageal groove was adopted as the diagnostic criterion of ZT. A classification system based on the size of the tubercle with regard to cases with thyroid ZT has been established by Pelizzo et al., which suggests four Grades based on the presence and size of tubercles. Grade 0: indicates cases without ZTs. Grade 1: indicates a small-sized tubercle on the lateral edge of the thyroid lobe; Grade 2: tubercle is recognizable in Grade 2 but is < 1 cm, and Grade 3: indicates tubercle sizes of > 1 cm [7]. Local ethics committee approval was obtained before the start of the study (Ethics Committee for Non-Interventional Clinical Research, Faculty of Medicine, Dicle University; Date: February 15, 2022 No.: 21).

The IBM Statistical Package for the Social Sciences for Windows 22.0 software was used for the statistical analysis during the evaluation of results. In the study, descriptive data were expressed as total number (n) and percentage (%) regarding categorical data, and as mean ± standard deviation (m ± SD) regarding the continuous data. Chi-squared analysis (Pearson Chi-squared) was used to compare categorical variables between groups. The hypothesis of a normal distribution of continuous variables was tested using the Kolmogorov–Smirnov test. The Student's t test was used to compare binary groups, where the one-way ANOVA test was used to compare more than two independent groups. The Tukey test was used as Post Hoc analysis to find the origin of significance. A p value of < 0.05 was considered statistically significant.

Results

A total of 1,000 patients with a mean age of 48.4 ± 19.1 (min = 18, max = 94) were included in the study. Out of these, 389 (38.9%) of the patients were female and 611 (61.1%) were male. Out of the total 222 (22.2%) patients that had thyroid ZT, 134 (60.4%) patients had unilateral thyroid ZT located on the right and 29 (13.1%) on the left, where there were 59 (26.6%) cases of bilateral thyroid ZT. In addition, nodules at the ZT level were observed in 13 (1.3%) patients. Of the right-located tubercles, 116 (60.1%) were Type 1, 65 (33.4%) were Type 2, and 12 (6.2%) were Type 3, where 60 (68%) of left-located tubercles were Type 1, 25 (28.4%) were Type 2, and 3 (3.4%) were Type 3 (Table 1). A review of all cases with ZTs indicated that 62.6% were Type 1, 32% were Type 2, and 5.3% were Type 3.

The mean age of patients with and without thyroid ZT was 50.1 ± 17.5 and 47.9 ± 19.5, respectively, and; therefore, there was no significant difference by mean age ($p = 0.101$). The incidence of thyroid ZT in female patients (27.5%) was significantly higher compared to male patients (18.8%) ($p = 0.001$) (Table 2, Fig. 1).

The mean age of the patients with thyroid ZT located on the right and left was 48.5 ± 17.3 and 51.7 ± 15.0, respectively, where the mean age of patients with bilateral thyroid ZT was 53.1 ± 18.9. Therefore, there was no significant difference based on mean age ($p = 0.206$). Bilateral thyroid ZT was seen in approximately 30% of the female and 23.5% of male patients, where there was no significant difference by gender ($p = 0.478$). The rate of bilateral involvement in patients with and without nodules at thyroid ZT level was 15.4 and 27.3%, respectively, where there was no significant difference by the presence of nodules ($p = 0.392$) (Table 3).

There was no significant difference in age, gender, and nodule presence by the type of tubercle in tubercles on the right side ($p > 0.05$).There was no significant difference in age, gender, and nodule presence by the type of tubercle in tubercles on the left side ($p > 0.05$).

Table 1 General features of the patients included in the study

	Number	%
Age, mean ± SD	48.4 ± 19.1	
Gender		
Female	389	38.9
Male	611	61.1
Zuckerkandl tubercles		
Present	222	22.2
None	778	77.8
Location		
Right	134	60.4
Left	29	13.1
Bilateral	59	26.6
Nodules in tubercles		
Present	13	1.3
None	987	98.7
Right tubercle type		
Type 1	116	60.1
Type 2	65	33.4
Type 3	12	6.2
Left tubercle type		
Type 1	60	68
Type 2	25	28.4
Type 3	3	3.4

SD standard deviation

Table 2 A comparison of demographic features of patients by presence of Zuckerkandl tubercle

	With Zuckerkandl tubercles		Without Zuckerkandl tubercles		*p*
	Number	%	Number	%	
Age, mean ± SD	50.1 ± 17.5		47.9 ± 19.5		0.101*
Gender					**0.001****
Female	107	27.5	282	72.5	
Male	115	18.8	496	81.2	

*The Student's *t* test, **Chi-squared analysis was used

Discussion

In our study, the incidence of thyroid ZT was investigated; ZT was observed in 22.2% of the contrast-enhanced neck CTs. ZT is difficult to detect via sonography because of its lateral or posterior placement, although ultrasonography has been very effective in the examination of the thyroid gland. ZT is easy to detect using CT thanks to its multiplanar anatomical imaging facility [3, 5]. Relevant studies in the literature report different thyroid ZT incidence rates. Lee et al. [5] reported the incidence of tubercles as 70%, which examined the CT scans of the neck belonging to 96 patients. In a study that investigated the presence of ZT during thyroid surgery, Sheehan et al. [9]. found the same rate as 61%. The incidence rates ranged from 59 to 87% in several studies with thyroidectomy operations or autopsy series [1, 2, 4, 7, 10, 12]. In this study, the incidence of ZT was lower compared to many studies in the literature. We believe the fact that there are several reasons for this. In many studies in the literature, fewer patients were screened compared to our study. In this study included a comparatively higher number of cases ($n = 1000$) (n: 1000). We think that the incidence of ZT can be seen at different rates in different regions. In addition, many studies in the literature were based on surgical dissection or autopsy series, and that small-sized ZTs could be more easily distinguished during surgical dissection or autopsy series compared to CT scans accounted for the aforementioned difference. Furthermore, the incidence of ZT was significantly higher in female patients compared to male patients and there was no significant difference by mean age between patients with and without ZT.

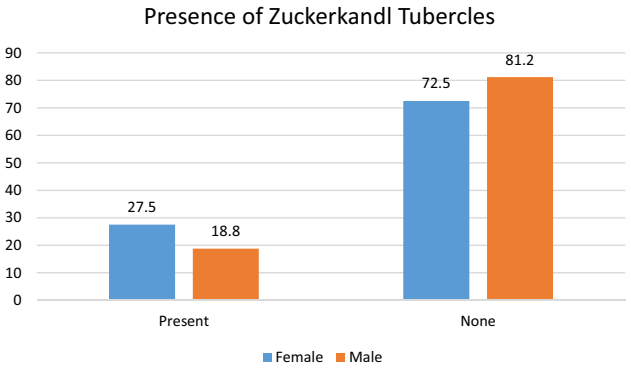
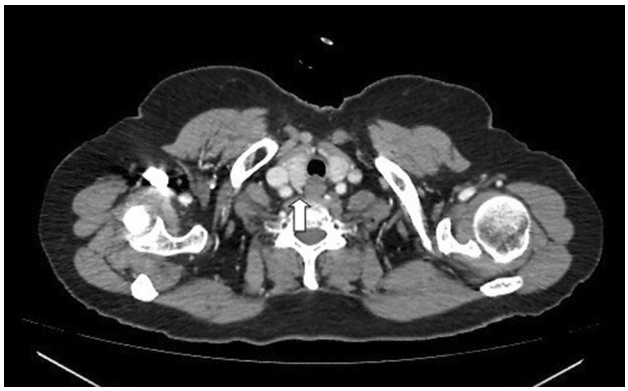


Fig. 1 Gender-related presence of Zuckerkandl tubercles

Confirming the location(s) of thyroid ZT will facilitate locating and protecting the RLN during the operation. In addition, failing to remove ZTs during thyroid operations may be associated with inadequate surgical outcomes. ZT may have unilateral or bilateral involvement. Many studies in the relevant literature reported that ZT was most frequently present on the right. It was suggested that the embryonal differentiation of the two sides might account for the above results [2, 3, 6–9, 11, 13]. Pelizzo et al. [7] and Lee et al. [5] reported the rates of right- and left-sided ZT localization as 78 vs. 75% and 89 vs. 73%, respectively. In the present study, ZT was most commonly (60%) located on the right, similar to results reported in the relevant literature. Furthermore, while the second highest incidence was seen with the bilateral ZTs (26%) in the present study, the least incidence was seen with the left-sided ZT (13%). In addition, there was



Case. 1 60-year-old female patient with Type 1 Zuckerkandl tubercle on the right extending to inferomedial (arrow)

Case. 2 20-year-old male patient, Type 2 Zuckerkandl tubercle on the right thyroid lobe inferomedial (arrow)

Case. 3 63-year-old male patient with Type 3 Zuckerkandl tubercle extending to the right thyroid lobe inferior (arrow)

Case. 4 29-year-old female patient with bilateral Zuckerkandl tubercle, Type 2 on the right (arrow) and Type 1 on the left (arrow), in both thyroid lobes

Case. 5 27-year-old female patient with Type 2 Zuckerkandl tubercle on the right (arrow) with a small-size nodule

no significant difference by age and gender as regards the localization of ZT as right-, left-sided, or bilateral.

To know the presence of thyroid ZT facilitates its separation from normal thyroid nodules, and lymph nodes and masses adjacent to the thyroid gland. Otherwise, it may lead to misdiagnoses, unnecessary examinations, or biopsies. Nodules may also occur in ZTs as in the regular thyroid tissue, since ZTs are made of normal thyroid tissue. Since these nodules are located posterolaterally, ultrasonography cannot be visualized. The best imaging modality in these nodules is mostly CT. Nodules at this level are often confused with parathyroid adenomas. In addition, when nodules at this level enlarge, they may compress the RLN due to close proximity, and malignant nodules may invade the RLN. Nodule localization at ZT level in CT should be reported in detail in terms of possible biopsy and operation [2, 6, 8, 11]. In the present study, the incidence of nodules at ZT level was 1.3%. ZTs were located on the right in approximately 70% of the patients diagnosed with nodules at ZT level. We believe this was due to the high incidence of right-sided ZT localization in our study.

Table 3 A comparison of presence of nodules by location with a view to demographic features and Zuckerkandl tubercle involvement

	Right		Left		Bilateral		*p*
	Number	%	Number	%	Number	%	
Age, mean ± SD	48.5 ± 17.3		51.7 ± 15.0		53.1 ± 18.9		0.206*
Gender							0.478**
Female	63	58.9	12	11.2	32	29.9	
Male	71	61.7	17	14.8	27	23.5	
Nodule							0.392**
Present	9	69.2	2	15.4	2	15.4	
None	125	59.8	27	12.9	57	27.3	

*One-way ANOVA test, **Chi-squared analysis was used

The size and extension of ZTs are extremely important in surgical operations. A review of all the cases with ZT in the present study indicated the incidence of Type 1, Type 2, and Type 3 ZT was 62.6, 32, and 5.3%, respectively. Type 2 ZTs have been frequently reported in different studies in the relevant literature [1–3, 7–11]. In a study by Sheehan et al. [9], which did not differentiate Type 1 and Type 0 in classification, the highest incidence was reported in Type 2 ZT (79%). In contrast with the results reported in the relevant literature, the highest incidence was seen with Type 1 and Type 2 ZTs in the present study. In addition, there was no significant relationship between the type of tubercles and age and gender.

The present study has certain limitations. The study was designed as a retrospective research and reflected the results of the patients, who presented to a single center. There were a relatively small number of cases included in the present study and further prospective, multi-center studies may be conducted in correlation with surgical specimens.

Conclusion

ZT is instrumental in locating the RLN during the thyroid operations. Reporting the presence of ZTs based on the CT scans is extremely important as it can prevent unnecessary interventional procedures, misdiagnoses, and likely complications in patients with planned thyroid operations.

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Author contributions MAD and İA: project development, data collection, and manuscript writing. MT: data collection. SH: data collection and manuscript writing. MT: statistical analysis.

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Declarations

Conflict of interest The authors have no competing interests to declare that are relevant to the content of this article.

Ethical approval All the procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee as well as the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Local ethics committee approval was obtained before starting the study (Ethics Committee for Non-Interventional Clinical Research, Faculty of Medicine, Dicle University; Date: February 15, 2022 No.: 21).

Consent to participate Informed consent was obtained from all the individual participants included in the study.

Consent to publish All the patients provided signed informed consents for publishing their data and photographs.

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