ORIGINAL ARTICLE

Zuckerkandl’s Tubercle. Location, Shape and Dimensions☆

Elisa Gil-Carcedo Sañudo,* Maria Eugenia Menéndez Argüelles,
Luis Ángel Vallejo Valdezate, David Herrero Calvo, Luis María Gil-Carcedo García

Servicio de Otorrinolaringología, Hospital Universitario Río Hortega, Valladolid, Spain

Received 28 February 2012; accepted 3 May 2012

KEYWORDS
Thyroidectomy; Zuckerkandl’s tubercle; Shape; Location; Dimensions

Abstract
Introduction and objective: Although Zuckerkandl’s tubercle is not known by many head and neck surgeons, it is a fundamental surgical anatomical detail, already described in the nineteenth century. Its detection is of great importance as the reference in the search for the recurrent nerve and superior parathyroid gland.
Material and methods: We designed a prospective study to analyse the posterolateral border of thyroid lobes, looking for this tubercle. We included 107 thyroidectomies performed by the same surgeon; 88 were total thyroidectomies (82.24%) and 19 hemithyroidectomies (17.75%), with dissection of a total of 195 thyroid lobes. Zuckerkandl’s tubercle should be sought by displacing the posterolateral margin of the thyroid lobes.
Results: It was reliably detected in 155 thyroid lobes (79.48%). The mean tubercle dimensions were 11 mm transverse axis and 9 mm longitudinal axis. The shape of the Zuckerkandl’s tubercle was sessile (70.96%) or pedunculated (29.03%). In the 5.80% of cases, the Zuckerkandl’s tubercle distal end was bifid. We did not find a Zuckerkandl’s tubercle individualised as an ectopic thyroid (0.00%). Zuckerkandl’s tubercle was more frequent in the right thyroid lobe (P = .06).
Conclusion: Zuckerkandl’s tubercle is recognised by its location, shape and dimensions.
© 2012 Elsevier España, S.L. All rights reserved.

PALABRAS CLAVE
Tiroidectomia; Tubérculo; Zuckerkandl; Forma; Situación; Dimensiones

Tubérculo de Zuckerkandl. Situación, forma y dimensiones

Resumen
Introducción y objetivo: Aunque no es conocido por buena parte de los cirujanos de cabeza y cuello, el tubéculo de Zuckerkandl es un detalle anatómico quirúrgico fundamental, descrito ya en el siglo XIX; su det ección tiene gran importancia al servir de referencia en la búsqueda del nervio recurrente y de la glándula paratiroides superior.
Material y método: Diseñamos un estudio descriptivo prospectivo para analizar el borde posterolateral de los lóbulos tiroideos buscando esta formación. Incluimos 107 tiroidectomías realizadas por un mismo cirujano, 88 son tiroidectomías totales (82,24%) y...

* Corresponding author.
E-mail address: e.gilcarcedo@gmail.com (E. Gil-Carcedo Sañudo).

2173-5735/$ - see front matter © 2012 Elsevier España, S.L. All rights reserved.
19 hemitiroidectomies (17.75%); con lo que se disecaron 195 lóbulos tiroideos. El tubérculo de Zuckerkandl debe buscarse luxando hacia fuera el borde posterolateral de los lóbulos tiroideos. Resultados: Se detecta con seguridad en 155 lóbulos tiroideos (79,48%). El tubérculo tiene unas dimensiones medias de 11 mm de eje transversal, 9 mm de eje longitudinal. La forma del tubérculo de Zuckerkandl es sesil (70,96%) o pediculada (29,03%). En el 5,80% de los casos el extremo distal del tubérculo de Zuckerkandl es bifido. No encontramos un tubérculo de Zuckerkandl individualizado a modo de tiroides ectópico (0,00%). El tubérculo de Zuckerkandl es más frecuente en el lóbulo tiroideo derecho (p = 0,06). Conclusion: El tubérculo de Zuckerkandl se reconoce por su situación, forma y dimensiones. © 2012 Elsevier España, S.L. Todos los derechos reservados.

Introduction

Throughout our surgical experience of hundreds of thy-roidectomies we frequently noticed a tuberosity or protuberance located in the posterolateral edge of the thyroid lobes (TL). Frequently, this protuberance was introduced behind the laryngotraheal axis. Moreover, it was surrounded by areolar tissue which was usually laborious to dissect, and the recurrent nerve as well as the inferior thyroid artery and one of its branches were hidden beneath it. When locating this protuberance, the superior parathyroid gland was immediately cranial to it.

Until we read the work of Gauger et al. we were not aware that this structure was known since the late nineteenth century. Its practical significance has spread very slowly and even at present it is still not widely known. It appears in the literature under different names: posterior protuberance (processus posterior glandulae thyroideae), Zuckerkandl’s tubercle (ZT), Madelung–Zuckerkandl tubercle, posterior tubercle, posterior horn, retrotracheal protuberance, retrotracheal lobe and retroesophageal lobe. The work of Mirilas and Skandalakis contains a detailed account of the ZT, from its initial descriptions to the present date.

Thus, the ZT is a protuberance emerging from the posterior margin of the TL. It was first described by Madelung in 1879 and then by Zuckerkandl in 1902. Its importance in thyroid surgery has been known since the early twentieth century, however it is not known by most surgeons and often goes unnoticed, being mistaken for an irregular form of the posterolateral edge of the TL. As an example, in 2 recent treatises on thyroid surgery, one attached great surgical importance to the ZT, while the other did not even mention it. Today, the importance of embryological, anatomical and surgical technique knowledge regarding the ZT is unquestionable, and solid information about it is crucial when addressing the critical points of thyroid and parathyroid surgery (Fig. 1).

We decided to study the morphology of this anatomicosurgical detail in a prospective and descriptive manner, in the belief that spreading information about its shape, size and location will help us to recognise it during interventions. Our main goal was to alert head and neck surgeons about the importance of the ZT, a primary anatomical reference for the location of key structures and a point of difficult dissec- tion in TL. Including the ZT within the resection specimen is essential to achieving an adequate total thryoidectomy, since its abandonment in the surgical field leaves a thyroid remnant that may result in hypertrophy with tracheoesophageal compression, persistence of hyperthyroidism in Graves’ disease, a permanent focus of carcinoma or dispersion of the target for radioiodine.

Methods

Around 100 thyroidectomies are performed annually at our service, specifically 111 were performed in the year 2011. Our investigation was designed as a prospective study of ZT in 107 consecutive thyroidectomies performed by the same surgeon on 105 patients, during the period 2009–2011. We operated on 84 females (80.00%) and 21 males (20.00%). The mean age was 54 years, with a range between 15 and 84 years. We conducted 88 total thyroidectomies (82.24%) and 19 hemithyroidectomies (17.75%).

We always performed full extracapsular dissection of each TL. So-called subtotal thyroidectomies are not practiced at our service.

The main disease leading to surgery was: multinodular goitre in 62 cases (59.04%), thyroid cancer in 28 (26.66%) (25 papillary carcinomas, 3 follicular carcinomas), Graves’
disease in 7 (6.66%), adenomas in 5 (4.76%) and Hashimoto’s thyroiditis in 3 (2.85%). Carcinomas frequently coexisted with multinodular goitre. In total, 8 of the 105 patients (7.61%) suffered from Hashimoto’s thyroiditis in addition to the primary diagnosis.

We excluded from the study any "not new" or rescue interventions performed to complete partial techniques conducted at other services and which subsequently developed thyroid disease.

We studied the posterolateral edge in 195 TL during surgery and then on the excised specimen. Of these, 99 were from the right side (RTL) and 96 from the left side (LTL).

We investigated whether the ZT was present during dissection of the posterolateral edge of the TL and, in positive cases, we determined its characteristics. In order to identify the ZT we considered its size, shape and location. Palpation was important to differentiate the ZT from the thyroid nodules; the nodules are almost spherical, are located within the thyroid tissue and have a firmer consistency.

Once removed, the thyroid gland was analysed on an auxiliary table prepared to the effect. When the ZT was present it was photographed and measured. Measurements were obtained according to the axes, considering the gland in the theoretical position occupied within a patient in the supine position. We referred to the cranio-caudal axis as transverse and to the axis running from the implantation base of the ZT to its distal edge as longitudinal (Fig. 2). We did not consider ZT width interesting, in so far as it was proportional to the magnitudes of the aforementioned axes. Measurements were done with a millimetric ruler, micrometre (calliper) and dividers (Fig. 3a). All photographs and figures were entered into a database. Calculations were performed with 6 decimals, although only the first 2 were recorded. For the statistical study we obtained the range and the mean, and for the distribution by sides we used the Pearson $\chi^2$ test (Chi-square).

We considered the ZT to be pedunculated when its longitudinal axis was at least 20% longer than the transverse axis, otherwise it was considered sessile. In both cases, the distal edge of the tuberosity could be divided, forming 2 protrusions and constituting what is known as a bifid ZT. The literature also contains a report of a ZT separated from the TL, like an ectopic thyroid.²¹

This methodology aimed to identify:

1 The percentage of cases where the ZT was detected securely.
2 Whether the TZ appeared on the right TL or the left TL.
3 The size in 2 dimensions: maximum transverse axis and maximum longitudinal axis (reliability <0.5 mm).
4 The shape: sessile, pedunculated, bifid or separate, like an ectopic thyroid.
5 The position on the posterolateral edge of the TL: cranial, medial or caudal.
6 The location with respect to the TL and neighbouring viscera: lateral, posterolateral or retrovisceral.

Results

Of the 195 TL studied, the ZT was located in 155 cases (79.48%). In 99 RTL it was located in 84 cases (84.84%), whereas in 96 LTL it was located in 71 cases (73.95%). We noted that the ZT was detected more frequently on the right side ($P=0.06$). The ZT was not detected in 40/195 TL (20.51%).

The mean length of the transverse axis was 11 mm (range: 8–31 mm), and that of the longitudinal axis was 9 mm (range: 6–27 mm) (Fig. 3b). The width of the ZT was proportional to the dimensions of the 2 axes considered (Tables 1 and 2).

The shape of the ZT was a flap-like lobe attached to the posterolateral edge of the TL. It had a slightly rough surface, a homogeneous feel upon palpation and a colour similar to the rest of the thyroid gland (Fig. 3c).
In the RTL, the ZT was sessile in 61 cases (72.61%), whilst in the LTL it was sessile in 49 cases (69.01%). The ZT was pedunculated in 23 cases in the RTL (27.38%) and in 22 in the LTL (30.98%). In the total set of 155 tubercles detected, the ZT was sessile in 110 cases (70.96%) (Fig. 3b) and pedunculated in 45 cases (29.03%) (Fig. 4). Considering the total set of all ZT, both sessile and pedunculated, 9 cases (5.80%) were bifid ZT, that is, with a divided distal edge.

When there is a thyroid portion which is totally or almost totally separate from the posterolateral edge of the thyroid lobe, it may be that the ZT has become separated and thus determined an ectopic thyroid. We detected an ectopic thyroid mass lateral to the TL in 6 of the 195 LT dissected (3.07%). We cannot safely say that the separate portion was a ZT (0.00%) (Fig. 5).

In the 155 cases where it was detected (79.48%), the ZT was usually located in the middle part of the

<table>
<thead>
<tr>
<th>Table 1 Modification by the Authors of the Classification by Pelizzo et al.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classification of the ZT by size (Pelizzo et al.5)</td>
</tr>
<tr>
<td>0. ZT not recognisable</td>
</tr>
<tr>
<td>1. ZT of minimal size</td>
</tr>
<tr>
<td>2. ZT smaller than 10 mm</td>
</tr>
<tr>
<td>3. ZT larger than 10 mm</td>
</tr>
<tr>
<td>Proposed modification of the classification by Pelizzo et al.5</td>
</tr>
<tr>
<td>0. ZT not recognisable</td>
</tr>
<tr>
<td>1. ZT doubtful</td>
</tr>
<tr>
<td>2. ZT smaller than 10 mm</td>
</tr>
<tr>
<td>3. ZT between 10 and 20 mm</td>
</tr>
<tr>
<td>4. ZT larger than 20 mm</td>
</tr>
</tbody>
</table>
Table 2  Classification of ZT by Sizes Among our Cases.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number of Cases</th>
<th>Percentage</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>29</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>11</td>
<td>-</td>
<td>40/195</td>
</tr>
<tr>
<td>2</td>
<td>32</td>
<td>20.64%</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>115</td>
<td>74.19%</td>
<td>155/195</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>5.16%</td>
<td>-</td>
</tr>
</tbody>
</table>

posterior lateral edge of the thyroid lobe. If we divide this edge into 3 theoretical portions, cranial, medial and caudal, most of the mass of the ZT was located in the medial section in 131 cases (84.51%), in 11 cases its location was cranial (7.09%) and in 13 cases it was caudal (8.38%).

If we consider the position of the TL after dissecting its external side and before being pulled and medially luxated, we did not find any case in which the ZT was clearly lateral to the TL. In other words, the ZT was always posterior to the TL, located behind in a posterolateral position. In

Figure 4  In this case, the ZT was pedunculated, its distal edge was introduced behind the trachea. The thyroid nodules were clearly differentiated (1, 2, 3, and 4) from the ZT. As it is common, the superior parathyroid gland was cranial to the ZT.

109 of the 155 ZT (70.32%) it was introduced behind the trachea to a greater or lesser extent, representing a retroviseral ZT (Fig. 6). Although we clearly observed how some ZT were insinuated behind the oesophagus in the LTL, we cannot statistically quantify the frequency of this datum.

Figure 5  The arrows show the points in which the TL was joined to an ectopic portion of the thyroid by a fine fibrous bridge. We cannot definitely say that the ectopic portion was a ZT.

Discussion

It is important that the surgical intervention and study of the ZT are always performed by the same surgeon. Some subjectivity is inevitable at the time of locating the ZT, but this subjectivity would increase significantly if the estimations were made by different persons.

The literature consulted did not specify the exact shape and location of the ZT. Its dimensions were grouped into different categories by Pelizzo et al. (Table 1).

Thyroid nodules may create problems in identifying the ZT. One reason which sometimes prevents recognition of the ZT is that surgery is often performed on multinodular goitres and occasionally some nodules may blur the posterolateral edge of the TL and camouflage the ZT. We have discussed that, in addition to its shape, location and dimensions, palpation helps to differentiate the ZT from a thyroid nodule.

The ZT is present in a variable number of cases, but its frequency in the literature coincides with that of 79.48% found in our study. However, there are also some differing views, since some authors claim that the ZT exists in all thyroid glands, whilst others detect it in very few cases.

In our study of the ZT we located it more often in the RTL (84.84%) than in the LTL (73.95%). This finding was close to statistical significance without reaching it (P=.06), but the difference between both sides was notable and reported by other authors. This varying side frequency may be due to the fusion conditions in the right and left lateral thyroid primordia compared with the central primordium.

The development of the thyroid gland takes place from a medial primordium and 2 lateral primordia. It begins at the end of the third week of gestation and is completed
in the tenth week. The unpaired medial primordium, of endodermal origin, arises from the oropharyngeal midline in the third or fourth week and gives rise to the thyroid follicular tissue. The lateral primordia, which appear from the last branchial body derived from the ventral portion of the fifth branchial pharyngeal pouch around the fifth week of gestation, contain parafollicular cells originating from the neural crest, are of neuroectodermal origin and secrete calcitonin. In the tenth week, the left and right lateral primordia are incorporated into the medial primordium and constitute the thyroid gland (Fig. 7). In our work, the ZT was not identified in a significant percentage of cases (20.51%). We believe that, in addition to other circumstances, this was because the lateral primordia may diffuse and disappear within the TL during development.

As it is well known, in its migration the descending thyroid gland leaves a stalk which joins the pharyngeal floor; the His thyroglossal duct. After the second month, this stem or conduit becomes fragmented and dissolves, leaving a dimple called foramen caecum at its source, which corresponds to the back of the tongue. The ZT is the expression of the lateral primordia at their point of union with the medial primordium. We believe that the ZT is a vestige of the lateral primordium, in the same way as Lalouette’s pyramid is a vestige of the thyroglossal duct.

The ZT is located behind the lateral edge of the TL. It only becomes apparent after dissecting, moving and anteromedially dislocating the TL. In 70.32% of cases, the ZT appears behind the trachea. In order to detect this situation, which we observed frequently, the latter must be tested before removing the ZT from its original position. We found some cases in which the ZT extended behind the oesophagus, but these were isolated cases and always observed in the LTL. The data in the literature is consistent with the rarity of this possibility.

We cannot compare our results with those of Pelizzo et al., since their classification into 3 grades according to the size of the ZT only considered 1 measurement (we assume it to be the longitudinal axis, since this is not made clear in their work). Furthermore, we see no clear distinction between what they call grade 1 (small tubercle in the lateral edge) and grade 2 (ZT smaller than 1 cm), and we also consider their grade 3 to be ambiguous (ZT larger than 1 cm). Therefore, in order to quantify the size of the ZT, we believe it more useful to obtain the 2 dimensions which we recorded in millimetres (longitudinal axis and transverse axis), and then refer the grade to the size of the major axis, either the longitudinal or transverse. Furthermore, we believe it relevant to classify those ZT measuring over 20 mm as a separate grade (Tables 1 and 2).

The data to be taken into account in order to detect the ZT are its location, size and shape, as well as the capacity to distinguish it from other morphological characteristics of the TL surface (nodules, cysts, nonspecific protrusions, etc.). We consider the identification of the ZT essential, both because it is key to the location of the recurrent nerve and the superior parathyroid, and because surgeons must be prepared for a more difficult dissection around it.

In our experience, the ZT is a reference for the detection of the recurrent nerve and the superior parathyroid gland. The general lack of knowledge about the ZT is clear; the excellent work of Wang studies the position of 312 superior parathyroids in 160 autopsies, but does not include the ZT among the anatomical references mentioned. In 1998, Pelizzo et al. published a very interesting work on the ZT; however, they did not mention it in a previous publication.
They had possibly seen it repeatedly during their interventions but, having no prior knowledge of its existence, it had gone unnoticed.

The ZT may also be important in oncogenesis; since it is the development site of parafollicular cells it could be the source of medullar carcinoma.\(^\text{5,6,23}\) Some authors believe that the ZT causes compression symptoms in up to 58.3% of cases measuring over 1 cm.\(^\text{1,7,21,22}\) Except for some rare cases of highly demonstrative MRI scans, we do not see a reliable method to discern whether tracheal or oesophageal compression is produced by the ZT or the entire TL.

There are considerable differences in the literature regarding the size of the ZT. Pelizzo et al.\(^\text{5}\) reported only 14% ZT over 10 mm, compared to 24% by Sheaham et al.,\(^\text{23}\) 55% by Hisham et al.\(^\text{7}\) and 71% by Gauger et al.\(^\text{1}\) In our study, we found ZT greater than 10 mm in 80% of cases (Table 2). The cited authors do not explain their method to measure ZT size. We obtained a larger size when considering the longer of the 2 axes studied, either the transverse or the longitudinal.

Considering that the ZT has the surgical importance manifested in the literature even in the most recent publications\(^\text{23}\): why is it not recognised by many surgeons? Firstly, due to a lack of knowledge about theoretical anatomical detail. Also, because being located on the posterolateral edge of the TL (at the level of the first tracheal rings, sometimes only glimpsed behind them), visualising it requires pulling the gland outwards, thus causing the posterolateral edge to lose its shape and position. Furthermore, being surrounded by dense areolar tissue and immediately related to the ligament of Berry, hinders the recognition and dissection of the ZT; this surgical moment is key to the preservation of the recurrent nerve.

Conclusions
- The ZT appears as a flap-like lobulation or a protrusion, attached to the TL.
- The ZT is located in the posterolateral edge of the TL.
- It is only observed after mobilising, dislocating and pulling the TL outwards and medially.
- The major axis of the ZT has a mean size of 10 mm (range: 6–31 mm).
- Its shape is sessile in 70.96% of cases and pedunculated in 29.03%. It is bifid (double) in 5.80% of cases.
- Among 195 TL studied, the ZT was located in 155 cases (79.48%). Out of 99 RTL studied, it was located in 84 cases (84.84%), whilst out of 96 RTL, it was located in 71 cases (73.95%). We noted that the ZT was detected more frequently on the right side (P=.06). The ZT was not detected in 40 TL (20.51%).

Conflict of Interests
The authors have no conflict of interests to declare.

References