Per Operative Study of Relation of Zuckerkandl Tubercle with Recurrent Laryngeal Nerve in Thyroid Surgery

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Abstract To identify Zuckerkandl tubercle and to determine relationship between the recurrent laryngeal nerve and Zuckerkandl tubercle (ZT). Peroperative study. Intra-operatively Zuckerkandl tubercle was identified. Size of the thyroid lobe and Zuckerkandl tubercle were co-related and direction of tubercle in relation to recurrent laryngeal nerve was examined. Grading of tubercle on the basis of size was done. We studied its direction and relation with recurrent laryngeal nerve. ZT was identified in 87.86% (179 out of 206) of cases. In the study amongst the 179 cases in whom ZT could be identified, ZT was found on the right side (85.41% i.e. 123 out of 144), 81.41% (92 out of 113) to the left side and 15.68% (8 out of 51) were B/L. ZT was found posterior to the tubercle in 97.22% (175 out of 179) cases and anterior to the tubercle in 2.77% (5 out of 179) cases. The relationship between recurrent laryngeal nerve and ITA was studied. ITA was anterior to RLN (in 70.89%) and posterior to RLN in 29.10%. Thus, ZT is an important landmark for identification of RLN during thyroidectomy (*p* value 0.001).

Level of evidence III

Keywords Zuckerkandl's tubercle ·
Recurrent laryngeal nerve · Thyroidectomy

Abbreviations

B/L	Bilateral
ZT	Zuckerkandl tubercle
RLN	Recurrent laryngeal nerve
ITA	Inferior thyroid artery
RLNP	Recurrent laryngeal nerve palsy
RLNI	Recurrent laryngeal nerve injury

Introduction

Historically, thyroid surgery has been fraught with complications. Injury to the parathyroid glands, recurrent laryngeal nerve or superior laryngeal nerve may result in lifelong consequences for the patients. Appropriate identification and preservation of the function of these structures are most important in improving the safety and efficacy of thyroid surgery [1].

Injury to the recurrent laryngeal nerve (RLN) is an important but avoidable complication of thyroidectomy. Deliberate identification of the RLN minimizes the risk of injury facilitated by important landmarks found along its course. Permanent RLNP occurs in 0.3–3% of cases, with transient palsies in 5–8% [2]. The rate of RLN palsy after thyroidectomy among endocrine surgeons is 1–2%, but the incidence of RLN injury can peak up to 14% [3, 4].

The most common mode of injury to recurrent laryngeal nerve is perhaps more frequently due to edema or stretching than to actual severance. When the nerve is identified and dissected, the reported RLN injury rate during thyroidectomy is 0–2.1%. This is reportedly higher in revision surgery (2–12%) or if the nerve is not clearly identified (4–6.6%) [5].

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Tubercle of Zuckerkandl

Schematic drawing showing relationship of recurrent laryngeal nerve with tubercle of Zuckerkandl. RLN recurrent laryngeal nerve; ZT tubercle of Zuckerkandl (self drawn)

Emil Zuckerkandl (1849–1910) [6, 7], an Austrian anatomist has described many anatomical structures in the body. Zuckerkandl's tubercle (ZT) is defined as posterior extension of the lateral lobes composing of thyroid tissue only and is derived from the 4th branchial cleft.

1. Close relationship between ZT and recurrent laryngeal nerve (RLN).
2. Dissection and excision of ZT for total thyroidectomy.
3. For medullary carcinoma in particular, ZT is embryologically designated as the primary site.

**Dr. Emil Emanuel
Zuckerkandl (1849 - 1910)**

The surgical importance of ZT can be summarized as [8, 9]:

(Large black arrow) Grade III Zuckerkandl tubercle.
(Small blue arrow) Recurrent laryngeal nerve.

Grading of ZT

ZTs were classified according to size:

- Grade 0 (unrecognizable),
- Grade I (≤ 5 mm),
- Grade II (6–10 mm) and
- Grade III (> 10 mm).

ZT appears as an indicative arrow for the nerve and neurovascular crossing point in some patients. After medial mobilization of the lobes, when present, ZT may be used as a landmark facilitating identification of the nerve. The resection of ZT for total thyroidectomy requires refined and meticulous dissection adjacent to the nerve. When enlarged by disease, the tubercle passes over the nerve like a bridge. This normal anatomical relationship is retained in the majority of cases [10]. Technique of thyroidectomy is improved because of the constant relationship between these two structures at a level where the risk of injury is greatest [11].

If tubercle of Zuckerkandl is not removed during thyroid surgery, it may be a source of persistent unrelieved symptoms or recurrence. An understanding of the anatomy of the tubercle of Zuckerkandl leads to safe surgical dissection. It usually enlarges lateral to the recurrent laryngeal nerve, with the nerve appearing to pass into a cleft medial to it—a situation that some surgeons used to describe as the nerve passing into the thyroid substance. Early elevation of the tubercle of Zuckerkandl usually allows the recurrent nerve to be easily and safely “encountered” even though not initially visible. However an uncommon but high risk situation is where the recurrent laryngeal nerve runs lateral to an enlarged Tubercle of Zuckerkandl, placing it at increased risk of damage during dissection. Superior parathyroid gland, also being derived from the 4th branchial cleft, is commonly found in close association, cephalad to the Tubercle of Zuckerkandl.

Materials and Methods

The study was conducted in the Department of E.N.T., SMS Hospital, Jaipur from January 2013 to Nov 2014 on 206 patients of thyroidectomy including 173 female patients and 33 male patients. Out of these 155 were cases of hemithyroidectomies, 45 cases were of total thyroidectomy, 5 cases of subtotal, 1 case of near total thyroidectomy.

Intraoperatively Zuckerkandl tubercle was identified, size of thyroid lobe and of Zuckerkandl tubercle were measured. Grading of tubercle as per its size has been done. Direction of tubercle towards the entry of recurrent laryngeal nerve and its relation with recurrent laryngeal nerve were observed. The position of superior parathyroid gland

and inferior thyroid artery with respect to Zuckerkandl tubercle were observed. Following observations were made:

1. Presence of Zuckerkandl tubercle.
2. Grading in relation to lobe.
3. Direction of Zuckercandle tubercle towards RLN.
4. Relation of RLN with parathyroid gland and Inferior thyroid artery.

Results

In our study ZT was identified in 87.86% (179 out of 206) of the cases. For 42 thyroid lobes ZT could not identified. A total of 206 cases among which 93 were of right side surgery, 62 of left side surgery and 51 were bilateral. Amongst the 179 cases in whom ZT could be identified, ZT was found on the right side [85.41% i.e. 123 out of 144(93 + 51)], 81.41% [92 out of 113(62 + 51)] to the left side and 15.68% (8 out of 51) were B/L (Tables 1, 2, 3).

Other observations of present study

1. The relationship between recurrent laryngeal nerve and ITA was studied. It revealed that mostly the ITA is anterior to RLN (in 70.89%) and posterior to RLN in 29.10% (Table 4).

Table 1 ZT (Zuckerkandl tubercle) $\pm$

ZT	No. of patients	%
Identified	179	87.86
Not identifiable	27	12.13

Table 2 Position of Zuckerkandl tubercle

Relation	No. of patients	%
Posterior	174	97.20
Anterior	1	0.56
Lateral	4	2.77

Table 3 Grading of Zuckerkandl tubercle

Grade (on basis of size of ZT in mm)	No. of patients	%
Zero	27	13.10
I	93	45.14
II	75	36.40
III	11	5.34

Table 4 Relationship of recurrent laryngeal nerve and inferior thyroid artery

Relation	No. of patients	%
Anterior	151	70.89
Posterior	62	29.10

Table 5 Relationship of superior parathyroid gland and ZT

Relation	Number of patients	%
Super lateral	175	97.22
Infer lateral	4	2.77

The superior parathyroid gland is super lateral to ZT in 97.22% cases and infer lateral in 2.77%

- ZT was identified in more than 90% cases of benign thyroid disease like colloid goiter(45 out of 48), colloid nodule(40 out of 42), colloid cyst(16 out of 17), benign follicular nodule (26 out of 28) and less frequently in cases of carcinoma like papillary carcinoma(15 out of 26). ZT could not be identified in cases of enlarged thyroid lobes due to distorted anatomy. Among these the incidence of grade I ZT is 49.51%, grade II is 32.52% and grade III is 9.48%.
- The superior parathyroid gland was located super lateral to ZT in majority i.e. 97.22% cases and was infer lateral to the ZT in few i.e. 2.77% cases (Table 5).

Discussion

An enlargement of the lateral edge of the thyroid lobe that stems from the fusion of the lateral and medial thyroid anlagen is called the tubercle of Zuckerkandl. It is an anatomical landmark that may be used in identifying the RLN, and it is closely associated with the superior parathyroid glands. The RLN generally courses deep to this structure and superficial to the lateral border of the trachea. However, this relationship can vary due to the enlargement of the tuberculum placing the RLN at risk of injury during exploration.

During thyroid surgery, identification and preservation of the recurrent laryngeal nerve and all of its divisions is essential to decrease the morbidity of the procedure. The relationship of the distal segment of the RLN to the cricothyroid joint has been reported to be more constant coursing posterior to the joint. The authors concluded that identifying the nerve distally may be more reliable with

less chance of disrupting the blood supply to the RLN. The course of RLN with respect to inferior thyroid artery is quite variable but significant.

The recurrent RLN lays in close proximity the posterior suspensory ligament as described by Berry in 1888. It is described to be embedded or lateral to the suspensory ligament. In a cadaveric study by Leow and Webb at the level of the cricoid cartilage, the mean distance between the attachment of the ligament to the cricoid cartilage and the RLN entry point into the larynx was 1.9 mm. In another study of 689 RLNs, all nerves were located dorsolaterally to the ligament of Berry and no nerve penetrated the ligament. Tubercle of Zuckerkandl is an important landmark that can be useful in identifying the RLN.

In a study of 104 lobectomies by Pelizzo et al. [10] the tubercle of Zuckerkandl was identified in 78.2% of the lobectomies on the right and 75.5% of the cases on the left. The authors concluded that identifying this tubercle will make identification of RLN easier.

Gil Carcedo [12] stated that the Zuckerkandl tubercle is a residue from the embryological development of the thyroid gland. He highlighted the importance of the Zuckerkandl tubercle, as it has proven to be a reliable point of reference to locate the superior parathyroid, the inferior thyroid artery and the RLN. In total, 195 thyroid lobes which he analyzed the Zuckerkandl tubercle was certainly detected in 155 thyroid lobes (79.48%).

Mirilas [6] reported the presence of Zuckerkandl tubercle in 86.2% cases. Zuckerkandl's tubercle was bilateral in 15%.

Gurleyik and Gurleyik [13] identified ZT in 66(66%) patients and 81(51%) in their study. ZT appears as an indicative arrow for the nerve and neurovascular crossing point in some patients.

Gravante et al. [14] found an incidence of Zuckerkandl tubercle 63–80% in his series of studies. Gravante et al. stated, “Although not always present, the Zuckerkandl tubercle is an easy and simple way to localize the recurrent laryngeal nerve.

In our study the incidence of grade I ZT is 51.95%, grade II is 41.90% and grade III is 6.14%. Yun and Lee [15] studied the distribution of ZTs according to grade as follows: Grade 0, right 10.7% and left 14.4%; Grade I, right 7.9% and left 11.1%; Grade II, right 43.5% and left 38.5%; and Grade III, right 37.9% and left 35.9%. Yun [15] studied the distribution of ZT according to grade as: grade 0, right 10.7% and left 14.7%; Grade I, right 7.9% and left 11.1%; Grade II, right 43.5 and left 38.5%; and Grade III, right 37.9% and left 35.9% Gravante et al. [16]. used only recognizable tubercles (grades 2 and 3) to investigate the relationship. It is classified into three grades according to size: I < 0.5 cm, II 0.5–1 cm, III > 1 cm.

Gurleyik and Gurleyik [13] noted prominent ZT in 53 of 87 (61%) right and 28 of 73(38%) left lobes. ZTs were present bilaterally in 15 (25%) of 60 total thyroidectomy cases. Sheahan [17] identified ZT more commonly on the right side (69.6%; 71/102) than on the left side (53.2%; 58/109). When cases where the ZT was not assessed were excluded, the tubercle was once again more common on the right (77.2%; 71/92) compared to the left (58.6%; 58/99) ($P=0.008$). Yun and Lee [15]. ZTs were identified in most patients (right 89.3%, left 85.6%). Yun [15] investigated the incidence and size of ZT and its positional relationship to the RLN and superior parathyroid (SP), during thyroid surgery. He identified ZT in most patients (right 89.3%, left 85.6%).

Gurleyik and Gurleyik [13] observed common relationship between the ZT and RLN i.e. the nerve usually passes posterior to the tubercle in 76(94%) of 81. Sheahan [17]. In 98.4% (127/129) of cases in which a ZT was identified, the recurrent laryngeal nerve was found deep to this structure. In two cases, however, a tubercle was identified deep to the recurrent laryngeal nerve. Gravante [16] found the recurrent laryngeal nerve lies medial to the tubercle in 93% of patients and lateral to the tubercle in the remaining 7%. During dissection in the tracheoesophageal groove as soon as the ZT is retracted medially the RLN can be traced with the tubercle pointing like an arrow towards entry point of RLN. Gauger [19] and Delbridge [18] conducted a study in which the recurrent laryngeal nerve was observed to lie in between the ZT and the main body of the thyroid gland or the tracheal surface in 93% of the cases with an enlarged ZT (Pelizzo grade 2 or 3). In up to 7% of cases the nerve ran lateral to the ZT, in which case it is at substantial risk of inadvertent injury if the anatomical importance of the ZT has not been recognized [18].

Conclusion

Zuckermandl tubercle which is defined as posterior extension of lateral lobes of the thyroid gland, is a common anatomical structure found in the majority of cases. Excision of the tubercle requires fine and meticulous dissection with great care because of close relationship between ZT and RLN. The RLN is uncommonly located on anterior surface of the tubercle. The unusual lateral or anterior course may increase the risk of injury. During resection of the tubercle, the recurrent laryngeal nerve can be dissected and protected by continuation of the capsular dissection technique. The ZT is a consistently useful guide to locate and subsequently protect the recurrent laryngeal nerve as it enters the cricothyroid muscle.

- The study was aimed to emphasise the importance of zuckermandl tubercle as an important landmark to trace recurrent laryngeal nerve in thyroid surgery.
- The ZT was identifiable in significant percentage (p value 0.01) (87.86%) of the studied cases.
- The ZT was seen to point towards the entry of recurrent laryngeal nerve and the nerve was medial to the ZT in majority of them.

Compliance with ethical standards

Conflict of interest All authors declares that they have no conflict of interest.

Ethical approval All procedures performed in the study were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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

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