Anatomical Attributes of Zuckerkandl Tubercle

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ABSTRACT

Introduction

Thyroid diseases are different from many other diseases in the relative visibility a small swelling of the thyroid offers to the treating surgeon and the availability of medical and surgical treatments. Thyroidectomy remains the cornerstone of management in many thyroid swellings, yet ridden with many complications like nerve palsies and hypoparathyroidism. Hence, proficient knowledge is required in preserving the recurrent laryngeal nerve and the parathyroid glands in their vulnerable surgical site. An almost certain way to ensure integrity of these structures during surgery is to be aware of anatomical landmarks guiding towards their identification one of which is zuckerkandl tubercle, a less often described structure, arising from posterior margin of thyroid gland.

Materials and Methods

We examined 42 thyroid gland specimens from embalmed cadavers available for study & research purpose in the department of anatomy of our medical college. The incidence, size, shape, laterality of the zuckerkandl tubercle & its relation with recurrent laryngeal nerve as well as parathyroid gland were evaluated and analysed.

Results

Thirty out of the 42 thyroid specimen showed presence of Zuckerkandl tubercle as a irregular lateral projection from the posterior border of thyroid gland. Among them, 17 were on right side while 9 were on left side & 4 of them bilaterally present in the specimens.12/42(28.5%) of specimen showed superior parathyroid gland close to the location of Zuckerkandl tubercle. 29 out of 31 of the specimen showed ZT pointing at the RLN.

Conclusion

The zuckerkandl tubercle is an anatomical structure whose presence is important for locating recurrent laryngeal nerve & parathyroid glands and preventing injury during thyroidectomy. Knowledge of its variations gained from our study will help in the prevention of inadvertent nerve injuries during thyroidectomy.

Keywords

Recurrent Laryngeal Nerve; Zuckerkandl Tubercle; Superior Parathyroid Gland

Recurrent laryngeal nerve (RLN) palsy(14%), hypoparathyroidism(19.8%) are postoperative complications which are frequent causes for litigation following thyroidectomy.[1,2] Thyroidectomy, ranging from lobectomy to total thyroidectomy remains a tailor-made treatment option to most of the patients with thyroid swellings in India which carries a thyroid disease burden of over 42 million.[3] Complications of thyroidectomy have testified mighty improvements in success rates which used to be around 40%during 18thcentury to 90% in 20th century. Increasing success can be attributed to improvements in surgical techniques, anaesthetic and antiseptic facilities.[4] Nevertheless thyroidectomy is still abetted with post operative complications such as haemorrhage, parathyroid injury, recurrent laryngeal nerve palsy.[5] According to several studies, injury of RLN during thyroidectomy varies from 1.5% to 14%.[6] The main mechanisms of damaging the RLN during thyroidectomy are pressure, laceration, thermal damage, division, ligation, ischemia, and

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manipulation. Furthermore, lack of surgical plan during dissection and being oblivious to anatomical variations of thyroid gland are well-known reasons for iatrogenic damage of the RLN. The result is that 12.5% of patients suffer from temporary vocal cord paralysis while 3.8% patients will experience permanent paralysis. Clinical features extending from dysphonia-dysphagia-dyspnoea manifest depending on the extent injury which can get exaggerated in cases with pulmonary morbidity.[7,8] Characteristics of thyroid disease, anatomical variations in surgery site, landmarks for RLN identification are some important factors that may influence the complications, malpractice litigation, sometimes even survival of the patient.

Anatomists and surgeons differ considerably in their descriptions & landmarks for identifying RLN. Beahr's, Simons, Lores & recurrent laryngeal nerve triangles are all surgical landmarks bounded by carotid artery, inferior thyroid artery & trachea-oesophageal grove. Nevertheless, these often-described boundaries to locate the RLN, having fallen short of being consistent landmarks with the structures themselves presenting with different anatomical variations. Zuckerkandl tubercle is a normal extension of thyroid gland from its posterolateral margin. It serves as a valid & reliable landmark for identification of RLN during thyroid surgeries. Many a times, it is regarded as a bothersome mass causing increased pressure symptoms, also as a metastatic lymph node or even may get jumbled with parathyroid adenoma. It may cause persistent symptoms if left out during thyroidectomy and can be a site of persistent radio iodine uptake on radioactive scans, causing misinterpretations by unwary Surgeons /Radiologists. Although ZT is not rare infrequent finding during thyroid surgeries, many textbooks in surgery either do not mention it or is regarded as an unusual finding. Since the first report by Emil Zuckerkandl, few studies in surgical literature describe the ZT notably in pathological thyroid specimens & scarcely in normal thyroid tissue.

Parathyroid mobilization during thyroid surgery can cause transient or permanent hypoparathyroidism. Reported incidence range from 17.6% to 19.8%, many times due to failure of recognition and preservation these glands during thyroidectomy. Parathyroid glands are essential for maintaining calcium homeostasis. Previous literature indicates that when ZT is present, the superior parathyroid glands are always present above & inferior parathyroid glands are inferior to tubercle. Due to variable position of parathyroid glands & difficulty in identification, landmarks like RLN, ZT, inferior thyroid artery in lower pole of thyroid gland are considered as convenient landmarks.

While many studies have described the association between ZT and RLN, there are fewer studies reporting the anatomical relation between ZT and parathyroid gland especially in Indian population. Several studies have reported to establish the incidence and variation with sizes & shapes of zuckerkandl tubercle, but all these findings were observed during surgeries on already diseased thyroid gland where in a lateral projection from diseased gland might not represent a true tubercle. Years of teaching head & neck anatomy to Medical, Dental & Allied health students, we came across ZT in normal thyroid specimens with various anatomical & topographic features. Our objective is to study the incidence, size, shape, laterality of the zuckerkandl tubercle & its relation with recurrent laryngeal nerve as well as parathyroid gland.

Materials and Methods

We identified & dissected 42 embalmed head & neck specimens from the department of Anatomy, of our medical college. A midline incision was made in the neck followed by reflection of skin, superficial fascia with platysma & deep fascia. Infrahyoid muscles were identified in the midline & reflected to expose the thyroid gland. After removing the fascia from the thyroid gland & exposing the vessels & nerves supplying it, the borders & surfaces of thyroid gland were examined. Anterior border was defined as a sharp border ascending the isthmus & reaching the apex of thyroid lobe. Posterior border was identified as that part engulfing behind the oesophagus. Lateral border of thyroid gland was defined as most margin of anterior surface of thyroid gland in its anatomical position. Zuckerkandl tubercle was studied for its presence, side, size, its relation with recurrent laryngeal

Table I: Results

INCIDENCE	31/42 (71.42%)
Laterality	9 -Left 17 -Right 4-Bilateral
Shape	Irregular, nodular or elongated Lateral Projection
Relation with recurrent laryngeal nerve	29/31 (97.22%) posterior/medial
Relation with parathyroid gland	12/42(28.5%) Superior parathyroid gland

Table II: Incidence & Grading of ZT in different studies

	GRADE 0 (NOT SEEN)	GRADE 1 (<5 MM)	GRADE 2 (6-10 MM)	GRADE 3 (>10 MM)
Gauger et al (84%)	37%	18% (gd1,2)		45%
Pelizo et al (73.9%)	23%	8.6%	53.8%	14.4%
Sheahan et al (82.1%)	29% (gd0,1)	61.1%	37%	24%
Mehanna et al (64.5%)	30.1% (gd0,1)		29.8%	22.1%
Hisham&Aina (89.3%)	19.8% (0,1)		25%	55.2%
Irawati et al (90.5%)	9.5%	28.9%	50.5%	11.1%
Singh et al (87.86%)	23%	45%	36%	5%
Present study (72.2%)	22.1%	28.9%	50.5%	6.9%

nerve & parathyroid gland. The parathyroid gland found near the tubercle was confirmed with histopathological study & H& E staining.

Results

We have analysed 42 of thyroid gland specimens from embalmed cadavers available for study & research purpose in department of anatomy of our medical college. Thirty of the 42 specimens showed the tubercle (Table I) out of which 17 belonged to right side while 9 of them belonged to left side and 4 of them bilaterally present in the specimens. 12/42 (28.5%) of specimen showed superior parathyroid gland close to the location of Zuckerkandl tubercle. 29 out of 31 of the specimen showed ZT pointing at the RLN.About 50% of Zuckerkandl tubercle to be predominantly of grade II, i.e. between 6-10 mm in size (Table II), while 30% were grade I and 7% were grade III.

Discussion

Study of Thyroidgland anatomy & surgery started as early as 16th century during Roman Empire principally from Leonardo da Vinci.[6] Later the 18th century witnessed notable advances in thyroid surgery with great contribution from Kocher – acclaimed as Father of Modern Thyroid surgery.[10] The notable advances in surgical practice that occurred in the 1800s – 20th century resulted in changing the then perspective of thyroid surgery from a bloody and fearsome procedure to a modern and safe surgery. Otto Wilhelm made lung (1867) discovered & described a posterior horn of thyroid gland. Emil zuckerkandl (1906) coined the term posterior process glandulae thyroidae.[11] Gilmour was the first to describe the relation of the tubercle with recurrent laryngeal nerve. During subsequent centuries the tubercle received less attention & mention in research& conventional textbooks.[6, 11]

Table III: Laterality of Zuckerkandl tubercle in different studies

MEHANNA et al	**72.6% (right) 53.9% (left)**
Gurleyik & Gurleyik	**53/87(61%) (RIGHT)**
Sheahan	**71/10% (69.6%) (RIGHT)**
Irawati et al	**93% (RIGHT)**
Singh et al	**85.41% (RIGHT)**
Present study	**31/42 - 73.8% ZT (+)** **26/31 - 83.87%** **RIGHT 3/31 - 9.65%** **LEFT 2/31 - 6.45% B/L**

Table IV: ZT pointing at RLN in different studies

	MEDIAL	LATERAL	POSTERIOR	ANTERIOR
Gauger et al	**93%**	**7%**	**-**	**-**
Yun et al	**-**	**<10%**	**90%**	**0.5%**
Gilcarcedo	**-**	**-**	**95%**	**-**
Pradeep et al	**98%**	**-**	**-**	**-**
Our study	**6.25% (small tubercle)**	**None**	**93.75% (15/16)**	**None**

Thyroid gland originates as medial, lateral anlage. Medial anlage arises as endoderm evagination of pharyngeal floor of the branchial apparatus to form the main gland.[13] The lateral anlage – ultimobranchial body (4th, 5th pouch) is formed from the lateral part of the gland. Zuckerkandl tubercle arises from the site of fusion between the two anlages. Hence, thyroid tubercle of Zuckerkandl is a nodule arising from the postero lateral margin of thyroid gland, implying it to be a remnant of the ultimobranchial body.[13,14]

Several authors studied the Zuckerkandl tubercle and their variations in shape, size & laterality, nonetheless the studies were done on patients undergoing thyroid surgeries for any of their pathology; however, we conducted the same study in cadavers with thyroid gland without any pathology. Thirty of the 42 specimens showed the tubercle (Table I) out of which 17 belonged to right side while 9 of them belonged to left side and 4 of them bilaterally present in the specimens. Table III provides a comparison among different studies with respect to laterality of ZT. With the greater number of the Zuckerkandl tubercle being found on right side & a few also on left side of the neck, it serves as an important landmark on either side during surgery. Shape of the tubercle varied as nodular, elongated, or irregular.

ZT can be classified into three grades according to size: grade I <0.5 cm, grade II 0.5 to 1 cm, grade III >1 cm.[17] Table II provides a comparison of grades of presentation of ZT in various studies. Akin to the studies of Pelizo & Sheehan et al[17] we found about 50% of Zuckerkandl tubercle to be predominantly of gradeII, i.e. between 6-10mm in size, while 30% were grade I and 7% were grade III.

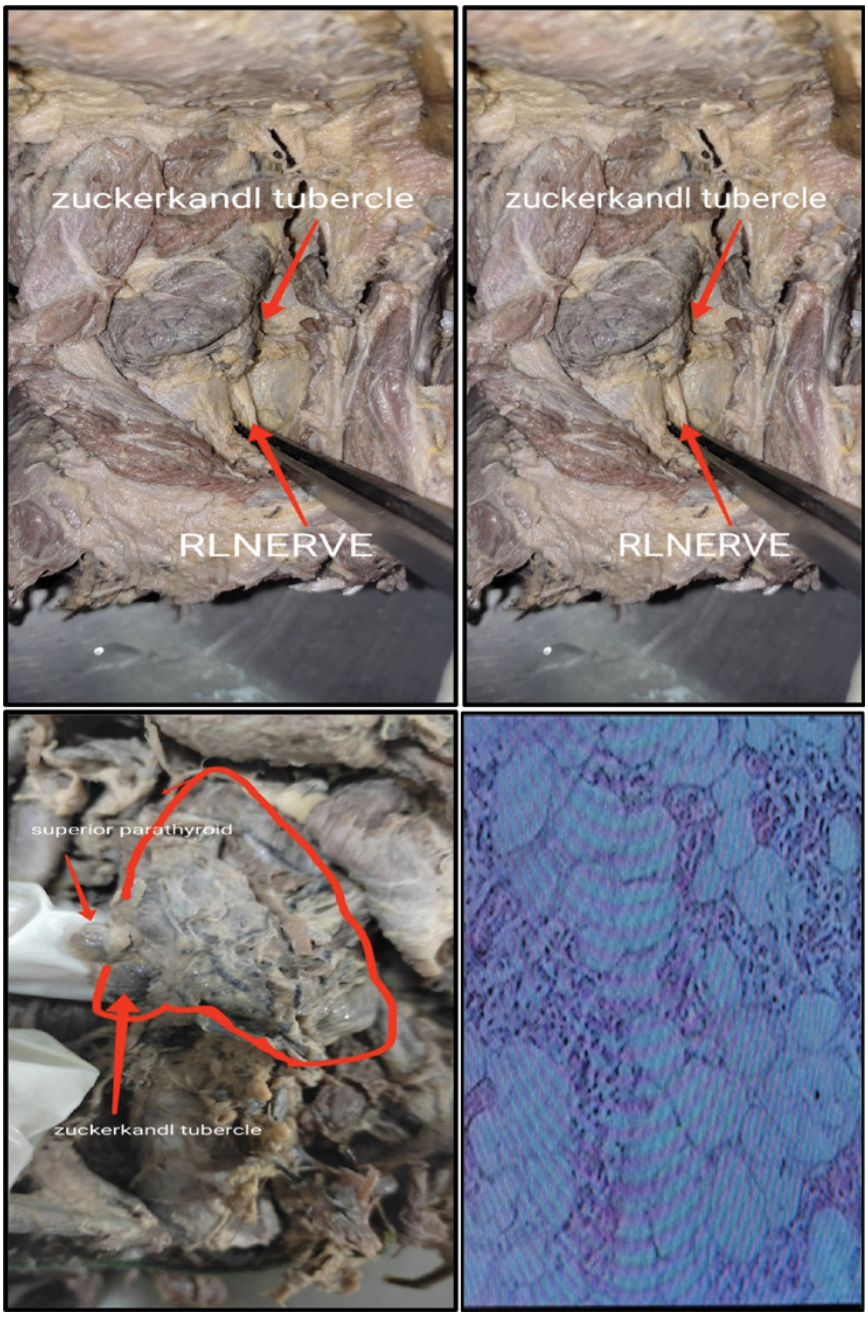

Fig. 1. Zuckerkandl Tubercles in our anatomy specimen and the histopathology of the identified superior parathyroid gland in relation to the tubercle.

As with the relationship of Zuckerkandl tubercle with recurrent laryngeal nerve, quite often we find variations in the medio–lateral relationship just like the physical features of the tubercle itself. Table IV gives a brief comparison of various study results to support the same. Gauger et al, Pradeep et al described the recurrent

laryngeal nerve to bear a medial relation with the tubercle[18,19] Yun et al; Gilarcedo et al related the nerve to have posterior relation to the tubercle. Gauger et al &Yun et al described the nerve even to be lateral to the tubercle however we did not encounter this relationship.[18,19] Thyroid gland being a midline structure, its protuberance Zuckerkandl tubercle & RLN are often situated behind it to enter the trachea-oesophageal grove. Therefore, posterior or posteromedial relation would be an appropriate description for the location for the nerve with the ZT tubercle. In our study, average distance between RLN and the ZT was 1.2 mm posteriorly or postero-medially. In the majority of specimen (79%), RLN was lying at d≤1 mm, making it a formidable landmark. Carlos reported the rare combination of the non-recurrent laryngeal nerve with Zuckerkandl tubercle - a rare anatomical variation of the RLN present in less than 1% of people. However, we have not encountered any of such cases in our studies.

While there are several studies on association of ZT with RLN, there are only few studies describing the relation between ZT & parathyroid in healthy population. Milzner described parathyroid glands in relation to thyroid vessels & capsule while Wang C reported 42% of inferior parathyroid glands in an anterior /posterolateral surface of thyroid gland, Hojaji F described relation of RLN & Parathyroid gland in cadaveric study.[22, 23]

In our study12/42 (28.5%) of specimen showed superior parathyroid gland close to the location of Zuckerkandl tubercle whichwere classically found near the poster lateral aspect of the superior pole approximately 1 cm superior to zuckerkandl tubercle. The findings were confirmed with histological section & staining (Figure 1). This constant relation with the tubercle is owing to the common origin & migration of both the structures from ultimobranchial body. However, the inferior parathyroid glands develops from 3rd pharyngeal pouch along with thymus hence, it were not observed near the tubercle & instead could have settled anywhere from lower pole of thyroid gland to mediastinum. Thus, the association of the tubercle with the superior parathyroid gland reaffirms its common origin from ultimobranchial body.

Conclusion

We found Zuckerkandl tubercle in thirty of our cadaveric studies as predominantly nodular-projectile, right sided, associated upwards with superior parathyroid gland & with a posteromedial relation to recurrent laryngeal nerve. Variations, such as those observed in this study, show that even with the most current knowledge of head and neck anatomy, Surgeons & Radiologists can still encounter rare anatomical changes that can sometimes make the surgical procedure a challenge.

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