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Landmark for Identification and Location of Parathyroid Glands during Thyroidsurgeries

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Abstract

Parathyroid glands always remain at risk of damage during the thyroid surgery as they lie in close proximity to the thyroid gland. Parathyroid glands are small endocrine glands that produce parathyroid hormone. The major function of parathyroid hormone is to maintain the level of calcium and phosphate within a narrow range in the body. Aim of the present study was to locate and identify the parathyroid glands during thyroid surgery and to observe their relationship with the surgical landmarks. The present study was a prospective study conducted in the department of otorhinolaryngology and HNS in SMGSH, GMC, Jammu for a time period of 1 year from Nov.2015 to Oct. 2016. 40 patients undergoing thyroid surgery were included in the study. Meticulous technique was employed during dissection and parathyroid glands were identified in the surgical field. Location of the each parathyroid gland was determined in relation to a nearby surgical landmark. The study included 12 right (R) and 8 left (L) hemithyroidectomies, 10 sub- total thyroidectomies and 1 total thyroidectomy. An average of 1.2 parathyroid glands were identified in hemithyroidectomies and 2.4 was the average number of parathyroid glands identified in subtotal and total thyroidectomies. Location of parathyroid glands was observed in relation to cricothyroid (CT) joint, recurrent laryngeal nerve (RLN), inferior thyroid artery (ITA) and tubercle of Zukerkandl for superior parathyroid glands, and in relation to RLN, RLN & ITA junction, tubercle of Zukerdandl & lower pole for inferior parathyroid glands. In this study RLN was the most frequent landmark for identification of superior parathyroid gland while the inferior parathyroid glands were frequently seen related to the lower pole of the thyroid gland.

Key Words

Surgical Landmarks, Thyroid Surgery, Recurrent Laryngeal Nerve, Inferior Thyroid Artery

Introduction

Parathyroid glands were the last of the organs to be discovered in humans. They were first discovered in Indian rhinoceros, by Richard Owen, in 1850, who described them as "a small, compact, yellow glandular body that was attached to the thyroid at the point where the veins emerged."

In 1877, a Swedish anatomist, Ivar Victor Sandstrom, described the gross anatomy and microscopic appearance of parathyroid glands in humans and suggested the name, 'glandulae thyroideae'. He described the glands in his monograph "On a New Gland in Man and Fellow Animals" (1).Typically there are four parathyroid glands in humans, one superior and one inferior on each side of the thyroid gland.

Superior parathyroid glands are less variable, most typically located near the crico-thyroid joint, just superior to where recurrent laryngeal nerve enters the larynx. This is the level of Zukerkandl's tubercle, the lateral projection from the thyroid gland. When it is present, the superior parathyroid glands are always superior and inferior parathyroid glands are inferior to it.(2)

The inferior parathyroid gland is found in a plane anterior to the recurrent laryngeal nerve, and just inferior, lateral or posterior to the inferior pole of the thyroid gland, in the vicinity of thyro-thymic tract. Sometimes it is carried with the thymus, into the anterior mediastinum, in the aortopulmonary window, or in the pericardium. Sometimes it is left in the carotid sheath.

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Due to variable position of parathyroid glands and difficulty in identification, different landmarks are taken into consideration for their identification like tubercle of Zukerkandl, recurrent laryngeal nerve, inferior thyroid artery, lower pole of thyroid gland.

Damage to the parathyroid glands during the thyroid surgery depends on the indication for thyroid surgery, extent of thyroid resection, anatomy of parathyroid glands, relation of parathyroid glands to the thyroid glands and their delicate blood supply.(3) Incidental parathyroidectomy is also not uncommon following thyroidectomy and in significant number of cases it may be due to the intrathyroid location of parathyroid glands. Incidental parathyroidectomy may be considered as preventable complication of thyroid surgery. The purpose of our study was to identify and locate the parathyroid glands during thyroid surgery.

Materials and Methods

The present study was a prospective study and was conducted in the department of Otorhinolaryngology and Head and Neck Surgery, SMGS Hospital, Jammu for a time period of 1 year from November 2015 to October 2016. Study was conducted after taking approval from the Institutional Ethical Committee GMC, Jammu. Aim of the study was to locate and identify the parathyroid glands during thyroid surgery and observe the relation of the parathyroid glands with the surgical landmarks. All the patients in Department of ENT, undergoing any thyroid surgery like Lobectomy, Hemithyroidectomy, Subtotal, Near-total and Total thyroidectomy with or without Neck dissection and Completion thyroidectomy, were included for the present study. Those patients presenting with thyroid dysfunction were first managed medically to make them euthyroid before being taken up for the surgery. Patients already diagnosed as having parathyroid adenoma, patients with preoperative hyperparathyroidism and those with thyroid malignancy involving the parathyroid glands as seen during the surgery were excluded from the study. Informed and written consent was taken from each patient regarding the procedure.

Surgical Technique

All the patients were taken up for the surgery under general anaesthesia. Thyroid gland was exposed and middle thyroid vein was ligated in the paracarotid tunnel. Superior thyroid vessels were ligated individually. Superior parathyroid gland was searched for at this point. The muscles and fascia were elevated from the inferior pole and the recurrent laryngeal nerve (RLN) indentified. The gland was mobilised medially and the inferior and superior parathyroid glands was looked for close to the RLN.

Extra capsular dissection was performed preserving the RLN and parathyroid glands. Vessels were ligated directly on the surface of the thyroid gland capsule. Parathyroids were peeled away as the dissection proceeded medially. Attempt was made to identify as many parathyroid glands as possible in the surgical field and to preserve those identified. In cases of lobectomy or hemithyroidectomy only ipsilateral parathyroids were identified.

No attempt was made to search the parathyroid glands not visualised in the surgical field. In case blood supply of the parathyroid gland was compromised/damaged or the gland accidently extripated, it was autotransplanted in the corresponding sternomastoid muscle.

Parathyriod glands were identified as well as located by their structural appearance, tubercle of Zukerkandl, recurrent laryngeal nerve (RLN), inferior thyroid artery (ITA) junction, lower pole of the thyroid gland, thyroid capsule and their symmetrical location on either side.

Results

A total of 12 right (R) and 8 left (L) hemithyroidectomies, 4 subtotal, 10 total (including one completion thyroidectomy) and 1 total thyroidectomy with neck dissection were performed as shown in *table 1*. Therefore there were 27 right side and 23 left sides in the study for the assessment. For description purpose, total thyroidectomy with radical neck dissection is included in total thyroidectomy group (*Table 2*). A total of 100 parathyroid glands were expected to be identified out of which 60 (60%) were identified. 19 (70.37%) right superior and 17 (74%) left superior parathyroid glands were identified. 15 (55.56%) right inferior parathyroid glands and 9 (39%) left inferior glands were identified (*Table 3*).

In 20 hemithyroidectomy cases, 2 parathyroid glands were seen in each of the 9(45%) patients, in 6(30%) patients only 1 parathyroid gland was identified in each while in 5(25%) patients no parathyroid gland was found. In 15 cases of subtotal and total thyroidectomy 2 glands each were seen in 8 (53.34%) patients, 4 glands were identified in 3(20%) patients each. In each of the 2(13.34%) patients, 3 glands were seen while in other 2(13.34%) patients only 1 gland was identified in each case.

Table1. Showing Type of Thyroidectomy Performed in our study

Type of Surgery	No of pts	Percentage
(R) Hemithyroidectomy	12	34.3%
(L) Hemithyroidectomy	8	22.8%
Subtotal thyroidectomy	4	11.4%
Total thyroidectomy	10	28.51%
Total thyroidectomy with Neck dissection	1	2.8%
Total	**35**	**100%**

R- right, L- left.

Table 3. Showing Total Number of Parathyroid Glands Identified out of the Number Expected in their Respective Location

Parathyroid gland type	Expected no. of PGs	No. of PGs identified
(L) superior	23	17 (74%)
(R) superior	27	19 (70.73%)
(R) inferior	27	15 (55.56%)
(L) inferior	23	9 (39%)

In the present study location of parathyroid glands had been observed in relation to CT joint, RLN, ITA and tubercle of Zukerkandl for superior parathyroid glands, and in relation to RLN, RLN & ITA junction, tubercle of Zukerdandl & lower pole for inferior parathyroid glands

In our study, 33(55%) parathyroid glands were found in relation to RLN. 10(52.63%) (R) superior and 10 (58.82%) (L) superior PGs were identified deep to the RLN. 5(33.34%) (R) inferior & 3(33.34%) (L) inferior parathyroid glands were positioned anterior to the plane of RLN (Table 5 & 6).

19 (22.22%) parathyroid glands were located in relation to the tubercle of Zukerkandl. 6(31.57%) out of 19 (R) superior and 5(29.41%) out of (L) superior glands were identified in relation to tubercle of Zukerkandl being superior to it. 4(26.67%) out of 15 (R) inferior & 4(44.45%) out of 9 (L) inferior PG were seen located inferior to it.

In our study, 17 (28.34%) parathyroid glands were located in relation to the inferior thyroid artery (ITA).

Table2. Showing Type of Thyroidectomy Performed in Our Study

Type of surgery	No. of parathyroid glands expected	No. of parathyroid glands identified in our study
R Hemithyroidectomy (n=12)	24	16 (66.67%)
L Hemithyroidectomy (n=8)	16	8 (50%)
Subtotal thyroidectomy (n=4)	16	11 (68.75%)
Total thyroidectomy (n=11)	44	25 (56.81%)
Total (n=35)	100	60(60%)

R- right, L- left.

Table 4. Surgical Landmarks Used and Number of Parathyroid Glands Identified in Their Relation

S.No.	Landmark	No of PGs
1.	RLN	33/60 (55%)
2.	Lower pole	12/24 (50%)
3.	CT joint	8/36 (28.34%)
4.	ITA	17/60 (28.34%)
5.	Tubercle of Zukerkandl	19/60 (22.22%)

ITA was helpful in 5(26.31%) (R) superior and 5(29.41%) (L) superior PG identification. ITA was helpful in 5(33.34%) out of (R) inferior and 1(11.12%) out of 9 (L) inferior PG identification.

We identified 8(28.34%) superior parathyroid glands in relation to cricothyroid (CT) joint. 5 (26.31%) out of 19 on (R) side and 3 (17.64%) out of 17 on (L) side were in relation to CT joint above the RLN and ITA junction. In some cases more than 1 landmark was used for identification of parathyroid gland.

Discussion

There are many fragile and physiologically essential structures near the thyroid gland, particularly the parathyroid glands (PGs) and recurrent laryngeal nerve. One of the most common complications of the thyroid surgery is hypocalcaemia.(4) At least two functional

Table 5. No. of right (R) and left (L) superior parathyroid glands located in relation to the following landmarks.

Landmark	R	L
RLN	10 (52.63%)	10 (58.82%)
Tubercle of Zukerkandl	6 (31.57%)	5 (29.41%)
ITA	5 (226.31%)	5 (29.41%)
CT joint	5 (26.31%)	3 (17.64%)

Table 6. No. of right(R) and left (L) inferior parathyroid glands located in relation to the following landmarks.

Landmark	R	L
Lower pole	7 (46.67%)	5 (55.54%)
Tubercle of Zukerkandl	4 (26.67%)	4 (44.45%)
RLN	5 (33.34%)	3 (33.34%)
ITA &RLN junction	5 (33.34%)	1 (11.12%)

parathyroid glands are necessary to prevent postoperative hypocalcaemia (5). To minimize the risk of these complications, the operating surgeon should have in depth knowledge of the anatomy of the thyroid and parathyroid glands. Moreover knowledge of the relation of parathyroid glands to the surgical landmarks helps in preventing inadvertent injury to the glands.

In the present study, all the patients were in the age ranging between 20-63 years with mean age 36.17 ± 13.18 years. In the present study, 28 (80%) were females (F) and 7(20%) males (M) with female to male ratio (F:M) of 8:1 which is comparable to previous studies(6,7, 8). Both benign and malignant thyroid swellings were included in the study. We had 24(71.42%) patients with benign thyroid swelling. Remaining 11(31.43%) patients had malignant thyroid tumor. The results are comparable to Shaha AR who reported 88% thyroid tumors as benign and 12% as malignant thyroid tumors.(9)

Considering that there are typically 4 parathyroid glands, 2 parathyroid glands were expected to be identified in a hemithyroidectomy while 4 parathyroid glands are expected in a subtotal or total thyroidectomy. A total of 100 parathyroid glands were expected to be identified out of which 60 (60%) were identified. Our result is comparable to Sheahan P et al. (10) who identified 490 (57.97%)out of expected 860 glands during thyroid surgery and Rulison ET (11) who identified 17(42%) glands on 10 cadavers. During the thyroid surgery over-enthusiastic approach to search for parathyroid gland can cause trauma to it resulting in increased risk postoperative hypocalcaemia.

Superior parathyroid glands are more constant in their location owing to their development and migration pattern (12,13). Inferior parathyroid glands develop from the third pharyngeal pouch along with thymus. It settles anywhere near the lower pole to the mediastinum. This makes it less likely to be identified as compared to the superior parathyroid. In our study, superior parathyroid glands were more frequently identified than their inferior counterparts. Sheahan P *et al.*(10) had identified all the respective glands with almost same frequency.

Different authors have used different surgical landmarks for identification of the parathyroid glands. In the present study, location of parathyroid glands had been observed in relation to CT joint, RLN, ITA and RLN junction and tubercle of Zukerkandl for superior parathyroid glands, and in relation to RLN, RLN & ITA junction, tubercle of Zukerdandl & lower pole for inferior parathyroid glands. These landmarks aid in identification and differentiating superior from the inferior parathyroid gland. Location of the parathyroid gland related to more than one landmark was also noted. Our pattern of locating the parathyroid glands is comparable to that of Sheahan P *et al.* (10). In a cadaveric study, Milzner RJ (14) described location in relation to thyroid vessels & capsule. Wang C (15) reported 42% of inferior PGs located in the anterior or postero- lateral surface of lower pole of the thyroid gland. Hojaji F *et al.*(16) found relation of RLN and the parathyroid glands in the cadaveric study.

In our study, 52.63% of the (R) superior and 58.82% of (L) superior PGs were identified deep to the RLN. RLN was observed to be more frequent landmark for identification of superior parathyroid gland followed by the tubercle of Zukerkandl, 31.57% and 29.41% for (R) and (L) side respectively. Ackerstrom G (17) reported 80% of the superior parathyroid glands posterior and superior RLN. Lower pole was the most frequent

landmark for the inferior parathyroid gland, 46.67% for (R) and 55.54% for (L) side. Similar results had been shown in the studies by Wang C (15) and Policeni BA (18), in which inferior parathyroid glands were related to lower pole in 42% and 50% respectively. RLN was the second common landmark (33.34% on both sides) for inferior parathyroid gland in our study.

There is much variation in the literature for describing the location of parathyroid glands to the surgical landmarks. However, meticulous technique of surgery and knowledge of anatomical relation of parathyroid glands to the surgical landmarks helps in avoiding trauma to the parathyroid glands. Our study was dedicated to identify parathyroid glands and describe their relation to various surgical landmarks during thyroid surgeries.

Conclusion

Identification of the parathyroid glands is important to prevent postoperative hypocalcaemia. Parathyroid glands are variable in number and location. Awareness of their location in relation to the surgical landmarks is crucial for the operating surgeon to avoid any inadvertent injury to the glands or their blood supply. Superior parathyroid glands are more constant in the location and thus more likely to be identified than the inferior parathyroid glands. Parathyroid glands are identified in a better way by the surgical landmarks like RLN, ITA, tubercle of Zukerkandl, CT joint and the lower pole of the thyroid gland. RLN is the most frequent landmark for identification of superior parathyroid gland while the inferior parathyroid glands are frequently around the lower pole of the thyroid gland.

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