Preservation of the Parathyroids in Thyroid Surgery

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Abstract: This article presents the importance of surgical anatomy of the superior and inferior thyroid arteries for the preservation of the parathyroid glands during total thyroidectomy. A superior to inferior surgical dissection technique is described for the preservation of these glands. Following the principles outlined in this report the the incidence of post-operative hypoparathyroidism decreased by 77%.

Introduction: As we are growing of age and learning curves are plateauing, the myths of thyroid surgery are slowly unraveling. When one looks back upon the misadventures and lessons learnt, it is now common knowledge that injuries to either the external branch of the superior laryngeal or the recurrent laryngeal nerve (RLN) take a far second seat to injury or unintentional removal of the parathyroid glands with resultant hypoparathyroidism. No matter how dramatic the effects of nerve injuries, either unilateral or bilateral, following thyroid surgeries they are hardly life threatening and rarely if ever fatal. Author sadly admits to losing one patient in his tribal thyroid surgical experience due to parathyroid shut down 11 months after surgery and is prompted to share his views on this surgical complication. Parathyroid dysfunction may be evident within 24 hours due to perennially undernourished and relatively low calcium reserve status of tribal population. The present synopsis addresses ways of avoiding this complication.

Normal Anatomy: The parathyroids vary in numbers and various authors report varying numbers and their incidences could be as follows. The number may vary from 1-12 but it is normally 4 (87%), 2 superior and 2 inferior. But there may be 3 glands (6%) 5 glands (0.2%) and 6 glands (0.6%).

The typical number of parathyroid glands is 2 pairs per person (in relation to thyroid gland) was externally visible only in fifty percent (50%) of cases. According to this study, middle third of posterior border of thyroid gland lodged most of the glands (60-65%).

The average weight of a parathyroid gland is 35 mg. The combined weight of the two superior and two inferior glands is approximately 135 mg. Anatomically, the superior parathyroids are most consistent in location as they develop from the 4th branchial arch, which is the same as the thyroid. They are found within one centimeter of the cricoaretenoid joint on the posterior surface of the upper pole of the thyroid gland. The inferior parathyroids are very variable in their location as they develop from the 3rd branchial arch, same as the thymus and can be dragged down for a variable distance in the superior mediastinum.

Because the location of the parathyroid glands is quite variable, the surgical approach must be based on a thorough knowledge of the embryological development of the parathyroids, and their most common locations. The superior parathyroid glands are less variable in location, with approximately 75% being
Located either cricothyroidal or juxtathyroidal, and the remainder are located primarily behind the upper pole of the thyroid gland. One percent, however, will be located either retro-esophageal or retropharyngeal. The inferior parathyroid glands are more variable; approximately 40% are located in the tissue immediately adjacent to the lower pole of the thyroid (both anteriorly and posteriorly) and another 40% are located in the tongue of thymic tissue between the inferior border of the thyroid gland and the clavicle. Fifteen percent will be located juxtathyroidal, approximately 1% are located in the mediastinum, and 2% are ectopic, at any location along the migrational path from the base of tongue to the lower neck. For superior and inferior parathyroids, approximately 2% to 5% of glands will be located intrathyroid.

Physiological Impact of Parathyroid Avascularisation - Hypocalcemia: Hypocalcemia following total thyroidectomy is the most common reversible complication of this type of surgery. Early recognition through serial examination and serum calcium analysis is imperative. For this reason, it is recommended that total serum calcium (or ionized calcium), magnesium, and albumin levels be analyzed every 8 to 12 hours. (If a parathyroidectomy is performed for primary hyperparathyroidism, calcium should be monitored for at least 72 hours after surgery. This can be performed on an outpatient basis). A low threshold should be maintained for replacement of calcium if signs are observed of overt hypocalcemia (fatigue, confusion, muscle spasm, Chvostek’s sign, Trousseau’s sign) or corrected calcium are less than 7.0 mg/dl. Calcium replacement should be given in the form of calcium gluconate (1 gm in 100 mL normal saline given over 4 hours) and oral calcium supplementation should be initiated. Because of the increased lability of serum calcium levels in the postoperative periods in cases of secondary and tertiary hyperparathyroidism, serum calcium determinations must be made every 6 to 8 hours for first few days. In addition, consideration of preventative treatment with calcitriol may be considered.  

A post-operative 1-hour PTH cut-off of < or = 15 ng/L for prophylactic supplementation should allow the prevention of the majority of cases of hypocalcemia, leading to significant cost savings by shortening hospital stays.

PTH assay, when checked 1 to 6 hours after thyroidectomy, has excellent accuracy in determining which patients will become symptomatically hypocalcemic. Routine use of this assay should be considered because it may allow earlier discharge of the normocalcemic patient and earlier identification of patients requiring treatment of postthyroidectomy hypocalcemia.

Vascularity of Parathyroid: A consistent finding that has impressed the author is that the main blood supply of both the superior and inferior parathyroid is the inferior thyroid artery and there is a definite fascial compartment. Identifying and respecting this fascial compartment will save the blood supply to the parathyroids. In most cases, the inferior thyroid artery contributes minimally to the thyroid gland with most of the blood supply going to the parathyroids.

Avoiding surgical insult through handling or devascularising the parathyroid gland is of utmost importance in thyroid surgeries and following a superior to inferior dissection technique is recommended.

Superior to Inferior Dissection – View YouTube Video: [https://youtu.be/YgsQJS03adU](https://youtu.be/YgsQJS03adU)

See Enlarged Pictures At End of Document
Figure 1 (left): The right Inferior Thyroid Artery (ITA) can be seen supplying the Inferior Parathyroid Gland (IPT). (RLN: Recurrent Laryngeal Nerve, SPT: Superior Parathyroid) Note: Left side dissection, patient's head to the right of the picture.

Figure 2 (middle): The right Inferior Thyroid Artery (ITA) supplies the parathyroid gland with minimal supply to the thyroid gland. Note: Right side dissection, patient's head to the top of the picture.

Figure 3 (right): The right Inferior Thyroid Artery (ITA) can be seen supplying the Inferior Parathyroid Gland (IPT). (RLN: Recurrent Laryngeal Nerve). Note: Right side dissection, patient's head to the top of the picture.

In a total of 307 patients, pathological findings showed inadvertent parathyroidectomy in 12% of cases. Of these, 32% were recognized intraoperatively. The parathyroid tissue was found in extracapsular locations in 37% of cases, intracapsular locations in 39%, and intrathyroidal locations in 24%. Careful examinations of the surgical specimen intraoperatively decreases the incidence of inadvertent parathyroidectomy during thyroidectomy.  

Many authors have different strategies of avoiding inadvertent removal of parathyroids and protecting the blood supply to the parathyroid gland. Although in all the advocated techniques, the main stay is doing a subcapsular dissection of the posterolateral border of the thyroid gland. The differences are generally whether one is to dissect inferior to superior vs. superior to inferior. In the former, the inferior thyroid artery is identified in the lateral carotid gutter and chased medially upwards; enroute identifying the recurrent laryngeal nerve and the parathyroids. Although this is quite nice and a safe technique, the author prefers the superior to inferior approach which is illustrated as below.

**Superior to Inferior Dissection:** The dissection of the parathyroids begins superiorly after ligating the superior thyroid artery, preferably after the delivery of the posterior branch of the superior thyroid artery as it often communicates with the ascending branch of the inferior thyroid artery. Staying in the subcapsular plane very close on the posterior surface of the upper thyroid pole, the superior parathyroid is identified as a deep yellow ovoid mass, which soon turns into purple should you handle it roughly. The plane, thus, found is pursued inferiorly and medially onto the cricothyroid joint. In this region, the RLN is identified entering the larynx. Figure 1 demonstrates the RLN in its fascial covering. Dissection is carried medially and inferiorly to identify the twigs of the inferior thyroid artery. Now the dissection proceeds inferiorly and laterally, staying in front of and anterior to the inferior thyroid artery. Only those branches of the inferior thyroid artery which are seen to enter the gland are ligated and the dissection proceeds laterally and inferiorly until the lowermost limit of inferior parathyroid gland tissue is pushed out laterally into its fascial / vascular plane out of harms way.
The author finds this the simplest and surest way of not only identifying and preserving the parathyroid but also protecting its vasculature, which is safe in its fascial compartment.

**Our experience of parathyroid dysfunction:**

Many of the patients that present to the author's clinic present with very large thyroids and advanced disease. In our initial series, hypoparathyroidism was found in 17 of 55 patients. After the refinement of the techniques of parathyroid preservation, our rate of post operative hypoparathyroidism dramatically decreased to 4 out of 56 patients. (Chi Square: p<0.005)

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**Case Study from 1994 to 2002 - Total Number of Total Thyroidectomies: 55**

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<th>Day 3</th>
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Calcium Support Required For Six Weeks or Less

Greater Than Six Weeks

Metabolic Deaths 1

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**Case Study from 2002 to 2006 - Total Number of Total Thyroidectomies: 56**

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<td>2</td>
<td>6</td>
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Calcium Support Required For Six Weeks or Less

Greater Than Six Weeks 2

Metabolic Deaths None

**Changing Dictums in Thyroid Surgery:** From the early days of my training in thyroid surgery, there was a simple dictum to address the blood supply of thyroid. Ligate the superior thyroid artery close to the gland and inferior thyroid artery away from the gland was the order. However, more years of work in tribal area has taught a lesson that such ligature would completely deprive the parathyroid blood supply – more so if you would to do a bilateral dissection. Hence the dictum needs to change. The new order should be to ligate the superior thyroid artery after identifying and saving its anastomotic vessel to inferior thyroid artery.
and ligate the inferior thyroid artery close to the gland if at all possible. This saves the dissection in the vascular plane and protects not only the external branch of the superior laryngeal nerve and the recurrent laryngeal nerve with all its branches but it also more importantly protects the blood supply of the parathyroid glands.

**Conclusion:** We have realized over a decade of thyroid surgical work in tribal settings that the real issue in thyroid surgery is not the recurrent laryngeal nerve or the external branch of the superior laryngeal nerve but preserving parathyroid function. This article does not address the issue of parathyroid reimplantation since this is a separate disciplined discussion. We strongly recommend subcapsular medial / lateral dissection to prevent physical as well as vascular insult to parathyroid glands in total thyroidectomies.

**References:**


