

Research Article

Location of Parathyroid Glands during Thyroid Surgery: An Anatomical Study in a Surgical Series

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Introduction: Performance of good thyroid surgery requires thorough knowledge location of parathyroid glands, in order to avoid inadvertent damage or resection leading to postoperative hypoparathyroidism. The purpose of the present study was to describe the location of normal parathyroid glands in our surgical series.

Methods: Prospective cohort study of 282 consecutive thyroid and parathyroid surgeries performed over a 2-year period by a single surgeon.

Results: The most common location for superior parathyroid glands was just above the Tubercle of Zuckerkandl, and the most common location for inferior parathyroid glands was superficially on the lateral surface of the thyroid. Inferior parathyroid gland locations demonstrated greater variability than that of superior glands. Just under one half of superior parathyroid glands and one quarter of inferior thyroid glands were related to the location of the Tubercle of Zuckerkandl.

Conclusion: The location of parathyroid glands in patients undergoing thyroid surgery shows significant variability. Awareness of possible locations of these glands is critical for the thyroid surgeon.

Keywords: Thyroidectomy; Parathyroid; Location; Anatomy

Abbreviation

RLN: Recurrent Laryngeal Nerve

Introduction

The number of thyroid operations performed has increased in recent years [1]. In experienced hands, major morbidity from thyroid surgery is uncommon. Perhaps the most common complication of thyroidectomy is postoperative hypocalcaemia. In most cases, post-thyroidectomy hypocalcaemia is a temporary; however, permanent hypoparathyroidism may develop in a minority of patients [2,3].

Post-thyroidectomy hypocalcaemia arises due to postoperative hypoparathyroidism secondary to intraoperative trauma to parathyroid glands, disruption of parathyroid blood supply, or inadvertent parathyroid resection. To minimize the risk of these complications, a thorough knowledge of the anatomy of the thyroid and parathyroid glands is essential. In particular, awareness of the likely position of parathyroid glands is critical to avoid postoperative hypoparathyroidism.

Most individuals have 4 parathyroid glands, comprising one superior and one inferior gland on each side, although supernumerary parathyroids are believed to be present in 5% [4]. The superior parathyroid gland originates endoderm of the fourth branchial pouch, and migrates towards the developing gland with the lateral thyroid process (ultimobranchial body). The inferior parathyroid gland originates from the third branchial pouch and migrates caudally with the developing thymus gland [5]. The Tubercle of Zuckerkandl is a lateral projections from the thyroid, which is believed to represent

remnants of the lateral thyroid process, and, when present, separates the parathyroid glands, with the superior gland always being located cephalad, and the inferior caudad [5]. When present, it serves as a useful landmark for the Recurrent Laryngeal Nerve (RLN), which it nearly always overlies in the vicinity of its extralaryngeal termination [6,7]. The thyrothymic ligament represents the remnants of the embryological path of descent of the thymus gland. When present, it may contain the inferior or supernumerary parathyroid glands [5].

The purpose of the present study was to describe the location of parathyroid glands in a series of patients undergoing thyroid or parathyroid surgery.

Methods

This was a prospective study of 282 consecutive thyroid and parathyroid surgeries performed by the senior author (PS) between May 2012 and September 2014. Exclusion criteria for the present study were cases which had gone previous thyroid or parathyroid surgery on the side ipsilateral to that being dissected. A prospective database was maintained into which anatomical, patient demographic, and other clinicopathological details were entered immediately after surgery.

The surgical technique employed in most cases in the present series was a capsular dissection technique, with reflection of parathyroid glands and / or parathyroid-containing tissue off the thyroid gland, without disruption of parathyroid blood supply. Parathyroid glands were “watched out for”, but if not readily identifiable, they were not systemically sought. We have shown that this technique does not lead to any increased risk of hypocalcaemia [2]. Criteria used to positively

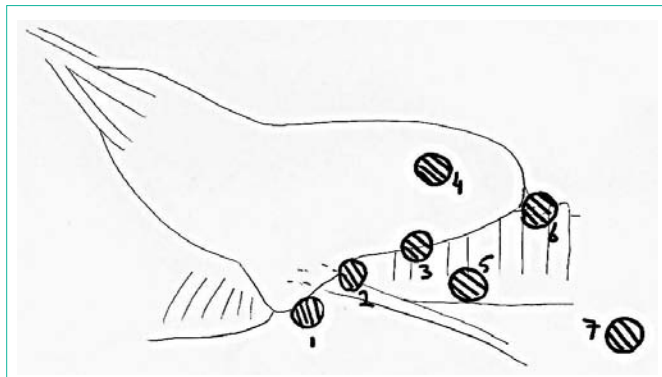


Figure 1: Location of inferior parathyroid glands.
Abbreviations: TZ: Tubercle of Zuckerkandl; RLN: Recurrent Laryngeal Nerve; 1: At or just caudad to TZ; 2: Overlying RLN; 3: Deeply located on lateral surface of thyroid; 4: Superficially located on lateral surface of thyroid; 5: Deeply located, away from lower lateral surface of thyroid; 6: Thyrothymic ligament; 7: Superior mediastinum

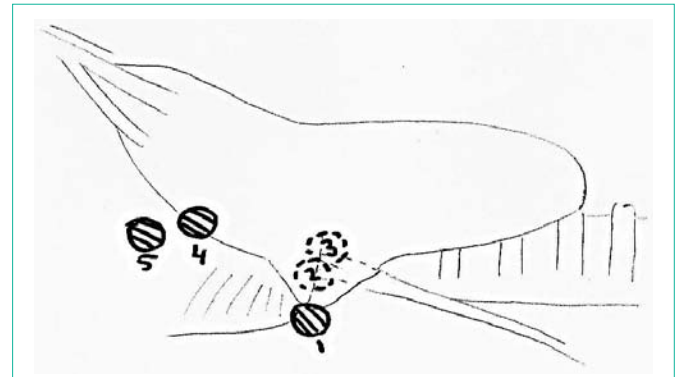


Figure 2: Location of superior parathyroid glands.
Abbreviations: TZ: Tubercle of Zuckerkandl; RLN: Recurrent Laryngeal Nerve; 1: At or just cranial to TZ; 2: Overlying RLN; 3: Low down on deep surface of thyroid, medial to RLN (not seen from above during mobilization of upper pole); 4: Deep surface of thyroid (seen from above during mobilization of upper pole); 5: Away from deep surface of thyroid

identify parathyroid glands were characteristic colour (caramel yellow-brown) and consistency (firm, well-defined, and non-friable), with or without colour change with devascularisation in certain cases. Positive identification of parathyroid was made only where the senior author was confident that parathyroid was unequivocally identified. Cases of “possible” parathyroids were considered to not have been positively identified.

The positions of parathyroid glands were free-texted into the prospective database just after surgery. For the purpose of the present study, these were grouped post-hoc into location categories. Inferior parathyroid glands were accordingly grouped into the following locations: (1) around or just caudad to the Tubercle of Zuckerkandl, or the expected position of the Tubercle of Zuckerkandl; (2) overlying the recurrent laryngeal nerve (RLN), caudad to the position of the Tubercle of Zuckerkandl; (3) deeply located on the lateral surface of the thyroid, caudad to the Tubercle of Zuckerkandl, and clear of the RLN; (4) superficially on the lateral surface of the thyroid; (5) deeply located, near to but clear of the lower surface of the thyroid, in paratracheal tissue; (6) in the thyrothymic ligament; (7) in the superior mediastinum (Figure 1). Location of superior parathyroid glands were grouped as follows: (1) around or just cranial to the Tubercle of Zuckerkandl, or the expected position of the Tubercle of Zuckerkandl; (2) just overlying or otherwise closely associated with the termination of the RLN; (3) low down on the deep surface of the superior pole, medial to the RLN, usually only encountered during dissection of the Tubercle of Zuckerkandl and cricotracheal region; (4) on the deep surface of the superior pole, encountered during mobilization of the superior pole from above, prior to dissection in the cricotracheal region; and (5) near to but clear of the deep surface of the superior thyroid pole (Figure 2).

Results

Of the 282 consecutive cases performed during the study period, 7 were excluded due to being revision cases. Of the remaining 275 cases, there were 145 total thyroidectomies, 115 thyroid lobectomies (56 right, 59 left), 10 bilateral parathyroid explorations, and 5 unilateral parathyroid explorations (2 right, 3 left). Thus there were 213 right sides, and 217 left sides, available for evaluation.

There were 134 right inferior parathyroids (62.9%), 120 right superior parathyroids (56.3%), 117 left inferior parathyroids (53.9%), and 119 left superior parathyroids (54.8%), recorded as having been definitively identified intraoperatively. The positions of these are given in Tables 1 and 2.

The most common location for inferior parathyroids was superficially on the lateral surface of the thyroid, followed by at or just below the Tubercle of Zuckerkandl or expected location of the Tubercle of Zuckerkandl, or deeply located on the lateral surface of the thyroid, caudad to the location of the Tubercle of Zuckerkandl (Table 1). For superior parathyroids, the most common locations were just above the Tubercle of Zuckerkandl or expected position of the Tubercle of Zuckerkandl, or on the deep surface of the superior pole, during mobilization of the superior pole from above (Table 2).

Discussion

Description of the location of parathyroid glands based on surgical series poses some challenges. These include the criteria used to define intraoperative parathyroid identification; rigour in seeking parathyroid glands; surgical technique; surgical approach; and presence of pathological parathyroid glands. In many instances, parathyroid glands are easily recognizable. However, in many cases, putative parathyroid glands can be very difficult to differentiate from lymph nodes, fatty issue, or thyroid nodules. In such cases, identification of parathyroid becomes highly subjective, depending to a large degree on the surgeon’s experience and honesty, as well

Table 1: Locations of inferior parathyroid glands.

| | | Right n=134 | Left n=117 |
|---|--|----------------|---------------|
| 1 | At or just caudad to Tubercle of Zuckerkandl | 34* | 27 |
| 2 | Overlying RLN | 8 | 8 |
| 3 | Deeply located on lateral surface of thyroid | 21 | 24 |
| 4 | Superficially located on lateral surface of thyroid | 46* | 38 |
| 5 | Deeply located, away from lower lateral surface of thyroid | 16 | 13 |
| 6 | Thyrothymic ligament | 8 | 6 |
| 7 | Superior Mediastinum | 2 | 1 |

* One case with two inferior parathyroid glands identified.

Table 2: Locations of superior parathyroid glands.

| | | Right n=120 | Left n=119 |
|---|--|----------------|---------------|
| 1 | At or just cranial to Tubercle of Zuckerkandl | 56 | 54 |
| 2 | Overlying RLN | 5 | 5 |
| 3 | Low down on deep surface of thyroid, medial to RLN (not seen from above during mobilization of upper pole) | 7 | 14 |
| 4 | Deep surface of thyroid (seen from above during mobilization of upper pole) | 42 | 42 |
| 5 | Away from deep surface of thyroid | 10 | 4 |

as threshold for deeming a structure to be a parathyroid gland. In the present series, all operations were performed by a single high-volume surgeon, with a high threshold for calling parathyroid, which should minimize variability in definition of positive parathyroid identification within the series, however, this was still a subjective assessment which could be subject to inter-observer variability. The likelihood of identifying parathyroid glands is also highly dependent on surgical technique and diligence in seeking parathyroid glands. In the present series, we employed a capsular dissection technique, with parathyroid glands watched for, but without systematically seeking parathyroid glands that were not readily visible [2]. Therefore it is possible that a different surgical technique, and / or a greater diligence in systematically identify in gall parathyroid glands, may have also yielded different results. Surgical technique and approach may also influence the reported location of parathyroid glands due to the perceived location of parathyroid glands being altered by retraction, release of adhesions, or other surgical interference prior to the glands being definitively recognized. Finally, pathological enlargement of parathyroid glands may lead to shifts in the position over time, possibly amplified by ongoing repeated movements of the larynx and thyroid gland with swallowing. Therefore, case series reporting on locations of parathyroid adenomas may report different locations to those of normal parathyroid glands in thyroidectomy series.

The results of our study show significant variability in parathyroid location, similar to the findings of other authors [8]. The Tubercle of Zuckerkandl was a useful landmark for identifying just under one half of superior parathyroids, and only one quarter of inferior parathyroids. The Tubercle of Zuckerkandl is a frequent landmark on the lateral surface of the thyroid which nearly always overlies the RLN, and serves as a very useful landmark for this structure [7]. We have previously reported the Tubercle of Zuckerkandl to be present in 61% of all thyroid lobes [7] and to be more commonly encountered, and consistently larger, on the right than on the left side [6]. As well as being an important landmark for the RLN, the Tubercle of Zuckerkandl separates the superior from inferior parathyroid glands, and so may aid in identification of these structures. However, the utility of the Tubercle of Zuckerkandl as a landmark for parathyroid glands is limited by the variability in location of parathyroids, as demonstrated in the present study, where the Tubercle of Zuckerkandl location was found to be related to just under one quarter of inferior parathyroids, and under one half of superior parathyroids.

Over one third of inferior parathyroid glands were located superficially up on the lateral surface of the lower thyroid lobe. These glands are particularly vulnerable to inadvertent resection or disruption to blood supply during thyroidectomy, as they are often closely associated with thyroid capsule, and thus easily removed with the specimen, or vulnerable to vascular disruption when mobilizing

the thyroid if extracapsular dissection is performed deep to the level of these glands. Thus, we recommend a capsular dissection technique, where dissection takes place right on the thyroid capsule, in order to ensure that these glands and their blood supplies are systematically reflected off the thyroid and preserved during thyroidectomy.

In this series, we distinguished between parathyroid glands that were deeply located, and associated with the capsule of the thyroid, and those which appeared to be clear of the thyroid capsule, or located "away" from the capsule (location #5 for both superior and inferior). The clinical significance of this distinction is that we believe those glands which are located "away" from the thyroid are easier to preserve with low risk of trauma during thyroid mobilization. In cases where parathyroid glands are covered in fat, it is likely that those located "away" from the thyroid may not be apparent to the surgeon who performs thyroidectomy utilizing a capsular dissection technique, unless the fatty tissue is deliberately dissected in an effort to definitely identify the parathyroids. In the present series, it was not our practice to seek glands that were not readily obvious. We believe many glands which were not seen may have been located in juxtathyroid fatty tissue. We have previously shown that a policy of not systematically dissecting this tissue in an effort to identify these glands does not lead to any higher a risk of postoperative hypocalcaemia or inadvertent parathyroid resection [2].

Our schema for describing the location of parathyroid glands is comparable to that of other authors. Rodgers et al categorized the location of parathyroids from A to G, with A to D representing locations of superior parathyroid glands, D to F representing locations of inferior parathyroid glands, and G representing intrathyroid parathyroid. The major difference between their study and ours was that theirs was based on locations of parathyroid adenomas, which may not be representative of the locations of normal parathyroid glands due to changes in the relative positions of adenomatous glands over time with growth [8]. For example, it is likely that an adenoma arising from an inferior parathyroid gland at locations #3 will come to occupy more or less the same location as an adenoma arising in locations #4 or #5, corresponding to a Type E adenoma according to Rodgers schema.

The major weaknesses in our study were the unavoidable subjectivity involved in parathyroid identification, and the fact that only 57% of parathyroids were definitively identified. However, subjectivity in a surgical series is unavoidable, as taking frozen sections to confirm parathyroid would not be justifiable due to cost and high likelihood of iatrogenic parathyroid injury; while the relatively low proportion of parathyroids identified was likely partly due to the high threshold for judging a structure to be a parathyroid, and also due to our philosophy of not systematically seeking parathyroids which are not readily obvious, on the basis that the extra dissection may increase the risk of postoperative dysfunction [2]. On the other hand, major strengths are its prospective design; the use of a consistent surgical technique and consistent criteria for parathyroid identification; and the performance of this study in a surgical series, so that, unlike cadaver studies, the findings of the locations where parathyroids are encountered are more likely to reflect the true-life surgical situation.

Conclusion

Awareness of the location of parathyroid glands during

thyroidectomy is essential to avoid inadvertent resection or vascular disruption. Inferior parathyroid glands display more variability in position and are frequently located superficially on the lateral surface of the thyroid where they may be vulnerable to inadvertent resection or vascular disruption. When present, the Tubercle of Zuckerkandl separates the inferior and superior parathyroid glands but its utility as a landmark is limited by variability in parathyroid position.

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