

Common Locations of Parathyroid Adenomas

Mauricio A. Moreno, MD¹, Glenda G. Callender, MD², Katherine Woodburn, BS², Beth S. Edeiken-Monroe, MD³, Elizabeth G. Grubbs, MD², Douglas B. Evans, MD⁴, Jeffrey E. Lee, MD², and Nancy D. Perrier, MD²

¹Department of Otolaryngology–Head and Neck Surgery, University of Arkansas for Medical Sciences, Little Rock, AR;

²Department of Surgical Oncology, Unit 444, University of Texas M. D. Anderson Cancer Center, Houston, TX;

³Department of Diagnostic Radiology, The University of Texas M. D. Anderson Cancer Center, Houston, TX; ⁴Department of Surgery, Medical College of Wisconsin, Milwaukee, WI

ABSTRACT

Background. We have developed a nomenclature system that succinctly specifies the locations of parathyroid adenomas in the neck. We report our experience using the system in a large, contemporary cohort of patients.

Methods. A prospective, endocrine surgery database at a single, tertiary care center was retrospectively analyzed. We reviewed the records of 271 patients operated on for sporadic primary hyperparathyroidism between January 2006 and May 2008 and analyzed the effect of adenoma location at operative intervention and outcome.

Results. Adenomatous gland locations were classified intraoperatively as: A (adherent to posterior thyroid capsule) in 12.5% of cases; B (tracheoesophageal groove) in 17.3%; C TE groove but (close to clavicle) in 13.7%; D (directly over the recurrent laryngeal nerve) in 12.2%; E (easy to identify, inferior thyroid pole) in 25.8%; F (fallen into thymus) in 7.4%; and G gauge (within thyroid gland) in 0.4%. More than one enlarged gland was present in 10.7% of patients and usually involved coexistence of enlarged types A and E glands. Type F glands were associated with a longer mean operative time ($p = 0.0487$) and type E glands with a higher rate of outpatient surgery ($p = 0.0195$). At 6 months from the surgery, 94.5% of the patients were normocalcemic.

Conclusions. Our nomenclature system provides a simple way to describe the locations of parathyroid adenomas. Type E adenomas were associated with a higher rate of outpatient surgery and type F adenomas with a longer

operative time. Biochemical cure rates were comparable for all locations of single adenomas.

The locations of the parathyroid glands vary considerably among individuals, and this variation can lead to failure to excise all adenomatous parathyroids during surgery for hyperparathyroidism.^{1,2} Despite major advances in the diagnosis and surgical management of sporadic primary hyperparathyroidism, the lack of a consistent, reliable system for radiologists, endocrinologists, surgeons, and others to communicate the exact locations of enlarged glands continues to impede optimal care. Wide adoption of a standardized classification system would enhance reporting of radiologic and surgical findings, enrollment of patients into multicenter trials, and comparison of outcomes between institutions.

We developed a nomenclature system that concisely and reliably describes the locations of diseased parathyroid glands to facilitate communication between specialists and to improve the continuity of care for patients with hyperparathyroidism.³ In the present study, we sought to evaluate the implementation of this system in a large, contemporary cohort of patients, describe the relative frequency of adenoma locations, and evaluate its potential impact in surgical and overall outcomes.

METHODS

We retrospectively reviewed a prospectively collected database of all patients who underwent a parathyroidectomy in the Section of Endocrine Surgery within the Department of Surgical Oncology at The University of Texas M. D. Anderson Cancer Center between January 2006 and May 2008. This cohort represents all patients treated since the development and application of our

nomenclature system. Inclusion criteria for this study were: (1) a biochemically proven diagnosis of sporadic primary hyperparathyroidism; (2) parathyroidectomy performed at our institution by one of the three faculty surgeons within the section of Surgical Endocrinology; (3) pathologic confirmation that the resected specimen contained a hypercellular parathyroid tissue; and (4) a minimum of 6 months of clinical and biochemical follow-up at our institution. Patients were excluded from the study if they: (1) underwent reoperation for recurrent or persistent hyperparathyroidism; (2) had secondary or tertiary hyperparathyroidism; (3) had multiple endocrine neoplasia syndrome; or (4) had incomplete data or less than 6 months of follow-up. This study was approved by The University of Texas M. D. Anderson Cancer Center's Institutional Review Board, and a waiver of consent was obtained.

Preoperative localization studies had been performed in all cases, and the nomenclature system had been used to describe the suspected locations of parathyroid adenomas. We routinely obtain a cervical ultrasound study, a Sestamibi scan, and/or a four-dimensional computed tomography (CT) study of the head and neck to localize parathyroid adenomas for preoperative planning. An intraoperative parathyroid hormone (IOPTH) assay had been used in all cases to determine the adequacy of resection and was indicated by a $\geq 50\%$ decrease of IOPTH value.

Intraoperative assessment provides the most accurate anatomical description of the location of parathyroid adenomas. In the present series, all data regarding gland location were obtained from intraoperative assessment and immediate classification by an experienced attending endocrine surgeon familiar with the nomenclature system.³ Our system is illustrated in Fig. 1 and is summarized as follows:

- Type A: Adherent to the posterior thyroid parenchyma, i.e., posterior to the upper pole of the thyroid but not intrathyroidal—type A glands are in the accepted, expected location of a normal parathyroid gland.
- Type B: Behind the thyroid parenchyma. Type B glands are exophytic to the thyroid parenchyma and lie in the tracheoesophageal groove. This category includes adenomas in retroesophageal, retropharyngeal, high lateral pharyngeal, and carotid sheath locations. A “B+” subcategory can be used to document the location of adenomas above the level of the hyoid bone. The “+” is meant to reflect cranial elevation.
- Type C: Caudal to the thyroid parenchyma, in the tracheoesophageal groove. A type C gland is more inferior than a type B gland on lateral

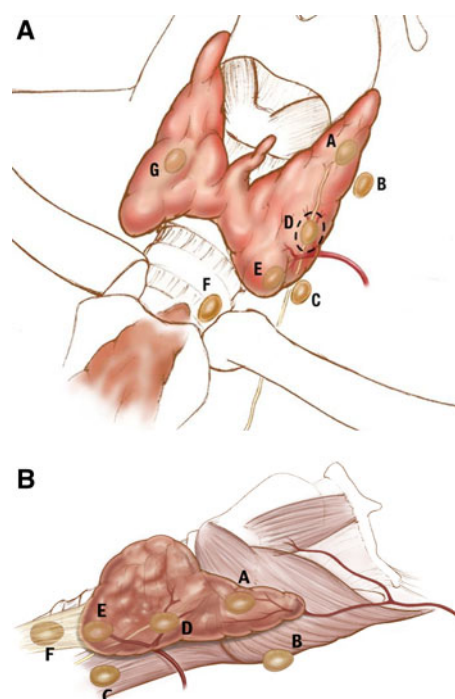


FIG. 1 Schematic representation of the nomenclature system for localization of parathyroid adenomas. Anterior view (a); right lateral view (b) of the superior thyroid pole is oriented to the left. The dotted circle depicts the region where the recurrent laryngeal nerve is most at risk

images and located inferior to the inferior pole of the thyroid (closer to the clavicle).

- Type D: Directly over the recurrent laryngeal nerve at the level of the inferior thyroid vessels. The dissection may be difficult because a type D gland is dangerously close to the recurrent laryngeal nerve.
- Type E: Located in the external aspect of the inferior pole of the thyroid. A type E gland is in a location that is more superficial in an anterior–posterior plane than the recurrent laryngeal nerve. It is the easiest to resect.
- Type F: “Fallen” into the thyrothymic ligament, below the inferior pole of the thyroid in a pretracheal plane. A type F gland is frequently referred to as an ectopic gland, and its resection usually involves transcervical delivery of the thyrothymic ligament or superior portion of the thymus.
- Type G: A gauge, true intrathyroidal gland location.

Intraoperative photography had been utilized to document the location of each parathyroid adenoma.

The database was analyzed and when necessary, patient records were reviewed. Demographics, the locations of all parathyroid adenomas, surgical dissection time, and

additional surgical procedures performed, whether patients were discharged on the day of surgery or admitted to the hospital, and postoperative complications were recorded. The surgical dissection time was defined as the time from the skin incision until the specimen was retrieved and removed from of the operative field. In our practice, patients are observed postoperatively for several hours and usually discharged home on the same day, at the discretion of the attending surgeon. Our requirements for same-day discharge include a straightforward dissection, minimal intraoperative bleeding, unilateral or limited bilateral exploration, and the patient's ability to tolerate an oral diet and having minimal pain. We considered surgical dissection time and timing of discharge to be surrogates of the technical complexity of the surgery. For this reason, all patients who underwent a simultaneous, nonparathyroid-related synchronous surgical procedure were excluded from analyses involving operative time and discharge timing.

Biochemical data at baseline, intraoperatively, and 6 months postoperatively were recorded in all patients; cure by parathyroidectomy was defined as normocalcemia 6 months after the date of surgery.

Statistical analyses were performed using Statistica software, version 8.0 (StatSoft, Inc., Tulsa, OK, USA). Differences between categorical variables were assessed by Fisher's exact test or the χ^2 test, and differences between continuous variables were assessed by two-sided Student's *t* test. Differences were considered statistically significant for *p* values <0.05.

RESULTS

Between January 2006 and May 2008, 348 patients underwent parathyroidectomy at our institution; of these, 271 patients met our inclusion criteria and were included in this study. The clinical characteristics of the study group are presented in Table 1. A synchronous surgical procedure unrelated to the treatment of the hyperparathyroidism was performed in 31 patients.

TABLE 1 Demographic characteristics of the study group

Characteristic	No. patients (<i>N</i> = 271)	%
Sex		
Male	62	22.9
Female	209	77.1
Median age (range)	60.4 years	15–91 years
Synchronous surgical procedure	31	11.4
Converted to four-gland exploration	12	4.4
Biochemical cure at 6 months	256	94.5

Thirty-two patients had surgical complications. Minor or transient complications included dysphonia in 11 cases, hypocalcemia in six cases, wound infection in five cases, phlebitis in two cases, seroma in two cases, and hypercalcemia and mild glottic edema in one case, respectively. Major complications included unilateral pneumothorax in two cases, bilateral pneumothorax in 1 case, and recurrent laryngeal nerve damage in one case. All three patients who presented with pneumothorax were managed conservatively. In the case of the recurrent laryngeal nerve damage, the nerve was inadvertently severed during the dissection of a type D gland. This patient presented with unilateral vocal cord paralysis that was addressed by a medialization laryngoplasty 6 months after the parathyroidectomy. Table 2 summarizes the intraoperative locations of the adenomas according to the previously described nomenclature system. The median surgical dissection time for the series was 30.7 (range, 3–159) minutes. The median dissection time stratifying by the location of the adenoma is presented in Table 3; dissection time was significantly longer for adenomas in location "F" versus all other single adenomas combined (*p* = 0.0487, Student's *t* test). Table 3 also shows that patients with type "E" adenomas required admission less often than all other single-gland combined (*p* = 0.0195, Fisher's exact test).

Patients with "E" adenomas required 24-h overnight hospital stay less frequently than patients with adenomas at other locations (*p* = 0.0195; Table 3). There were no significant differences in operative success rates between any of the single-adenoma location groups; only multigland disease was associated with a lower rate of normocalcemia at 6 months (*p* = 0.0139 vs. single adenomas at any location; Table 3). Twelve of the 271 (4.4%) planned minimally invasive cases were converted to standard cervical exploration; 256 (94.5%) patients met the criteria for biochemical cure.

TABLE 2 Relative distribution of parathyroid adenomas according to our nomenclature system

Gland location	No. patients (<i>N</i> = 271)	%
A	34	12.5
B	47	17.3
C	37	13.7
D	33	12.2
E	70	25.8
F	20	7.4
G	1	0.4
Multigland	29	10.7

TABLE 3 Average dissection time, length of hospital stay, and 6-month biochemical cure rates stratifying adenoma location according to our nomenclature system

Gland location	Median dissection time (min)	Outpatient procedure [‡]		Required overnight admission [‡]		Normocalcemia at 6 months		Hypercalcemia at 6 months	
		No	(%)	No	(%)	No	(%)	No	(%)
A	27.9	28	90.3	3	9.7	33	97.1	1	2.9
B	29.4	34	82.9	7	17.1	41	87.2	6	12.8
C	31.4	27	75	9	25	37	100	0	0
D	32.2	24	88.9	3	11.1	33	100	0	0
E	29.5	58	96.7 [†]	2	3.3	69	98.6	1	1.4
F	38.7 [§]	16	80	4	20	18	90	2	10
G	–	–	–	–	–	1	–	0	–
Multigland	33.8	13	52	12	48	24	82.8 [‡]	5	17.2
Overall		200	83.3	40	16.7	256	94.5	15	5.5

[§] $p = 0.0487$ (unpaired t test, “F” adenomas vs. all other single-adenoma locations)

[†] $p = 0.0195$ (Fisher’s test, “E” adenomas vs. all other single-gland locations)

[‡] $p = 0.0139$ (Fisher’s test, multigland disease vs. combined single gland locations)

[‡] Patients who underwent a synchronic, nonparathyroid-related surgical procedure were excluded from the length-of-stay analysis

DISCUSSION

Since January 2006, we have been using a nomenclature system to define the exact locations of diseased parathyroid glands. This system is known by the radiologists, surgeons, anesthesiologists, and pathologists who are involved in the treatment of hyperparathyroidism at our institution. We have presented our experience in 271 consecutive patients with parathyroid adenomas classified by this system.

The most common location of parathyroid adenomas in this series was the type E location, directly behind the inferior thyroid pole and relatively superficial compared with other locations. In our experience, resection of adenomas in this location is straightforward—hence the “E” for easiest. These cases can be usually performed under local anesthesia and via a small incision; in an academic setting these cases are optimal for resident education. This preoperative classification also is informative to the anesthesiologist, who will anticipate a short procedure, which in turn may affect the choice of anesthetic, narcotic use, and operative timing. Furthermore, in the present series, patients with type E adenomas were more likely to undergo outpatient surgery than were patients with adenomas at other locations. Although the decision to discharge a patient is subjective and surgeon-dependent, we believe that this finding suggests that patients with type E adenomas require a lesser degree of intraoperative dissection and recover faster during the immediate postoperative period.

Much less common in our series were type F (“fallen”) adenomas, which accounted for 7.4% of cases. Parathyroid adenomas at this location are of particular concern because

they are easy to miss. Resection of adenomas in this location is technically more difficult than resection in other locations, as evidenced by our finding that type F adenomas required a significantly longer mean dissection time than did single adenomas at other locations. Furthermore, we observed greater variability in the dissection time for type F adenomas than for adenomas at other locations. This finding was not surprising given that identifying a parathyroid adenoma within the thyrothymic ligament can be time-consuming and on occasion may require target-specific instrumentation, such as a sternal retractor.

The thyroid parenchyma is recognized as a potential site for “missed” adenomas.² In our series, true intrathyroidal glands—classified as type G—were exceedingly rare and accounted for only one patient (0.4%) among the group treated for single adenomas. In this particular case, preoperative imaging by US and Sestamibi scan had suggested the intrathyroidal location of the adenoma, allowing for a planned hemithyroidectomy, which successfully treated his condition. The low frequency of type G adenomas emphasizes that, in the absence of preoperative imaging suggesting an intrathyroidal gland, a thyroid lobectomy should only be performed as a method of last resort and after thorough exploration of all potential locations (A–F). The inability to identify an adenoma in the expected location during an operation invariably causes anxiety; this may lead the occasional parathyroid surgeon to perform a nonsystematic cervical exploration and reach a premature decision for hemithyroidectomy. Based on our current findings, we can only conclude that there is little role for total or hemithyroidectomy in the absence of suggestive preoperative imaging.

Since our nomenclature system is based on locations that are unique to superior and inferior glands, preoperative images may play an important role in assisting the surgeon to determine high-yield locations based on the type of “missing” gland. If preoperative images suggest a superior gland adenoma, the surgeon should concentrate in exploring locations A, B, and C, whereas locations D, E, and F should be the primary focus of exploration for expected inferior gland adenomas. Most importantly, even in the absence of relevant or accurate imaging, the nomenclature system provides a guide for performing the cervical exploration in a systematic fashion, which is particularly relevant for surgeons in training or for occasional parathyroid surgeons. Consistent exploration of locations A through F will usually yield positive findings, but if the findings are negative, the surgeon can be reassured that all likely adenoma sites have been ruled out before considering a thyroid lobectomy.

Adenomas in the type D location are in close relationship with the recurrent laryngeal nerve. Because the recurrent laryngeal nerve can not be visualized by any imaging modality knowledge of the surgical anatomy and a high index of suspicion are essential to identify type D adenomas intraoperatively. Such glands appear on the mid posterior surface of the thyroid lobe. The surgeon must be aware that the presence of an adenoma in this location, particularly if it is large, may distort the regional anatomy, making recognition of normal structures more difficult and putting the recurrent laryngeal nerve at risk. In the present series, the only case in which the nerve was injured was a type D adenoma. This experience underscores the importance of early intraoperative identification of type D adenomas. In a training environment, preoperative knowledge of such a location should prompt heightened surgical supervision.

Perhaps one of the most important advantages of the nomenclature system is that it provides a common language for specialists to interact. In our experience, the adoption of the system by radiologists has made communication much more fluent and efficient and we expect to demonstrate this in future studies that describe its use in preoperative localization imaging. The positive impact of appropriate communication between health care providers not only improves patient safety but also helps to control costs and the risks of litigation.⁴ According to the *Agency for Healthcare Research and Quality*—an organization that measures and compares the quality of care that patients receive from different health care providers—the level of communication between physicians not only plays a critical role in a patient’s outcome but also has an impact on the

overall quality of care that patients receive at a given institution.⁵

In our series, the operative success rate as defined by normocalcemic status 6 months after parathyroidectomy was 96.3% for patients with single adenomas. This value is within the range reported in the medical literature.⁶ Interestingly, the locations of adenomas did not affect success rates in our patients with single-gland disease. Unlike in previous series, the rate of conversion to four-gland exploration in the present series was only 4.4%, which is lower than the 7–20% previously reported.^{7,8} The reasons for such a low conversion rate may be multiple, but we believe that the nomenclature system plays a role by assisting surgeons during the systematic evaluation of potential gland locations.

CONCLUSIONS

We report our experience using a new nomenclature system for parathyroid adenomas. We concluded that this system is an accurate outcome predictor for operative time, hospital admission, and it might be an excellent guideline for systematic exploration of the neck in an academic environment. Most importantly, this system has allowed surgeons, endocrinologists, radiologists, anesthesiologists, pathologists, and other medical personnel to speak a common language when communicating about patients with hyperparathyroidism.

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