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Pyramidal lobe of the human thyroid gland: an anatomical study with clinical implications

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Abstract

The presence, position, extent, relationships to neighboring structures and size of the human pyramidal lobe were investigated in 58 human *post-mortem* specimens in order to determine the variability of this structure. The pyramidal lobe is found in 55.2% of cases as a single conical extension of the thyroid gland. It was present more often in male (53.1%) than in female (46.9%) specimens and located slightly more often on the left side of the midsagittal plane (53.1%). According to the origin and location of its base, we defined five types of pyramidal lobe, with the left-sided types (Types III and IV) being predominant. The pyramidal lobe was 22.6 mm long, 11.2 mm wide and 3.6 mm thick (mean values). The means of all measured parameters were higher in female than in male specimens (pyramidal lobe was 2.3 mm longer, 1.6 mm wider and 0.4 mm thicker in female specimens) but these differences were not significant. In addition, we found that the size of the pyramidal lobe was dependent on the presence of a fibrous or muscular band that may represent a fibrous remnant of the thyroglossal duct or the *levator glandulae thyroideae* muscle. The pyramidal lobe was four times longer and its base was two and a half times wider and three times thicker when it was associated with this band. We believe that our data can be used to perform safer and more effective partial thyroidectomy in order to preserve thyroid function after surgical treatment.

Keywords: anatomy, thyroid gland, pyramidal lobe, variability.

Introduction

The thyroid gland is usually described as the largest endocrine gland and comprises two lateral lobes (left and right) connected along the median line by an isthmus. Besides these two lateral lobes, there is the pyramidal lobe, which extends superiorly from the isthmus of the thyroid gland, usually to the left of the median plane [1, 2]. This lobe appears related to the distal portion of the thyroglossal duct, which develops along the migratory path of the thyroid gland and usually disappears later in development [3, 4]. The pyramidal lobe (PL) may also be associated with the muscle called the *levator glandulae thyroideae* [2, 5]. The PL is considered as the thyroid anomaly [6], morphological variation of the thyroid gland [7] or normal component of the thyroid gland [1, 8].

The presence of the PL may be misinterpreted during a preoperative diagnosis on ultrasonographic or scintigraphic images. According to Geraci G *et al.* (2008) the PL was identified in only 50% of cases during preoperative diagnostic treatments using either ultrasonography or Tc-99m pertechnetate scintigraphy [9]. The fact that these two preoperative diagnostic treatments are not reliable for detection of the PL makes anatomical studies important in order to ensure safer thyroid surgery. The PL may be a source of recurrent disease when it is not removed during indicated total thyroidectomy [1, 3, 8]. The identification and removal of the PL are also of great importance for successful postoperative radioactive iodine treatment in patients with differentiated thyroid carcinoma [9, 10]. If the PL is not removed in patients who receive radioactive iodine postoperatively it will reduce the therapeutic benefit of treatment by absorbing most of the radioactive agent.

The aim of this study was to determine the variability of the pyramidal lobe of the human thyroid gland with regard to its presence, position, extent, relationships to neighboring structures and size. Such information can be used to perform safer and more effective thyroid surgery.

Materials and Methods

The PL was examined in 58 human *post-mortem* specimens without visible pathological changes or history of thyroid disease (29 male and 29 female, mean age 52.6 years, range 15 to 84 years). The *post-mortem* specimens were blocks of tissue including the tongue, hyoid bone with related muscles, larynx, trachea, thyroid gland, distal

portion of the pharynx and proximal portion of the esophagus. The *post-mortem* specimens belong to the Belgrade Institute of Anatomy and were obtained in accordance with the ethical and legal recommendations of the Faculty of Medicine, University of Belgrade, Republic of Serbia, following the Ethical Principles for Medical Research Involving Human Subjects (*WMA Declaration of Helsinki*). All *post-mortem* specimens were fixed in buffered formalin (4% neutral solution of formaldehyde) for at least two months.

After fixation, the *post-mortem* specimens were carefully dissected under a dissecting magnifier in order to expose the thyroid gland and related structures. The PL was identified as a component of the thyroid gland and photographs were taken for each *post-mortem* specimen. Measurements of the PL were performed directly, using a digital electronic caliper (Womax, Germany) sensitive to 0.01 mm. Three linear parameters of the PL were measured: the length (from the base to the apex), the width (transverse diameter of the base) and thickness (anteroposterior diameter of the base).

Statistical analyses were performed using an in-house program (Institute of Medical Statistics and Informatics, Faculty of Medicine, University of Belgrade). Differences in the incidence of the PL types, and between genders were tested using a Pearson *chi*-square test. The measured linear parameters (length, width and thickness of the PL) were compared between genders using a Student *t*-test. A *p*-value less than 0.05 was considered significant.

Results

The PL was found in 55.2% of cases (32 out of 58 specimens) as a single conical extension of the thyroid gland that ascends along the medial aspect of the thyroid lamina toward the hyoid bone. It was more frequent in male (17/32) than in female (15/32) specimens but this gender difference was not significant ($p>0.05$). The PL was more frequently located on the left side of the midsagittal plane (17 out of 32 specimens).

With respect to the origin and location of its base (inferior and wider portion fused with the thyroid isthmus or lobes), we found five types of the PL (Table 1, Figure 1).

Table 1 – ***Types of the pyramidal lobe according to the origin and location of its base and their incidence***

Type	Origin and location of the base	Incidence [%]
I	Central part of the isthmus	28.1 (nine cases)
II	Junction of the right lobe with the isthmus	28.1 (nine cases)
III	Junction of the left lobe with the isthmus	21.9 (seven cases)
IV	Left lobe	18.8 (six cases)
V	Right lobe	3.1 (one case)

The first type (PL originating from the central part of the isthmus) and the second type (PL originating from the junction of the right lobe with the isthmus) were more frequent (28.1% of cases each) than the very rare fifth type (PL originating from the right lobe in 3.1% of cases), although overall there were no significant differences ($p>0.05$) in the incidence of the PL types. The anterior aspect of the base of the PL was covered with the related sternohyoid muscle and divided from it by a well-developed section of the pretracheal layer of the deep cervical fascia. After removal of the sternohyoid and omohyoid muscles, we found that the base of the PL was located directly below the level of the arch of the cricoid cartilage and inferomedial from the oblique line of the thyroid cartilage (Figure 1). In terms of the PL position, the cricoid arch and the oblique line represent useful anatomical landmarks. The cricoid arch is palpable below the laryngeal prominence while the oblique line can be identified according to the related attachments of the sternothyroid, thyrohyoid and cricothyroid muscles. The posterior aspect of the base of the PL showed a direct relationship with the cricothyroid muscle. The apex of the PL (superior and narrower portion) was found immediately medial from the related sternohyoid muscle and in most of cases (71.9%) it was located below the level of the superior border of the thyroid cartilage (Figure 1, b, d and f). In some cases the apex of the PL reached the hyoid bone (15.6% of cases) (Figure 1, a and e).

The PL was associated with a fibrous or muscular band (FMB) in 59.4% of cases (19 out of 32 specimens) (Figure 1, c, d and f). The origin of this band is not clear but we believe that it may be a fibrous embryological remnant of the thyroglossal duct or the *levator glandulae thyroideae* muscle. In order to avoid speculation about the origin of the FMB we use a neutral term "a fibrous or muscular band" and its abbreviation herein. The FMB extended from the hyoid bone inferiorly to the apex of the PL with loose insertion along its posterior surface. The presence of the FMB was particularly associated with the third type (PL originating from the junction of the left lobe with the isthmus; 21.9% of cases) and the fourth type (PL originating from the left lobe; 18.8% of cases) of the PL.

The means of the three measured parameters of the PL were: 22.6 mm (length), 11.2 mm (width) and 3.6 mm (thickness) (Table 2).

Table 2 – ***The size of the pyramidal lobe (32 post-mortem specimens) demonstrated by means of three measured linear parameters (length, width and thickness) and standard deviations***

Parameter	Mean length[a] [mm]	SD
Length	22.6 (7.9–45.8)	10.5
Width	11.2 (6.1–18.5)	3.1
Thickness	3.6 (1.8–6.8)	1.1

[a] Means are presented with the range (minimum–maximum) given in parentheses; SD – Standard deviation.

The means of all measured parameters were higher in female than in male specimens (PL was 2.3 mm longer, 1.6 mm wider and 0.4 mm thicker in female specimens) but these gender differences were not significant ($p>0.05$). On the other hand, we found that the size of the PL was highly significantly influenced by the presence of the FMB. The PL was four times longer ($Z=4.939$, $p=0.000$), and its base two and a half times wider ($Z=3.361$, $p=0.001$) and three times thicker ($Z=3.937$, $p=0.000$) when associated with the FMB compared with cases in which the PL was not associated with the FMB. We used the Mann–Whitney (Sum rank) test in order to compare measured linear parameters between these two groups when the distribution of these variables (which we tested using Kolmogorov–Smirnov test) was not normal.

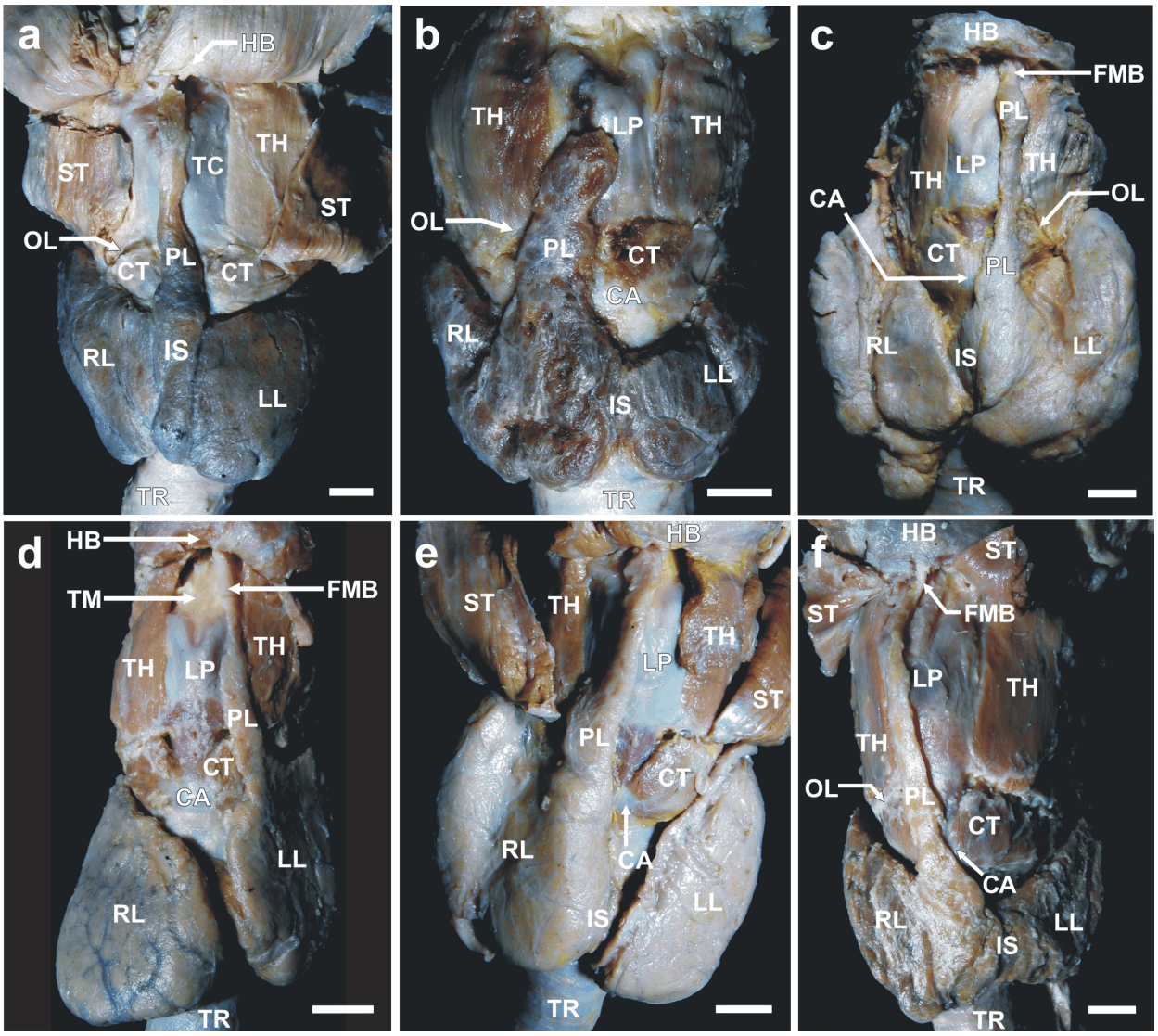

Figure 1 – ***Pyramidal lobe (PL) of the human thyroid gland: (a) Type I, specimen 07; (b) Type II, specimen 55; (c) Type III, specimen 33; (d) Type IV, specimen 51; (e) Type V, specimen 35; (f) Fibrous or muscular band (FMB) associated with the PL, specimen 03. Legend: RL – Right thyroid lobe; LL – Left thyroid lobe; IS – Thyroid isthmus; TC – Thyroid cartilage; OL – Oblique line of the thyroid cartilage; LP – Laryngeal prominence; HB – Hyoid bone; TM – Thyrohyoid membrane; CA – Cricoid arch; CT – Cricothyroid muscle; ST – Sternothyroid muscle (reflected); TH – Thyrohyoid muscle; TR – Trachea. Scale bar: 1 cm.***

Discussion

The presence of the PL in 55.2% of cases (32 out of 58 specimens) reported here is the same as that found by Braun EM *et al*. (2007) but somewhat lower than that indicated by Tanriover O *et al*. (2011), Zivic R *et al*. (2011) and Ozgur Z *et al*. (2012) who found the PL in 57.8%, 61% and 65% of cases [1, 5, 8, 11]. Based on these data, which demonstrate that the PL occurs in more than half of specimens or patients, this structure may be thought of as a normal component of the thyroid gland, as suggested by Braun EM *et al*. (2007) [1]. As a result, the possible presence of the PL should not be ignored during preoperative diagnosis in patients with thyroid disease when it often remains unvisualized. Braun EM *et al*. (2007) demonstrated a discrepancy in the presence of the PL between two investigated groups. In the first group of cadaveric subjects, the PL was found in 55% of cases upon dissection but in only 13% of cases (three out of 23 scintigraphic images) in living subjects using thyroid scintigraphy [1]. The reason for the rare occurrence of the PL in thyroid scintigraphic images may be related to the low spatial resolution of this diagnostic method. According to this study, thyroid scintigraphy is much more efficient at assessing functional properties than it is in visualization of normal or variable thyroid morphology. A much better method for detecting the PL in living subjects is computed tomography (CT) of the neck. Park JY *et al*. (2012) found the PL in 41.3% of patients, even though the PLs smaller than 9 mm were not included in their remarkable study of 327 patients [12]. As a result, the actual reported PL presence was an underestimate. On the other hand, they demonstrated how useful a neck CT is in exact detection of the fine morphological details of the thyroid gland.

Our data confirm previous findings [1, 2] that the PL is more often present in males than in females and more frequently located on the left side of the midsagittal plane (Figure 1, c, d and f). The position of the PL

depends on the PL type (Table 1). The PL is located on the left side of the midsagittal plane in the third and fourth PL types (40.7% of cases) (Figure 1, c and d). The right-sided position is associated with the second and fifth PL types (31.2% of cases) (Figure 1, b and e). Although the PL often originates from the junction of the right lobe with the isthmus, the left-sided types of the PL (Types III and IV) predominate. When the PL originates from the isthmus (Type I, 28.1% of cases) it is located on the right rather than the left side of the midsagittal plane.

The most interesting finding of this study is an association between the PL and a fibrous or muscular band that was observed in 59.4% of cases (Figure 1, c, d, and f). The origin of this FMB remains unknown. Mansberger Ar Jr and Wei JP (1993) pointed out that the PL may be attached to the hyoid bone by a fibrous tissue [13] and Ignjatović M (2009) illustrated a case in which a double pyramidal lobe was joined to the hyoid bone by a fibrous cord, without any further explanation [14]. Similar findings were reported by Ozgur Z *et al*. (2011) and Prakash *et al*. (2012), who defined the FMB as the *levator glandulae thyroideae* muscle in the form of a fibrous or fibromuscular band based on visual inspection only [2, 5]. We believe that the FMB may originate from two structures. First, it may represent the fibrous remnant of the thyroglossal duct or tract that is found in 41.3% of infants and children as a predominantly left-sided structure according to a histological study conducted by Sprinzl GM *et al*. (2000) [15]. Second, it may represent the *levator glandulae thyroideae*, an accessory and variable muscle that has been reported to occur in 0.49% [16] to 31.2% of cases [2]. The dilemma about the origin of the FMB may be solved by combining micro-dissection with histological techniques, which will provide data about the relationship between the FMB and the hyoid bone, neurovascular elements related to the FMB and its histological structure.

The size of the PL was highly dependent on the presence of the FMB. When associated with the FMB, the PL was four times longer and its base two and a half times wider and three times thicker than in the absence of the FMB. This influence of the FMB on the PL size, especially on its length, may be attributed to errors during measurements due to the inability to determine the exact border between the fibrous or muscular tissue of the FMB and the glandular tissue of the PL, meaning that length may have been either overestimated or underestimated. In order to avoid this kind of methodological error we decided to detect this border using a dissecting magnifier, and then to take the measurements. By using this approach, we believe that potential errors were minimized or eliminated. The mean PL length measured (22.6 mm) herein falls in the middle of the range of lengths reported in the literature: 20 mm [11], 20.1 mm [8], 24.1 mm [1] and 25 mm [12]. This association of the PL size with the FMB presence may be explained by the development of the PL, which remains as the most distal portion of the thyroglossal duct. The portion of the thyroglossal duct located between the hyoid bone and the apex of the PL usually obliterates during the fifth gestational week and shortly afterward breaks into fragments [17, 18]. The persistence of the thyroglossal duct in the form of the FMB probably increases the volume of the glandular tissue accumulated along an elongated fibrous structure and increases the size of the PL.

In rare cases, the PL may be the site of primary thyroid disease. Ogawa C *et al*. (2009) reported a case of a minimally invasive follicular carcinoma arising from the apex of the PL [19]. The tumor was excised with the PL and the whole of the thyroid isthmus, including prelaryngeal lymphadenectomy. The patient had no complications and after 15 months of post-operative monitoring, she remained disease-free. Zivic R *et al*. (2011) also mentioned two cases with malignant foci found in the PL. In the first case, the PL was the site of an isolated papillary carcinoma while in the second case it was the site of a multiple papillary carcinoma [8]. In such rare cases, our data about the presence, position, types, relationships and size of the PL may be used to ensure safer partial thyroidectomy in order to preserve thyroid function after surgical treatment.

Conclusions

The PL is a normal component of the thyroid gland. Morphological variability of the PL is manifested by differences in its presence, position, extent and size. The PL was found in 55.2% of cases, more often in males than in females and more often on the left side of the midsagittal plane. There are five types of the PL, and these are correlated with the right-sided or left-sided position of the PL. In this study, the PL was 22.6 mm long, 11.2 wide and 3.6 mm thick on average and its size was highly dependent on the presence of the FMB. The FMB is a fibrous or muscular band that is either a fibrous remnant of the thyroglossal duct or the *levator glandulae thyroideae* muscle. The PL was four times longer and its base two and a half times wider and three times thicker when it was associated with the FMB.

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References

[1] Braun EM, Windisch G, Wolf G, Hausleitner L, Anderhuber F, *The pyramidal lobe: clinical anatomy and its importance in thyroid surgery*, Surg Radiol Anat, 2007, 29(1):21–27.

[2] Prakash, Rajini T, Ramachandran A, Savalgi GB, Venkata SP, Mokhasi V, *Variations in the anatomy of thyroid gland: clinical implications of cadaver study*, Anat Sci Int, 2012, 87(1):45–49.

[3] Mohebati A, Shaha AR, *Anatomy of thyroid and parathyroid glands and neurovascular relations*, Clin Anat, 2012, 25(1): 19–31.

[4] Janus JR, Moore EJ, Price DL, Kasperbauer J, *Robotic thyroid surgery: Clinical and anatomic considerations*, Clin Anat, 2012, 25(1):40–53.

[5] Ozgur Z, Celik S, Govsa F, Ozgur T, *Anatomical and surgical aspects of the lobes of the thyroid glands*, Eur Arch Otorhinolaryngol, 2011, 268(9):1357–1363.

[6] Bhatnagar KP, Nettleton GS, Wagner CE, *Subisthmic accessory thyroid gland in man: a case report and a review of thyroid anomalies*, Clin Anat, 1997, 10(5):341–344.

[7] Ranade AV, Rai R, Pai MM, Nayak SR, Prakash, Krisnamurthy A, Narayana S, *Anatomical variations of the thyroid gland: possible surgical implications*, Singapore Med J, 2008, 49(10):831–834.

[8] Zivic R, Radovanovic D, Vekic B, Markovic I, Dzodic R, Zivaljevic V, *Surgical anatomy of the pyramidal lobe and its significance in thyroid surgery*, S Afr J Surg, 2011, 49(3):110, 112, 114 passim.
[9] Geraci G, Pisello F, Li Volsi F, Modica G, Sciumè C, *The importance of pyramidal lobe in thyroid surgery*, G Chir, 2008, 29(11–12):479–482.
[10] Rosário PW, Maia FF, Cardoso LD, Barroso A, Rezende L, Padrão EL, Purisch S, *Correlation between cervical uptake and results of postsurgical radioiodine ablation in patients with thyroid carcinoma*, Clin Nucl Med, 2004, 29(6):358–361.
[11] Tanriover O, Comunoglu N, Eren B, Comunoglu C, Turkmen N, Bilgen S, Kaspar EC, Gündogmus UN, *Morphometric features of the thyroid gland: a cadaveric study of Turkish people*, Folia Morphol (Warsz), 2011, 70(2):103–108.
[12] Park JY, Kim DW, Park JS, Kang T, Kim YW, *The prevalence and features of thyroid pyramidal lobes as assessed by computed tomography*, Thyroid, 2012, 22(2):173–177.
[13] Mansberger AR Jr, Wei JP, *Surgical embryology and anatomy of the thyroid and parathyroid glands*, Surg Clin North Am, 1993, 73(4):727–746.
[14] Ignjatović M, *Double pyramidal thyroid lobe*, J Postgrad Med, 2009, 55(1):41–42.
[15] Sprinzl GM, Koebke J, Wimmers-Klick J, Eckel HE, Thumfart WF, *Morphology of the human thyroglossal tract: a histologic and macroscopic study in infants and children*, Ann Otol Rhinol Laryngol, 2000, 109(12 Pt 1):1135–1139.
[16] Lehr RP Jr, *Musculus levator glandulae thyroidae: An observation*, Anat Anz, 1979, 146(5):494–496.
[17] Organ GM, Organ CH Jr, *Thyroid gland and surgery of the thyroglossal duct: exercise in applied embryology*, World J Surg, 2000, 24(8):886–890.
[18] Foley DS, Fallat ME, *Thyroglossal duct and other congenital midline cervical anomalies*, Semin Pediatr Surg, 2006, 15(2): 70–75.
[19] Ogawa C, Kammori M, Onose H, Yamada E, Shimizu K, Yamada T, *Follicular carcinoma arising from the pyramidal lobe of the thyroid*, J Nippon Med Sch, 2009, 76(3):169–172.

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