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THE TOPOGRAPHIC ANATOMY OF THE
THYROID GLAND.*

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The problem was suggested by Prof. Waldeyer, of the Anatomical Institute of Berlin, and the work was begun in his laboratory in the summer semester of 1904.

It was recognized that many observations had been made upon the topography of the gland, but since they were made before the present methods of preservation of material were in use it seemed advisable to undertake this work. Accordingly most of the material used was formalin hardened, the remainder being hardened by arterial injections of alcohol 2 parts, carbolic acid 1 part, and glycerin 1 part. The material consisted of 23 fetuses, ranging in age from five months

*From the Anatomical Laboratory of St. Louis University.

to term—all formalin hardened¹; 19 children from 1 to 7 months of age, formalin hardened²; 55 adults from 20 to 70 years of age, 30 formalin hardened, 25, alcohol-carbolic acid-glycerin hardened.

Two methods of making the measurements were used, (1) from sagittal and transverse sections, and (2) from dissections.

The sagittal sections show at once the position of the isthmus of the gland with reference to the vertebral column and the trachea. The transverse sections were reconstructed on profile paper, so as to show the relations of the gland to the vertebral column and surrounding organs. (The reconstructions were made according to the method described in the *Topography of the Thorax and Abdomen*, University of Missouri Studies, Science Series, Vol. I, No. 1.)

When the neck region was dissected in the ordinary way, the measurements were made by driving a steel pin vertically through the isthmus of the gland into the vertebral column and using it as a point from which to measure in all directions. A point on the profile paper was taken to represent the position of the pin, and all of the structures were located on the paper in accordance with the measurements on the body. The measurements were taken in a horizontal plane and not over the convex surface of the gland. When the gland and other soft parts had been removed, the vertebral column was mapped out in the same way as the gland by using the point where the pin entered the column as the starting point for the measurements. In some cases the soft parts only were measured, thus giving the relations of the gland to the trachea.

In the following description the gland will be considered as composed of an isthmus and two lateral lobes. The gland as a whole is roughly U-shaped.

Each lateral lobe is more or less cone shaped, with its apex extending considerably above and its base only a little below

1. Most of these were material belonging to Dr. Jackson, University of Missouri, upon which he worked out the topography of the pancreas. This part of the work was done in Prof. Waldeyer's laboratory.

2. The neck organs were removed at autopsy by Dr. Thompson, Dept. of Pathology, St. Louis University, and placed in formalin.

the plane of the isthmus. The external surface of the gland is markedly convex from side to side, and slightly so from above downward. The internal surface is concave from before backward, fitting accurately over the sides of the larynx, trachea, pharynx and esophagus. The isthmus is the thin plate of gland substance molded over the anterior surface of the trachea, uniting the contiguous surfaces (margins) of the lower part of the lateral lobes.

The relationship which the gland bears to the other structures in the region is well shown in Figures 1 and 3.

The anterior surface of each lateral lobe is covered by the sternothyroid muscle and separated from it by a thin layer of fascia. The inner margin of the sternohyoid muscle overlaps the inner margin of the sternothyroid a few millimeters, so that the uncovered (intermuscular) portion of the gland is reduced to a small area. This interspace becomes smaller from above downward, since the muscles of the two sides almost meet in the midline at the lower margin of the isthmus, thus leaving only a small V-shaped portion of the gland not covered with muscle. This medial portion of the isthmus is covered with superficial fascia and skin containing small veins of the inferior thyroid and anterior jugular systems. The anterior margin of the sternomastoid crosses the region of the lateral lobes obliquely from below upward and outward.

Each lateral lobe lies between the carotid sheath externally, the trachea internally, and the above named muscles anteriorly. The upper part of the lobes usually extend as far back as the sides of esophagus and pharynx. In the child and fetus the lobes protrude, in many cases, into the post-pharyngeal space, and while they seldom meet behind the pharynx the two lobes hold it in a firm grasp.

While the thyroid is a true cervical organ, it comes into close relationship with such thoracic organs as the lungs and thymus gland. The lower pole of each lobe is separated from the apex of the corresponding lung in the adult by a small interspace containing the vertebral and ascending cervical vessels and the arch of the thoracic duct (on the left side).

In Figure 1 the apices of the lungs, which lie only about 2 mm. below the surface of the section, are indicated by

the dotted lines in the quadrilateral spaces bounded by the first ribs and the scaleni and longus colli muscles.

Figure 2 shows the relative levels of the lung and gland in the adult, while Figure 4 shows the relation in the fetus at term where the gland is much higher in the neck, and consequently not in close relation with the lungs.

By comparing Figures 1 and 2 with 3 and 4 it will be seen that the superior division of the mediastinum is much larger proportionately in the fetus than in the adult and is filled, in its anterior portion, by the thymus gland, which comes into close relationship with the lower part of the thyroid. In many of the dissections of the fetus these glands were in direct contact.

The parts of the gland will be located with reference to the vertebral column and then with reference to the trachea and larynx; first as determined by projections from dissections and then by projections from cross sections.

THE ADULT GLAND.

1. *As Measured from Dissection.* The isthmus lies over the seventh cervical and first thoracic vertebrae. In every case the upper border of the isthmus was below the disk between the sixth and seventh cervical vertebrae. In more than 50% of the cases the upper border of the isthmus is below the disk between the seventh cervical and first thoracic vertebrae, but in only two cases is it below the first thoracic vertebra.

It lies upon the three first rings of the trachea. In 66% of cases it completely covers the first ring, but in no case does it overlap the cricoid cartilage to any considerable extent. In every case its upper border is above the middle of the second ring. The isthmus is so variable in size and width that its lower border may be found anywhere from the third to the sixth ring. In the few cases, three in the series, in which it reaches the fifth or sixth ring it extends below the lateral lobes. More than half of all the cases cover rings two and three.

The apex of the right lobe varies from the upper part of the fifth to the lower part of the sixth cervical vertebra, with the greater number opposite the fifth vertebra and fifth disk. The apex of the left lobe is never higher but often a little

lower than the right, the difference being only a few millimeters in any case. However, a much larger number of the left than of the right were below the fifth intervertebral disk.

The lower poles do not show so much variation as do the apices, nor do they differ as much from each other. The ordinary variation in position is from the middle of the first to the lower part of the second thoracic vertebra, with the larger proportion of the cases above the second vertebra.

Each lateral lobe extends upward and backward along the sides of the larynx and pharynx into a conical space bounded internally by the larynx and pharynx, anteriorly by the sternothyroid and omohyoid muscles, and posteriorly by the carotid sheath and the prevertebral fascia. The upper part of the anterior border follows more or less closely the attachment of the sternothyroid muscle to the oblique line of the thyroid cartilage.

In 27 cases the thyroid cartilage was projected along with the gland to show the relative position of the apex of each lateral lobe to this cartilage. The united portion of the anterior portion of the alae is used as the basis of comparison. In 13 of the 27 cases the apex on the right was as high as the upper end, while only six of the left lobes reached this level. Of the other 14 right lobes, 9 reached the middle and 5 only the lower end of the anterior border. On the left side six were on a level with the upper end, 13 the middle, and 8 the lower end of this border.

2. *As Measured from Cross Sections.* The projections made from cross sections show the relation of the glands to the vertebral column only, since these projections were made for a different purpose and the larynx and trachea were not included in them.

The average position of the isthmus is over the first and second thoracic vertebrae. Its upper border may be as high as the middle of the seventh cervical, and its lower border as low as the third thoracic disk, but since it is usually about as broad as a vertebra and disk, when the upper border is high, the lower border is correspondingly high, and vice versa.

The apices of the two lateral lobes are at about the same level in most cases. They vary from the fourth to the sixth cervical disk, a majority being opposite the fifth and sixth vertebrae. The lower poles of the two lobes are usually

at about the level of the first thoracic vertebra. In nearly every case the lower lobes were above the second thoracic vertebra.

THE GLAND IN THE CHILD.

From the material at hand it was only possible to locate the gland with reference to the larynx and trachea, because all the material at this stage had been removed at autopsy. The upper border of the isthmus touches the cricoid cartilage in a majority of cases. The cricoid is completely covered in 7 of the 19 cases. In every case except one the first ring of the trachea is covered. In this one case the isthmus is very narrow and might be said to be absent, for it is difficult to distinguish any thyroid tissue in it macroscopically. The isthmus covers rings 2 and 3; one-half ending below ring 3, and the other half passing over ring 4.

The lateral lobes appear to be proportionately larger and less conical than those of the adult. In nearly every case the apex is at the level of the base of the superior cornu of the thyroid cartilage. They cover most of the cricoid cartilage and that part of the thyroid cartilage below and behind the oblique line, so that the sternothyroid muscle is displaced upward and forward at its attachment to the thyroid cartilage and is made to hook over the anterior border of the gland instead of passing to its attachment in the plane of the body of the muscle, as it does in the adult.

THE GLAND OF THE FETUS.

Most of the specimens were full term fetuses hardened in the dorsal position by injection with formalin.

The gland is very much like that of the young child in size and position. The isthmus corresponds to the fifth and sixth cervical vertebrae (Figs. 2 and 4), usually not extending below the middle of the sixth. It lies over the first four rings of the trachea. In about 30% of the cases it was high enough to lie over the cricoid, but in these cases it usually did not reach below the third ring of the trachea.

The lateral lobes extend high up into the space between the thyroid cartilage, sternothyroid and omohyoid muscles and carotid sheath. In many cases they extend beyond the outer border of the omohyoid muscles into the superior carotid

triangles. These lobes are so thick anteroposteriorly that they displace the sternothyroid muscle at its attachment to the thyroid cartilage, as in the child. The apex of the lateral lobe is usually high upon the posterior part of the thyroid cartilage, being as high as in the child and almost constantly higher than in the adult.

VARIATIONS AND ANOMALIES.

The middle lobe or pyramid varies more than any other part of the gland, both in size and position. It may be entirely absent, or vary from a small tubercle on the upper margin of the isthmus, or one of the lateral lobes, to a well developed band of gland tissue extending upward to the hyoid bone. It is more often connected with the left lobe at its union with the isthmus than with any other portion of the gland, though it not infrequently connects with the right lobe. Nearly every gland has a more or less well developed band connected with its upper border, though only about three-fifths of these bands contain any gland tissue. This band can be traced to the hyoid bone, to the posterior inferior margin of which it is attached. The usual structure of this band is connective tissue, containing gland substance below and muscle fibers above—the muscle fibers may or may not fill in all of the remaining portion of the band. Occasionally two or more separate nodules of gland tissue are imbedded in the band and connected to each other by muscle fibers. When the muscle fibers are well developed and the gland substance reduced to a small nodule on the upper part of the isthmus it is called the levator glandulae thyroideae, but all of these conditions should be classed together as being persistence of the thyroglossal duct.

The isthmus is rarely absent, though many times it is only a very thin band of gland substance. In this series it was entirely absent in one fetus and one adult, and practically absent in two other cases.

Among the glands which were dissected there were several with one or more accessory slips of muscle. When there was but one slip it was considered as the levator glandulae thyroideae, even though it was not connected with the isthmus of the gland. In a few cases this middle slip was found along

with an extra slip to each lateral lobe. Figures 5 and 6 show this condition. In these cases the muscle fibers arise from the fascia covering the anterior surface of the gland and end by blending with the inner margins of the thyrohyoid muscles. In Figure 5 the fibers end near the lower part of the thyroid cartilage, while in Figure 6 they remain more or less separate up to the hyoid, where they insert along with the inner fibers of the thyrohyoid. In Figure 5 the middle slip (f) does not contain many muscle fibers, but from its position and appearance it may be taken to represent the thyroglossal duct. In Figure 6 this middle slip (i) is muscular and well developed and arises from both surfaces of a small pyramidal lobe.

Figure 7 has two well developed slips symmetrically placed, but without any well defined remains of a median portion. These fibers arise from the fascia along the upper margin of each lateral lobe and may be traced to the hyoid bone as the inner portion of the thyrohyoid..

Figure 8 is from a child seven months old. It shows a condition different from those described above. Here the three slips are found, but the right one arises from the fascia on the posterior surface of the gland, while the left one arises from the anterior surface. Otherwise this case does not differ from the others.

These muscle slips do not correspond to the extra muscles of this region, as described in Porier and Charpy, in that they do not connect with the constrictors of the pharynx.

CONCLUSIONS.

1. That the thyroid gland is smaller, proportionately, in the adult than in the fetus and young child.
2. That the thyroid gland descends upon the vertebral column with the assumption of the erect position.
3. That there is an apparent descent of the thyroid gland upon the neck organs. The gland is lower on the thyroid and cricoid cartilages of the adult, but it is attached to the same rings of the trachea. This apparent descent may be due to the fact that the hyoid, thyroid and cricoid are telescoped upon each other in the fetus and young child and thus brought closer to the fixed part of the thyroid gland.
4. That some remains of the thyroglossal duct can be

found in almost every case, and that a pyramid is present in over three-fifths of all cases.

5. That the isthmus may be very small, but that it is rarely entirely absent.

6. That accessory muscle slips are to be found, which seem to be aberrant slips of the thyrohyoid or possibly of the sternothyroid. They do not appear to have any special function, but act in conjunction with the fascia to hold the gland in position.

EXPLANATION OF FIGURES.

Figure 1. Section through lower portion of first thoracic vertebra. Adult.

sp. c. spinal cord.	p. platysma.
d. m. dura mater.	a. j. v. anterior jugular vein.
c. centrum of first thoracic vertebra.	st. hy. sternohyoid.
r. first rib.	st. th. sternothyroid.
j. c. longus colli.	th. gl. thyroid gland.
v. v. vertebral vessels.	tr. trachea.
n. eighth cervical nerve with its junction with first thoracic nerve.	i. th. v. thyroid vessels (inferior).
th. d. arch of thoracic duct.	oe. esophagus.
sc. a. scalenus anticus.	s. g. inferior cervical sympathetic ganglion.
c. s. carotid art., jugular vein and vagus nerve in carotid sheath.	tr. p. transverse process of vertebra.

Figure 2. Reconstruction of thyroid gland and surrounding structures from set of sections to which Figure 1 belongs.

m. manubrium sterni.	r. rib.
cl. clavicle.	v.-vii. cervical vertebra.
l. lung.	i.-iv. thoracic vertebra.

Figure 3. *Section through sixth cervical vertebra. Fetus at term.

- o. h. omohyoid. Other labeling same as Figure 1.

Figure 4. *Reconstruction of region of thyroid of fetus, of which the section shown in Figure 3 is part.

thym. thymus gland. Other labeling same as Figure 2.

Figure 5. Thyroid gland with accessory muscles.

5a. front view.	f. fascia, etc., representing remains of thyroglossal duct.
5b. right lateral view.	l. hyoid.
5c. left lateral view.	m. thyrohyoid.
a. thyroid cartilage.	n. sternothyroid.
b. cricoid cartilage.	o. oblique line of thyroid cartilage.
c. thyroid gland.	p. sternohyoid.
d. extra muscle of right lobe.	
e. extra muscle of left lobe.	

Figure 6. Thyroid gland with accessory muscles.

6a. front view.	g. extra muscles of left lobe.
6b. right lateral view.	i. levator glandulae thyroideae.
6c. left lateral view.	Other labeling same as in Figure 5.
h. extra muscles of right lobe.	

Figure 7. Thyroid gland with accessory muscles.

7a. front view.	j. extra muscle of left lobe.
7b. right lateral view.	Other labeling same as in Figure 5.
7c. left lateral view.	
k. extra muscle of right lobe.	

Figure 8. Thyroid gland of child with accessory muscles.

*Figures 3 and 4 are from a reconstruction by Dr. H. D. Kistler, awarded a gold medal by the International Jury of Awards, L. P. E., St. Louis, 1904.

Fig. 1

Fig. 2.

Fig. 3.

Fig. 4.

Fig 5a

Fig. 5b

Fig. 5c

Fig. 6a

Fig. 6b

Fig. 6c

Fig 7a

Fig 7b

Fig 7c