

CONCERNING THE SURGICAL ANATOMY OF THE THYROID  
WITH SPECIAL REFERENCE TO THE PARATHYROID  
GLANDS\*

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CERTAIN steps in the operative procedures which are employed as routine in the surgery of the thyroid gland may be attended by confusion if the operator lacks an exact knowledge of the anatomy of the parts involved. Thus, in connection with the operation of excision of a lateral lobe, considerable uncertainty prevails as to the relationship of the surgical capsule, the parathyroid glands and the recurrent laryngeal nerve to the posterior part of the lobe. The consideration of these essential anatomical details, as they bear upon the operation of lobectomy, is the basis of this paper.

*Excision of Lobe.*—The removal of a lateral lobe of the thyroid gland is frequently indicated in the surgical treatment of simple goitre and exophthalmic goitre. The extirpation of the lobe as usually practised is intracapsular, that is, the lobe is shelled out of the surgical capsule, which is a connective-tissue envelope formed from the deep cervical fascia (Fig. 1). All surgeons recognize the importance of careful dissection at the posterior aspect of the lobe in order to avoid injury to the recurrent laryngeal nerve and to safeguard the parathyroid glandules. Yet there is divergence of opinion and of practice as to whether the extirpation should include the posterior part of the lobe or whether a layer of thyroid tissue should be left in this region (Fig. 2). The latter procedure offers a greater degree of protection to the inferior laryngeal nerve and to the parathyroid glands; but it results in more hemorrhage, which in some cases is difficult to control; moreover, it prolongs the operation and leads to greater post-operative exudate.

The present study was undertaken primarily to determine whether the theoretical advantages of leaving a portion of the posterior part of the lobe, that is, the part in relation with the recurrent laryngeal nerve and the parathyroid bodies, have sufficient anatomical basis to outweigh the practical disadvantages of the procedure. With this object in view,

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an effort has been made to trace the course and to establish the relations of the surgical capsule in the posterior region of the lobe and to determine the relationship of the parathyroids and the recurrent laryngeal nerve to this fascia and to the thyroid itself.

*Surgical Capsule.*—Transverse sections of the neck were made from three cadavers. The drawing (Fig. 3), which may be considered typical, shows the general arrangement of the fascial planes.

Several features in the gross sections are worthy of note. First, the surgical capsule in the non-goitrous neck is not as well marked as might be expected from the conditions noted in operations upon goitrous glands. However, it is fair to assume that the difference in the fascial planes around a normal and a goitrous thyroid is merely one of degree. In other words, although the surgical capsule may be thicker and better marked around a goitrous than a normal thyroid the structural details and arrangement are essentially the same. Second, the sheath of the great vessels is closely associated with the surgical capsule of the thyroid. This feature is corroborated by microscopic sections (Figs. 4 and 5). *Third, the surgical capsule at the posterior aspect of the lobe divides into two layers*, one, relatively dense, passes posterior to the oesophagus to enter into the formation of the prevertebral fascia; the other passes forward and mesially to the postero-external aspect of the trachea. *This layer is of especial importance, since it constitutes the surgical capsule in this region.* It consists of a thin dense layer closely apposed to the thyroid (Figs. 6, 7 and 8).

The separation of the surgical capsule into two layers, as just described, is of considerable importance. In the normal (non-goitrous) neck this separation defines a triangular area bounded by these two fascial layers and, mesially, by the oesophagus. This space contains loose areolar tissue and in it lies the *recurrent laryngeal nerve* (Figs. 3 and 6). When the thyroid enlarges the space may be obliterated, in which case the two layers lie in apposition. Certain anatomical details which bear directly upon the operation of lobectomy are thus made clear. They may be summarized as follows: There is a continuation of the surgical capsule in the posterior region of the lobe; outside of this fascial layer lies the recurrent nerve which is consequently safeguarded in a true intracapsular extirpation of a lobe. However, it is evident that in the performance of an intracapsular extirpation, or lobectomy, the capsule is likely to be torn in the region of its division into the two layers; the operator then follows the posterior layer in the dissection and the cellular plane between the two layers is entered and the recurrent laryngeal nerve is endangered.

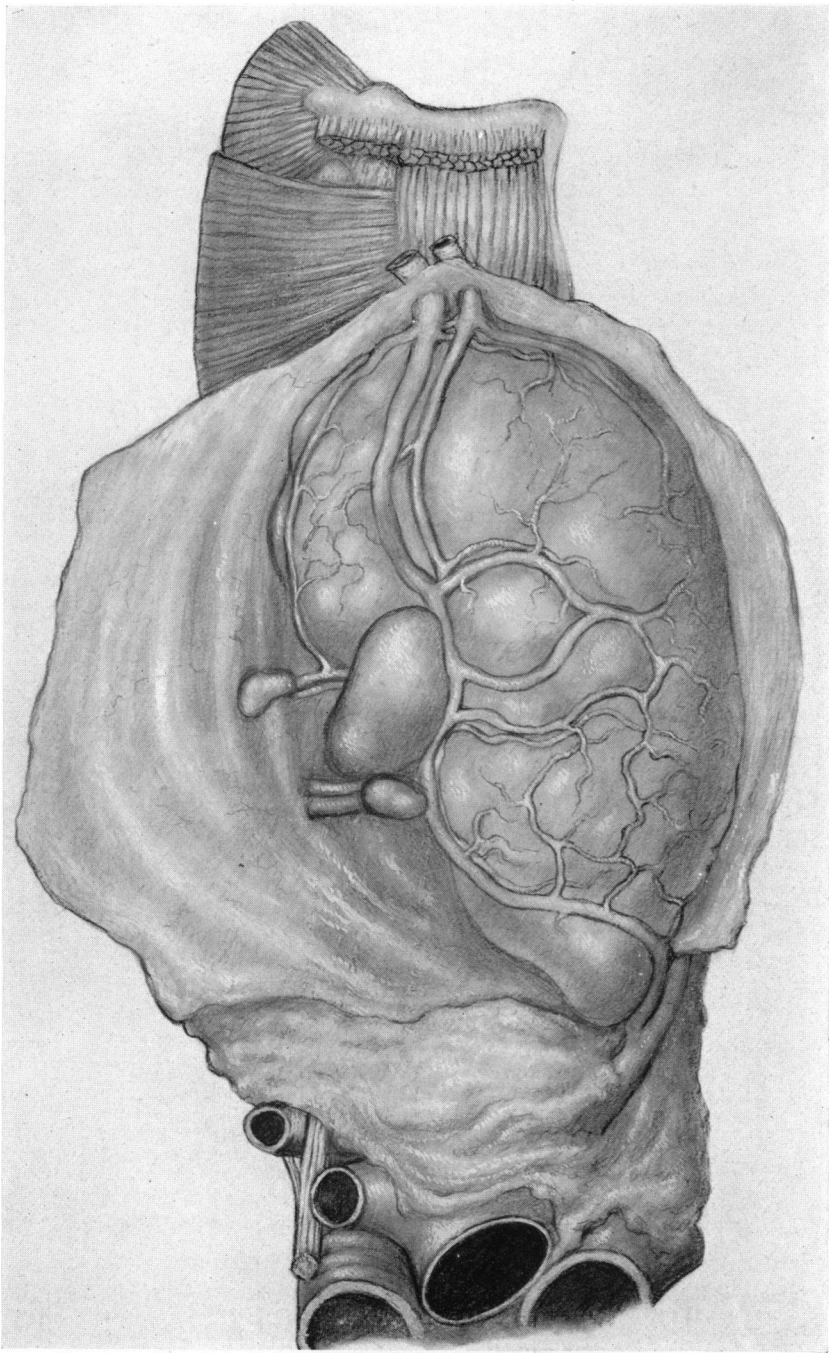


FIG. 1.—Autopsy specimen from patient with exophthalmic goitre, showing the capsule cut and stripped from the right lobe, the lobe being drawn forward so as to expose the structures in relation with its posterior surface. The relations of the parathyroids to the inferior thyroid artery and capsule are of particular interest in this specimen. The superior parathyroid stripped off readily with the capsule, the inferior did not strip off and was left in close contact with the thyroid and the lower branch of the inferior thyroid artery.

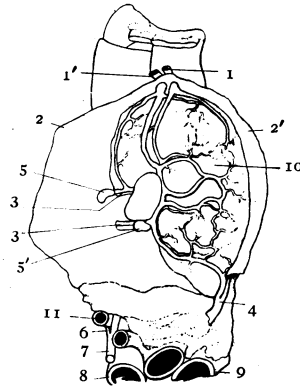


FIG. 1a.—1, superior thyroid artery; 1', superior thyroid vein; 2, 2', surgical capsule stripped from the gland; 3, branches of inferior thyroid artery with accompanying veins; 4, inferior thyroid veins; 5, superior parathyroid; 5', inferior parathyroid; 6, recurrent laryngeal nerve; 7, vagus nerve; 8, trachea; 9, aorta; 10, thyroid; 11, subclavian artery.

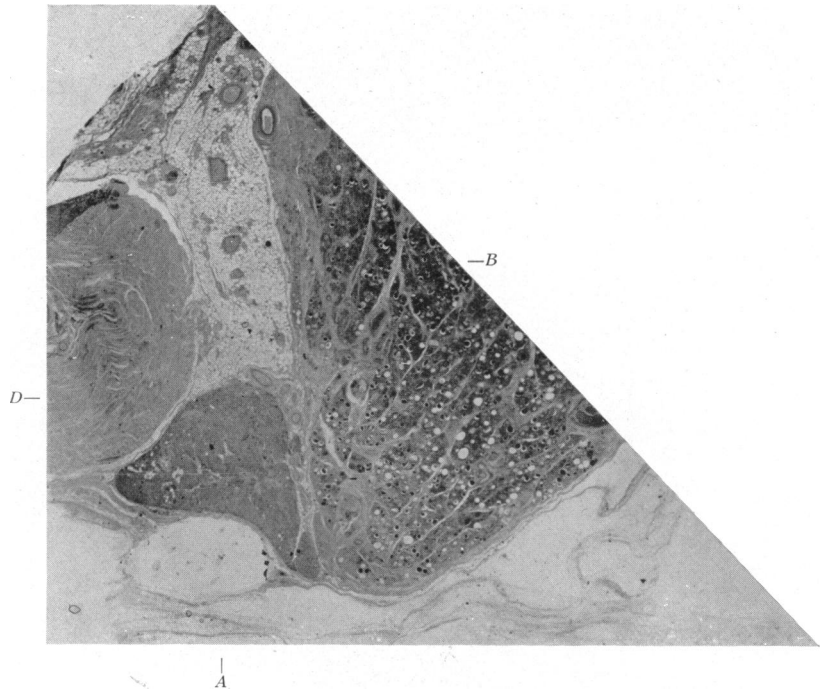


FIG. 2.—Approximate line of division when posterior part of lobe is left so as to safeguard the parathyroids and recurrent laryngeal nerve, of which four filaments may be seen between thyroid and oesophagus. A, parathyroid; B, thyroid; D, oesophagus (magnification, x15).

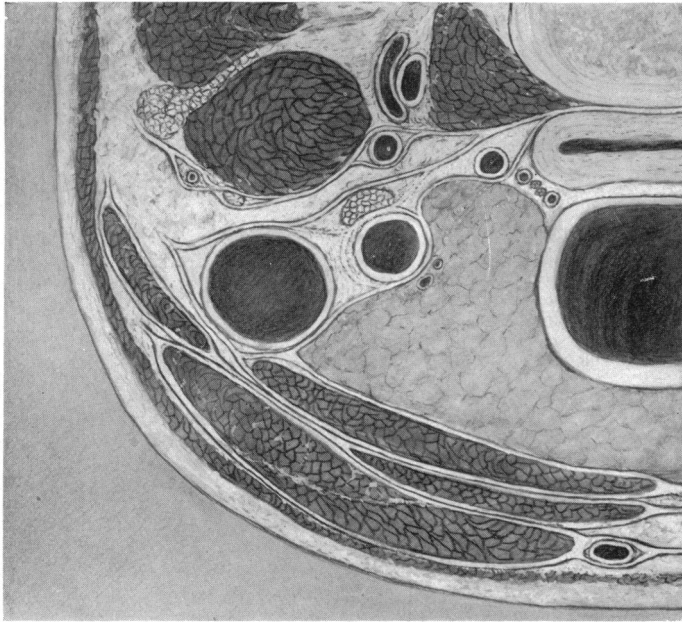


FIG. 3.—Transverse section of the neck at level of the middle of the seventh cervical vertebra, showing general arrangement of the fascial planes.

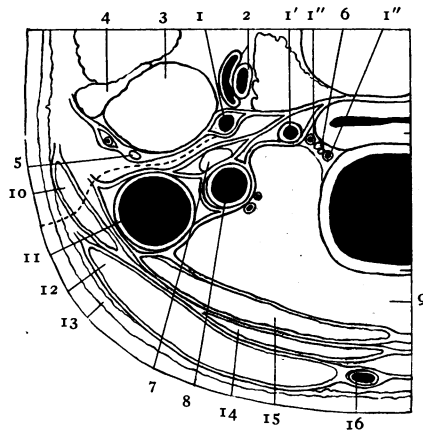


FIG. 3a.—Outline of Fig. 3. 1, 1', 1'', inferior thyroid artery; 2, vertebral artery and vein; 3, scalenus anticus; 4, brachial plexus; 5, phrenic nerve; 6, recurrent laryngeal nerve; 7, vagus; 8, carotid artery; 9, thyroid; 10, omohyoid; 11, jugular vein; 12, sternomastoid; 13, platysma; 14, sternohyoid; 15, sternothyroid; 16, anterior jugular vein. Dotted line indicates approach for ligation of inferior thyroid artery by posterior method. (The operative approach is above the omohyoid, 10.)

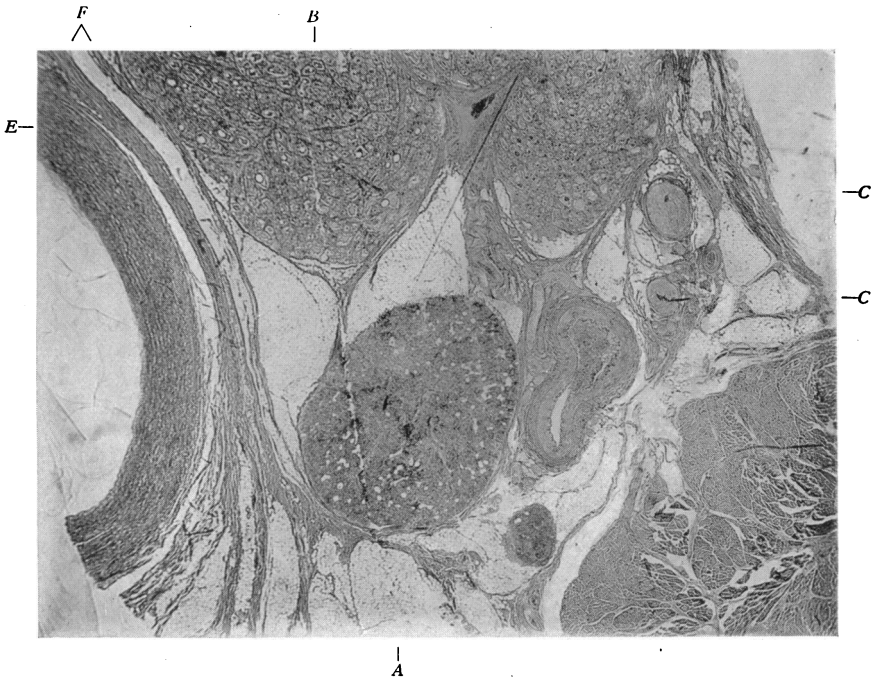


FIG. 4.—Showing close relationship between the sheath of the great vessels and the surgical capsule of the thyroid. *A*, parathyroid; *B*, thyroid; *C*, recurrent laryngeal nerve; *E*, carotid; *F*, surgical capsule and carotid sheath.



FIG. 5.—Showing close relationship between sheath of the great vessels and the surgical capsule of the thyroid. *A*, parathyroid; *B*, thyroid; *E*, carotid; *F*, surgical capsule and carotid sheath.

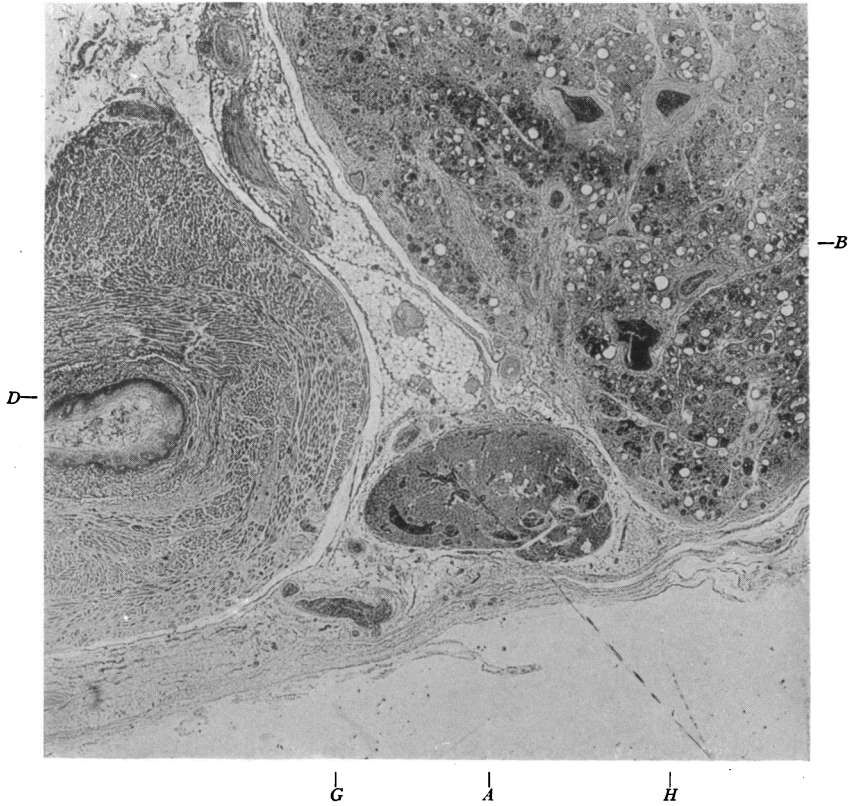


FIG. 6.—Division of the capsule into two layers at the posterior aspect of the lobe; cellular space, containing parathyroid and recurrent laryngeal nerve between these two layers. *A*, parathyroid; *B*, thyroid; *D*, oesophagus; *G*, high power of this area, Fig. 8; *H*, of Fig. 7.





FIG. 7.—High power of Fig. 6, showing division of surgical capsule into two layers (magnification  $\times 120$ ).

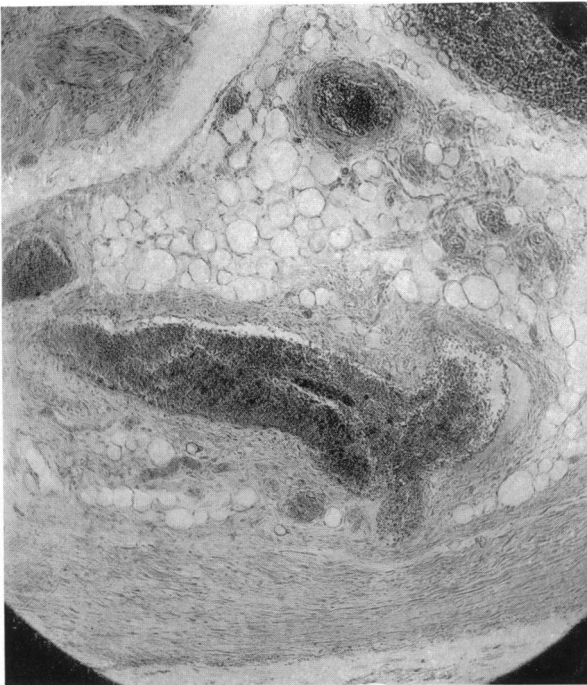


FIG. 8.—High power of Fig. 6, showing dense layer of connective tissue which passes posterior to esophagus (magnification,  $\times 120$ ).

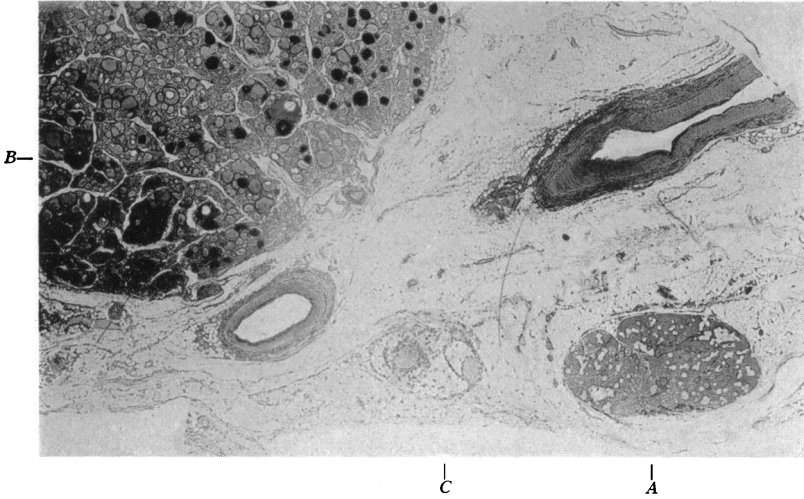


FIG. 9.—Parathyroid external to the capsule and at such a distance from the thyroid as to be safeguarded by an intracapsular operation. The nerve and branch of inferior thyroid artery lie between the parathyroid and the thyroid (Class I). A, parathyroid; B, thyroid; C, nerve.

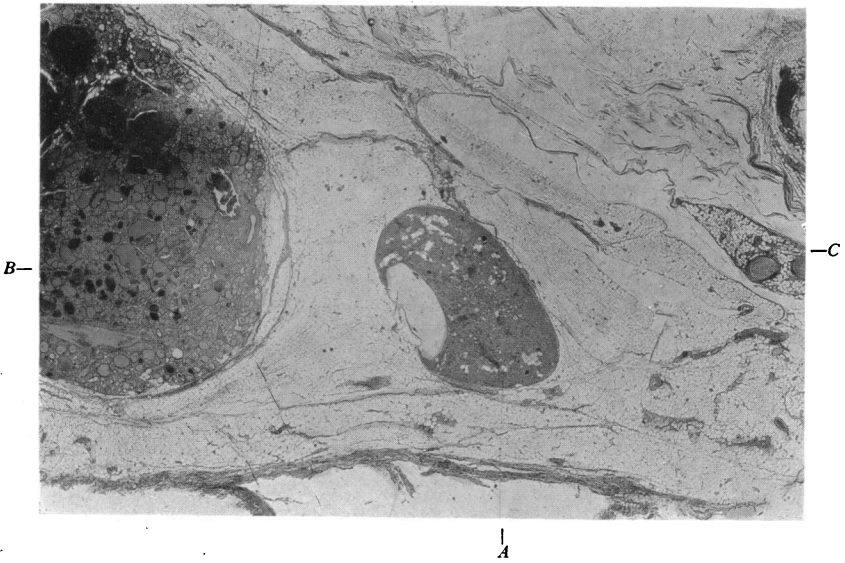


FIG. 10.—Parathyroid external to the capsule and at such a distance from the thyroid as to be safeguarded by an intracapsular operation. The parathyroid lies between the nerve and the thyroid (Class I). A, parathyroid; B, thyroid; C, recurrent laryngeal nerve.

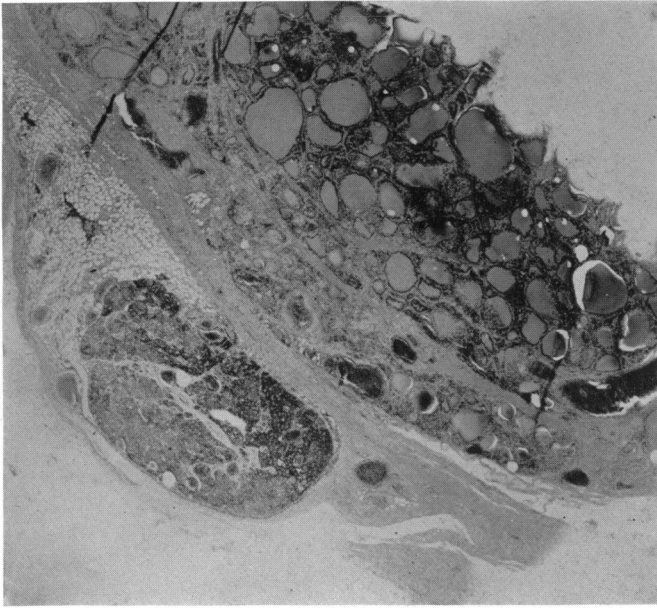


FIG. 11.—Parathyroid separated from thyroid by dense capsule.

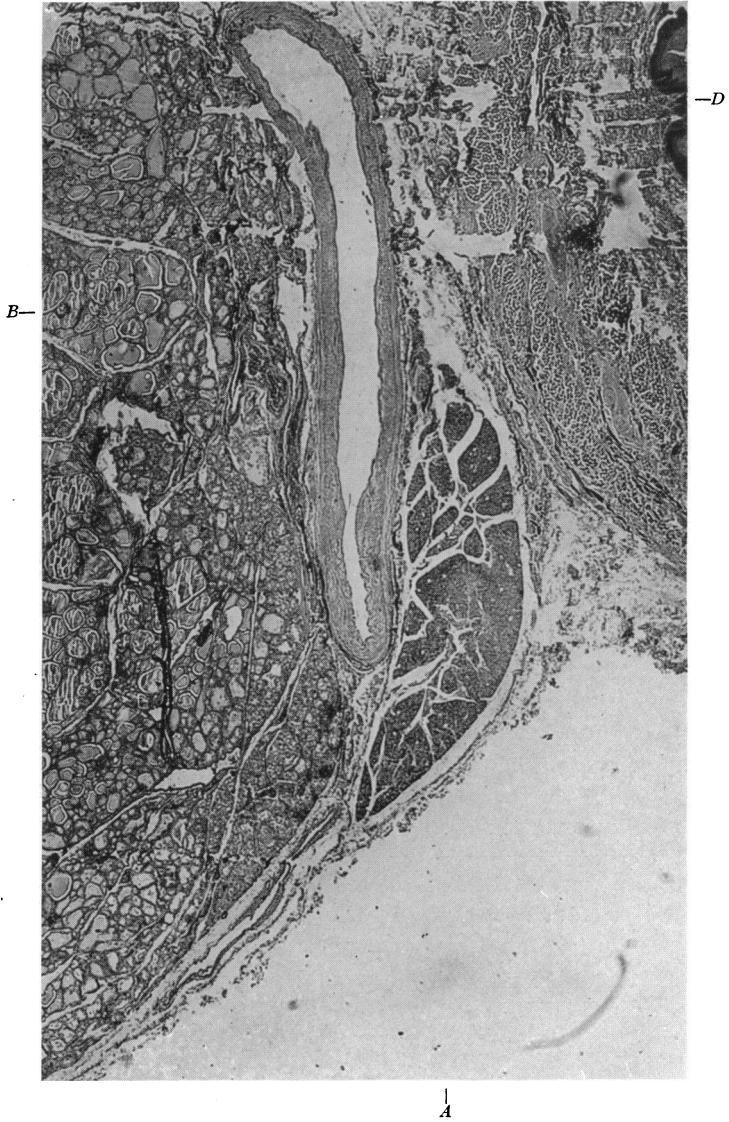


FIG. 12.—Parathyroid so close to thyroid that it might be endangered in an “intracapsular” removal of lobe (Class II).

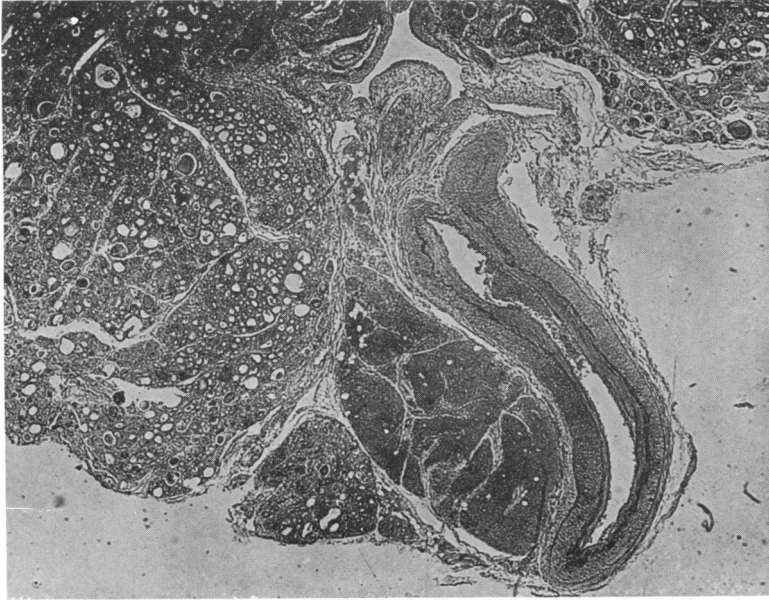


FIG. 13.—Parathyroid so close to thyroid that it would be endangered in an “intracapsular” removal of the lobe (Class II). A, parathyroid.

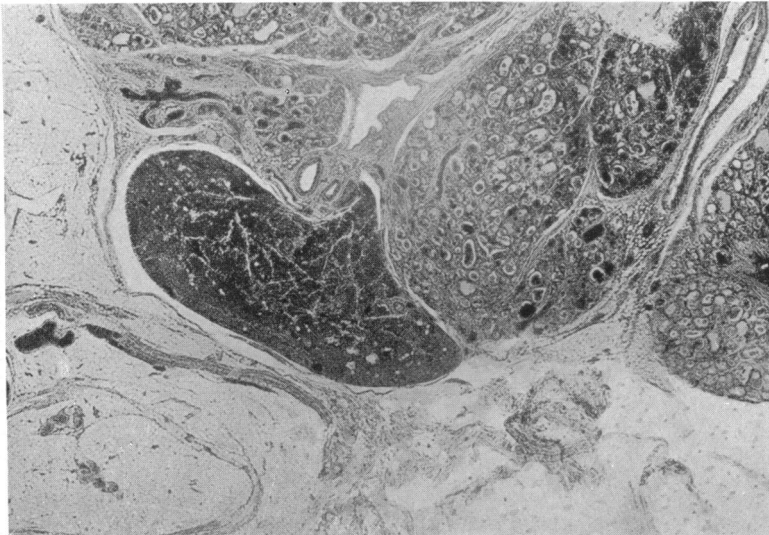


FIG. 14.—Parathyroid in such close relation to the thyroid that it would probably be removed with the lobe in an intracapsular lobectomy (Class III).

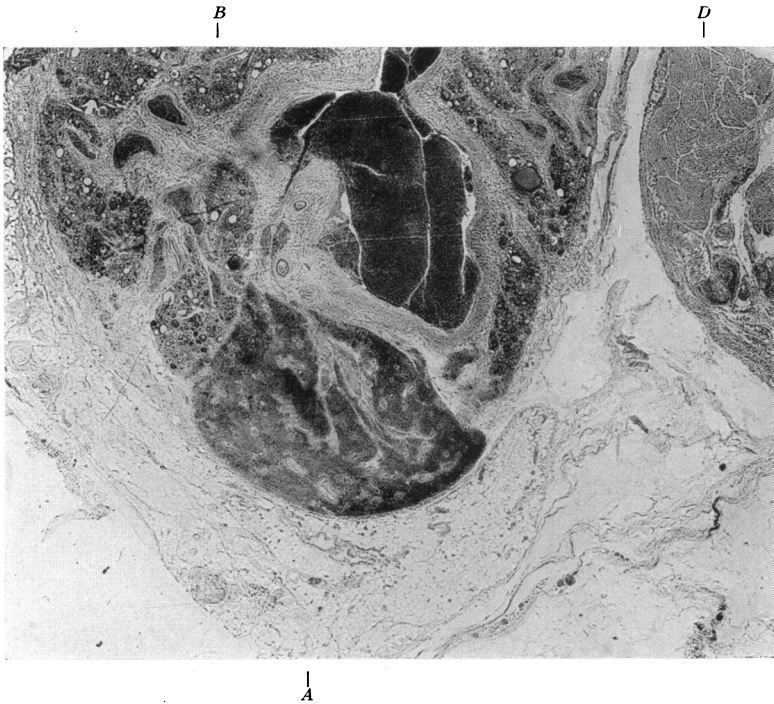


FIG. 15.—Parathyroid in such close relation to the thyroid that it would probably be removed with the lobe in an "intracapsular" lobectomy (Class III). A, parathyroid; B, thyroid; D, cesophagus.

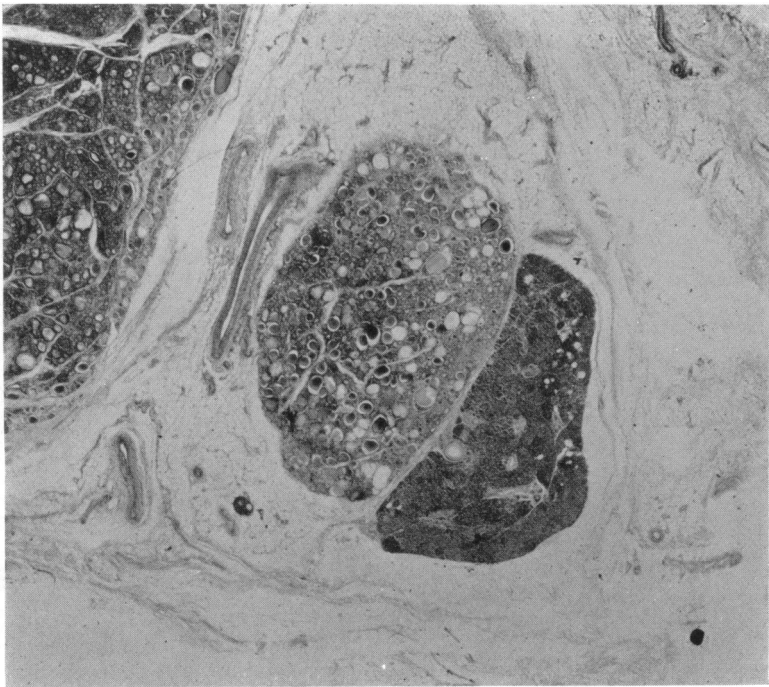


FIG. 16.—Parathyroid in close relation to an accessory thyroid.

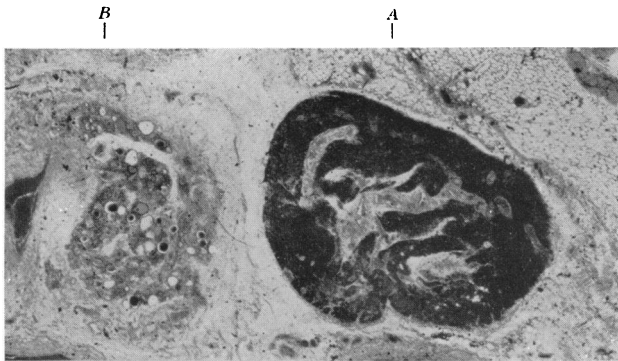


FIG. 17.—Parathyroid situated at and below the extreme lower pole of the thyroid lobe. *A*, parathyroid; *B*, thyroid.

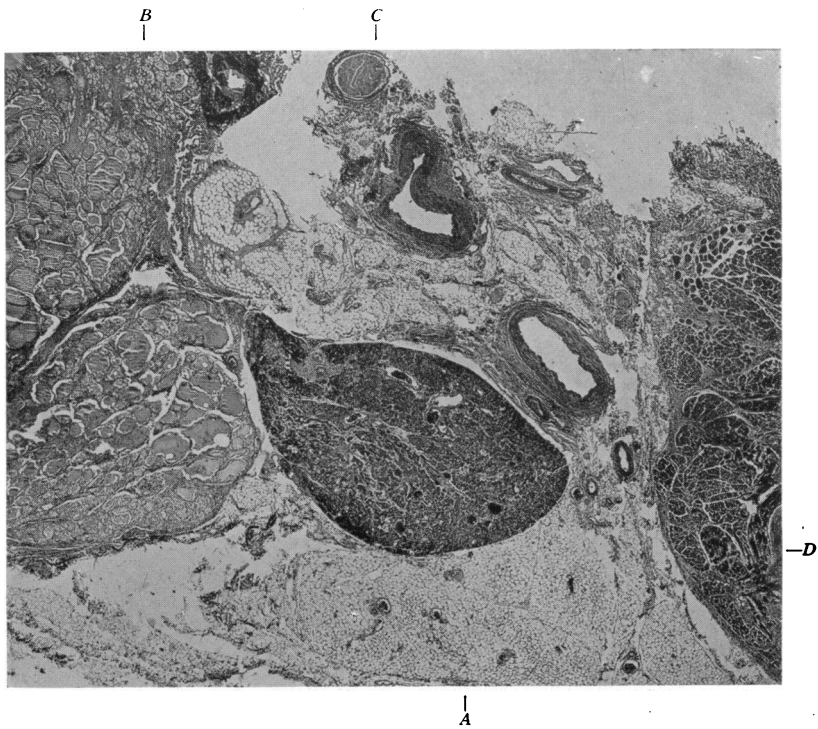


FIG. 18.—To contrast different relationships of thyroid, parathyroid, recurrent laryngeal nerve, inferior thyroid artery and esophagus. Compare Fig. 19.





FIG. 19.—To contrast different relationships of the thyroid, parathyroid, recurrent laryngeal nerve, inferior thyroid artery and cesophagus. Compare with Fig. 18. *A*, parathyroid; *B*, thyroid; *C*, nerve; *D*, cesophagus.



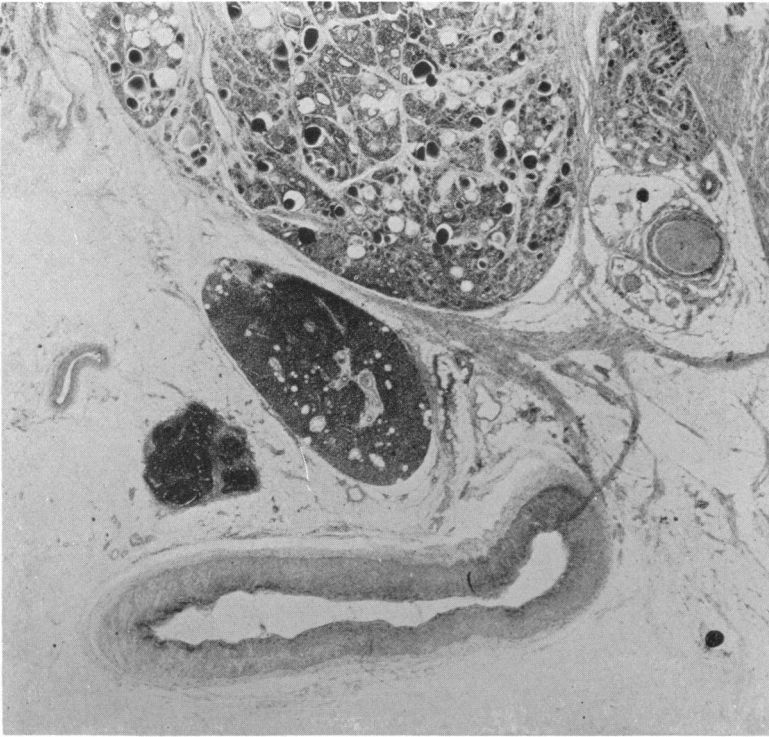


FIG. 20.—Parathyroid lying between branch of inferior thyroid artery and thyroid gland; separated from the latter by a dense layer of fascia.



FIG. 21.—Showing parathyroid flattened out on side of thyroid.

## THE PARATHYROID GLANDS

*The Topography of the Parathyroids.*—The tissues of the neck anterior to the spine were removed at autopsy in 25 cases. They were cut transversely in thin layers and a search was made for the parathyroid glands. When tissue suggestive of a parathyroid was found it was blocked with the surrounding structures and sections were made for microscopic examination.

Sixty parathyroids were found and studied. They may be grouped as follows:

Class I. Those which lay external to the capsule at sufficient distance from the thyroid and in such a position as to be safeguarded in an intracapsular extirpation of the lobe. These numbered 26, or 43.3 per cent. (Figs. 9, 10 and 11).

Class II. Those whose relationship to the capsule and to the thyroid was such as to make it doubtful whether they would be saved in an intracapsular removal of the lobe. These were 9 in number, or 15 per cent. (Figs. 12 and 13).

Class III. Those whose position was such that they would almost certainly have been removed with the thyroid in an intracapsular extirpation of the lobe. These numbered 25, or 41.7 per cent. (Figs. 14 and 15).

*Summary.*—25 specimens sectioned for parathyroids; 60 parathyroids found:

TABLE I

0 parathyroid .....	2 cases
1 parathyroid .....	2 cases
2 parathyroids .....	10 cases
3 parathyroids .....	6 cases
4 parathyroids .....	5 cases
Right superior .....	12
Left superior .....	14
Right inferior .....	16
Left inferior .....	16
Right middle <sup>1</sup> .....	1
Not classified <sup>2</sup> .....	1

The occurrence of the parathyroid glands in pairs may properly be considered the typical arrangement, a superior and inferior body being present on each side. *Although variations in the anatomical positions are frequent*, it may be stated that the superior most often lies in relation to the middle third of the posterior border of the lateral lobe of the thyroid; the inferior in relation to the inferior third of the posterior

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<sup>1</sup> Only three were found; all on one side.

<sup>2</sup> Only one was found in the first case studied; its situation was not recorded.

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surface of the lobe or lower, even below the inferior pole. Accessory accumulations of characteristic parathyroid cells may be present, especially below the thyroid and within the thyroid (Getzowa). Such aberrant parathyroids probably prevent, in some cases, ill effects from the sacrifice of considerable parathyroid tissue.

In Table II the situation of each parathyroid relative to the surgical capsule is represented as follows:

Class I. Those which lay external to the surgical capsule in such a position as to be safeguarded in an intracapsular extirpation of the lobe ("I" in table).

Class II. Those whose relationship to the surgical capsule and to the thyroid make it doubtful whether they would have been saved ("II" in table).

Class III. Those whose relationship was such that they would almost certainly have been removed ("III" in table).

TABLE II

No. of specimen	Left superior	Left inferior	Right superior	Right inferior	Not classified
1.....	.....	I.....	I.....	.....	III*
2.....	.....	I.....	I.....	III.....	
3.....	I.....	II.....	.....	I.....	
4.....	.....	III.....	.....	III.....	
5.....	II.....	I.....	I.....	I.....	
6.....	I.....	.....	III.....	I.....	
7.....	III.....	III.....	III.....	III.....	
8.....	No parathyroids found				
9.....	.....	.....	I I <sup>1</sup> .....	I.....	
10.....	No parathyroids found				
11.....	III.....	I.....	III.....	I.....	
12.....	III.....	.....	III.....	.....	
13.....	II.....	III.....	III.....	III.....	
14.....	II.....	III.....	III.....	II.....	
15.....	.....	I.....	.....	.....	
16.....	I.....	I.....	.....	.....	
17.....	.....	II.....	.....	II.....	
18.....	I.....	.....	III.....	.....	
19.....	III.....	III.....	III.....	.....	
20.....	II.....	.....	.....	III.....	
21.....	.....	II.....	.....	I.....	
22.....	.....	III.....	.....	I.....	
23.....	I.....	.....	.....	III.....	
24.....	.....	I.....	.....	I.....	
25.....	I.....	I.....	I.....	.....	

*Summary of Table II.*—In a unilateral intracapsular removal of a lobe:

Left lobe: Two parathyroids would have been sacrificed (Class III) 2 times, or 8 per cent.; two parathyroids likely to be sacrificed (Class II) 2 times, or 8 per cent.

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Right lobe: Two parathyroids would have been sacrificed (Class III) 2 times, or 8 per cent.; two parathyroids likely to be sacrificed (Class II) once, or 4 per cent.

To estimate the risk to the individual, the percentage based upon the 50 lobes in the 25 cases must be divided by two; therefore, on the basis of these figures, the operation of unilateral intracapsular lobectomy is attended with a risk of 8 per cent. that two parathyroids will be removed; this would be increased to 14 per cent. if the doubtful cases were included.

In bilateral intracapsular removal of both lobes: 4 parathyroids would have been sacrificed (III) in one case, 4 per cent.; 4 parathyroids likely to be sacrificed (II) in two cases, 8 per cent.; endangered in 12 per cent.

TABLE III

	Apparently safe (not removed) (Class I)	Doubtful (Class II)	Probably removed (Class III)
Right superior .....	4	0	8
Left superior .....	6	4	4
Right inferior .....	8	2	6
Left inferior .....	7	3	6
Middle right <sup>1</sup> .....	1	..	..
Not classified <sup>2</sup> .....	..	..	1
	—	—	—
	26	9	25

It must be emphasized that the relation of the parathyroids to the thyroid and its capsule is not of necessity the same for the whole set of parathyroids in an individual; that is, if one glandule is close to or at a distance from the thyroid, it does not follow that the others in the same individual are in the same relative position; such may or may not be the case, as is shown by the following analysis:

Of the ten cases in which only two parathyroids were found, in two both would have been removed; in one instance they were the two superior parathyroids and in the other the two inferior parathyroids. In four of the remaining 8 cases one parathyroid would have been removed; in three of these an inferior and in one a superior. Of the four remaining cases, in two both parathyroids would have been preserved, in one case it was doubtful whether they would have been saved, and in the fourth case one would have been saved and one was doubtful.

Of the six cases in which three parathyroids were found, in one case all three would have been removed, namely, two superiors and one

inferior. Of the remaining five cases one parathyroid would have been removed in two instances; in one the right inferior, in the other the right superior.

In the five cases in which all four parathyroids were found, in one case all four would have been removed. In another three would have been removed; namely, two inferior and a right superior. In two cases two would have been removed; namely, the left inferior and the right superior in one case and the right superior and left superior in another. In the fifth case three would have been left; the fourth parathyroid (left superior) belonged to Class II.

*Conclusions.*—Although these figures and deductions have been arrived at through the study of the thyroid under practically normal conditions they are presumably approximately correct even under the somewhat changed conditions which prevail in connection with enlargement of the thyroid. That parathyroids are removed frequently in goitre operations has been shown by Iversen, MacCallum and others; there is, however, marked disagreement as to the frequency with which they are thus sacrificed.

It must be emphasized that the relation of the parathyroids to the thyroid and its capsule is not of necessity the same for the whole set of parathyroids in an individual.

In the 25 cases analyzed by us one (or more) parathyroids would apparently of necessity have been removed in an intracapsular lobectomy in 21 of the 50 lobes, or 42 per cent. The significant feature, however, is that two parathyroids would almost certainly be removed in a unilateral intracapsular lobectomy in 8 per cent. of individuals, and possibly removed in 6 per cent. additional cases (*cf.* Table II).

It must be confessed that our studies have not led to conclusions which warrant recommendations for radical departure from the generally accepted operative procedures. The most that can be hoped is that they will emphasize certain important anatomical features and perhaps lead to a clearer appreciation of the reasons for certain generally accepted principles in regard to the surgery of the thyroid. These principles may be briefly reviewed.

Since usually two parathyroids lie on each side, and inasmuch as two parathyroids apparently can satisfy the demands of the body, the chance that tetany will develop as a result of extirpation of one lobe is extremely remote. It is reasonably safe, therefore, as far as tetany is concerned, to perform complete intracapsular extirpation of one lobe, as is so often done, for instance, in exophthalmic goitre.

Attention must be called to the fact that in a considerable percentage

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of the reported cases of tetany which have followed operations for simple goitre the tetany has followed an operation upon the second lobe, one lateral lobe having been removed at a former operation. Such cases must be explained as follows: After extirpation of one lobe an operation upon the remaining lobe becomes necessary. Although the operator, who may be a different surgeon from the one who performed the first operation and not know the details of that operation, may elect resection or partial extirpation of the second lobe, conditions may be such as to divert him into the performance of complete extirpation of the second lobe. In such an operation parathyroids may be sacrificed, and if one or two parathyroids have already been removed in the former operation, parathyroid insufficiency and consequent tetany will result. It follows that *for the prevention of tetany the posterior part of the lateral lobe must always be left on at least one side*; it likewise follows that, even when one lobe only is operated upon, permanent safety is better insured by leaving *in situ* the posterior part of that lobe. Then, if a subsequent operation with complete removal or removal of the lower half of the second lobe becomes necessary, the operation may be performed with relative safety. Although the above condition rarely arises, one of the writers has seen two cases.<sup>8</sup>

In regard to safeguarding the recurrent nerve it may be emphasized again that in a true intracapsular extirpation of a lobe the recurrent nerve is relatively immune from injury. Nevertheless, as has been explained, the capsule may be torn at its posterior part and the cellular plane which contains the recurrent may be entered and the nerve injured. This danger is avoided by leaving a portion of the posterior part of the lobe.

To summarize: It is advantageous, but not imperative, to leave *in situ* the posterior parts of both lateral lobes in relation with each of which a recurrent laryngeal nerve and two parathyroids usually lie. Complete bilateral extirpation, the isthmus only being left, should never be considered. The posterior part of the one lobe must always be left.

The authors are indebted to Dr. Hermann Schulte and Dr. W. C. Clarke of the College of Physicians and Surgeons, Columbia University, for assistance in the preparation of this article; also to the French Hospital for the use of the laboratory.

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<sup>8</sup> Pool: Tetany Parathyreopriva, ANN. OF SURG., 1907, xlvii, p. 507. Pool and Turnure: Post-Operative Tetany, Parathyroid Transplantation. ANN. OF SURG., 1912, lvi, p. 804.