

## The anatomical relationship between the external laryngeal nerve and the superior thyroid artery in the region of the superior thyroid pole.

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*The study of the external laryngeal nerve dissected in 342 superior thyroid poles at the Department of Anatomy, Faculty of Medicine, Chulalongkorn University demonstrated that in 219 cases (64.04%) the normal course of the nerve was situated adjacent to the inferior pharyngeal constrictor muscle not enclosed by the thyroid sheath in the region of the superior thyroid pole. The aberrant courses of the external laryngeal nerve endangered during operation could be divided into two general categories : A total number of 100 nerves (29.24%) coursed adjacent to and was adherent to the superior thyroid artery within the thyroid sheath while another 23 examples (6.72%) were identified as passing around or between the branches of the superior thyroid artery proximal to its innervation of the cricothyroid muscle. Because of the aberrant courses, the surgeon should carefully avoid injury to the external laryngeal nerve in the region of the superior thyroid pole as well as in the region of the inferior thyroid pole.*

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นงเยาว์ พันธุ์รัตน์, ธันวา ตันสถิตย์, วิไล ชินธเนศ, พัฒน์พงศ์ นาวีเจริญ. ความสัมพันธ์ทางกายวิภาคของเส้นประสาทเอ็กเทอร์นอลลาริงเจียลกับหลอดเลือดแดงซูปรีเรียไทรอยด์ในบริเวณขั้วบนของต่อมไทรอยด์. จุฬาลงกรณ์เวชสาร 2533 34 (7): 509-520

การศึกษาทางเดินของเส้นประสาท *external laryngeal* บริเวณขั้วบนของต่อมไทรอยด์ 342 ข้าง ที่ภาควิชากายวิภาคศาสตร์ คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัยพบว่า มีทางเดินของเส้นประสาทในแบบปกติ คือเส้นประสาทอยู่ชิดกับกล้ามเนื้อของคอหอยและอยู่นอกเยื่อหุ้มต่อมไทรอยด์ ทั้งหมดพบในกลีบข้างของต่อมไทรอยด์ 219 ข้าง (64.04%) ความสัมพันธ์ในแบบที่ไม่ปกติซึ่งเป็นเหตุให้เกิดอันตรายได้ในขณะตัดเส้นเลือดที่มาสู่ต่อม แบ่งได้เป็น 2 แบบ คือใน 100 ข้างของต่อมไทรอยด์ (29.24%) พบ *external laryngeal nerve* ทอดติดอยู่กับ *superior thyroid artery* ใน *sheath* หุ้มต่อมไทรอยด์ และ 23 ข้างของต่อม (6.72%) *external laryngeal nerve* คล้องอยู่รอบแขนงของ *superior thyroid artery* ดังนั้นในการผ่าตัดเอาต่อมไทรอยด์ออกจำเป็นต้องระวังที่จะไม่ทำอันตรายต่อ *external laryngeal nerve* ในบริเวณขั้วบนของต่อมไทรอยด์ โดยเฉพาะในพวกที่ *external laryngeal nerve* มีความสัมพันธ์กับโครงสร้างต่าง ๆ บริเวณขั้วบนของต่อมไทรอยด์ในแบบที่ไม่ปกติ เช่นเดียวกับที่ได้ระวัง *recurrent laryngeal nerve* ที่ขั้วล่างของต่อมไทรอยด์ขณะทำการตัดเส้นเลือดที่มาเลี้ยงต่อม

The most common cause of hoarseness after thyroidectomy is injury to the external laryngeal nerves on one or both sides.<sup>(1-4)</sup> Damage to the recurrent laryngeal nerve, which is routinely identified and protected,<sup>(5-8)</sup> is rarely a cause. The possible explanation is that the external laryngeal nerve has received less than other structures which may be injured during thyroid surgery.

The external laryngeal nerve leaves the superior laryngeal nerve approximately 1.5 cm. below the nodose ganglion and descends from behind the internal carotid artery in the carotid sheath. Descending on the inferior pharyngeal constrictor just under the oblique line of the thyroid cartilage, it curves anteriorly and medially to supply the cricothyroid muscle. At the point where the nerve crosses the posterior edge of the thyroid cartilage it is usually covered by the inferior pharyngeal constrictor muscle fibers.<sup>(5-6,8-10)</sup> It runs close to the superior thyroid artery and therefore is highly vulnerable if the vessels of the superior thyroid pole are divided without sufficient attention by the surgeon.

The external laryngeal nerve regulates the tension of the vocal cords by rotating the cricoid cartilage.<sup>(4,11)</sup> Isolate injury to the external laryngeal nerve does not interfere with abduction of the vocal cords though it interferes with the tension of the cords.<sup>(2,10)</sup> Paralysis of the cricothyroid muscle results in any one, or more of the following changes in the quality of the voice : hoarseness, weakness, huskiness, decreased range of pitch or volume, inability to produce certain sounds, and ease of fatigue in speaking.<sup>(4,5,10,12-14)</sup> Laryngoscopic examination after unilateral cricothyroid paralysis reveals that the edge of the involved cord may be irregular or may have a wavy outline.<sup>(15-19)</sup> It usually lies at a lower level<sup>(12,15,20-21)</sup> than the opposite normal cord, producing an oblique glottic aperture.<sup>(22)</sup> It is sometimes shortened. The involved cord bulges on expiration and retracts on inspiration due to lack of tonus.<sup>(1,10)</sup> However, the cord will move normally in adduction and abduction.

Bilateral injury may be difficult to detect.<sup>(5,7,10-11,13)</sup> The best method of detecting injury to this nerve is by checking the ability of the patient to produce highpitched tones.<sup>(23)</sup> It is assumed that any coincidental laryngeal inflammation or trauma that produce

this disability would normally have subsided within 3 months. If this disability last more than this period then it is considered to be a positive test of nerve injury.

This study aimed to determine the course of the external laryngeal nerve in relation to other structures in the region of the superior thyroid pole especially with the superior thyroid artery and its branches and the thyroid sheath.

## Material and methods

A total of 342 external laryngeal nerves were dissected in 171 cadavers at the Department of Anatomy, Faculty of Medicine, Chulalongkorn university over a period of 5 years. In no case was there any previous surgery connected with the cervical region. After the skin and platysma muscles were removed, full access to the external laryngeal nerve was obtained by division of the omohyoid, sternohyoid and sternothyroid muscles. These muscles were dissected free up to the hyoid bone. With this procedure the external laryngeal nerve was free far above the superior pole of the thyroid gland. After dissection all specimens were documented graphically and some were photographed.

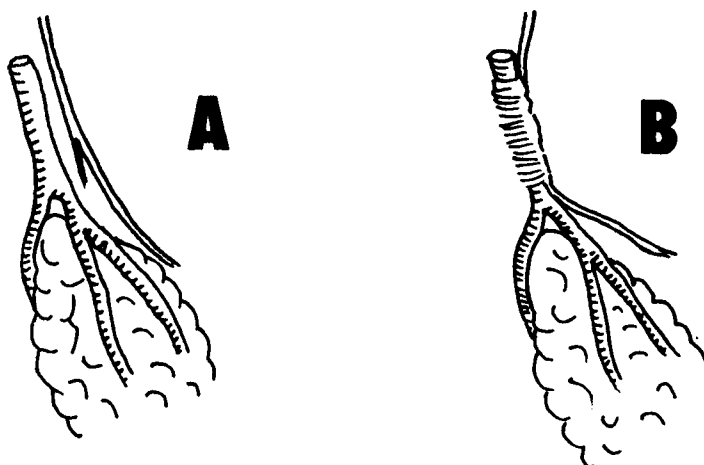
## Results

Our study of 342 lobes of the thyroid gland found 219 external laryngeal nerves (64.04%) situated adjacent to or embedded in the inferior pharyngeal constrictor muscle and not enclosed within the thyroid sheath. Two of these were divided into two branches above the level of the hyoid bone. 100 nerves (29.24%) were found within the thyroid sheath. It coursed adjacent to and was adherent to the superior thyroid artery beneath the sternothyroid muscle. 23 nerves (6.72%) were of surgical significance and were summarized in table 1 and figure 1. In this group, the external laryngeal nerve descended along the posterior edge of the superior thyroid artery within the thyroid sheath and then looped around in front of the artery or its branches in its course to innervate the cricothyroid muscle.

**Table 1.** Summary of courses of the external laryngeal nerve.

TYPE	SIDE		TOTAL	(%)
	RIGHT	LEFT		
A	107	112	219	(64.04)
B	52	48	100	(29.24)
C.1	0	0	0	
C.2	10	7	17	( 4.97)
C.3	2	3	5	( 1.46)
C.4	0	0	0	
C.5	0	1	1	( 0.29)
C.6	0	0	0	
<b>TOTAL</b>	<b>171</b>	<b>171</b>	<b>342</b>	<b>100</b>

- A. normal course
- B. adherent to superior thyroid artery
- C. around branches of superior thyroid artery
  - 1. main stem
  - 2. posterior branch
  - 3. main stem distal to posterior branch
  - 4. anterior branch
  - 5. lateral branch
  - 6. both posterior and lateral branches

**Figure 1.** Types of courses of the external laryngeal nerve.

- A. normal course.
- B. adherent to superior thyroid artery.

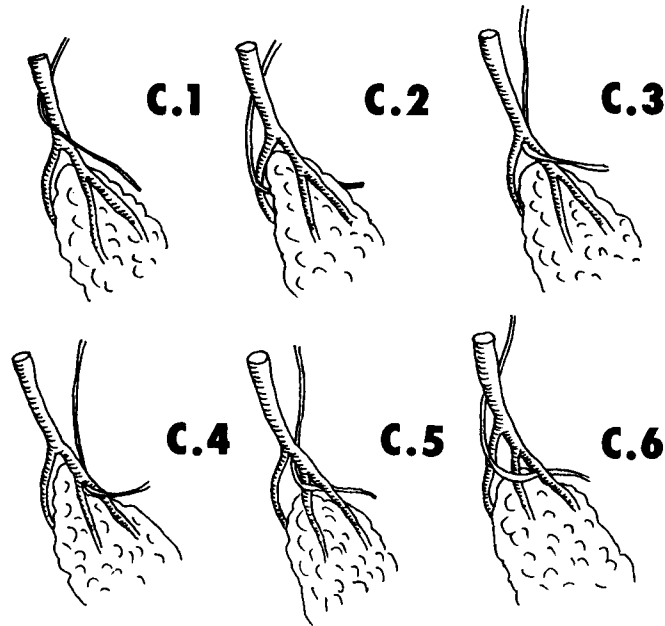


Figure 1. (Continued)

- C. around branches of superior thyroid artery.
1. main stem
  2. posterior branch
  3. main stem distal to posterior branch
  4. anterior branch
  5. lateral branch
  6. both posterior and lateral branches.

Of the 23 dissected nerves in this group, 17 nerves (4.97% of the 342 nerves) looped around the posterior branch of the artery, while 5 nerves (1.46%)

looped around the artery distal to the origin of the posterior branch and one (0.29%) coursed around the lateral branch.

Table 2. These study compared with the classical Moosman's series (1968) and the recent Lennquist's study (1987).

TYPE	THIS STUDY	MOOSMAN	LENNQUIST	
			CADAVER	CLINICAL
A	64.04	79	82	80.56
B	29.24	15	0	0
C	6.72	6.00	18.00	19.44
C.1	0	0.5	4	0
C.2	4.97	3.5	2	4.35
C.3	1.46	0.5	4	0
C.4	0	1.3	6	16.67
C.5	0.29	0.3	0	0

Table 2 (Cont'd)

TYPE	THIS STUDY	MOOSMAN	LENNQUIST	
			CADAVER	CLINICAL
C.6	0	0	2	0
NO. OF NERVES	342	400	50	36

- A. normal course  
 B. adherent to superior thyroid artery  
 C. around branches of superior thyroid artery
1. main stem
  2. posterior branch
  3. main stem distal to posterior branch
  4. anterior branch
  5. lateral branch
  6. both posterior and lateral branches

## Discussion

Although the consequences of the external laryngeal nerve injury may be relatively mild, some patients experience problems so severe as to restrict their professional and social activities especially in women and singers. There is no doubt that the external laryngeal nerve is a clinically importance structure.

This nerve is ordinarily situated adjacent to the inferior pharyngeal constrictor muscle and is not enclosed by the thyroid sheath. The latter, a translucent layer of fascia, sometimes called the surgical capsule, invests the thyroid gland. It extends upward to attach to the fascia of the inferior pharyngeal constrictor muscle and the oblique line of the thyroid cartilage, and thus contains the superior thyroid artery. Removing the thyroid gland during thyroidectomy, the surgeon may develop a plane of dissection within the thyroid sheath adjacent to the medial side of the artery and ordinarily separate the artery from the external laryngeal nerve.

In our study we found the nerve within the thyroid sheath and it was adherent to the superior thyroid artery in 29.24 percent as compared with 15 percent in the series of Moosman and Dewese (1968).<sup>(10)</sup> In such a case, the surgical method based on developing a plane within the thyroid sheath (the surgical capsule) medial to the vessels would not avoid inclusion of the nerve, unless it was identified and separated from the artery prior to ligation.

In 6.72 percent, similar to 6 percent reported by Moosman and Dewese,<sup>(10)</sup> the external laryngeal nerve

looped around in front of the arterial branch. Durham and Harrison<sup>(11)</sup> reported such a course in 14 percent of their material, while Lennquist, Cahlin and Smeds<sup>(24)</sup> estimated a similar course in a higher percentage of their dissection. In this instance it would be necessary to identify the arterial branch entrapping the nerve. The surgeon should divide and ligate this arterial branch separately to free the nerve, Supporting this surgical method, Lekacos and his team (1987)<sup>(23)</sup> reported, in a clinical prospective study, 3 cases of external laryngeal nerves injury detected after 54 classical high ligations of the superior thyroid artery. On the contrary, no injury of the nerve was noted in 227 cases in which the technique of separation ligation of the branches of the superior thyroid artery was used.

Other suggestions from previous studies to avoid injury to the nerve include :

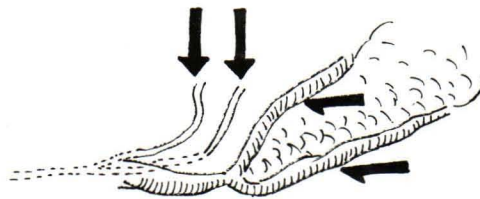
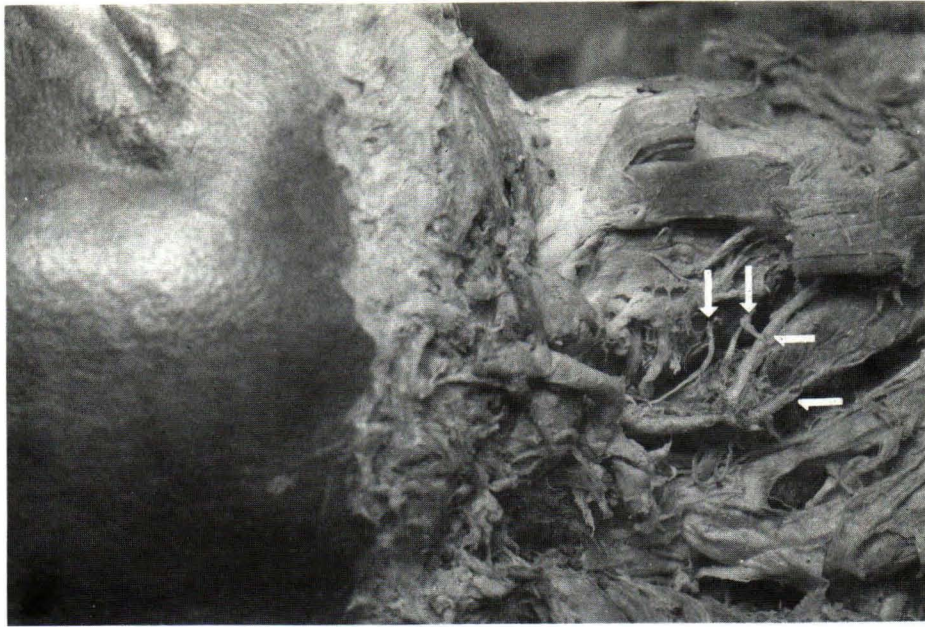
Identifying and preserving the nerve prior to ligation of the superior thyroid vessels 1.<sup>(25-26)</sup>

Careful skeletizing of the superior pole vessels with protective attention to the nerve, though not to dissect it free in a course covered with fiber of the pharyngeal constrictor muscle<sup>(6,27)</sup>

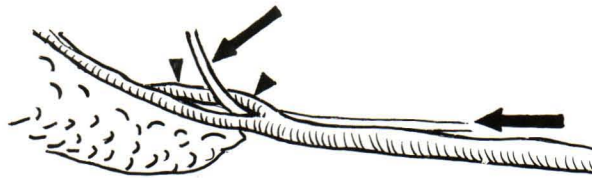
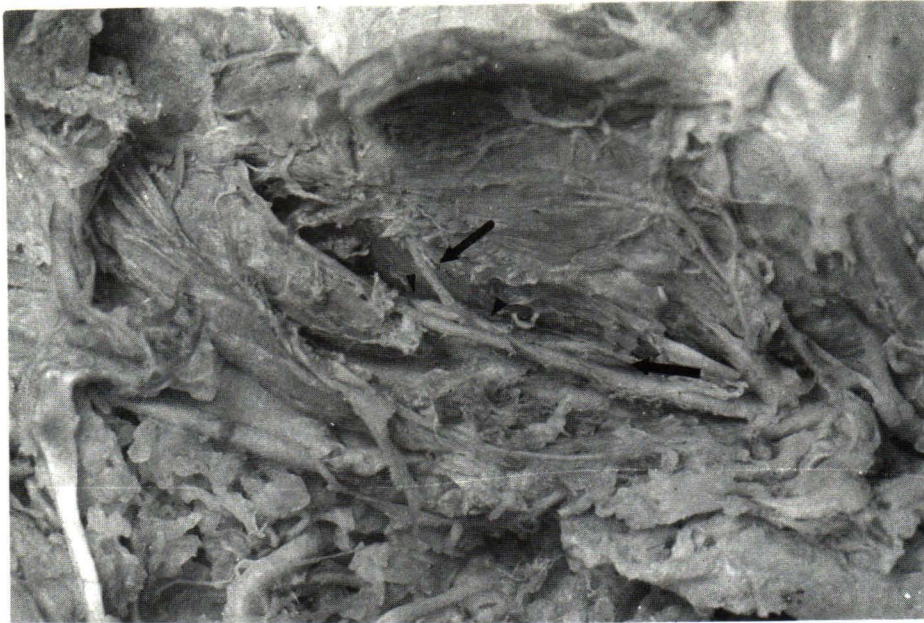
Ligation of the superior pole vessels after the whole lobe has been mobilized<sup>(28)</sup>

Retracting the superior pole downwards and outwards and dissecting medially to laterally.<sup>(24,29)</sup>

Not to use diathermy during dissection around the superior thyroid pole<sup>(24)</sup>

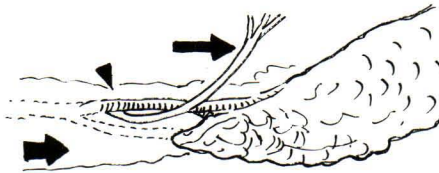


**Figure 2.** High division of the external laryngeal nerve. Note the two terminal branches (vertical arrows). The anterior branch (upper horizontal arrow) and the lateral branch (lower horizontal arrow) of the superior thyroid artery reach the superior thyroid pole. Angle of mouth is in the upper left corner.

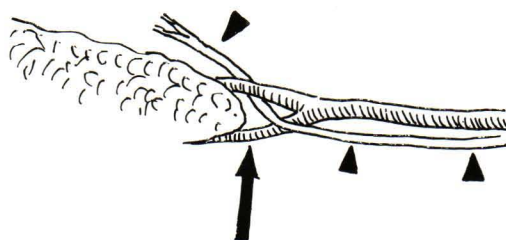


**Figure 3.** The external laryngeal nerve (long arrows) loops around the posterior branch (arrow heads) of the superior thyroid artery. Note the main artery (parallel with the right long arrow). Head is on the right side of the picture.





**Figure 4.** The external laryngeal nerve (half-arrow) loops around the superior thyroid artery (arrow head) distal to the origin of the posterior branch which is covered with the thyroid sheath (large arrow) Head is on the left.



**Figure 5.** The external laryngeal nerve (arrow heads) courses around the lateral branch (long arrow) of the superior thyroid artery. The posterior branch can't be seen in this view.

In future, the incidence of permanent voice change after thyroidectomy should be minimized due to all these suggestions.

There is no statistical difference of these aberrant courses between the left and the right sides. Thus, the surgeon must perform meticulous dissection around this area on both sides. The statistical method used for evaluation of the result was the chi-square with Yates' correction ( $P = 0.05, 0.10$ ).

## Summary

The external laryngeal nerve usually courses medial to the superior thyroid artery and can be easily separated from each other. However an aberrant course of this nerve was observed in 342 superior thyroid poles. In 29.24 percent, the nerve was adherent to the artery within the thyroid sheath, and in 6.72 percent, the nerve was entrapped between the arterial branches. Because of this aberrant position, the nerve may be included during ligation of the superior thyroid artery in thyroidectomy.

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