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A Variant Branch of the Internal Laryngeal Nerve Supplying Filaments to the Cricothyroid Muscle: An Autopsy Case

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Abstract: We report a variant branch of the internal laryngeal nerve found in a Japanese male body. This branch, arising in the piriform fossa from the inferior portion of the loose network formed by the intercommunicating subbranches of the internal laryngeal nerve, descended in the interval between the thyroid and arytenoid cartilages accompanied by a branch of the superior laryngeal artery as far downward as the lowest portion of the thyroid cartilage. Here it crossed lateral to the inferior laryngeal nerve to which it gave off a communicating branch and reached the deep surface of the cricothyroid muscle. In this muscle it split into several divisions, each of which issued filaments to this muscle. The terminal branch of this variant branch ended in the fascia covering the cricothyroid muscle and the cricoid cartilage.

Key words: laryngeal nerve, cricothyroid muscle, variation, gross anatomy

INTRODUCTION

In the classic reports, atlases and textbooks of human anatomy by Kallius (1897), Schäfer and Symington (1909), Grosser (1910, 1912) and by Piersol (1916), the variation in the anatomy of the superior and recurrent laryngeal nerves (LN) is well described. In recent studies, however, little if any attention has been paid to the variation in the fine anatomy of these two nerves (Williams, 1951, 1954; Pernkopf, 1952; Mitchell, 1954; Lanz and Wachsmuth, 1955; Berry et al., 1995).

In a course on anatomical dissection, a hitherto unreported variation was observed in the laryngeal region in a Japanese male cadaver, in which a solid branch arose from the internal LN, not from the external LN, reaching the cricothyroid muscle and giving filaments to it. We report the findings obtained in this study in the hope that they will contribute to extending the knowledge as to the variability of the fine anatomy of the LN.

MATERIALS AND METHODS

The variant branch (VB) in question was observed in only one out of 30 sides of Japanese adult cadavers. It was situated on the right side in a male who had died at the age of 88 years. The cervical viscera including the larynx and pharynx along with the associated vessels and nerves were resected and immersed for 3 days in 99 % ethanol containing 0.001% alizarin red (sodium alizarin sulfonate; Wako, Japan) prior to and also dur-

ing dissection. With this solution even fine-caliber nerve branches were strongly stained red, thus allowing us to easily identify them and to elucidate their course. Dissection procedures were performed under a stereomicroscope by using iridectomy scissors and fine forceps (Watanabe-Yayoi).

RESULTS

Right side

Variant branch of the internal LN

The internal LN penetrated the thyrohyoid membrane and, reaching the spatium paralaryngicum submucosum (Pernkopf 1952), the space beneath the piriform fossa, separated into many subbranches which in turn communicated loosely to each other, thus forming a loose network (Fig. 1). The variant branch (VB) was solid and arose from the inferior portion of this network of nerve branches at the level of the muscular process of the arytenoid cartilage and descended, together with a branch of the superior thyroid artery, almost vertically between the thyroid cartilage and the lateral cricoarytenoid muscle as far downward as the lower margin of the lamina of the thyroid cartilage. Here it turned its direction anteriorly, and, crossing laterally the inferior LN to which it gave off a communicating branch, reached the deep surface of the cricothyroid muscle (Fig. 2). Upon entering this muscle, it split into several divisions, each of which diminished rapidly in caliber because of its giving off numberless filaments to this muscle. From one of the divisions a fine branch issued, which, emerging out of the muscle, joined with

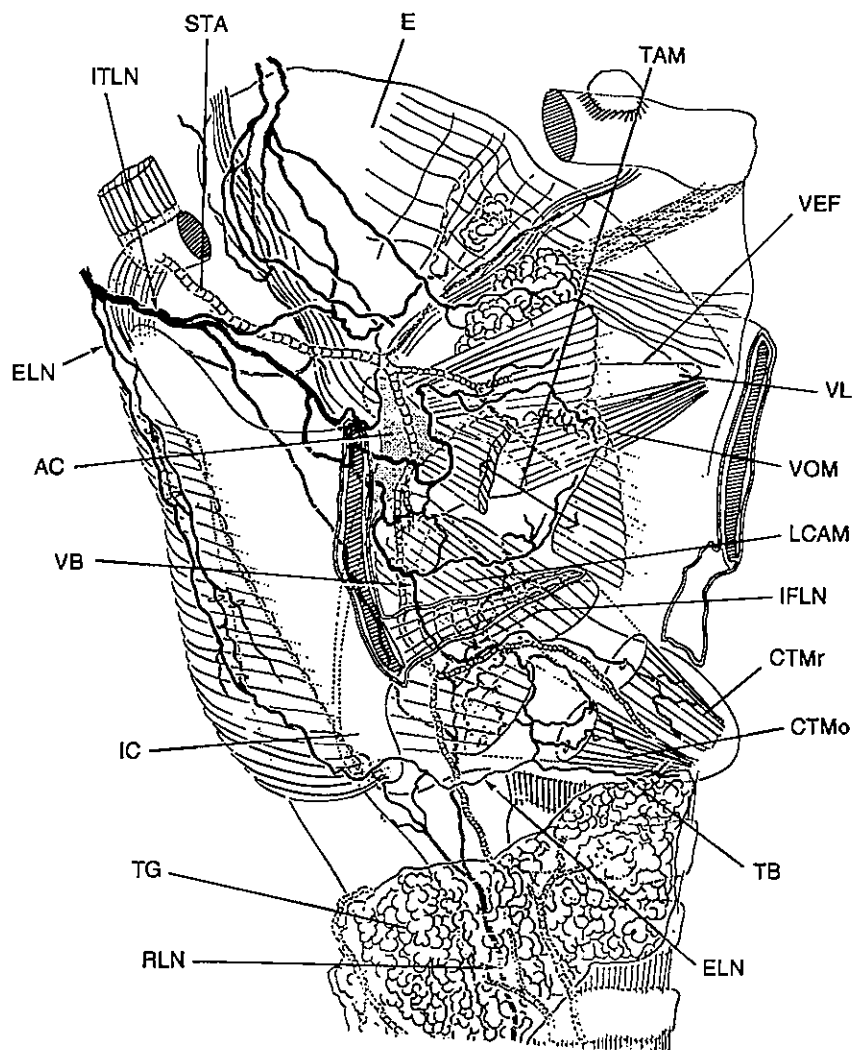


Fig. 1. Diagrammatic representation of the laryngeal region of the right side of this case cadaver, showing the course and distribution of the branches of the superior and recurrent LN, seen from the right. Note that the VB arises from the lower subbranch of the internal LN. Abbreviations: AC, arytenoid cartilage; CTMo, oblique part of cricothyroid muscle; CTMr, straight part of cricothyroid muscle; E, epiglottis; ELN, external laryngeal nerve; IC, inferior cornu of thyroid cartilage; LCAM, lateral cricoarytenoid muscle; IFLN, inferior laryngeal nerve; ITLN, internal laryngeal nerve; RLN, recurrent laryngeal nerve; STA, superior thyroid artery; TAM, thyroarytenoid muscles; TB, terminal branch; TG, thyroid gland; VB, variant branch; VEF, vestibular fold; VL, ventricle of larynx; VOM, vocal muscle.

the external LN (see below). The joined branch, which is practically the terminal branch of this VB, ended in the fascia covering the cricothyroid muscle and cartilage (Fig. 1).

External LN

The external LN was of very small caliber as compared with the ones usually seen and also with the VB. It arose in the usual way from the superior LN before penetrating the thyrohyoid membrane, descending on the external aspect of the middle and inferior constrictor muscles of the pharynx (Fig. 1). At about the level of the inferior margin of the thyroid cartilage, the branch turned anteriorly and inferiorly, and, crossing lateral to the inferior cornu of the thyroid cartilage,

reached the external aspect of the cricothyroid muscle. During its course it communicated with a branch of the recurrent LN. The joined branch, still of small caliber, continued on the external aspect of this muscle anteriorly until communicating with the terminal branch of the VB mentioned above.

Left side

The cricothyroid muscle was innervated in a normal manner by a branch arising from the external LN. The internal LN projected a fine branch which took the same course as that taken by the VB on the right side, but was distributed exclusively to the mucous membrane covering the ventricle of larynx and did not extend as far downward as the cricothyroid muscle (Fig. 3).

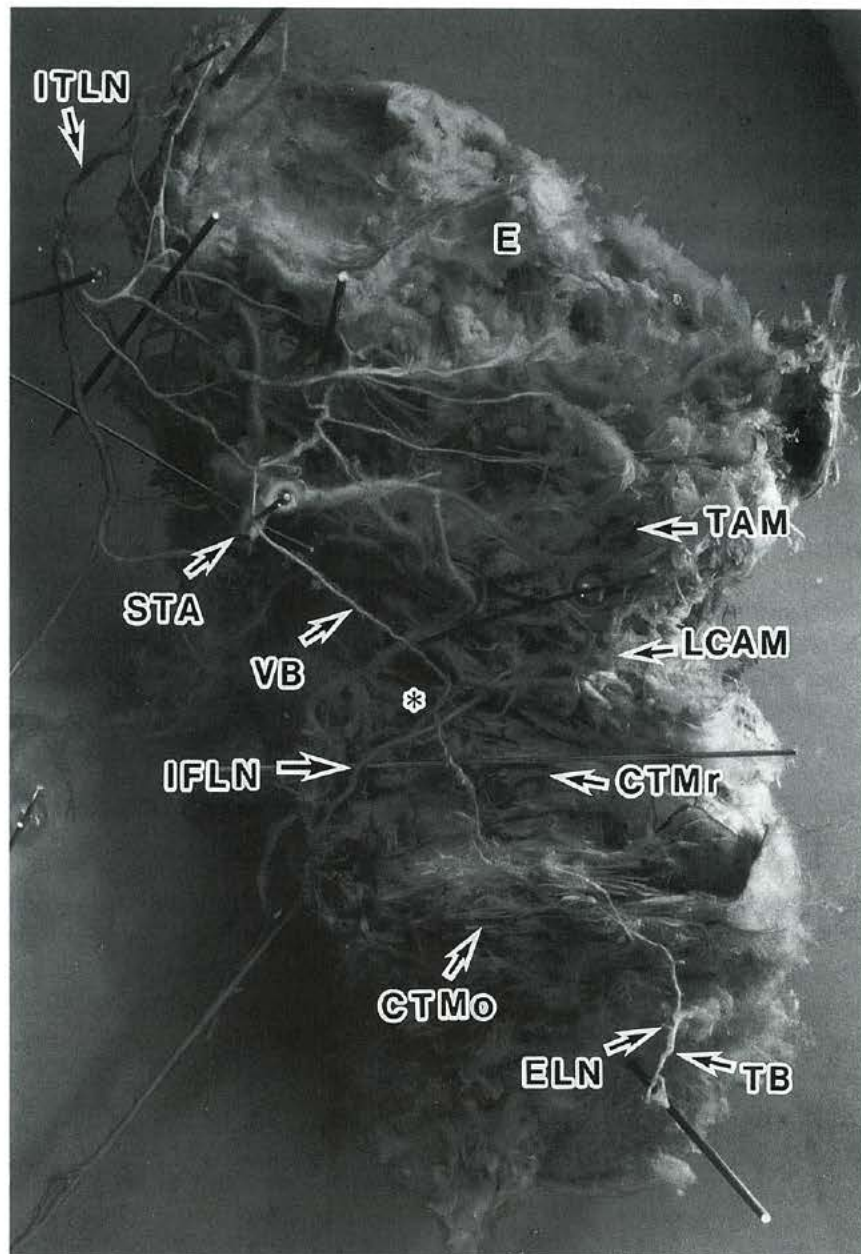


Fig. 2. Photograph of the laryngeal region, seen from the right. The thyroid and cricoid cartilages have been removed in order to show the entire course of the VB. The straight part of the cricothyroid muscle has been removed in order to reveal the course of the VB in this muscle. Asterisk indicates the site where the VB gives off a communicating branch to the inferior LN. $\times 1.8$

DISCUSSION

Occurrence of the VB

In this study we encountered the VB in only one out of 30 sides of Japanese adult cadavers, hence it is a rare occurrence. In fact, a variant such as this has never been described either in the reports by Williams (1951, 1954) and Mitchell (1954), or in the leading atlases and textbooks on human anatomy of Schäfer and Symington (1909), Piersol (1916), Pernkopf (1952), Lanz and Wachsmuth (1955) and Berry et al. (1995).

Morphological and functional significance of the VB

In this study it was observed that the VB, after entering the cricothyroid muscle, separated abruptly into several divisions, each of which was diminished in caliber by splitting into divisions and more importantly by issuing filaments to this muscle. As regards the external LN, which is ordinarily the principal supplier of the cricothyroid muscle, it was observed that, after joining with a branch issuing from the recurrent LN, it reached the external aspect of this muscle and communicated here with one of the divisions of the VB.

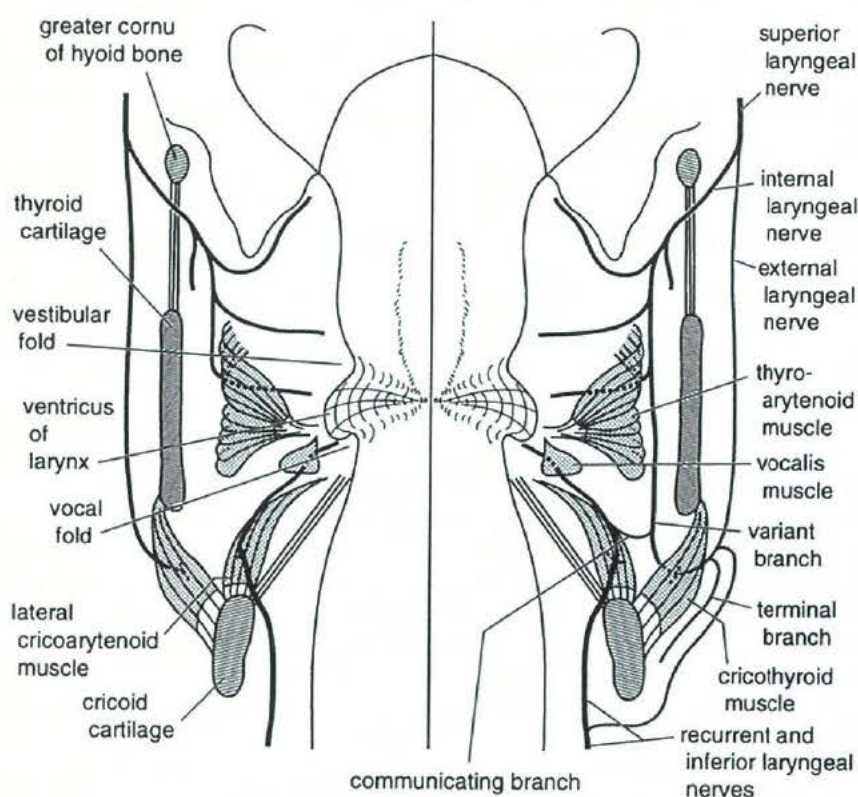


Fig. 3. A diagram showing the course and destination of the branches of the superior and inferior LN of both sides of the cadavers examined in this study, posterior view.

The branch in this case, however, was of much smaller caliber than the VB. The same is the case with the communicating branch to the inferior LN which issued from the VB as it laterally crossed the inferior LN. Thus it is unlikely that these fine branches are the sole supply of motor filaments to this muscle; rather, it is conjectured that in this case the VB plays a more substantial role in supplying the cricothyroid muscle (see below).

Background for the occurrence of the VB

Skeletal elements of the larynx

The thyroid cartilage is said to be derived from the ventral part of the skeletal element in the 4th and 5th branchial arches (Dubois, 1886; Kallius, 1897; Grosser, 1910, 1912; Collins, 1995), while the cricoid cartilage develops in the 6th branchial arch (Hamilton and Mossman, 1978; Collins, 1995; Sadler, 1995). At about the middle of the second month of gestation in the human embryo, the blastemal lamina of the thyroid cartilage on each side appears, having a foramen known as the thyroid foramen (Grosser, 1912). A branch of the 5th branchial nerve, thus intermediate in position between the superior LN and recurrent LN, passes through this foramen before reaching the internal structure of the larynx (Grosser, 1910). This nerve is also briefly referred to in the atlas of the human anatomy by

Lanz and Wachsmuth (1955), though they do not detail the nature of this nerve. Furthermore, Piersol (1916) reported an extreme case in which the internal LN entered the larynx through this foramen instead of piercing the thyrohyoid membrane. Thus, it should be mentioned that the morphology of the superior LN is more variable than it is generally considered to be.

Muscular elements of the larynx

The cricothyroid muscle is described by Larsen (1993), Collins (1995) and Sadler (1995) as developing in the 4th branchial arch. At the final stage of its development, however, this muscle is located between the skeletal elements of the 4th and 6th branchial arches. In this connection this muscle sometimes is supplied by a slender branch, the *middle* LN (Schäfer and Symington, 1909; Piersol, 1916), which arises from the pharyngeal plexus. This supports our above-mentioned supposition that, besides the external LN, other branches of the LN have the potential to supply the cricothyroid muscle.

Cause of the occurrence of the VB

It is speculated that in the earlier stages of the human embryo the gap between the superior and inferior LN might be filled by a row of branches, the predecessors of the LN, which arises from the nerves

supplying the 4th, 5th and 6th branchial arches. Most of them, however, except the predecessors of the superior and recurrent LN, have undergone regeneration due to their loss of entrance to the larynx in connection with the uniting of the skeletal elements of these branchial arches to each other. The VB observed in this study and the middle LN mentioned above might be the residues of these branches. At present, however, because of lack of sufficient evidence, this speculation is not substantiated, being in need of systematic studies from the developmental viewpoint. An understanding of the LN with the blastemal lamina of the thyroid car-

tilage and the muscular anlage of the laryngeal muscles would be critical to any explanation of the occurrence of this branch.

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