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НЕВОЗВРАТНЫЙ ГОРТАННЫЙ НЕРВ: АНАТОМИЧЕСКАЯ «ЛОВУШКА»

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THE NON-RECURRENT LARYNGEAL NERVE: AN ANATOMICAL “TRAP”

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Резюме. NRLN – это редкий анатомический вариант, встречающийся примерно у 4–6% людей, причем в 97,1% случаев он выявляется с правой стороны, а в 2,3% – с левой. Предоперационное выявление аберрантных подключичных артерий и NRLN с использованием методов визуализации, таких как ультрасонография и компьютерная томография, может быть эффективным почти на 100% [3][4]. Интраоперационный мониторинг нервов служит дополнительным методом выявления этих вариаций во время операции. Вероятность правостороннего NRLN значительно коррелирует с наличием аберрантной подключичной артерии, которая связана с Dysphagia Lusoria (дисфагия Bayford-Autenrieth). Хотя симптомы, связанные с аберрантной подключичной артерией, часто отсутствуют, иногда они могут проявляться в виде дисфагии, хронического кашля и необъяснимой ишемии правой верхней конечности. Левосторонний NRLN присутствует только при наличии состояния «situs invertus», в противном случае отсутствует, поэтому это редкий вариант [1].

Ключевые слова: невозвратные гортанные нервы и их клиническое значениет.

Resume. The NRLN is an uncommon anatomical variant, occurring in approximately 4-6% of individuals, with 97.1% of cases identified on the right side and 2.3% on the left side. Pre-operative detection of aberrant subclavian arteries and NRLNs using imaging techniques such as ultra-sonography and computed tomography can be nearly 100% effective. Intraoperative nerve monitoring serves as an additional method to identify these variations during surgery [3][4].

The likelihood of a right sided NRLN is significantly correlated with the presence of an aberrant subclavian artery, which is associated with Dysphagia Lusoria (Bayford-Autenrieth Dysphagia). While symptoms related to an aberrant subclavian artery are often absent, they can sometimes manifest as dysphagia, chronic coughing and unexplained ischemia of the right upper limb. The left sided NRLN is present only with the presence of the condition “situs invertus”, otherwise absent so it’s a rare variant [1].

Keywords: non-recurrent laryngeal nerves- clinical implication.

Relevance. Research on the non-recurrent laryngeal nerve (NRLN) is important for preventing nerve damage during surgeries like thyroid procedures, enhancing medical education, and improving surgical techniques. Understanding its anatomical variations helps ensure safer surgeries, reduces complications, and supports better patient outcomes.

Aim: to investigate the anatomical variations of the non-recurrent laryngeal nerve and assess its clinical significance in surgical procedures [1][4].

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Objectives:

1. To study literature data on the recurrent and non-recurrent laryngeal nerves, their embryological origin, topographical variations and types.

2. To study clinical implications, identification including pre and intra operative identification.

Material and methods. based on a combination of search terms (recurrent and non-recurrent laryngeal nerves, their embryological origin, clinical implications of their damage, their identification), systematic reviews and original articles in English were identified and reviewed.

Results and their discussion. The recurrent laryngeal nerve (RLN) originating from the cervical vagus (cranial nerve X) provides sensory and motor function to the larynx. Sensory function involves the subglottic region while all the laryngeal muscles, except for the cricothyroid are innervated by the RLN. This nerve is responsible for both vocal cord abduction and adduction [1].

The arteries of the head and neck derive from six pairs of aortic arches, formed by the fifth gestational week. Each vessel follows a course along the axis of the pharyngeal arches and is accompanied by a cranial nerve. The third aortic arch forms the common and part of the internal carotid artery, while the fourth arch forms the aortic arch to the left and the proximal part of the subclavian artery to the right. The RLN, a branch of the vagus nerve (cranial nerve X), derives from the sixth pharyngeal arch and accompanies the sixth aortic arch. Because the right sixth aortic arch degenerates during fetal development, the right RLN is translocated superiorly, coursing around the right subclavian vein. In contrast, the left sixth aortic arch remains, hence the left RLN pivots around the ductus arteriosus, which in the neonate forms the ligamentum arteriosus of the aortic arch [1][5].

Anomalous regression of the distal dorsal aorta leads to the aberrant origin of the right Subclavian artery from the aortic arch. As a result, the right RLN fails to loop around the right subclavian artery and becomes a right non-RLN. To the left, for a left non-RLN to occur, concurrent regression of the fourth and sixth aortic arches is required.

Damage to the RLN during thyroidectomy is responsible for vocal cord paralysis. On the right, the RLN courses posterior to the right subclavian artery and ascends superiorly to the lateral trachea located in the tracheoesophageal groove before entering the larynx at the level of the first tracheal ring. On the left, the RLN courses posteriorly to the aortic arch at the level of the ligamentum arteriosum, traveling along the tracheoesophageal groove superiorly before entering the larynx [4]. Non-recurrent laryngeal nerve (non-RLN) is a rare anatomic variant with a reported incidence of 0.3-0.8% on the right and 0.004% on the left side. (Even though the prevalence of non-RLN is estimated to range between 0.3-0.8% and 0.004% for right and left non-RLN respectively, cadaveric studies suggest a higher prevalence of 2.2%) In that case, the nerve enters the larynx directly after its origin from the cervical vagus [5]. The risk of injury to the RLN is 1-2%. On the other hand, the risk of injury to a non-RLN skyrockets to 12.9%, with the first report of such an injury in 1932 given by Pemberton. Furthermore, non-RLN has been observed with concurrent variants of the great vessels. The presence of an aberrant right subclavian artery (ARSA) or arteria lusoria originating from the aortic arch is associated with the presence of a right non-RLN. The purpose of this study is to review current evidence on the coexistence of vascular

variants and non-RLN to raise surgeons' awareness, thus preventing potential injury to the nerve [2].

Identifying a non-RLN is almost always associated with variants of the great vessels. Medially placed vagus in relation to the common carotid artery as an operative marker of a non-RLN. The most common vascular variant associated with a non-RLN is the ARSA, arising from the aortic arch, following a retroesophageal course. This subclavian artery variant, also known as arteria lusoria, may present with dysphagia in 5% of cases. Combination of a right-sided aortic arch, an aberrant left subclavian artery and the absence of an aortic diverticulum suggests a left non- RLN [5].

97.1% (n=101) cases regarded a right, while 2.3% (n=3) a left non-RLN. What is more, the majority of right non-RLN were accompanied with an ARSA in 97% of cases (n=98). One case of right non-RLN involved an intrathyroidal right common carotid artery (CCA) (0.9%), while in 2 cases, normal vascular anatomy was reported (1.9%). Furthermore, all left non-RLNs were associated with a right aortic arch in situs inversus. A female predominance was noted, with a 2:1 ratio. Observation of the course of the non- RLN allows its classification into two types: Type I and II. Type I non-RLN arises directly from the cervical vagus and travels along the superior thyroid pedicle, while type II travels along the inferior thyroid artery [5].

Prevention of the dreaded complication of vocal cord paralysis and injury to RLN and NRLN during thyroid gland surgery is of utmost importance as it is almost always associated with vascular variations. Therefore, efforts should be focused on the preoperative identification of such variants. A preoperative neck and chest CT or MRI scan can accurately demonstrate vessel anatomy [2].

Neck ultrasound is a readily available and inexpensive method to detect vascular variations related to a non-RLN as an adjunct to thyroid ultrasound. However, the results are operator dependent. CT and MRI scans may give more detailed anatomical information but have the disadvantage of higher cost as well as a high dose of radiation in the case of a CT scan. Careful dissection with the aim of identifying the RLN is imperative. Constant intraoperative neuro-monitoring helps the surgeon identify and preserve the recurrent laryngeal nerve. When the surgeon fails to identify the recurrent inferior laryngeal nerve in its predicted place, he should consider the presence of a non-RLN. The surgeon should dissect the vagus nerve and recognize the non-RLN at its origin from the cervical vagus, and follow its course to the cricothyroid muscle. Another approach is to dissect the suspected non-RLN in a retrograde manner, starting from its insertion into the cricothyroid muscle, keeping track of it in the neck [4].

Recurrent laryngeal nerve palsy is one of the complications of thyroid surgery with a re- ported incidence of 1-2%.

Unilateral RLN injury → vocal cord paralysis → hoarseness, changes in vocal pitch, or noisy breathing.

Bilateral RLN injury → more serious symptoms: significant difficulties in breathing and swallowing. The symptoms associated with an aberrant subclavian artery usually are silent, but can include dysphagia, chronic cough, and unexplained ischemia of the right upper limb [5].

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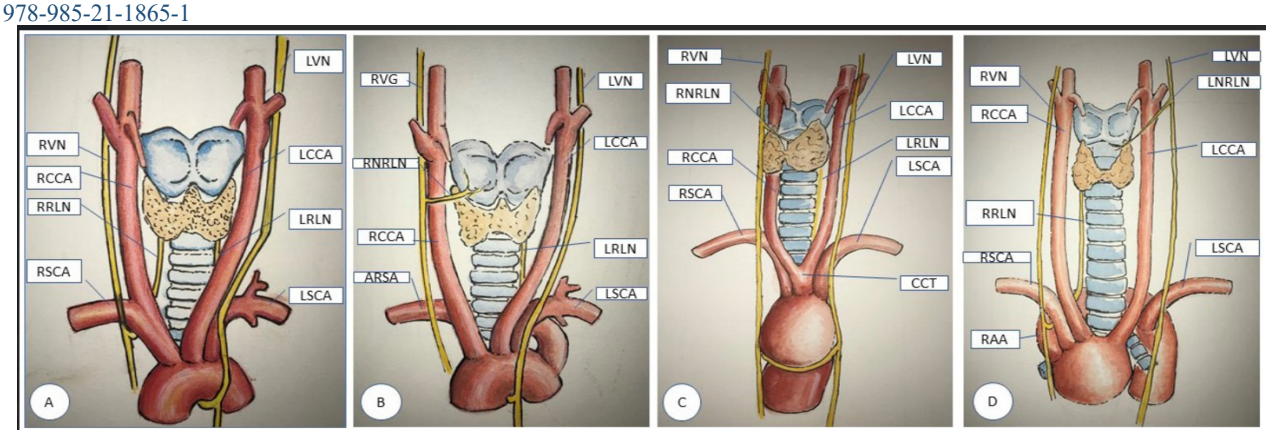

Fig. 1 – Schematic presentation of the recurrent laryngeal nerve (RLN) and vessel anatomy. A=Normal anatomy; B=Right non-RLN and ARSA; C=Right non-RLN and Intrathyroidal right common carotid; D=Left non-RLN and Right-sided aortic arch; RVN=right vagus nerve; LVN=Left vagus nerve; RRLN=Right recurrent laryngeal nerve; LRLN=Left recurrent laryngeal nerve; RCCA=Right common carotid artery; LCCA=Left common carotid artery; RSCA=Right subclavian artery; LSCA=Left subclavian artery;
RNRLN=Right non recurrent laryngeal nerve; ARSA=Aberrant right subclavian artery; LNRLN=Left non recurrent laryngeal nerve; CCT=Common carotid trunk [1].

Conclusion:

1.The NRLN is a rare yet clinically significant structure for surgeons and poses an increased risk of iatrogenic injury, most often resulting in temporary or permanent vocal cord paralysis. A thorough understanding of the prevalence, origin, and associated pathologies is vital for preventing injuries and complications during surgical procedures.

2**. Anatomical Awareness Is Crucial:** The non-recurrent laryngeal nerve (NRLN) presents a rare but significant variation in laryngeal nerve anatomy. Understanding its anatomical course is essential for surgeons to prevent accidental nerve damage during thyroid and neck procedures.

3. **Preoperative Identification Minimizes Surgical Risks:** Advanced imaging techniques, such as ultrasound and computed tomography (CT), along with intraoperative neuromonitoring, can aid in identifying the presence of the NRLN. Early detection improves surgical precision and reduces the likelihood of complications such as vocal cord paralysis.

4. **Surgical Techniques Must Adapt to Variations:** Conventional surgical approaches may not be sufficient when encountering an NRLN. Surgeons should adopt meticulous dissection techniques and anticipate anatomical anomalies to ensure patient safety and optimal surgical outcomes.

5. **Raising Awareness Among Medical Professionals Is Essential:** Given the potential risks associated with this anatomical variation, increased education and awareness among healthcare practitioners are necessary. Comprehensive training and anatomical research can enhance surgical preparedness and improve patient outcomes.

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