Variations in the Origin of the Superior Laryngeal Artery and their Clinical Significance: A Case Report with a Proposal for a New Classification

Variaciones en el Origen de la Arteria Laríngea Superior y su Significado Clínico: Reporte de un Caso con una Nueva Propuesta de Clasificación

B. Landzhov; L. Gaydarski; I. Angushev; Y. Tivcheva; L. Olewnik; N. Krastev; V. Kirkov & G. P. Georgiev

SUMMARY: The superior laryngeal artery is the primary vessel providing the blood supply to the larynx. Commonly, it is derived from the superior thyroid artery. Different variations in the origin have been described in the current literature; knowledge of such variations is crucial for various surgical interventions of the larynx and surgical procedures in the lateral region of the neck regarding the carotid triangle. It should be noted that radiological studies, such as selective angiography of the thyroid gland, can also be misleading in cases of variations. Herein, we describe a case of bilateral superior laryngeal artery originating directly from the external carotid artery of the neck. The arteries at first have a transverse course and then pierce through the thyrohyoid membrane alongside internal laryngeal nerves. Moreover, we also review the known variations in the origin of the superior laryngeal artery and propose a new classification of all known variations.

KEY WORDS Anatomical variants; Classification; Clinical significance; Superior laryngeal artery.

INTRODUCTION

The superior laryngeal artery (SLA) is one of the main vessels supplying the larynx with arterial blood. Generally, the origin of the SLA is described as a derivative from the superior thyroid artery (STA), which is a branch of the external carotid artery (Standring, 2016). Commonly, the SLA is reported to pass downwards toward the larynx, accompanied by the internal ramus of the superior laryngeal nerve. The SLA penetrates the thyroid membrane and enters the larynx, where it divides into several branches, which provide the blood supply for the mucosa, glands, and laryngeal muscles. The blood supply area of the SLA is described from the top of the epiglottis to the inferior part of the thyroarytenoid muscle (Standring, 2016). Even though the most common origin of the SLA is from the STA, as described in many studies (Adachi, 1928; Andrea, 1975; Bergman et al., 2021; Devadas et al., 2016; Livini, 1903; Macalister, 1868; Nayak et al., 2011; Quain, 1844; Rusu et al., 2007; Schwalbe & Pfitzner, 1891; Terracol & Guerrier, 1951; Vázquez et al., 2009), the percentage of cases where the SLA originates from the STA ranges between 68 % (Rusu et al., 2007) and 94 % (Andrea, 1975). However, there are quite a few different variations in the origin of the SLA, which, despite their rare occurrence, have definite clinical significance in a wide range of surgical interventions of the larynx, such as laryngeal reconstruction, partial laryngectomy, and laryngeal transplantation (Anthony et al., 1996; Cernea et al., 1992; Hurtado-Lopez et al., 2005). Moreover, surgeons generally use the STA as a landmark during surgical interventions of the carotid triangle (Cernea et al., 1992). Cases of aberrant SLA originating directly from the external carotid artery (ECA) or even from the common carotid artery (CCA) could cause confusion and incorrect identification of ECA branches, which might have detrimental consequences (Cernea et al., 1992; Anthony et al., 1996; Hurtado-Lopez et al., 2005).

1Department of Anatomy, Histology and Embryology, Medical University of Sofia, 1431 Sofia, Bulgaria.
2Department of Anatomical Dissection and Donation, Chair of Anatomy and Histology, Medical University of Lodz, Poland.
3Department of Health Policy and management, Medical University of Sofia, 1431 Sofia, Bulgaria.
4Department of Orthopedics and Traumatology, University Hospital Queen Giovanna-ISUL, Medical University of Sofia, 1431 Sofia, Bulgaria.

Received: 2022-02-08    Accepted: 2022-03-10
The SLA is not only an essential artery from an anatomical point of view because it is the main artery providing the blood supply to the larynx (Standring, 2016), but it is also a vital artery from a clinical point of view because of its high clinical significance. Therefore, detailed knowledge of the variations in the origin of the SLA is paramount for all medical professionals working in the anterior and lateral regions of the neck. First, a brief comparison of the results submitted by different studies (Quain, 1844; Macalister, 1868; Schwalbe & Pfitzner, 1891; Livini, 1903; Adachi, 1928; Terracol & Guerrier, 1951; Andrea, 1975; Rusu et al., 2007; Vázquez et al., 2009; Nayak et al., 2011; Devadas et al., 2016; Bergman et al., 2021) was performed throughout the years.

The most common origin of the SLA is from the STA, which is present in 68 % (Adachi, 1928) to 94 % (Rusu et al.). Second, SLA is being described to originate from the ECA, with an incidence rate of 4 % (Adachi, 1928) to 32 % (Rusu et al., 2007). A rare variation of the SLA originating from the lingual artery (LA) has been described in 1.7 % (Devadas et al., 2016) to 5.4 % of cases. Another uncommon variation of SLA originating from a linguo-facial trunk was described with a probability rate of 2.7 %. SLA originating from the CCA has been described with an incidence rate of 1 % (Quain, 1844;
Schwalbe & Pfitzner, 1891) to 5% (Terracol & Guerrier, 1951; Vázquez et al., 2009). The SLA can also originate from carotid bifurcation, and this deviation has a probability of 4% (Vázquez et al., 2009). A more unusual variation of the origin of the SLA is from the ascending pharyngeal artery (APA) (Lasjaunias & Moret, 1976; Devadas et al., 2016), with an incidence rate of 1.7% (Devadas et al., 2016). Cases of SLA originating from the facial artery (FA) have also been described (Bergman et al., 2021); however, the exact percentage of this uncommon variation has not been specified. Another variation is the SLA originating in a common trunk with the LA, with an incidence rate of 1.5%, which has been described by Livini (1903). Seldom the SLA can be found originating from a common trunk with the hyoidean branch from the ECA – only one such case has been described by Macalister (1868). A singular case of doubled SLA was reported. Finally, SLA was described as absent in 4% of cases (Vázquez et al., 2009).

All of the described variations in the origin of the SLA and their probability rates are summarized in Table I.

To be utmost thorough with the data representation of our review of the literature, we made a comparison between all the previously conducted studies on this matter that we could find in the literature. All of the cited studies have been conducted on formalin-fixated cadavers. In Table II, we summarize the total sample size of heminecks used throughout the studies and the male to female ratio (where the data were provided). Furthermore, we made a comparison of the most common variations in the origin of the SLA and gave the left to right ratio of the described variations (where the data were provided). It should be noted that variations described by singular authors are excluded from the comparison table for obvious reasons. In addition, we performed a meta-analysis of the data. Incidence rates of the variations were calculated by dividing the number of variant cases by the number of total cases.

Clinical significance of the variations in the origin of the SLA

Variants of the SLA, as mentioned above, are not uncommon. Therefore, knowledge of these variations can be crucial in surgical settings and stress the need for extensive yet practical classification. There are a series of complications due to unrecognized variations in SLA during procedures such as laryngeal reconstruction, partial laryngectomy, and laryngeal transplantation (Cernea et al., 1992; Anthony et al., 1996; Hurtado-Lopez et al., 2005). As Anthony et al. (1996) noted, the reattaching of a single superior thyroid artery can revascularize the entire larynx. In cases of variants of the SLA, its preservation is crucial for retaining the functions of the aryepiglottic fold and epiglottis and the laryngopharynx in the arytenoid region. The typically meandering intralaryngeal branches of the SLA supply the following: the aryepiglottic fold – superior posterior branch, anterior laryngeal wall- anterior branch, medial wall- medial branch, posterior medial branch – arytenoid region, anteroinferior
Table II. Summary of the number of heminecks used in the different studies (total sample); the male to female ratio; the incidence rate of different variations in the origin of the SLA with their left to right ratio. In brackets are shown the percentages (%). SLA - superior laryngeal artery; STA – superior thyroid artery; ECA - external carotid artery; LA - lingual artery; CCA - common carotid artery.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Male</th>
<th>Female</th>
<th>SLA originating from STA</th>
<th>SLA originating from ECA</th>
<th>SLA originating from CCA</th>
<th>SLA originating from LA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total sample</td>
<td>Male</td>
<td>Female</td>
<td>right</td>
<td>left</td>
<td>total</td>
</tr>
<tr>
<td>Quain, 1844</td>
<td>292</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>266(91)</td>
<td>-</td>
</tr>
<tr>
<td>Schwalbe and Pfitzner, 1891</td>
<td>132</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>92(70)</td>
<td>-</td>
</tr>
<tr>
<td>Livini, 1903</td>
<td>200</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>175(72)</td>
<td>-</td>
</tr>
<tr>
<td>Adachi, 1928</td>
<td>215</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>198(92)</td>
<td>-</td>
</tr>
<tr>
<td>Terracol &amp; Guerrier, 1951</td>
<td>42</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>29(69)</td>
<td>-</td>
</tr>
<tr>
<td>Andrea, 1975</td>
<td>247</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>232(94)</td>
<td>-</td>
</tr>
<tr>
<td>Russo et al., 2007</td>
<td>100</td>
<td>74(74)</td>
<td>26(26)</td>
<td>-</td>
<td>68(68)</td>
<td>-</td>
</tr>
<tr>
<td>Vázquez et al., 2009</td>
<td>142</td>
<td>63(44)</td>
<td>79(56)</td>
<td>28(18)</td>
<td>111(78)</td>
<td>-</td>
</tr>
<tr>
<td>Nyak et al., 2011</td>
<td>74</td>
<td>58(78)</td>
<td>16(22)</td>
<td>31(42)</td>
<td>59(80)</td>
<td>4(5)</td>
</tr>
<tr>
<td>De vadas et al., 2016</td>
<td>60</td>
<td>50(83)</td>
<td>10(17)</td>
<td>-</td>
<td>55(92)</td>
<td>3(5)</td>
</tr>
<tr>
<td>Meta-analysis</td>
<td>1504</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1285(85)</td>
<td>-</td>
</tr>
</tbody>
</table>

Moreover, there is a significant discrepancy between Types II to IV proposed in the above studies, and the parameters used are not identical. It is important to note that the clinical significance of the SLA does not only apply to reconstructive or partial laryngectomy processes, and procedures on the larynx per se and various operative techniques in which the arterial vessels are used as landmarks, such as ligation of the ECA. As a result, the arterial vessels should be carefully identified and ligated before any procedure is performed on the larynx.

It should be noted that in angiographic studies in cases of variations, additional landmarks, such as the variation of the T sympathetic nerve, are used as landmarks. This is true for the arterial vessels, as the dominant vessel of the larynx is the ECA. In cases of variations, the T sympathetic nerve should be carefully identified and ligated before any procedure is performed on the larynx.
by the two authors (Vázquez et al., 2009). Therefore, we suggest a new, thorough classification including all the known variations in the origin of the SLA. To create a simple and easy-to-understand yet thorough anatomical classification, we divided all of the reviewed above variations in the origin of the SLA into five categories: I to III are regarding the deviations in the origin point of the SLA. Category III addresses variations of the SLA arising from a common trunk with other arteries. Furthermore, as category IV, we marked the duplicated SLA, and finally as category V – the absence of the SLA.

**Anatomical classification**

Type I. Variations in the SLA arising from branches of the ECA:
1. The SLA arising from the STA.
2. The SLA arising from the LA.
3. The SLA arising from the APA.
4. The SLA arising from the FA.

Type II. Variations of the SLA arising from the carotid tree:
1. The SLA arising from the ECA.
2. The SLA arising from the CCA.
3. The SLA arising from the carotid bifurcation.

Type III. Variations of the SLA arising from a common trunk:
1. The SLA arising from a common trunk with the LA.
2. The SLA arises from a common trunk with the Hyoidean branch originating from the ECA.
3. The SLA arising from a linguo-facial trunk.

Type IV. Doubled SLA
Type V. Absent SLA.

All of the described variations are shown in Figure 2.

**CONCLUSION**

Comprehensive knowledge of the variations in the origin of the SLA is paramount for every medical profession regarding the lateral region of the neck due to the high clinical significance of the SLA for a plethora of surgical, radiological, and invasive procedures. Therefore, this article aims to provide meticulous information regarding the variable origin of the SLA. Furthermore, the systematized classification that we propose strives to clarify the variant origin of the SLA.

**ACKNOWLEDGMENTS**

“The authors sincerely thank those who donated their bodies to science so that anatomical research could be performed. The results from such research can potentially increase mankind's overall knowledge that can then improve patient care. Therefore, these donors and their families deserve our highest gratitude.”

Fig. 2. The variations described in the classification are shown. SLA - superior laryngeal artery; STA – superior thyroid artery; ECA - external carotid artery; LA - lingual artery; CCA - common carotid artery, CB – carotid bifurcation, APA - ascending pharyngeal artery; FA - facial artery, HA – hyoid artery.
La arteria laríngea superior es el vaso principal que proporciona el suministro de sangre a la laringe. Comúnmente, se deriva de la arteria tiroidea superior. Han sido descritas diferentes variaciones en su origen y el conocimiento de éstas resulta crucial para las intervenciones quirúrgicas realizadas en la laringe, como también en los procedimientos quirúrgicos que se realizan en la región lateral del cuello, respecto al triángulo carotídeo.

Cabe señalar que los estudios radiológicos, como la angiografía, son especiales en el diagnóstico de las variaciones anatómicas. Aquí, describimos un caso de arteria laríngea bilateral que se originaba directamente de la arteria tiroidea superior. Han sido descritas diferencias variaciones en su origen y el conocimiento de éstas resulta crucial para las intervenciones quirúrgicas realizadas en la laringe. Comúnmente, se deriva de la arteria tiroidea superior. Han sido descritas diferentes variaciones en su origen y el conocimiento de éstas resulta crucial para las intervenciones quirúrgicas realizadas en la laringe, como también en los procedimientos quirúrgicos que se realizan en la región lateral del cuello, respecto al triángulo carotídeo.

RESUMEN: La arteria laríngea superior es el vaso principal que proporciona el suministro de sangre a la laringe. Comúnmente, se deriva de la arteria tiroidea superior. Han sido descritas diferentes variaciones en su origen y el conocimiento de éstas resulta crucial para las intervenciones quirúrgicas realizadas en la laringe, como también en los procedimientos quirúrgicos que se realizan en la región lateral del cuello, respecto al triángulo carotídeo. Cabe señalar que los estudios radiológicos, como la angiografía, son especiales en el diagnóstico de las variaciones anatómicas. Aquí, describimos un caso de arteria laríngea bilateral que se originaba directamente de la arteria tiroidea superior. Han sido descritas diferentes variaciones en su origen y el conocimiento de éstas resulta crucial para las intervenciones quirúrgicas realizadas en la laringe, como también en los procedimientos quirúrgicos que se realizan en la región lateral del cuello, respecto al triángulo carotídeo.

PALABRAS CLAVE Variantes anatómicas; Clasificación; Significado clínico; Arteria laríngea superior.

REFERENCES


Andrea, M. Vascularización Arterial de la Laringe. Distribución Macro y Microvascular (Doctoral Thesis). Lisbon, School of Medicine, Lisbon University, 1975.


Corresponding author:
Prof. Boycho V. Landzhov, MD, PhD Department of Anatomy
Histology and Embryology Medical University of Sofia
2 Zdrave Str.
1431 Sofia
BULGARIA

E-mail: landzhov_medac@abv.bg


Corresponding author:
Prof. Boycho V. Landzhov, MD, PhD Department of Anatomy
Histology and Embryology Medical University of Sofia
2 Zdrave Str.
1431 Sofia
BULGARIA

E-mail: landzhov_medac@abv.bg