

## ANATOMICAL VARIATIONS ON THE ORIGIN OF THE LINGUAL ARTERY AND THEIR CLINICAL SIGNIFICANCE - REVIEW FROM THE LITERATURE

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### ABSTRACT

Aim of the study: The purpose of the study is to document in the specialised literature the variation in origin of the lingual artery (LA). Material and methods: we analysed 85 summaries of scientific papers, 43 in extenso articles, using ISI Thomson Web of Knowledge, and PubMed databases. Additionally, a search in 8 anatomy books was performed. Results: the most common variation of origin of the lingual artery (LA) was in the form of a common trunk with facial artery (FA), the linguofacial trunk, in an average percentage of 16.39% of the cases. The results were observed mostly unilateral, less of them being bilateral. Conclusions: the results depict a wide variety of origins of LA, offer a better perspective for maxillofacial surgeons and can contribute to the clinical success of surgical procedures performed in the cervical region.

**Key words:** lingual artery, origin variations, clinical consequences

### INTRODUCTION

External carotid artery (ECA) is the terminal bifurcation branch of the common carotid artery (CCA), which, in most cases, arises from the carotid triangle. In the

literature, the lingual artery (LA) is considered an anterior collateral branch of ECA, often with an individual origin at the level of the greater horn of the hyoid bone or, more rarely, through a common trunk

with the facial artery (FA), the linguofacial trunk [1, 2, 3].

The lingual artery passes through the region of the carotid triangle, the submandibular region, the floor of the mouth and the tongue, where it ends with the deep lingual artery. The close relationship of this artery with the hypoglossal nerve, in the region of the carotid triangle, can lead to damage to this nerve during the surgical ligation of the lingual artery [2].

The lingual artery vascularises the suprahyoid muscles, the muscles and mucous membrane of the tongue, the palatine tonsil, the palatoglossal arch, the glossoepiglottic folds, the epiglottis, the sublingual gland, the mucous membrane of the floor of the mouth and the lingual alveolar mucosa [2].

ECA and its anterior branches, the lingual, facial, and superior thyroid (STA) arteries show numerous variations of origin. Being aware of these variations in origin can be useful during neck surgery procedures and for interpretation of angiographies [4].

Classical anatomical literature as well as recent reports show that, in most cases, the lingual artery has an individual origin from the ECA and more rarely through a common trunk with the FA [5].

The structures of the head and neck regions are mainly vascularized by the external carotid artery and its branches. Variations on the branching pattern of the external carotid artery are very important for oral and maxillofacial surgeons, ENT surgeons, surgical oncologists, vascular surgeons and radiologists, both for diagnosis and surgical interventions [6].

This study represents a review of the specialised literature on the prevalence of variations in origin of the lingual artery (LA), trying to determine their clinical significances.

## **MATERIAL AND METHODS**

A systematic search in the scholarly literature was conducted, in order to identify articles which presented variations regarding the origin of the lingual artery. 84 summaries of scientific works and 43 in extenso articles published after 2000 were accessed using ISI Thomson Web of Knowledge and PubMed databases and the following keywords: lingual artery origin, external carotid artery variations and clinical significance. Additionally, a manual search in 8 anatomy books was performed. Of these scholarly papers, 34 were considered to be relevant for this study. We implemented the same research methodology used in a previous study [1, 7].

## RESULTS AND DISCUSSIONS

According to the literature data accessed, the LA has an individual origin from the ECA in most cases, this pattern of origin having the highest prevalence, as follows: Sanjeev IK et al, 2010, showed in their study on Indian population that the LA has an individual origin from the ECA in 78.38% of cases, and the level of origin, also variable, was 4 to 10 mm above the origin of the ECA [4]; according to Anuradha M and Chitra S' study on Indian population, 2017, the LA individually arises from the ECA in 90% of cases [8]; Ogeng'o J et al, 2015, showed in their study on Kenyan population that, in 44.1% of the cases, the LA has an individual origin from the ECA, a low prevalence compared to most of the literature reports [9]; according to Mata JR et al, 2012, the LA showed individual origin from the ECA in 77.8% of cases (the study was performed on Brazilian population) [10]; Delic J et al, 2010, show that, in 84.6% of cases, the LA has an individual origin from the ECA [11]; Yonenaga K et al, 2011, in a study on Japanese population, showed that the LA had an individual origin from the

ECA in 41.1% of cases, lower prevalence compared to most reports in the literature [12]; according to Ozgur Z et al' research on Turkish population, 2008, the LA had an individual origin from the ECA in 90% of cases [13]; Heltzel S et al, 2015, show that the LA has an individual origin from the ECA in 77% of cases, and the origin level was, on average, 12.21 mm above the origin of the ECA [14]; Esakkiammal N et al, 2017, showed that most of the time, 86.5%, the LA had an individual origin from the ECA [15].

According to the studies identified in the specialised literature, the LA had an individual origin from the ECA with the following prevalence: 90% maximum frequency, 41.10% minimum frequency and 74.42% average frequency.

According to the references accessed in the specialised literature, the most frequent variation regarding LA origin, reported in most studies, was the common origin with the facial artery through a common trunk, the linguofacial trunk.

Table no. 1 centralises the previous observations regarding the prevalence of the linguofacial trunk.

**Table 1:** Prevalence of the linguofacial trunk in different studies (%)

Studies	Prevalence of the linguofacial trunk %
Sanjeev IK et al, 2010 [4]	18.92
Anuradha M and Chitra S, 2017 [8]	10

Ogeng'o J et al, 2015 [9]	44.7
Mata JR et al, 2012 [10]	19.4
Delic J et al, 2010 [11]	3.29
Yonenaga K et al, 2011 [12]	28.6
Ozgur Z et al, 2008 [13]	7.5
Heltzel S et al, 2015 [14]	21
Esakkiammal N et al, 2017 [15]	13.5
Lucev N et al, 2000 [16]	20
Gupta V and Agarwal R, 2014 [17]	11.3
Yadav A et al, 2014 [18]	15.38
Fazan VP et al, 2009 [19]	22
Zümre O et al, 2005 [20];	20
Troupis TG et al, 2011 [21]	3.3
Anil A et al, 2000 [22];	10-20
Yildrin M et al, 2001 [23]	15
Latha A and Sugavasi R, 2016 [24]	4
Hayashi N et al, 2005 [25]	18
Lappas DA et al, 2002 [26]	14

The above observations indicate that the linguofacial trunk is the most common variation regarding the origin of the LA from the ECA. According to the references covered, the maximum frequency of this variation of origin was 44.7%, the minimum frequency was 3.29%, and the average of the reported frequencies in all studies covered was 16.39%, which means that this variation is not uncommon. The existence of the linguofacial trunk was, in most reports, unilateral, with the exception of the study conducted by Fazan VP et al, 2009 [19],

who showed the bilaterality of this variation in 4.9% of cases and the study conducted by Troupis T et al, 2015, case report, [27], who also showed the bilaterality of this variation.

A hypothesis on the linguofacial trunk existence, as origin variation of the LA, shows that its occurrence could be determined by the remnants of the second aortic arch in the fetal period. The existence of this variation may be critical in certain surgical procedures where uncontrolled bleeding may occur or in the case of biopsies, tumour invasion or

traumas in the oral and maxillofacial region. During surgical procedures in the cervical region, the most dangerous possible complication is the rupture of the ECA or one of its branches, complications that may occur due to the existence of these common vascular trunks. Under these conditions, angiography remains the 'gold standard' for the preoperative visualization of the vascularization of this region [27].

The presence of the thyrolingual (common trunk of origin for the STA and the LA) and the thyrolinguofacial trunks (common trunk of origin for the STA, the LA and the FA), regarding the origin of the LA from the ECA, represent rare variations of origin.

The prevalence of the thyrolingual trunk has been reported in various studies accessed, as follows: Sanjeev IK et al, 2010, show that this variation of origin occurs in 2.7% of the cases [4]; Mata JR et

al, 2012, show that the thyrolingual trunk was present in 2.5% of the cases [10]; Ozgur Z et al, 2008, show that the LA originated from the ECA through the thyrolingual trunk in 2.5% of the cases [13]; Heltzel S et al, 2015, show that the LA originates from the ECA in 2% of the cases through a common trunk with the STA, the thyrolingual trunk [14]; Zümre O et al, 2005, show that the thyrolingual trunk was present in 2.5% of the cases [20]; and Patel JP et al, 2013, show in their study that the thyrolingual trunk was present in 3% of the cases [28].

This type of variation may expose the lingual artery to surgical risk during thyroid gland surgery. The mean prevalence of this anatomical variation was 2.53%.

Table no. 2 centralises the previous observations regarding the prevalence of the thyrolingual trunk.

**Table 2:** Prevalence of the thyrolingual trunk in different studies (%)

Studies	Prevalence of the thyrolingual trunk %
Sanjeev IK et al, 2010 [4]	2.7
Mata JR et al, 2012 [10]	2.5
Ozgur Z et al, 2008 [13]	2.5
Heltzel S et al, 2015 [14]	2
Zümre O et al, 2005 [20]	2.5
Patel JP et al, 2013 [28]	3

The prevalence of the thyrolinguofacial trunk, branch of the ECA, rare unilateral variation, was reported as follows: Gupta V and Agarwal R, 2014, [17]; Zümre O et al, 2005, [20]; Patel JP et al, 2013, [28] and Anitha T et

al, 2011, [29]. This unilateral variation in origin was also reported by other authors (case report) [5].

Table no. 3 centralises the previous observations regarding the prevalence of the thyrolinguofacial trunk.

**Table 3:** Prevalence of the thyrolinguofacial trunk in different studies (%)

Studies	Prevalence of the thyrolinguofacial trunk %
Gupta V and Agarwal R, 2014 [17]	3.3
Zümre O et al, 2005 [20]	2.5
Patel JP et al, 2013 [28]	1
Anitha T et al, 2011 [29]	2

The mean prevalence of this anatomical variation was 2.2%.

Baxla M et al reported the case of a bilateral thyrolinguofacial trunk, surgically relevant variation because this arterial trunk is susceptible to damage during neck surgery procedures, such as thyroidectomy or the reconstruction of an aneurysm [30].

As very rare variations on the origin of the LA from the ECA we mention: the origin of the LA from the CCA, 6 mm below the CCA bifurcation [31]; the origin of the LA through the thyrolingual trunk arising from the CCA bifurcation [32] and the unilateral origin of the LA from the terminal portion of the FA [33]. Knowing these very rare variations of the origin of the LA is important in various surgical procedures, such as, for example, the extraoral ligation of the lingual artery.

In descending order of frequency, we have established 4 types of variations

regarding the origin of the LA from the ECA: Type I - the linguofacial trunk; Type II – the thyrolingual trunk; Type III - the thyrolinguofacial trunk; Type IV – other origins.

A complicated process of angiogenesis underlies the ECA and its branches formation [15, 34].

Particular morphologic patterns both at vascular level and at bone level (such as the relation of the mandible to the maxillae) might suggest predisposition to certain disorders and complications [35].

The precise knowledge of the cervicofacial vascular anatomy is essential during maxillofacial surgical procedures. The rare and extremely rare variations in the origin of the anterior branches of the ECA may complicate these interventions [36].

From the surgical and radiological point of view, knowing the variations in the origin of the LA in the cervical region is necessary in order to avoid errors in invasive procedures in this region, such as, for example, extraoral ligation of the lingual artery [10]. Considering the anatomical variations in the LA origin, some of the invasive procedures in the area present a potential risk to the patient [10]. These anatomical variations require imaging procedures for detection, their

highlighting being mandatory in all surgical interventions in the cervical region [5, 20].

## CONCLUSIONS

Preliminary identification of variations in the origin of the lingual artery provides greater safety for the surgeon during surgical procedures in the anterior and lateral cervical regions, thus avoiding possible iatrogenic vascular lesions, with serious consequences.

## CONFLICT OF INTEREST

The authors declare that they have no conflict of interests.

## AUTHOR CONTRIBUTION

All authors have equal contributions to this paper and thus are main authors.

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