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An Anatomical Study of the Facial Artery

Un Estudio Anatómico de la Arteria Facial

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SUMMARY: The facial artery (a branch of the external carotid artery) is the main artery of the face. It gives rise to seven branches viz. inferior labial, superior labial, inferior alar, superior alar, lateral nasal and angular arteries, which are variable. This study included a dissection of twenty embalmed adult cadaveric head and neck specimens. The parameters of origin, branching patterns, termination and variations were analysed and compared with sex and laterality. The facial artery followed the standard anatomical description of origin in 84.62 % of the sample. Variations: (i) origin as a linguofacial trunk in 12.82 % and (ii) high origin in 2.56 % was observed. Male specimens displayed a higher number of linguofacial trunk origins (7.69 %). The branching patterns of the facial artery was classified into six types, with subtypes for Types 1 and 2. Subtype 1-A (standard anatomical description with early termination) occurred in most of the sample (46.15 %). Males were found to have more variations in branching patterns than females (48.72 % and 41.03 % respectively). Termination of the facial artery was as follows: inferior labial artery (5.13 %), superior labial artery (10.26 %), inferior alar artery (10.26 %), superior alar artery (46.15 %), lateral nasal artery (5.13 %), and angular artery (20.51 %). A single case (2.56 %) of an abortive artery was noted. Statistical analysis showed that sex was independent of each parameter observed in this study. Anatomical knowledge of the facial artery is of importance to clinicians and surgeons during procedures such as musculomucosal, island flaps and aesthetic dermatology.

KEY WORDS: Facial Artery; External Carotid Artery; Musculomucosal flap; Linguofacial trunk; Angular Artery.

INTRODUCTION

The facial artery is the main artery of the muscles and skin of the face (Pilsl *et al*., 2016). The facial artery is a branch of the external carotid artery and arises at the level of the greater cornu of the hyoid bone superior to the lingual artery (Kumar *et al*., 2014). Anatomical textbooks describe the facial artery coursing upwards over the body of the mandible, passing along the cheek, to the lateral side of the nose and terminating at the medial aspect of the eye (Koh *et al*., 2003; Loukas *et al*., 2006; Lohn *et al*., 2011; Drake *et al*., 2015; Pilsl *et al*.). The facial artery has been described as giving off a superior and inferior labial branches as well as a lateral nasal branch, which terminates as the angular artery (Drake *et al*.). Recent literature has noted additional branches which are not described in textbooks (Koh *et al*.; Loukas *et al*.; Lohn *et al*.; Pilsl *et al*.). Additional branches include the inferior and superior alar branches, or sometimes referred to as septal and alar branches (Koh *et al*.; Loukas *et al*.; Lohn *et al*.; Pilsl *et al*.).

Variations of the facial artery exist in the origin, course, branching pattern and termination but these have not been clearly described (Pilsl *et al*.). The artery has been observed to have anomalous origins with the lingual artery from a linguofacial trunk, as well as having an intraparotid origin (Midy *et al*., 1986; Koh *et al*.; Nayak *et al*., 2006; Vadgaonkar *et al*., 2012; Cardinot *et al*., 2014).

Termination of the facial artery is variable in the literature (Loukas *et al*.; Lohn *et al*.; Pilsl *et al*.). Early terminations which have been recorded include the facial artery terminating as the submental artery, labial arteries or the alar arteries (Vadgaonkar *et al*., 2012; Cardinot *et al*.).There have been reports of the facial artery splitting into an anterior and posterior branch, viz. a duplex artery (Koh *et al*.; Loukas *et al*.; Pilsl *et al*.) or the facial artery terminating prior to reaching the inferior lip, being referred to as an abortive artery. In these cases the arterial supply of the facial artery is then taken over by other arterial branches in the face, such as the transverse facial artery and nasal branch of the ophthalmic artery (Bergman *et al*., 1988; Vadgaonkar *et al*., 2012; Cardinot *et al*.).

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Various studies have classified the facial arteries' branching pattern and termination, but few have reported on the variable origin (Troupis *et al*., 2015; Mangalgiri *et al*., 2015). In addition, few studies have reported on the differences of the facial artery anatomy between sex and laterality. Knowledge of the facial artery patterns' of distribution is essential in procedures using musculomucosal and island flaps, as well as aesthetic dermatology, especially in female patients who opt for cosmetic surgery (Loukas *et al*.; Pilsl *et al*.).

MATERIAL AND METHOD

This study comprised of a sample size of twenty embalmed adult cadaveric heads and necks (11 males and 9 females). The specimens were obtained from the Department of Clinical Anatomy, School of Laboratory Medicine and Medical Sciences at the Nelson R Mandela School of Medicine campus and the Westville campuses of the University of KwaZulu Natal. Ethical clearance was obtained from Biomedical Research Ethics Committee (BREC) of the University of KwaZulu-Natal (BE503/18). The mean age of the cadavers was 79 years old with the age range of between 55-97 years of age.

The skin was reflected and the subcutaneous fat and fascial layers were removed in order to reveal the facial artery. The facial artery was found in the anterior triangle of the neck, within the submandibular triangle. The artery was observed in relation to the submandibular salivary gland, passing either behind it, or laterally over the gland. In order to observe the facial artery origin, the tendon of the posterior digastric muscle was incised and reflected. This muscle tendon was used as a landmark for the origin of the facial artery, which was consistently found deep to this tendon. This however, excluded cases in which there was variation of the origin present.

RESULTS AND DISCUSSION

Twenty embalmed adult cadaveric head and neck specimens were utilised and dissected in the study. However, one of the specimens had a previous surgery on the right side of the face, which made gathering data on the right facial artery not possible. Therefore, the final study sample consisted of 39 facial arteries (20 left and 19 right). The standard anatomic definitions of the facial artery do not include many of the possible variations which have been found in this study and previous studies.

Origin: The description of the origin of the facial artery was based on its origin from the parent trunk (external carotid artery) and the level at which the artery originated. In 84.62 % (89.47 % right, 80 % left) of cases the facial artery followed the standard anatomical description i.e. it arose from the parent trunk (Fig. 1a). Many authors noted variations in origin, such as the facial artery originating with the lingual artery from a common trunk viz. the linguofacial trunk (Ozgur *et al*., 2008; Troupis *et al*.), and an intraparotid origin (Mangalgiri *et al*., 2015). Although the current study did not find any intraparotid origins, it did observe origins from the linguofacial trunk (Fig. 1b) in 12.82 % of the specimens [Right 2/19 (10.53 %); Left 3/20 (15 %)]. In addition, the current study observed that the male specimens showed a higher number of variations in origin when compared to the female specimens [Male: 3/21 (14.29 %); Female: 2/18 (11.11 %)]. A variation noted by the study, was a case in which the facial artery originated higher up, below the mandible on the left side of a male specimen [1/20 (5 %)]. Such a variation was not noted in previous studies. Statistical analysis showed that the presence or absence of a linguofacial trunk on the right (p=0.937) and the left (p=0.592) was not dependent on sex.

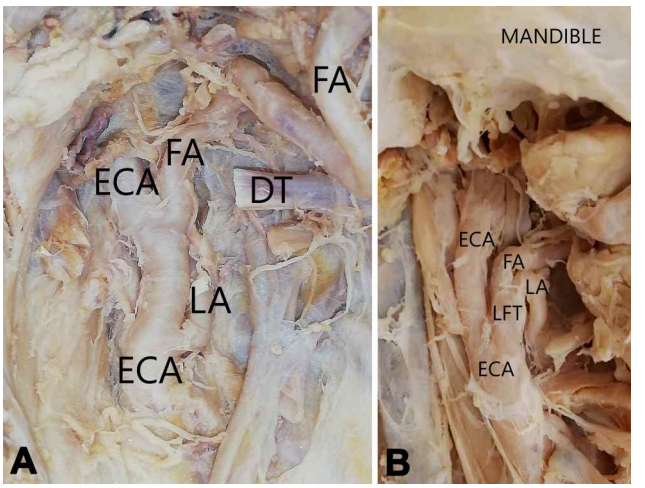

Fig. 1.Origin observations of the facial artery [Standard anatomical origin (A); Linguofacial trunk origin (B)]. ECA. External carotid artery; FA. Facial artery; LA. Lingual artery; DT. Digastric tendon; LFT. Lingofacial trunk.

Branching: The branching patterns of this study were classified into six types based on the origin of the branches (Fig. 2; Table I).

Type 1, each of the branches arose separately from the facial artery, as in the standard anatomic definition (Fig. 3). This occurred in 25/39 (64.10 %) overall [Right: 11/19 (57.89 %); Left 17/20 (85 %); Male: 15/21 (71.43 %); Female: 13/18 (72.22 %)].

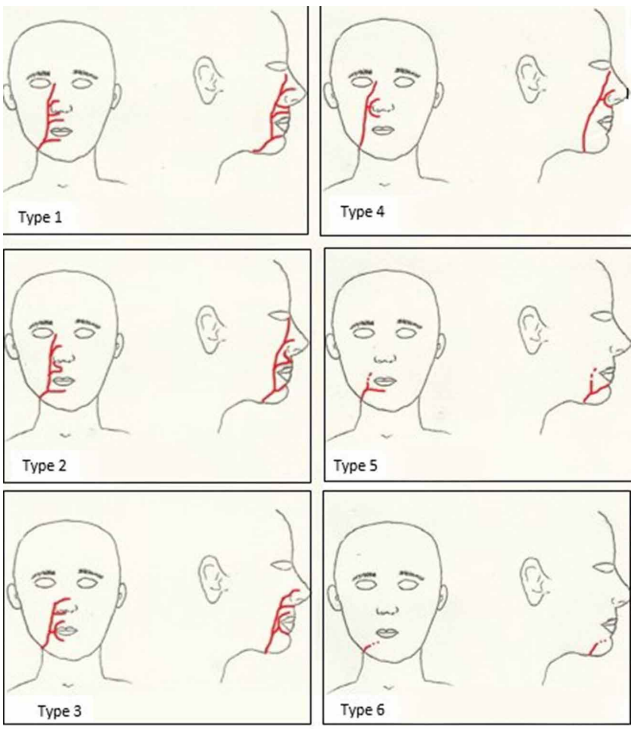

Fig. 2. Schematic of branching pattern classifications used in the current study.

Type 2, the superior labial branch gave off the inferior alar branch. This occurred in 7/39 (17.95 %) overall [Right: 7/19 (36.84 %); Left: 0/20 (0 %); Male: 4/21 (19.05 %); Female: 3/18 (16.67 %)].

Type 3, the superior and inferior labial branches originated from a common trunk and the facial artery had early termination. This occurred in 1/39 (2.56 %) overall [Right: 0/19 (0 %); Left: 1/20 (5 %); Male: 1/21 (4.76 %); Female: 0/18 (0 %)].

Type 4, the superior and inferior alar branches came from a common trunk and no superior labial and inferior labial branches were present. This occurred in 1/39 (2.56 %) in a female specimen on the left.

Type 5, the facial artery was rudimentary, which is when the artery terminated after giving off an inferior labial artery, but before reaching the upper lip. This occurred in 1/39 (2.56 %) in a male specimen on the right.

Type 6, the facial artery was abortive, which is when the facial artery gives off no facial branches. This occurred in 1/39 (2.56 %) in a female specimen on the left.

Types 1 and 2 were further divided into subtypes, as this study found that although the branches originated from the facial artery in a common manner, their termination and/or the branches present displayed variations (Table I).

Most anatomical textbooks describe the facial branches of the facial artery as arising independently of one another (Drake *et al*.), which is in agreement with Type 1 of this study. Loukas *et al*. described five main types of variations based on the patterns observed in their research with regards to the distribution of the branches of the facial artery. The study further described sub-types of each based on the sub-variations within each group. Lohn *et al*. described six main types of distribution patterns of the facial artery with regards to the final branch of the facial artery. In Lohn *et al*.'s study, the branching patterns of the six types were further classified into four patterns. Pilsl *et al*. classified the facial artery into four types based on the course of the artery, the branches present and the terminal branch.

Previous studies have noted branches, such as the superior and inferior alar branches, which are not mentioned in the standard anatomical description of the facial artery

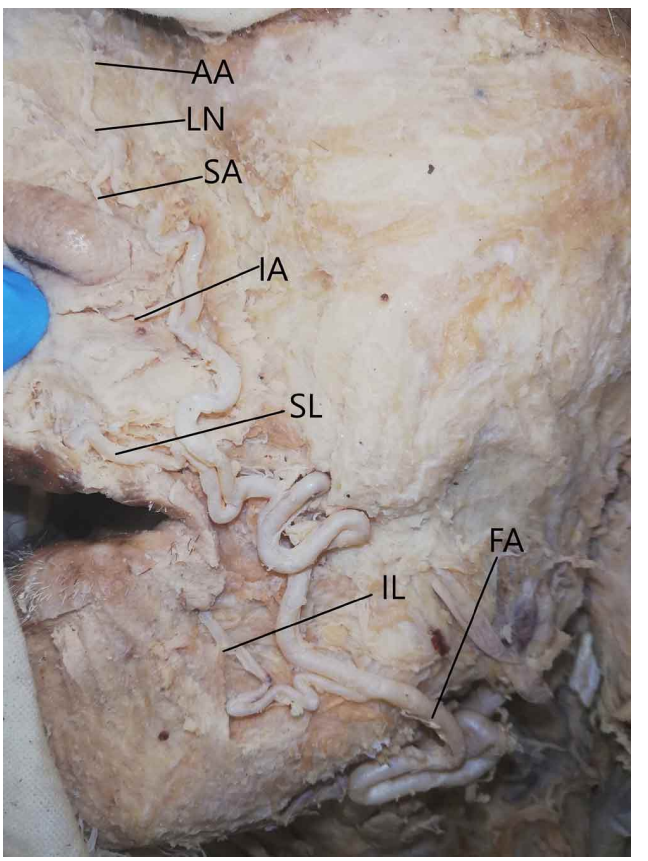

Fig. 3. Standard anatomical branching pattern (Type 1). FA. Facial artery; IL. Inferior labial artery; SL. Superior labial artery; IA. Inferior alar artery; SA. Superior alar artery; LN. Lateral nasal artery; AA. Angular artery.

Table I. Classification of branching patterns of facial artery.

Types and Subtypes	Male			Female		
	Right n (%)	Left n (%)	Total n (%)	Right n (%)	Left n (%)	Total n (%)
1 Directly off FA	1/10 (10 %)	2/11 (18 %)	3/21 (14.29 %)	1/9 (11.11 %)	1/9 (11.11 %)	2/18 (11.11 %)
1-A Early termination into IL, SL, IA, SA, LN	4/10 (40 %)	5/11 (45.45 %)	9/21 (42.86 %)	4/9 (44.44 %)	5/9 (55.56 %)	9/18 (50 %)
1-B No IL branch & early termination	-	2/11 (18.18 %)	2/21 (9.52 %)	1/9 (11.11 %)	1/9 (11.11 %)	2/18 (11.11 %)
1-C No IL or IA branches with early termination	-	1/11 (9.09 %)	1/21 (4.76 %)	-	-	-
2 SL gives off IA	1/10 (10 %)	-	1/21 (4.76 %)	-	-	-
2-A Early termination into IL, SL, IA, SA or LN	3/10 (30 %)	-	3/21 (14.29 %)	1/9 (11.11 %)	-	1/18 (5.56 %)
2-B No IL branch	-	-	-	1/9 (11.11 %)	-	1/18 (5.56 %)
2-C Early termination with branch supplying other side	-	-	-	1/9 (11.11 %)	-	1/18 (5.56 %)
3 SL &IL from common branch with early termination	-	1/11 (9.09 %)	1/21 (4.76 %)	-	-	-
4 IA & SA from a common branch, no SL & IL branches	-	-	-	-	1/9 (11.11 %)	1/18 (5.56 %)
5 Rudimentary artery	1/10 (10 %)	-	1/21 (4.76 %)	-	-	-
6 Abortive artery	-	-	-	-	1/9 (11.11 %)	1/18 (5.56 %)

Key: FA – Facial artery; IL – Inferior labial; SL- Superior labial; IA- Inferior alar; SA – Superior alar; LN – Lateral nasal; AA – Angular artery.

(Loukas *et al*.; Lohn *et al*.; Pilsl *et al*.). Each study used their own classifications to categorise these variant branches. Furthermore, their investigations of the facial artery have not comprehensively described the various branches, nor their relation to sex or laterality.

In the current study, the authors used the term inferior alar branch for the facial artery branch, which supplied the inferior part of the nose and septum. The term superior alar branch was used in describing the facial artery branch, which supplied the superior portion of the alar of the nose. A variation where the facial artery gave off an anterior and posterior branch to form a duplex artery was not observed in the current study as in others previously (Koh *et al*.; Loukas *et al*.; Lohn *et al*.). However, the current study observed one case where the superior labial artery on the right side gave rise to the right inferior alar artery, after which crossed over to the left to supply the left inferior alar branch.

Table III. P-values for associations between termination and sex on the right and left side.

Termination	Right	Left
Inferior labial	0.437	0.714
Superior labial	0.109	0.823
Inferior alar	0.045	0.581
Superior alar	0.423	0.201
Lateral nasal	0.795	0.795
Angular artery	0.656	0.795

This was not noted in any studies previously (Fig. 4). The current study classified this pattern as Subtype 2-C. It was observed that there were overall more variations on the left side of the face [Right: 16/19 (84.21 %); Left: 18/20 (90 %)], and variations were more common in the female specimens [Male: 18/21 (85.71 %); Female: 16/18 (88.89 %)]. This finding is relevant as the facial artery could be in danger during cosmetic procedures such as neurotoxin injections and aesthetic enhancements which

Table II. Termination of the Facial artery according to laterality.

Termination	Overall - Number (%)	Right - Number (%)	Left - Number (%)
Inferior labial	5.13	5	5.26
Superior labial	10.26	20	0
Inferior alar	10.26	0	21.05
Superior alar	46.15	45	47.37
Lateral nasal	5.13	0	10.53
Angular artery	20.51	25	15.79
Abortive artery	2.56	5	0

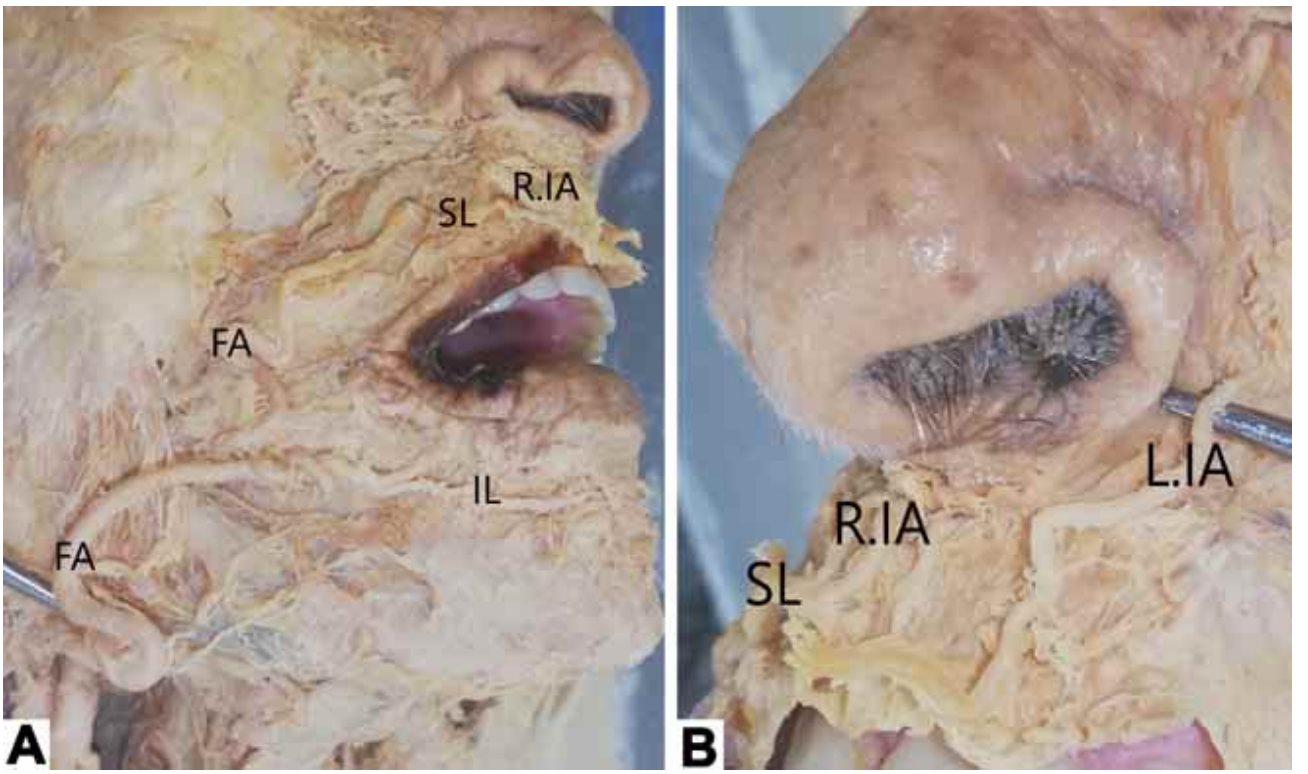

Fig. 4. Sub-type 2-C viewed from the right (A) and left (B). FA. Facial artery; IL. Inferior labial artery; SL. Superior labial artery; IA. Inferior alar artery; RIA. Right inferior alar artery; LIA. Left Inferior alar artery; SA. Superior alar artery.

have become popular amongst females (Lazzeri *et al*., 2012; Yang *et al*., 2014).

Termination: Anatomical textbooks describe the termination of the facial artery as the angular artery, located at the medial aspect of the eye (Drake *et al*.). Many variations in the termination of the facial artery have been described in the literature (Midy *et al*.; Koh *et al*.; Loukas *et al*.; Lohn *et al*.; Pilsl *et al*.). The results of the current study showed that the facial artery terminated as the angular artery in only 20.51 % [8/39; Right 3/19 (Females 1/19; Males: 2/19) Left 5/20 (Females 2/20; Males 3/20)] of the specimens observed. The specimens showed variant termination as the inferior labial artery [2/39; 5.13 %; Right 1/19 (Males 1/10, Females 0/9); Left 1/19 (Males 1/11, Females 0/9)], superior labial artery [4/39; 10.26 %; Right 0/19; Left 4/20 (Females 3/9; Males 1/11)], inferior alar artery [4/39; 10.26 % Right 4/19 (Females 3/9; Males 1/10)], superior alar artery [18/39; 46.15 %; Right 9/19 (Females 4/9; Males 5/10); Left 9/20 (Females 3/9; Males 6/11)] and lateral nasal artery [2/39; 5.13 %; Right 2/19 (Females 1/9; Males 1/10)]. The observed terminations of the facial arteries and their prevalence (%) according to laterality are summarised in Tables II and III.

Cases of abortive arteries have been reported in the literature (Midy *et al*.; Loukas *et al*.; Lohn *et al*.). The current study observed a single abortive artery during dissections on the left side of a female specimen. The current study also observed a rudimentary artery on the right side of a male specimen. A rudimentary artery is a variation where the facial artery one terminates having given off only an inferior labial branch, it has no other significant branches in the face (Loukas *et al*.). The findings of this study illustrated the need for knowledge of the possible variations as these could cause complications in the cosmetic procedures, should surgeons not be aware of the variations which exist.

CONCLUSION

The current study observed a number of variations of the facial artery amongst individual specimens and according to sex and laterality. Procedures to repair oral defects would make use of musculomucosal, myocutaneous and submental artery island flaps, which require the facial artery blood supply (Pribaz *et al*., 2000). The information on the facial artery variations in this study can help mitigate the risk of damage to the facial artery during cosmetic procedures such as neurotoxin injections (Lazzeri *et al*.).

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RESUMEN: La arteria facial (una rama de la arteria carótida externa) es la arteria principal de la cara. Da lugar a siete ramas: labial inferior, labial superior, alar inferior, alar superior, arterias nasales y angulares laterales, además de ramas pequeñas variables. Este estudio incluyó una disección de veinte muestras de cabeza y cuello de cadáveres adultos fijados. Los parámetros de origen, patrones de ramificación, terminación y variaciones fueron analizados y comparados con el sexo y la lateralidad. La arteria facial se originó de manera normal en el 84,62 % de la muestra. Variaciones: (i) origen como tronco linguofacial en 12.82 % y (ii) se observó un origen alto en 2,56 %. Las muestras en los hombres mostraron un mayor número de orígenes del tronco linguofacial (7,69 %). Los patrones de ramificación de la arteria facial se clasificaron en seis tipos, con subtipos para los Tipos 1 y 2. El subtipo 1-A (descripción anatómica normal con terminación temprana) se observó en (46,15 %) de la muestra. Las muestras de varones tenían una mayor variación en los patrones de ramificación que las muestras de mujeres, 48,72 % y 41,03 % respectivamente. La terminación de la arteria facial fue la siguiente: arteria labial inferior (5,13 %), arteria labial superior (10,26 %), arteria alar inferior (10,26 %), arteria alar superior (46,15 %), arteria nasal lateral (5,13 %) y arteria angular (20,51 %). Se observó un solo caso (2,56 %) de una arteria abortiva. El análisis estadístico mostró que el sexo era independiente de cada parámetro observado en este estudio. El conocimiento anatómico de la arteria facial es importante para los médicos y cirujanos durante procedimientos como colgajos musculomucosal y en la dermatología estética.

PALABRAS CLAVE: Arteria facial; Arteria carótida externa; Colgajo musculomucosal; Tronco linguofacial; Arteria angular.

REFERENCES

Bergman, R. A.; Thompson, S.; Afifi, A. & Saadeh, F. *Compendium of Human Anatomic Variation*. Munich, Urban & Schwarzenberg, 1988.

Cardinot, T. M.; Vasconcellos, H. A.; Vasconcellos, P. H. B.; Oliveira, J. R.; Siqueira, P. B. & Aragão, A. H. B. M. Anatomic variation of the facial artery and its implications for facial surgery: case report. *J. Morphol. Sci., 31(1)*:62-6, 2014.

Drake, R. L.; Vogl, A. W. & Mitchell, A. W. M. *Gray's Anatomy for Students*. 3rd ed. Philadelphia, Churchill Livingstone Elsevier, 2015.

Koh, K. S.; Kim, H. J.; Oh, C. S. & Chung, I. H. Branching patterns and symmetry of the course of the facial artery in Koreans. *Int. J. Oral Maxillofac. Surg., 32(4)*:414-8, 2003.

Kumar, A.; Elumalai, G.; Thangamani, M.; Palayathan, N. & Sing, M. K. A Rare variation in facial artery and its implications in facial surgery: case report. *J. Surg., 2(5)*:68-71, 2014.

Lazzeri, D.; Agostini, T.; Figus, M.; Nardi, M.; Pantaloni, M. & Lazzeri, S. Blindness following cosmetic injections of the face. *Plast. Reconstr. Surg., 129(4)*:995-1012, 2012.

Lohn, J. W.; Penn, J. W.; Norton, J. & Butler, P. E. The course and variation of the facial artery and vein: implications for facial transplantation and facial surgery. *Ann. Plast. Surg., 67(2)*:184-8, 2011.

Loukas, M.; Hullett, J.; Louis, R. G. Jr.; Kapos, T.; Knight, J.; Nagy, R. & Marycz, D. A detailed observation of variations of the facial artery, with emphasis on the superior labial artery. *Surg. Radiol. Anat., 28(3)*:316-24, 2006.

Mangalgiri, A.; Namdev, L. N.; Mahore, D. & Kapre, M. The study of higher origin of facial artery and its surgical significance. *Indian J. Otolaryngol. Head Neck Surg., 67(1)*:72-4, 2015.

Midy, D.; Mauruc, B.; Vergnes, P. & Caliot, P., A contribution to the study of the facial artery, its branches and anastomoses; application to the anatomic vascular bases of facial flaps. *Surg. Radiol. Anat., 8(2)*:99-107, 1986.

Nayak, S. Abnormal intra-parotid origin of the facial artery. *Saudi Med. J., 27(10)*:1602, 2006.

Ozgur, Z.; Govsa, F. & Ozgur, T., Assessment of origin characteristics of the front branches of the external carotid artery. *J. Craniofac. Surg., 19(4)*:1159-66, 2008.

Pilsl, U.; Anderhuber, F. & Neugebauer, S. The Facial Artery-The Main Blood Vessel for the Anterior Face? *Dermatol. Surg., 42(2)*:203-8, 2016.

Pribaz, J. J.; Meara, J. G.; Wright, S.; Smith, J. D.; Stephens, W. & Breuing, K. H. Lip and vermilion reconstruction with the facial artery musculomucosal flap. *Plast. Reconstr. Surg., 105(3)*:864-72, 2000.

Troupis, T.; Michalinos, A.; Kakisis, J.; Natsis, K.; Sofifis, G. & Skandalakis, P. Bilateral lingual-facial trunk: anatomic and clinical implications. *Folia Morphol. (Warsz), 74(4)*:548-51, 2015.

Yang, H. M.; Lee, J. G.; Hu, K. S.; Gil, Y. C.; Choi, Y. J.; Lee, H. K. & Kim, H. J. New anatomical insights on the course and branching patterns of the facial artery: clinical implications of injectable treatments to the nasolabial fold and nasojugal groove. *Plast. Reconstr. Surg., 133(5)*:1077-82, 2014.

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