STUDY OF FACIAL ARTERY AND ITS BRANCHES WITH SPECIAL REFERENCE TO SUBMENTAL AND PERIORAL BRANCHES IN SOUTH INDIAN SUBJECTS

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CERTIFICATE

This is to certify that the dissertation work on **STUDY OF FACIAL ARTERY AND ITS BRANCHES WITH SPECIAL REFERENCE TO SUBMENTAL AND PERIORAL BRANCHES IN SOUTH INDIAN SUBJECTS** is the bonafide work done by **Dr.M.Vijayalakshmi** in the Institute of Anatomy, Madras Medical College, Chennai – 600003 during the year 2004-2007 under my supervision and guidance in partial fulfillment of the regulation laid down by **The Tamil Nadu Dr. M. G. R. Medical University**, for the M.S., Anatomy branch V examination to be held in March 2007.

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CONTENTS

AIM OF THE STUDY

Beauty given is 'Beauty Glowing'

The age of **'Beauty by Birth'** is changing into the age of **'Beauty of choice'**. The beauticians give only the outside 'touch up'. But scientific persons like plastic surgeons give permanent beauty, repairing the defects and remodelling the existing structure.

The act of sharing beauty itself is a beautiful event. This is the one which has led to the achievement of cosmetic and reconstructive facial surgeries.

In plastic surgeries of face like cleft-lip, palate, etc, or reconstructive surgery of nose with Abbe's flap and other lip flaps, the procedures involve surgical manipulation of one of the branches of the facial artery in the face. Of these, the superior labial artery takes its credit in being the artery supplying the superficial aspect of the dangerous area of the face.

In a condition called 'caliber persistent labial artery`, the labial artery enlargement with constant diameter was made out which was either vertical or oblique from the depth of the lip to the surface of the mucosa. This 'caliber persistent labial artery` was mistaken for cystic tumours. When it presented with surface disintegration of the mucous membrane, it was mistaken for squamous cell carcinoma with ulcers. When the surgeon operating on such patient is not aware of it, this may lead to severe bleeding and sometimes even death of the patient. This is a clinically found lesion and should not be an

incidental finding by the pathologist who reports the operated specimen. Knowledge of this will avoid unnecessary surgery and intra operative bleeding.

Diagnostic and therapeutic radiological methods and development in surgical methods like embolisation of the tumour- feeding vessel in case of tumours including angiomas and arteriovenous malformations need a thorough knowledge of the vascular pattern of that particular area.

In facial artery, the main trunk or one of its branches is being used in diagnostic radiology and therapeutic interventions like embolisation or ligation. Variations in the branching of facial artery are as frequent as its anastamoses with the major branches of the carotid arteries.

Commendable are the works done by plastic surgeons and anatomists all over the world. Plastic surgeons and anatomists of China, Korea, Iran, Turkey, West Indies, U.K, etc. have come out with much more details of this arterial anatomy in the recent years.

This inculcated an interest in doing this Study of Facial Artery in Human in South Indian subjects.

Isolated dissection of facial artery was done in human cadavers to gain knowledge of the location of this artery and its branches with respect to easily identifiable landmarks and thus helping to avoid complications.

The aim of this study is to equip both the anatomists and the surgeons to have a thorough understanding of the vasculature of the face and the plastic

surgeons in particular, to have a more confident approach to reconstructive procedures in this region.

This study about the Facial Artery with reference to its origin and branching pattern is done under the following headings:

Facial Artery (Main Trunk)

Mode of origin

- Separate trunk from external carotid
- Common linguofacial trunk

Level of origin

- With reference to the greater cornu of the hyoid bone and to the angle of the mandible.

Distance of entry of facial artery into the face from the angle of the jaw.

Branches of Facial Artery:-

1. Sub-mental artery:

- Distance of origin of submental artery from the origin of facial artery.
- Distance of the submental artery from the mandibular border.
- Distance of origin of submental artery from the angle of the mandible.
- Length of the submental artery.

(The above parameters are useful in planning the submental musculocutaneous flaps.)

2. Inferior labial artery:

- Number of inferior labial arteries (Single Inferior labial artery or Two Inferior labial arteries).
- Origin of infra (sublabial) labial artery when present.
- Length of the infralabial (sublabial) artery.
- Distance of origin of infralabial artery from the angle of the mouth.
- Length of the inferior labial artery.
- Distance of origin of inferior labial artery from the angle of the mouth and the level of origin of inferior labial artery with reference to the angle of the mouth.

(The above and the following are the parameters useful in raising labial flaps.)

3. Superior labial artery:

- Length of superior labial artery.
- Distance of origin of superior labial artery from the angle of the mouth.
- Distance between the origin of inferior and superior labial arteries.
- Distance of origin of superior labial artery from the mandibular margin.

4. Septal and Alar branches:

- Origin of septal branch.
- Length of septal branch.
- Distance between the origin of septal branch and the origin of superior labial artery.

5. **Inferior alar branch:**

- Origin of the inferior alar branch.
- Length of the inferior alar branch.
- Distance of origin of superior labial artery and inferior alar branch.
- Distance between the origin of lateral nasal branch and the inferior alar branch.

(The above parameters are useful in raising nasolabial island flaps in reconstruction surgeries of nose.)

6. **Other branches of facial artery**

- Normal branches.
- Unusual branches.

Branching Pattern and Mode of Termination of facial artery

The above may pave way for construction of new flaps based on the abnormal arteries and also to avoid unforeseen failures when usual methods are followed.

REVIEW OF LITERATURE

HENRY GRAY (1858) in the Text Book of Gray's Anatomy, names the facial artery as 'external maxillary artery' which branches from the external carotid artery above the lingual artery, immediately above the greater cornu of hyoid bone. It takes an upward course beneath the skin and platysma to reach deep to the posterior belly of the digastric and stylohyoid muscles, where it is crossed by the hypoglossal nerve. It grooves the posterior part of the submandibular gland. It lies first on the middle constrictor and may reach the lateral surface of the styloglossus where it is separated from the tonsil by the lingual fibres of the superior constrictor. Then it descends down to the lower border of the mandible in a lateral groove on the submandibular gland, where it lies between the gland and the medial pterygoid muscle. Then, it curves round the inferior border of the mandible anterior to the masseter to reach the face. It is just under the skin and platysma and its pulse is felt well at this place. In the face, it ascends forward across the mandible, the buccinator, traversing a cleft in the modiolus, near the buccal angle, ascends to the side of the nose to reach the medial palpebral commissure. In the face, deep to the facial artery are the buccinator and levator anguli oris. The artery passes within or superficial to the levator anguli superioris, to get embedded in the levator labii superioris alaeque nasi at its termination.

He also says that the facial artery gives out the ascending palatine, tonsillar, glandular, muscular and the submental artery in the neck, and in the face the inferior labial, superior labial and the lateral nasal branches. It ends as the angular artery distal to the superior nasal branch.

He says that the facial artery pulsation is the most palpable where it crosses the mandibular base and between the thumb and the finger near the buccal angle.

He also says that the tonsillar branch may sometimes arise from the ascending palatine artery. The submental artery is the largest branch in the neck, and the superior labial artery give off a septal and an alar branch. He mentions about the numerous anastamoses not only with the corresponding contralateral branches but also in the neck with the sublingual branch of the lingual, ascending pharyngeal and palatine branch of the maxillary and on the face, with the mental branch of the inferior alveolar, transverse facial branch of the superficial temporal, infra orbital branch of the maxillary and dorsal nasal branch of the ophthalmic arteries. The anastamoses in the lips are by the main trunks, which is an important fact in the labial injuries.

Variations quoted by him are:–

- The facial artery may arise with the lingual as a common linguofacial trunk.
- Facial artery varies in size and supply to the face.
- It may end as the submental artery and often extends only to the buccal angle. The deficiency is filled by the branches of the neighbouring arteries.
- In the latest editions of Gray's Anatomy – The Anatomical Basis of Clinical Practice (2005), it is said about a small inconstant premasseteric artery in the face that passes along the anterior margin of the masseter.

G.J. ROMANES (1902) in Cunningham's Text Book of Anatomy describes the normal course of facial artery in the neck and face. He mentions about the four branches in the neck, namely, the ascending palatine, the tonsillar, the glandular and the submental branches, and in the face the inferior labial, the superior labial and the lateral nasal branches.

He mentions that the facial artery also gives many unnamed branches in the neck, in addition to the named four branches. He says that there are frequently two inferior labial arteries on each side and the superior labial artery gives a septal branch and the labial arteries are readily palpable when the lips are held between the finger and the thumb. He mentions about the lateral nasal as a constant branch which ramifies on the side of the nose.

GRONROOS (1902) in the Annals of Anatomy, published a case in which, the facial artery ended as submental artery, sending tiny branches along the anterior border of the masseter muscle. In this case, he observed that the buccinator branch of the internal maxillary (maxillary) artery was very much enlarged and after appearing on the cheek, turned up to the usual position of the facial artery to supply the buccal, nasal and the angular branches.

GEORGE A. PIERSOL (1907) refers the facial artery as external maxillary artery arising from the anterior surface of the external carotid artery, a short distance above the lingual artery. He describes its course in the neck as grooving the submaxillary (submandibular) gland, vertical at the border of the mandible anterior to the masseter as it enters the face. In the face, it has an oblique and sinuous course across the face to the nasolabial angle and almost vertical course beyond this. This terminal vertical portion of the vessel according to him is usually termed as angular artery. This anastamoses with the nasal branch of ophthalmic artery. He mentions about the ascending palatine, tonsilar, submandibular and submental branches from the cervical portion of the artery.

From the facial portion, the masseteric branches arise from the posterior surface of the artery, directed upwards to supply the muscle and to anastamose with the branches of internal maxillary and transverse facial arteries. The inferior labial artery passes along the outer surface of the horizontal ramus of the mandible and supply the muscles and integument there and anastamose with the mental branches of the inferior alveolar and submental arteries. Hence,

according to him, the inferior labial arteries are two in number. Also, the inferior labial (coronary) artery passes between the mucosa of the lip and orbicularis oris supplying them and anastomosing with its fellow of the opposite side. The superior labial artery has the same course as the inferior coronary artery and it gives a septal branch. Lateral nasal branch arises from the facial artery as it enters the nasolabial angle and passes forward over the ala of the nose.

The angular artery is the terminal portion of the external maxillary artery beyond the nasolabial angle. It passes directly upward in the angle between the nose and the cheek, giving branches to the adjacent structures, anastomoses with the nasal branch of the ophthalmic artery and with infraorbital branch of internal maxillary artery.

He says that the variations in the facial artery may be:

The external maxillary artery (facial artery) arising by a trunk common to it and lingual artery. It may arise above the level of angle of jaw. Quite frequently, the facial artery does not extend upon the face beyond the angle of the mouth replaced by the branches of the transverse facial or internal maxillary artery in the upper part of its course. The ascending palatine branch arises directly from the external carotid or from the ascending pharyngeal or the occipital artery. Tonsillar artery is said to be usually arising from the ascending palatine artery. He says that the submental may be greatly reduced in size or even absent, being replaced by whole or in part by the sublingual artery. He also says that these two arteries are inversely proportionate so far as their development is concerned.

He advises that in case of injury, as in division of labial branch, ligation of the wounded vessel is advisable if it is possible, since when the external maxillary artery is ligated, recurrence of the haemorrhage is likely to occur due to very free anastomoses between the branches of the opposite sides. He also says that in bleeding after tonsillectomy, either the tonsillar branch of

the external maxillary (facial artery) or the main vessel where it runs between the posterior belly of digastric and styloglossus may be involved. But as the blood may be furnished by the ascending pharyngeal artery, ligation of the external carotid would be more likely to be efficient rather than ligating the facial artery.

TOLDT (1921) in Anatomischer Atlas illustrated the presence of a branch from the facial artery which ascends along the anterior edge of the masseter but he did not name it.

BEUNTARO ADAICHI (1928) was the first person to describe the premasseteric branch of the facial artery accurately, which arises at the lower border of the mandible. He found it as strong as or even stronger than the facial artery in 3% of the cases and to exist as a small vessel in unspecified large number of cases.

He has also found in his study of 1000+ hemifaces, the presence of strongly developed transverse facial artery which even supplied the labial branches and ended as angular artery.

Dr. GRANT (1943) studied the variations in the origin of lingual artery in 211 specimens. He found that:

- in 80%, the superior thyroid, lingual and facial arteries arose separately;
- in 20%, the lingual and facial arteries arose from a common stem, inferiorly or high on the external carotid artery
- in one specimen, the superior thyroid and the lingual arteries arose from a common trunk.

J. PARSONS SCHAFFER (1952) in Morri's Anatomy, uses the term 'external maxillary artery' for the facial artery. He says that either the facial artery arises separately above the lingual, from the forepart of the external

carotid or sometimes in common with lingual artery. He calls it as angular artery at the medial angle of the eye. According to him, among the branches of the external maxillary artery (facial artery) in the neck the ascending palatine artery may arise often as a distinct branch of external carotid. Tonsillar branch (ramus tonsillaris) and the ascending palatine artery tend to vary inversely in size and either may be small or absent when the ascending pharyngeal is large. He also says that there is also compensatory adjustment between the size of these three arteries and that of the minor palatine of the descending palatine artery. He mentions about a small twig from the glandular branches supply the Wharton's duct separately.

In the face, he says that the inferior labial artery has frequently an additional branch, the 'sublabial artery` passes from the external maxillary to the region just below the lower lip.

He says that the superior labial artery is usually larger than the inferior labial artery. It courses tortuously in the upper lip, 1.2 cm from the junction of the mucus membrane and the skin. It gives off a septal branch. He says that the compression of this vessel will sometimes control the haemorrhage from the nose.

He also mentions that the angular artery is the terminal branch of external maxillary, anastomosing with dorsal nasal branches of ophthalmic and with infra-orbital artery.

Of the clinical aspects of the facial artery, he says that the external maxillary artery, when divided at the margin of the mandible just in front of the masseter both ends must be ligated here. He also says that the facial artery can be felt a little behind the angle of the mandible or just beneath the mucus membrane as it gives off the labial branches and also that the labial branches can be felt lying deeply when the lip is taken between the finger and the thumb. According to him, it can also be felt by the side of the nose as it runs upto the

medial angle of the eye. The small angular branch is always troublesome to secure from its position.

F.WOOD JONES ET AL (1953) in Buchanan's Manual of Anatomy said that the facial artery (external maxillary artery) arises from the anterior aspect of external Carotid in the Carotid triangle immediately above the lingual artery, sometimes common with that vessel. He describes the normal course of facial artery in the neck and its tortuous and superficial course in the face from the anterior border of masseter to the angle of the mouth, angle of the nose and the medial angle of the eye. He mentions about the ascending palatine, tonsilar, glandular and the submental branches in the neck. In the face he mentions about the muscular branches distributed to the structures in the masseteric, buccal, and infraorbital regions, where they anastamose with the buccal, transverse facial and infraorbital arteries. He describes the other branches in the face as follows:

- Mental branch (inferior labial artery) runs between the mandibular base and lower lip anastomose with inferior labial, mental and submental arteries.

- Inferior labial artery (inferior coronary artery) arises inferior to the angle of the mouth runs between the mucous membrane and orbicularis oris in the lower lip, anastomoses with the opposite side and also the previous branch.

- Superior labial artery (Superior coronary artery), larger than the inferior labial arises from the facial above the angle of the mouth and has a similar course as the inferior labial. Near the midline of the upper lip, the superior labial is said to give the septal branch.

R.J. LAST & CHUMMY S. SINNATAMBY (1954) – Last's Anatomy – 'Regional and Applied' cites that sometimes there may be a common linguofacial trunk from the external carotid artery. He says that the

pulsation of the facial artery can be felt at the anterior border of the masseter, as it crosses the inferior border of the mandible. He says that the submental branch is given from the facial artery before it passes to the face and this branch is accompanied by the myelohyoid nerve into the submandibular fossa. It is said by him that the submental branch sends perforating branches through myelohyoid to anastomose with a sublingual branch of lingual artery.

ERNEST GARDNER, DONALD J. GREY, RONAN O' RAHILLY (1960) in their Text 'Anatomy – A regional study of human structure' mentions the facial artery as external maxillary artery. He also mentions about the frequent linguofacial trunk. He describes the normal course of facial artery in the neck as well as in the face and says that it takes part in numerous anastomoses, including some across the median plane, the latter aiding in the collateral circulation after ligation of the common or external carotid artery on one side.

He classifies the branches in the neck as ascending palatine, tonsillar, submandibular and the submental arteries, the last one being the longest in the neck.

He also says that among the branches in the face, the inferior labial artery is usually two on each side. The other branches in the face the superior labial artery which is larger and more tortuous and gives the septal and alar branches, the lateral nasal artery supplying the ala and dorsum of the nose and the terminal angular artery. He also mentions that haemorrhage is controlled by compressing both parts of a cut lip between index fingers and thumbs.

HENRY HOLLINSHEAD (1961) refers the facial artery as external maxillary artery. The chief branches of the facial artery described by him in the neck are ascending palatine, tonsillar, submandibular and submental artery and in the face, the labial, lateral nasal and the angular branches. He mentions that the tortuosity of the labial arteries is more marked in the aged and it is found just under the mucosa of the lip. He also mentions about two inferior labial

arteries, in which case the lower arises from the facial below the level of the alveolar border of the mandible and courses farther from the free margin of the lip and less close to the mucosa. He says that the superior labial artery gives the nasal septal branch which is the common source of bleeding from the nose. According to him, the facial artery has anastomoses with buccinator branch of internal maxillary, transverse facial artery (from superficial temporal) and with the infraorbital artery from the internal maxillary while the angular portion anastomoses broadly with the dorsal nasal branch of ophthalmic artery. The anastomoses of the two facial arteries across the midline of the face, especially the labial vessels is mentioned by him as the probable important part of collateral circulation available after ligation of external or common carotid artery on one side.

The abnormalities of the facial artery, mentioned by him are

- A deficient facial artery, its place being taken in part by the other branches.
- He has cited a case in which the facial artery ended with the labial branches, its place above the mouth being taken by enlarged branches from transverse facial artery and by similarly enlarged dorsal nasal branch from the ophthalmic.

RUSSELL T. WOODBURNE A.M. (1961) describes the normal branching of the facial artery from the external carotid artery and its course in the neck and face. He describes the branches in the neck as ascending palatine artery, the tonsillar artery, branches to the submandibular gland and muscles of the region, and the submental artery. He says that the neck branches do not reach the face. The inferior labial artery and the larger superior labial artery, the lateral nasal artery and the terminal angular artery are the branches in the face described by him. He mentions about the frequently occurring ‘second inferior labial’ or ‘infra labial’ artery that runs in the sulcus between the lower lip and chin and the superior labial artery giving a septal branch to nasal septum.

SIR SOLLY ZUCKERMAN C.B. (1961) in 'A New System of Anatomy' says that the facial artery and the lingual artery, the antertior branches of the external carotid arise at about the level where they are crossed by the hypoglossal nerve just above the greater horn of hyoid bone. He mentions about the single trunk of origin of the above arteries. He says that the submental artery runs forwards underneath the submandibular gland.

RICHARD S. SNELL (1963) in 'Clinical Anatomy of Medical Students' mentions the facial artery as arising from the anterior surface of the external carotid, above the level of greater cornu of hyoid bone and says that it is the highest of the three branches in the anterior aspect of the neck. He gives the normal branches of facial artery in the neck as ascending palatine, tonsillar, glandular and the submental arteries, and in the face as the inferior labial, superior labial and the lateral nasal arteries, the septal branch being from the superior labial artery.

MITZ et al (1973) says that in 80% of cases, the facial artery terminates as lateral nasal branch at the ala of the nose.

W.J. HAMILTON (1976) in his Text Book of Human Anatomy, says that the facial artery loops upwards deep to the mandible, grooves the submandibular gland, turns round the lower border of the mandible where its pulsation is felt at the anterior border of the masseter and has an oblique course on the face to end at the inner canthus of the eye.

He says that the labial branches are relatively large vessels which are readily felt on holding the lip between the thumb and the finger, particularly near the angle of the mouth.

He concludes that the tortuosity of the artery in the neck and face possibly facilitates stretching of the soft tissue and free movement of the cheeks, jaw, tongue, pharynx and larynx in mastication and deglutition.

KOZIELAC and JOZWA (1977) in Gray's Text Book of Anatomy cited their findings in a study of 110 human fetuses. They have found the occurrence of common linguofacial trunk in 43% and the facial artery not reaching the medial orbital angle in 42%. In the latter cases, it ended as superior labial artery in 20% and inferior labial artery in 22%.

HERBERT (1978) has confirmed the presence of a strongly developed transverse facial artery, which gave the labial branches and ended as angular artery.

KEITH L. MOORE (1980) in 'Clinically oriented Anatomy' says that the facial artery is the major arterial supply to the face and it arises from the external carotid artery. He says that the facial artery is superficial at the lower margin of the mandible as it crosses the mandible to the face and it is one finger's breadth lateral to the angle of the mouth near its termination of its sinuous course through the face. He also mentions that the terminal part of the facial artery beyond its superior branch is the angular artery. He says that the facial artery can be occluded by pressure against the mandible where the vessel crosses it. But he refers that because of the numerous anastomoses between the branches of the facial artery and other arteries of the face, compression of the facial artery on one side does not stop all bleeding from a lacerated facial artery, or one of its branches. He says that the pressure should be applied on both sides of the cut end of a lacerated lip to stop the bleeding. He also indicates that the anaesthesiologist standing at the head of the operating table may palpate the facial artery as it winds round the inferior border of the mandible, when the pulse of the other arteries are inconvenient to be palpated.

MIDY D., MAURUC B., VERGNES P. & CALIOT P. (1986) present the result of their dissection of 40 facial arteries and their collaterals. Three segments of the facial portion were studied and they present it as 4 types, namely the labial, nasal, angular and abortive types.

RONALD A. BERGMAN Ph.D., ADEL K. AFIFI M.D. ET AL (1988) Illustrated, Encyclopedia of Human Anatomic Variations - Opus II- Cardiovascular system - Arteries, Head, Neck, Thorax.

He says the following about facial artery.

Facial artery may be frequently rudimentary, may terminate as submental artery (not reaching the face, or as a labial or alar nasi (lateral nasal artery) and not as the angular in 43% of cases studied. In this case it was replaced by nasal branch of the ophthalmic artery at the medial side of the orbit or by the transverse facial or by the maxillary artery.

Facial artery when larger than usual may replace the frontal branches of the ophthalmic or the nasal artery. Submental artery may arise from the lingual artery instead of from facial artery. Unusual branches of facial artery observed are ascending pharyngeal, superior laryngeal, tonsillar, sternocleido mastoid, maxillary or sublingual. Facial artery may replace the lingual artery and supply the sublingual gland. Superior and inferior labial branches of the facial artery may be poorly developed or absent in which case they are replaced by the contra lateral vessel which is usually enlarged. Facial artery may arise by a common trunk with lingual. Occasionally facial artery arises above its usual position. Then it descends beneath the angle of the jaw to assume its ordinary course. The arch thus formed above the submandibular gland may extend for some distance beneath the ramus of the jaw, lying between internal pterygoid and styloglossus muscle. The arteria anguli nasi is usually the terminal branch of the facial artery. It is frequently small and is variable in its distribution. Ascending palatine artery may:-

- directly arise from the external carotid (20%),
- arise from the facial artery in 70%,
- arise from the ascending pharyngeal in 8%,
- arise from the lingual in 1%,
- arise from the occipital in 1%.

NIRANJAN N.S. (1988) has dissected 25 adult preserved cadavers and he has come out with the following findings:

He presents that the facial artery was symmetrical in 17 out of 25 (68%) of the dissected specimens. In his study, the facial artery terminated as an angular artery in 34 sides (68%), as a lateral nasal vessel in 13 (26%) and as a superior labial vessel in 2 (4%) and in 1 (2%) as the alar base. A longer course of the facial artery was noted in 5 (10%) of the specimens.

SOI KONNEN K., WOLF J., HIETANEN J. MATTILA K. (1991) have studied the anatomy and the tortuosity of the facial, transverse facial and infra orbital arteries in 69 human cadavers, age ranging between 18 – 95 years. They have given 4 categories of facial vascularisation according to the gradually diminishing relative dominance of the facial artery.

The type of vascularisation was not dependant on age or sex. The tortuosity of all three arteries showed a statistically significant increase with age. A weak correlation was found between the relative dominance and the tortuosity of facial artery.

N. ANTHONY MOORE (1993) in Mosby's 'Success in Medicine' says that the facial artery arises from the external carotid just distal to the lingual artery but may arise in common as a linguofacial trunk. He describes the normal course of facial artery in relation to the submandibular gland, deep to the mandible, its ascent to the face and its termination at the medial angle of the eye as the angular artery which anastomoses with the dorsal nasal artery (from ophthalmic artery), forming an anastomosis between the external and the internal carotid arteries.

RENAN UFLACKER (1993) of South Carolina in 'Atlas of Vascular Anatomy – an angiographic approach' says that facial artery originates from the anterior aspect of external carotid artery as the third branch just above the lingual artery and the greater cornu of hyoid bone. It ascends to reach the lower

border of the mandible becoming superficial and subcutaneous. He says that at this point, the main facial artery can have two different courses, a more posterolateral (or) jugal course a more anteromedial (or) labial course.

The facial artery turns cranially to the side of the nose ending at the medial palpebral commissure, anastomosing with the dorsal nasal branch of the ophthalmic artery. He mentions about the abundant anastomoses of the facial artery of one side with its contralateral branches in the face and neck and also with the sublingual branch of the lingual artery and with the palatine branch of the maxillary artery and also in the face with the mental branch of the inferior alveolar artery, the infra orbital branch of maxillary and dorsal nasal branch of ophthalmic artery. He has said that the territory vascularised by the facial artery is in haemodynamic equilibrium with the adjacent arteries that may be part of the facial territory. As he mentions about the branches of the facial artery, he indicates that the ascending palatine artery which is the branch given off from the facial artery close to its origin may directly arise from the external carotid artery, from the ascending pharyngeal or from the accessory meningeal artery. After mentioning about the tonsillar and glandular branches, the submental artery is described as the largest cervical branch which sometimes replaces the entire facial trunk when it is hypoplastic. He says that among the inferior and superior labial, the septal and an alar branch are usually from the superior labial artery. The lateral nasal branch also called the angular artery ascends on the side of the nose and inferior masseteric artery arises from the facial artery after it has passed under the mandible.

LAMBERTY B G H CORMACK (1994) describes the course and branches of the facial artery in the neck and in the face.

He says that the facial artery approaches the medial angle of the eye as the angular artery, where it passes beneath the medial palpebral ligament and anastomoses with the branches of the ophthalmic artery. He also says that the facial artery can be mobilized with ease between the lower border of the

mandible and the angle of the mouth unlike the portion of the artery above the angle of the mouth which is fixed and passes superficial to or through the facial muscles. He also says that this artery gives a number of named and many small unnamed cutaneous branches.

He mentions about the premasseteric branch as the one arising from the facial artery at the lower border of the mandible and ascending along the anterior border of the masseter in the company of facial vein.

He says that the superior labial branch from the facial artery gives off the septal and alar branches. He calls the terminal part of facial artery as angular artery, beyond the levator anguli oris, where it runs towards the medial canthus of the eye, just beneath the skin, giving many significant unnamed cutaneous branches.

The variations of the facial artery mentioned by him are:–

(i) It may be weak in 10% of the cases, reaching only the angle of the mouth and giving only labial branches.

(ii) It may fail to reach the face at all in 1% of the cases, being represented only by the submental branch. He says that in these cases, the territory of absent facial is ‘taken over’ by the contralateral facial and ipsilateral transverse facial from the superficial temporal artery or sometimes aided by the infra orbital and buccinator arteries from the maxillary artery.

Cormack reveals that 78% of the facial arteries end as lateral nasal (alar) artery supplying the alar skin. He illustrates that in the remaining 22% cases, the facial artery may end as follows:-

- It may end as superior labial artery without giving the inferior labial and other branches distal to the superior labial artery.

- The facial artery may divide into lateral nasal (alar) and the angular artery at the level of the angle of the mouth itself without giving both labial branches.

- It may stop short with the lower jaw, ending as inferior labial artery.

He also says that the superior labial branch of the facial artery gives the septal and alar branches. The alar branch passes around the ala deep in the groove between the ala and the upper lip and then in the groove between the nose and the cheek where it divides into two branches, one of which passes superiorly and anastomoses with the external nasal and the other passes towards the tip of the nose.

He says that the alar branch may arise from the facial artery directly instead of from its superior labial branch. He mentions about a significant anastomoses between the superior and inferior labial arteries at the angle of the mouth.

PARK C., LINEA WEAVER WC, BUNCKE H.J. (1994) studied the vascular anatomy of the perioral region by dissecting fresh cadavers. They have confirmed the presence of a septal branch and an alar branch to the upper lip and a vertical labiomental branch to the lower lip. They have opined that new regional flaps with deep septal or alar branch can be raised to correct the defect of the lower lip or a composite flap with the labiomental branch can be used to correct combined defects of the upper lip and nose or partial defects of the lower lip.

LOVAS JG, RODU B., HAMMOND HL, ALLEN CM, & WYSOCKI G.P (1998) have seen Caliber Persistent Labial Artery in 187 cases clinically and an additional 23 cases through surgical oropathological services. This is usually mistaken for a squamous cell carcinoma. They reported that the Caliber Persistent Labial Artery presents as soft bluish elevation above the labial mucosal surface. The unique feature of this is the

lateral pulsation which only the artery can exhibit. Incidence of this condition was reported to be more in upper lip, with a ratio of 2:1. Males and females were almost equally affected with the ratio of 76:86, being in clinical cases and 9:13 in histopathologic cases.

This is usually mistaken for a tumour like haemangioma, varix, vascular malformation, phlebolith or artery itself. None of the cases in the above study manifested as an ulcer nor as carcinoma. They stress that the clinician should look for a lateral pulsation in the lip mucosal papules, to avoid unnecessary surgery and intra-operative bleeding and the pathologists should recognize this as a clinical lesion biopsied, rather than mistaking it for an incidental finding.

RAN W, NiS. & FAN X (1998) – The Plastic Surgeons of China dissected 8 adult cadavers and studied the relation between the superior labial artery and the skin of nasolabial groove. They have revealed the following results: Superior labial was one of the branches of facial artery and could be found in every cadaver. The diameter of the artery was 0.8 (+/–) 0.1 mm and the length was about 90 mm. The right and left facial arteries were connected in the midline in the formation of arcuate artery. The arcuate artery lay within the submucous tissue beyond the vermilion border about 6 mm. They also confirmed the presence of concomitant veins. When the facial artery sectioned was beyond the site of superior labial artery the skin of nasolabial groove on the same side could receive blood supply from contralateral superior labial artery.

This anatomical research concludes that the insular skin flap of the nasolabial groove with retrograde superior labial artery could be used in patients.

ONDEROGLU S. (1999) has examined the facial artery with the surrounding tissue in the modiolus from 15 formalin fixed human cadavers. Each specimen of 1 cm – 3 cubic mass from the region where facial artery bisected the line drawn horizontally from the angle of the mouth was excised

and studied under light microscope. He evaluated that the facial artery was surrounded by only adipose tissue except in one specimen. He says that there was not a fibrous canal nor cleft at the angle of the mouth in the modiolus.

A.S. MONI (1999) describes the facial artery as the chief artery of the face, arising from the external carotid in the carotid triangle and terminating near the medial angle of the eye as angular artery, after its tortuous facial course. He gives its branches in the neck as ascending palatine, tonsillar, glandular and submental artery and in the face the inferior labial, superior labial, lateral nasal and muscular branches to the muscles of facial expression. He says that the pulsation of the artery can be felt along the lower border of the mandible near the antero inferior angle of the masseter and during injury of face, bleeding from the facial artery can be stopped by compressing the artery against the lower border of the mandible.

JUNG DH, KIM HJ, KOL HS, OH CS, KIM KS, YOON J.H., & CHUNG IH. (2000) studied 51 cadavers and their corresponding nasal sections after injecting red latex. The blood vessels that supply the nasal tip were examined with naked eye in these cadavers, with reference to their size and distribution of the vessels. The subdermal layer in which the vessels lie and the course of the vessels were also investigated.

They have come out with the following results:- Blood supply to the nasal tip was proved to be lateral nasal artery in 78% (80/102 cases). It was by dorsal nasal arteries in 22% (42/102 cases). Columellar branches were narrow and varied in number and hence appeared insufficient as a main blood supply. These arteries passed through musculoaponeurotic layer, but they were also in close proximity to the main surgical plane in the dome of the lower lateral cartilage, which is important in external rhinoplasty.

SCHULTE DL, SHERRIS DA, KASPERBAUER JL. (2001) did detailed anatomical dissection of mid and lower face of injected, 9 cadaver heads ranging in age from 41 – 90 years. They have studied 16 superior labial

arteries and 15 inferior labial arteries. According to them, the superior labial artery was single in all the cases.

At the angle of the mouth or labial commissure this artery was superior to the vermilion border in 94% and within 10 mm of the free margin of the lip. In the midline, the superior labial artery was within the vermilion border in 75%. It was within orbicularis oris in 19% and between the mucosa and orbicularis oris in 81%. Inferior labial artery was single in all dissections. Its course was variable in position relative to the vermilion border or to its take off from facial artery. In the central position it was found within orbicularis oris in 13% and between the mucosa and orbicularis in 87%. It was found within 15 mm of free margin of the lip.

ZHAO YP, ARIJI Y., GOTOH M, KURITA K, NATSUME N., MA XC. & ARIJI E. (2002) have published the Doppler sonographic features of facial artery in the anterior face in 46 healthy volunteers and 3 patients with haemangioma. Detection of main trunk by doppler in the anterior face, and the superior and inferior labial arteries was 100%. Detection of branches in the buccinator was 92.4%. No significant difference was made between the indexed values of right and left artery. Significant correlation was found between the right and left main trunk with reference to the flow diameter and minimum velocity and the flow diameter and pulsatility index of the superior labial artery. Doppler sonographic study of the haemangiomas was characterized as a hypoechoeic area with internal and surrounding blood flows. This method of study appears to be useful in the follow-up examination of haemangioma in this area.

NAKAJIMA H, IMANISHI N, & AISO S. (2002) have studied 25 facial arteries radiographically in 19 fresh cadavers that had been injected with lead oxide gelatin mixture. Anatomical variations of the major branches of the facial artery in the upper lip and nose were investigated and they classified into 3 types on the basis of anatomy of the lateral nasal artery, which was

determined as an artery running towards the alar base. In 22 cases (88%), the facial artery bifurcated into superior labial artery and lateral nasal artery at the angle of the mouth. In 2 cases (8%), the facial artery became the angular artery after giving superior labial and lateral nasal sequentially. In 1 case (4%), the facial artery became an angular artery after branching off into superior labial artery. The lateral nasal branch arose from the superior labial artery. Branches from the superior nasal and lateral nasal arteries were observed. Vascular anastomosis between these two branches were created in the upper lip, columellar base and nasal tip and an intimate vascular network was formed. This study is useful in creating a bilobed upper lip flap for a clinical case with a full thickness defect of the ala.

EDIZER M., MAGDEN O., TAYFUR V., KIRAY A., ERGUR I., & ATABEY A. (2003) investigated the arterial anatomy of the lower lip in 14 adult male preserved cadaver heads. And in one cadaver head that was used for silicon rubber injection to fill the regional arterial tree. They have published that the inferior labial artery was the main artery of the lower lip and it branched off from facial artery in all cases. The mean length of inferior labial artery was 52.3 mm (range 16 – 98 mm). Mean distance of origin of inferior labial artery from the labial commissure was 23.9 mm. The mean external diameter of the inferior labial artery at its origin was 1.2 mm.

The sublabial artery was present in 10 cases (71%) of the cadavers. Mean diameter of this artery was 1 mm, length was 23.4 mm and it was at 27.6 mm from the labial commissure. They have also told that the sublabial artery may originate from the facial artery or inferior labial artery. They found that this region of the face does not have a constant arterial distribution, the inferior and sublabial artery (if it exists) can be in different locations unilaterally or bilaterally and their diameter and length may vary.

KOH KS, KIM KJ, OH OS, & CHUNG IH. (2003) investigated the topography and the course of facial artery in 47 Korean cadavers. They have

said that the final branch of the facial artery was the lateral nasal branch in 44% of cases and the angular branch in 36.3% cases. In 54.5% of the cases, the facial artery ended symmetrically. They found that there were only individual variations, but not racial difference. They also said that the superior and inferior labial arteries on the right side were more dominant than those on the left. The distance between the branching points of inferior alar branch and the lateral nasal branch was 15.9mm and it was 25.2mm between the superior labial and inferior alar branch. The branching point of the inferior labial was 30.9mm apart on average from the superior labial branch. The courses of the facial arteries showed no significant differences based on either laterality or gender.

MAGDEN 'O', EDIZER M, TAYFEN V, ATABEY A, &ERGUR I. (2004) the anatomists of Turkey have published their findings from dissection of 14 preserved cadavers and another cadaver head used to show the arterial tree by colored silicone injection technique.

They have found that the superior labial artery was the main artery of the upper lip and it always branched from the facial artery. Its length was 45.4 mm (the range being 29 to 85 mm). The mean distance of origin of the superior labial artery from the labial commissure was 12.1mm. It was 1.3 mm in external diameter at its origin. The mean distance of origin of superior labial artery from the lower border of the mandible was 46.4 mm. The alar branch of superior labial artery was single in 82%. The mean length of this branch was 14.8 mm and mean diameter being 0.5 mm at its origin. The distance between the origins of superior labial artery and the septal branch was 33.3 mm. Septal branch was single in 90 % of the cases. The mean length of the septal branch was 18.0 mm and it was 0.9 mm in diameter at its origin.

They have concluded that the arterial distribution of the upper lip was not constant as the superior labial artery can occur in different locations, unilaterally or bilaterally with branches showing variability.

MAGDEN O. along with **EDIZER M, TAYFUR V, & ATABEY A. (2004)** dissected the submental regions of 13 formalin-fixed cadavers bilaterally, in order to study the feasibility of submental artery island flap which is a versatile option in reconstruction of perioral, intraoral and other facial defects, leaving an acceptable donor site scar. They have come out with the following findings with the mean values of measurements. The facial artery was 2.7 mm in diameter at its origin.

It crossed the mandibular border 26.6 mm from the mandibular angle. The origin of submental artery was 27.5 mm from the origin of the facial artery 5 mm from the mandibular border and 23.8 mm from the angle of the mandible. The diameter of the submental artery was 1.7 mm at the origin.

The submental artery was found to course superficial to the submandibular gland. In one case, the artery passed through the gland. The total length of the submental artery was 58.9 mm. The artery anastomosed with the contralateral artery in 92% of the cadavers. The submental artery was deep to the anterior belly of digastric muscle in 81%.

This detailed anatomical data regarding the location, dimension and relationship of facial artery, the submental artery and the submental vein may be useful in the dissection of submental artery island flap.

PINAR YA, BILGE 'O', GOVSA F. (2005) studied the perioral branches of facial artery, as the use of flaps to reconstruct lip defects require detailed knowledge of local vasculature. New flaps for the surgery around the mouth can be devised by the surgeons with such detailed knowledge of the facial artery. They have confirmed the consistent presence of septal and alar branches in the upper lip and a labiomental branch in the lower lip. Vascular anatomy of perioral regions was studied in 25 cadavers, fixed in 10% formaldehyde solution and red latex injected into common carotid arteries before dissection. The following are their findings from their dissections:

Facial artery was symmetrical in 17 out of 25 heads (68%). It terminated as angular facial vessel in 11 halves (22%), as a nasal facial vessel in 30 halves (60%), as an alar vessel in 6 halves (12%) and as a superior labial vessel in 2 (4%) facial halves. It terminated as hypoplastic type of facial artery in one (2%) facial half. The average external diameter of the superior labial artery was 1.6 mm (with a range of 0.6 to 2.8 mm) at its origin. The origin of superior labial artery was superior to the angle of the mouth in 34 of 47 specimens (72.3%) and at the angle of the mouth in 13 of 47 specimens (27.7%). In 2 of the remaining 3 specimens, superior labial artery was the continuation of facial artery and the other was hypoplastic.

The columellar branches were supplied by the Superior labial artery in all the specimens except the hypoplastic type. The columellar branches were classified according to their number and type. Inferior labial artery was not found in 5 specimens (10%). In other specimens the site of origin of the inferior labial artery varied between lower margin of the mandible and the angle of the mouth. The external diameter of the above was 0.5 to 1.5 mm.

The inferior labial artery arose from the facial artery above the angle of the mouth in 4 specimens (8%), inferior to the angle of the mouth in 11specimens (22%) and at the angle of the mouth in 30 specimens (60%).

They observed that the labiomental arteries which formed anastomoses between the facial artery, inferior labial artery and submental artery showed variations in their course in the labiomental region.

VAZQUEZ L, LOMBARDI T, GUINAND M, KINSI H, SAMSON J. (2005) used ultra sonography including pulsed and color doppler analysis as a non-invasive method to illustrate the Caliber Persistent Labial Artery (CPLA) in the lip. Three patients with suspected CPLA were examined with the above method, and localized and determined the extension of the infralabial artery. The sonograms were compared to clinical and histopathologic findings. Sonograms showed clear enlargement of the labial

artery in the 3 cases examined. The course of this Constant Diameter Artery was either vertical or oblique from the depth of the lip to the surface of the mucosa. This abnormality was confirmed histopathologically. Hence, ultrasonography and doppler study are the non-invasive tools for the diagnosis and pre-operative s evaluation, as well as follow-up of labial lesions related to CPLA and to distinguish CPLA from other vascular lesions of the lip such as aneurysm.

LOUKAS M, HULLETT J, LOUIS RG Jr, KAPOS T, KNIGHT J, NAGY R, & MARYOZ Z (2006) of West Indies examined 284 hemifaces from 142 formalin fixed cadavers. They recognized and categorized their observations regarding distribution pattern of facial artery as follows:

Type 'A' (47.5%) in 135 hemifaces -- Facial artery bifurcates into superior labial artery and lateral nasal artery. The lateral nasal divided into superior and inferior alar and ends as angular;

Type 'B' (38.7%) in 110 hemifaces -- Same as type 'A' but lateral nasal ends as superior alar and angular was absent.

Type 'C' (8.4%) in 24 hemifaces -- Facial artery terminates as superior labial artery.

Type 'D' (3.8%) in 11 hemifaces -- Angular artery arises from the facial trunk rather than as termination of lateral nasal, and facial ending as superior alar artery.

Type 'E' (1.4%) in 4 cases -- Facial artery ended as rudimentary twig without giving any significant branches.

DEVELOPMENTAL ANATOMY OF FACIAL ARTERY IN HUMAN BEING

Development of facial arteries and great vessels involve three major phases. During the initial phase at 3½ weeks the visceral arches serve a little more than a conduits carrying blood from the heart to the rest of the embryos.

By 6 weeks, the first two arches have lost their connection with the heart. The first aortic arch vessel has been essentially replaced. The dorsal end of the second aortic arch artery (hyoid artery) adjacent to the internal carotid artery (dorsal aorta) persists as a stem of the stapedial artery, virtually supplying the entire facial region.

The external carotid artery first appears as a sprout which grows headward from the aortic sac close to the ventral end of the third arch artery. The proximal portion of the third aortic arch vessel that is adjacent to the internal carotid (6 weeks) grows forward and upward and by 9 weeks, has fused with the stapedial artery. Only a small portion of the stem of the stapedial artery persists at this stage (i.e.) at 9 weeks. The external carotid and its branches form the definitive vascular system for the most of the face.

In early embryo, the embryonic aortic arch arteries are however become surrounded by neural crest very early, although there is initially no expression of either smooth muscle or elastin antigen by these cells. Rosenquist and Beall (1990) have shown that the original smooth muscle cells disappear along the great vessels to their first branching point.

Ablasion of cardiac neural crest leads to changes in the embryonic aortic arch vessels. They may be absent, too large, too small or aberrant in their connection and there is loss of bilateral symmetry.

The source of blood supply to the territory of the trigeminal nerve varies at different stages of development. When the first and second aortic arch

arteries begin to regress at 4mm stage by the time the third arch appears, the supply to the corresponding arch is derived from a transient ventral pharyngeal artery which grows from aortic sac and terminates by dividing into mandibular and maxillary branches. A pair of mandibular arteries grows into the region occupied by the first pair of aortic arches. Later on, the stapedial artery develops and passes through the condensed mesenchymal sight of the future ring for stapes and replaces second pair of arches in the hyoid branchial arches. It anastomoses with the cranial end of the ventral pharyngeal artery and thereby annexing its terminal distribution. The fully developed stapedial artery possess three branches namely the maxillary, mandibular and the supraorbital, which follow the division of trigeminal nerve. The mandibular and maxillary diverge from a common stem. When the external carotid artery emerges from the base of the third arch, it incorporates the stem of the mental pharyngeal artery and its maxillary branch communicates with the common trunk of origin of maxillary and mandibular branches of the stapedial artery and annexes these vessels.

There is evidence suggesting that the fusion between the external carotid and the stapedial artery constitute a developmental weak point predisposed to haemorrhage which may be responsible for some aspects of cranio facial anomalies.

MATERIALS AND METHODS

STUDY MATERIAL

The study material consists of:

a) 21 adult cadaveric heads (42 hemifaces).

b) 4 full term foetuses (8 hemifaces).

c) 2 clinical cases.

METHODS OF STUDY

1. **Conventional Dissection Method**
    a) In adult cadavers
    b) In foetal cadavers
2. **Dye injection Method**
    a) Red latex predissectional injection of the facial artery.
    b) Red Oxide in fat medium injection of the facial artery prior to dissection.
3. **Histological study**
4. **Clinical Study**

1. Conventional Dissection Method

Adult Cadaveric study:-

Adult human Cadavers were selected from those allotted to the first M.B., B.S., and first B.D.S., students at the Institute of Anatomy, Madras Medical College, Chennai-3.

In 11 Cadavers (22 hemifaces) the dissection was carried out as follows:-

The skin, platysma, and the superficial fascia over the carotid triangle on each side of the neck and also the face on each side were carefully reflected laterally from a midline incision. The margins of the sternocleidomastoid and the superior belly of omohyoid were defined after reflecting the deep cervical fascia. The submandibular gland was mobilised, after defining the margins of the posterior belly of digastric and stylohyoid above. The carotid sheath thus exposed in the carotid triangle was opened and the external carotid artery and its branches were tried and identified. The third branch from the external carotid in the neck, the facial artery, was identified and it was traced distally deep to the mandible.

The level of origin and the mode of origin of facial artery was noted and recorded. The tiny ascending palatine and tonsillar branches were identified after clearing the dense plexus of veins in this area. The submandibular branches which were always more than 2 in number were identified.

The submental artery which arose from the facial artery, as the artery separated from the submandibular gland was identified. This branch was traced as it turned forwards on the myelohyoid muscle to the anterior belly of digastric and to the chin. The distance of origin of the submental artery from the origin of facial artery, its distance from the mandibular margin and its length were measured in each specimen and recorded.

The facial arterial trunk was traced on the face to its termination. The mode of termination was noted. The inferior, and superior labial branches were traced upto their anastomoses in the midline. The lengths of these branches, their distance from the angle of the mouth, the mandibular margin, and the distance between their origins were measured in each specimen and recorded.

The septal and alar (inferior alar) branches of the superior labial artery and the lateral nasal branch of the facial artery were traced to their termination. The length of the septal and inferior alar branches and the distance of their origin from superior labial and lateral nasal arteries were measured in each specimen and recorded.

Foetal Cadaveric Study:-

Full term foetuses 4 in number, obtained from the Institute of Obstetrics and Gynaecology, Egmore, were embalmed and preserved in formalin solution. About 200-300 ml of 10% formalin solution was used in each foetus, and it was injected into the anterior fontanalle, pleural, pericardial and peritoneal cavities followed by subcutaneous injections in some places like limbs, thoracic wall and the abdominal wall.

The red latex mixture was injected into the external carotid, prior to the dissection. Careful and meticulous dissection was carried out in the neck and the face, following the same method as done in the adult cadavers.

2. Dye Injection Method

Latex used for commercial purpose, mixed with red ink was injected, as a method for better identification of the branches.

Linear skin incision about 1inch length was made along the anterior border of the sternocleidomastoid muscle, at the level of the upper border of the thyroid cartilage. Carotid sheath was identified and opened, and the external carotid artery was traced at its origin. A small caliber rubber canula was introduced through a linear incision on the arterial wall and advanced to 3cms into the external carotid artery. The external carotid artery was ligated proximal to the portal. About 3 ccs of the latex-ink mixture was injected and the specimen was left for 24 hours for the dye to settle. The above method was carried out in 10 hemifaces.

In another 10 hemifaces the same procedure was carried out, but redoxide with molten bull's fat was used as injection medium. This medium was prepared by mixing the bull's fat, turpentine oil and vegetable oil in the proportion of 2:1:1. Redoxide powder was added for colouring. First the bull's fat was melted in a thick bottomed vessel to which red oxide powder was added and thoroughly mixed. The turpentine oil and vegetable oil were added to the above mixture to prevent the bull's fat from solidifying quickly. This mixture was loaded in a metal syringe when it was still hot and in liquid form and injected into the external carotid quickly with force. The specimen was allowed to settle down for at least 6 hours before carrying out the dissection on it. Dissection was carried out in the usual conventional method already described.

During the above dissections, variations in the facial artery and its branches were photographed and documented.

3. Histological Study

As described by Onderoglu.S (1999), chunks of tissue at the modiolus, measuring about 1 cubic centimetre were taken from fresh cadavers and processed for histological study. The tissue sections were stained with eosin and haematoxylin and studied under light microscope for the presence of artery, its structure, and the tissue surrounding the artery. Verhoeff's staining method also was used to differentiate various tissue structures.

4. Clinical Study

3 Cases from plastic surgery and vascular surgery departments, Government General Hospital, Chennai-3, have been selected for the study with the following provisional diagnosis:

S.No	Name	Age/Sex	Diagnosis
1)	Sudha	14/Female	Mandibular tumour – Left cheek
2)	Palayam	25/Male	A-V malformation – Lower jaw - Left cheek
3)	Vasantha	16/Female	A-V malformation (? Angioma) - Left cheek

In the above three cases angiogram was done as described below to identify the facial artery, which was suspected to be the tumour feeding vessel. Transfemoral approach was followed. By Seldinger's method, the femoral artery was catheterised under aseptic precautions. The catheter was advanced proximally and manipulated to the left external carotid artery. Urograffin (contrast) was injected. Periodic angiogram pictures were taken and studied.

OBSERVATION

Facial arteries in 42 hemifaces in human cadavers preserved in formalin were studied. Of these, conventional dissection method was carried out in 22 hemifaces. Predissectional red latex injection in 10 sides and red oxide with bull's fat mixture injection in 10 more sides were carried out to study the branches of the facial artery.

The main facial trunk was studied for its mode of origin from the external Carotid artery as separate trunk or common trunk with lingual artery – Level of origin with reference to the greater cornu of hyoid bone or the angle of mandible. Point of entry into the face in relation to the angle of the mandible. The branches of the facial artery were observed with specific reference to the submental, labial, septal and alar branches, as they are very important for the facial reconstructive surgeries and in raising new cutaneous flaps.

FACIAL ARTERY

Mode of origin:

- ***Separate origin*** from external carotid was observed in 29/42 hemifaces (69.05%).
- ***Common linguofacial trunk*** was observed in 13/42 hemifaces (30.95%).
- ***Common linguofacial trunk*** was found to be present bilaterally in 5/21 cadavers (23.8%) and unilaterally in 3/21 (14.28%).

High origin of facial artery:

The facial artery arose just above the angle of the mandible in 1 case (1/42), i.e., 2.38%. Here it was found that the submental artery was almost in line with the origin of facial artery.

In one more case (2.38%) the origin of facial artery was 0.5 cm above the greater cornu of the hyoid bone that it appeared as though the lingual artery was taking origin from the facial artery.

Hypoplastic/Rudimentary facial artery

In 1/42 (2.38%) hemifaces, the branches of the facial artery in the face was observed to be very thin and the submental artery was the largest last branch.

Distance of the facial artery crossing the mandibular margin from the angle of the mandible (PC - Pic.9)

This was measured with the help of an inch tape in centimeters and recorded as in Table I. The distance ranged from 2.5 cms to 3.3 cms average being 3 cms.

Branches:

Submental Artery:-

Site of origin:

- The submental artery always arose from the facial trunk as the facial artery separates from the submandibular gland to enter the face.
- In one case where the facial artery had a high origin just above the angle of the mandible, the submental branch arose almost in line with the origin of facial artery. In this case, the other branches in the face were of thin caliber.
- The submental artery was found to run deep to the submandibular gland in (97.62%)specimens except in one case(2.38%) where it was found to have a superficial course. It was always found to be accompanied by veins.

Distance of origin of facial artery from the external carotid, to the origin of the submental artery: (AB Pic.9)

This forms an important parameter in raising the submental flap. Taking this into account, it was measured with thread and then inch tape in all the 42 specimens and was recorded as in Table II. This distance varied from 3.0 cms to 3.9 cms. The average distance was 3.45 cms.

Distance of origin of the submental artery from the mandibular margin: (BC Pic.9)

- The distance between the origin of the submental artery and the mandibular margin closest to its origin was measured and all readings were tabulated in Table III.
- The distance varied from 4mm to 7mm and the average distance was 5 mm.

Distance of origin of submental artery from the angle of the mandible: (BP Pic.9)

- This was measured with an inch tape and all the values were recorded as in Table IV.
- It varied from 2cms to 3.5cms, the average being 2.99 cms.

Length of the submental artery: (CO Pic.9)

- The length of submental artery was measured from the point of origin from the facial trunk to its termination in the midline anteriorly.
- This was measured with the help of a thread which was in turn measured with an inch tape and all the measurements were recorded as in Table V.

- The length of the artery varied from 5.1 cms to 9.5 cms, averaging to 7.2 cms.

- Right sided arteries and Left sided arteries did not show any difference in their length, measuring 7.1 cms on an average on the right side and 7.3 cms on the left side.

Inferior labial artery:-

Number of inferior labial artery:

Two inferior labial arteries were found in 13/42 cases (30.95%). It was single in rest of the 29/42 cases (69.05%).

Infralabial (sublabial) artery

When two inferior labial arteries were present the proximal one was termed as 'Infralabial' or 'Sublabial' branch. It was found to arise separately from the facial trunk in all the specimens, except in one, where it arose in common with the inferior labial artery. It was very short and it travelled between the vermilion border and the mandibular margin.

5 out of the 13 infralabial (sublabial) arteries were found to anastomose with the mental branch of the inferior alveolar arteries. The rest of the infralabial branches ended by anastomosing with the opposite side branch or the mental branch of the submental artery and by supplying the subcutaneous muscle and adjacent tissue in this region.

Length of the infralabial (sublabial) arteries: (DN Pic.9)

- It was measured with a thread and then with an inch tape and recorded as in Table VI.

- The length varied from 2.6 cms to 3.3 cms, averaging to 2.95 cms.

The distance of origin of infralabial (sublabial) branch from the angle of the mouth: (DQ Pic.9)

This distance was measured with an inch tape and recorded as in Table VII. It was found to vary from 1.8cms to 3.0cms, average being 2.12cms.

Inferior Labial artery

In all the 42 hemifaces dissected the inferior labial artery originated from the facial trunk either at or below the level of the angle of the mouth.

Length of the inferior labial artery: (EM Pic.9)

This was measured from the point of its origin to its termination in the midline with the help of a thread which in turn was measured with an inch tape. The lengths of all the inferior labial arteries were recorded as in Table VIII. The length measured varied from 3.7 cms to 7.9cms, on the right side average being 5.92 cms. On the left side it measured from 4 cms to 9 cms averaging to 5.66 cms. On the whole the length varied from 3.5 cms to 9 cms, the average being 5.79 cms. It was found that the right sided arteries were relatively longer than the left sided arteries.

Distance of origin of inferior labial artery from the angle of the mouth and the level of origin of inferior labial artery: (EQ Pic.9)

This was measured with an inch tape and recorded as in Table IX. When the origin corresponded to the angle of the mouth it was marked as 'C' and when it arose below the angle of the mouth it was marked as 'B'. The level of origin corresponded to the angle of the mouth ('C') in 14/42 specimens, i.e., 33.3%. The distance varied from 1cms to 2cms, the average being 1.22 cms. The level of origin was found to be below the angle of mouth ('B') in 28/42 specimens, i.e., 66.7%. The distance varied from 1.5cms to 4.6cms, the average being 2.77 cms. The distance of origin on the whole varied from 1 cm

to 4.6 cms, from the angle of the mouth, the average being 2.3 cms irrespective of level of origin.

Superior labial artery:

The superior labial artery was observed to be single in all the specimens.

Distance of origin of superior labial branch from the angle of the mouth: (FQ Pic.9)

The distance of superior labial artery from the angle of the mouth varied as the level of origin differed. It arose from the facial:

- **B**elow the level of the angle of the mouth in 5/42 specimens, i.e., (11.9%).
- **C**orresponding to the level of angle of mouth in 7/42 specimens, i.e., (16.66%).
- **A**bove the level of angle of the mouth in 30/42 specimens, i.e., (71.43%).

This distance was measured with an inch tape and recorded as in Table X. It measured when the superior labial artery arose at a level –

Below the angle of the mouth (B) 1 cm to 2.1 cms (average 1.76cms).

Corresponding to the angle of the mouth (C) 1 cm to 2 cms (average 1.41cms).

Above the angle of the mouth (A) 1 cm to 2.5 cms (average 1.69cms).

Overall average distance from the angle of the mouth was 1.65 cms.

Distance between the origin of superior and inferior labial arteries: (EF Pic.9)

- This was measured with the help of a thread and then an inch tape and all the reading were recorded as in Table XI.

- The distance varied from 0.8 cm to 3.9 cm, and the average distance was 1.9 cms.

Distance of origin of superior labial artery from the mandibular margin: (FC Pic.9)

This distance also varied with the level of origin of the superior labial artery. This was measured vertically with an inch tape from the point of origin of superior labial artery from the facial artery to the mandibular margin. All readings were recorded as in table XII. It measured:

- When the superior labial arose above the level of angle of the mouth (A) 3.84 cms (Range – 3.2 to 4.3 cms).

- When the origin corresponded to the angle of the mouth (C) 3.38 cms (Range – 3.0 to 3.5 cms).

- When the superior labial arose below the level of the angle of the mouth (B) 1.78 cms (Range – 1.5 to 2.2 cms).

Overall average distance observed was 3.52cms, the range being 1.5cms to 4.3 cms

Length of the superior labial artery: (FL Pic.9)

- This was measured with the help of a thread and then with an inch tape. All the measured lengths were recorded as in Table XIII.

- It varied from 3cms to 9cms on the right side, the average being 7.3 cms. On the left side it measured between 3 cms and 8.9 cms, the average being 6.99 cms. On the whole, the length varied from 3 cms the 9 cms, the average being 7.14 cms.

- It was found that the right sided superior labial arteries were relatively lengthier than the left sided arteries.

Septal branch:

Origin of Septal branch:

Septal branches originated from superior labial artery in 40/42 (95.24%) and it was from inferior alar in 2/42 (4.76%). It arose as a single branch in all 42 hemifaces.

Length of Septal branch: (IK Pic.9)

The length of the septal branch from its origin to its termination measured with a thread and then an inch tape was recorded as in Table XIV. It measured between 0.5 cm and 1.5 cms averaging to 1.1 cms.

Distance between the origin of superior labial artery and the septal branch: (FI Pic.9)

This was measured with a thread and then by an inch tape as in Table XV. It was observed to vary from 3.1 cms to 4.2 cms, the average being 3.53 cms.

Inferior Alar branch:

It was always found to be a single branch and it ran deep in the groove between the ala and the upper lip and then in the groove between the nose and the cheek

Origin of inferior alar artery:

It was observed that the inferior alar originated from:

Superiorlabial artery in 35/42 specimens (83.3%).

Lateral nasal artery in 5/42 specimens (11.9%).

Facial artery in 2/42 specimens (4.76%).

Length of the inferior alar branch: (HJ Pic.9)

This was measured with thread and then inch tape from its origin till its termination in the groove between the upper lip and the ala. All the measurements were recorded as in Table XVI. It varied from 1.2 cms to 2.8 cms, the average being 1.53 cms.

Distance between the origin of superior labial and inferior alar branch: (FH Pic.9)

This length was measured with an inch tape in 35/42 specimens and the measurements were recorded as in Table XVII. This measured between 2.0 cms and 3.8 cms, the average distance being 2.36 cms.

Distance between the origin of inferior alar and the lateral nasal branch: (GR Pic.9)

The distance between the inferior alar branch from the origin of lateral nasal branch in 5/42 cases were measured and recorded as in Table XVIII. This distance varied from 1.6 cms to 2.2 cms and the average was 1.96 cms.

Other branches of Facial artery:

Branches in the neck:

Tonsillar Branches were observed to be tiny and single. It was found to arise in common ascending palatine artery in 7/42 specimens (16.6%).

Ascending palatine branch: Except in one specimen, in all the other 41 specimens (97.6%) the ascending palatine artery arose from the facial artery. In one specimen (2.4%), the ascending palatine artery originated from the lingual artery and it was found to give the palatine, tonsillar and pharyngeal branches.

Branches in the face:

Premasseteric Branch: This tiny branch was found to arise from the facial artery soon after (or) at its entry into the face. It was observed to be present in 12/42 specimens (28.5%).

Parotid Branch: Tiny short branch arising from the facial above the level of mandibular margin, was found to supply the parotid gland in 6/42 specimens (14.2%).

Buccal Branch: Short branch dipping into the buccal area was found in 4/42 specimens (9.5%).

Types of Branching pattern:

The following patterns of branching were observed:

A. Facial artery gave superior labial and the lateral nasal branch and continued as angular artery in 18/42 specimens (42.85%).

B. Facial artery continued as angular artery after giving a common branch which divide into superior labial and lateral nasal branches in 5/42 specimens (11.9%).

C. Facial artery gave origin to superior labial and lateral nasal branches in succession, but the angular artery was absent. These specimens showed anastomoses with the infraorbital arteries at the infraorbital foramen through an arteriole from the facial trunk in 10/42 specimens (23.8%).

D. Facial artery continued as angular artery after giving the superior labial artery. The lateral nasal artery arose from the superior labial artery in 4/42 specimens (9.5%).

E. Facial artery ended as angular artery after giving the superior labial artery in 2/42 specimens (4.8%).The angular artery had a deviated

course towards the infraorbital foramen where it was joined by a fine twig from the infraorbital foramen. Then it passed through the lower fibres of the orbicularis oculi to reach the medial angle of the eye.

F. Facial artery ended as superior labial artery in 1/42 specimens (2.4%). In this, the lateral nasal and the angular branches were absent. Prominent infraorbital arteries were observed which anastomosed with a twig from the facial artery at the origin of superior labial artery.

G. Facial artery ended as inferior alar branch after giving the superior labial artery in 2/42 specimens (4.8%).

Termination of facial artery

It was observed in the present study that the facial artery terminated as

- *Angular artery* in 29/42 specimens (69%).
- *Lateral nasal artery* in 10/42 specimens (23.8%).
- *Superior labial artery* in 1/42 specimens (2.4%).
- *Inferior alar branch* in 2/42 specimens (4.8%).

Symmetrical branching pattern

The branches in the face and neck on both the sides were identical and same in number and termination was similar in 10/42 specimens (23.8%). In the rest of 32/42 specimens (76.2%), the branching pattern and termination of facial artery was found to vary from side to side.

Foetal Cadaveric Study:-

- 4 full term foetuses preserved in formalin were studied. Red latex was injected into the common carotid by means of a thin Venflon set introduced upto the level of the external carotid. The common carotid was ligated proximal to the site of injection. Dissection carried out

carefully and the facial artery was traced from its origin in the neck to the face and its further course in the face observed.

- It was observed in this study that in all the specimens the facial artery originated by a separate trunk from the external carotid artery above the lingual artery.

- Long course of facial artery which was traced beyond the medial angle of the eye to the forehead was observed in 1/8 specimen (12.5%).

- The facial artery ended as superior labial artery in 1/8 specimen (12.5%).

- The submental arteries were traced in all 8 specimens

- In 2/8 specimens, the inferior labial arteries were short and thin where the mental branches from the mental foramen were prominent.

Histological Study:-

Chunks of tissue measuring 1 cubic centimetre were taken from the modiolus. They were processed, sectioned and stained with haematoxylin and eosin. It was studied under a light microscope. It was observed that the facial artery was surrounded almost on all the sides by adipose tissue or fibro fatty tissue. The structure of the facial artery and the surrounding tissues were confirmed by Verhoeff's staining method.

Clinical Study:-

3 cases from the Department of Plastic Surgery (Mandibular tumour of left cheek and 2 cases of AV malformation of the lower jaw on the left side) were selected and angiogram was done for the facial artery. The facial artery was traced only upto the lower margin of the mandible beyond which only multiple small vessels were visualised in the tumour region.

DISCUSSION

The present study of facial artery in human cadavers was undertaken to study the variations in the branching pattern of facial artery in general and particularly the submental and the labial branches with reference to various related parameters. These details are very useful in reparative and reconstructive surgery of the nose and lip and in raising the skin flaps in the submental region of the neck.

Adult Cadaveric Study:

Separate origin of facial artery from the external carotid.

Henry Gray (1858), G.J.Romanes (1902), George A Piersol (1907), J.Parson Schaffer (1952), Earnest Gardner et al (1960), Russell T Woodburne.A.M (1961), Henry Hollinshead (1962), Richard A. Snell (1963), W.J Hamilton (1976), Keith L Moore (1980), Lamberty B.G.H Cormack (1994) have quoted that the facial artery arose from the external carotid as a separate branch but they have not mentioned any statistical data about the incidence. In the present study, separate origin of facial artery was observed in 29/42 hemifaces (69.05%).

Common Linguofacial trunk

Henry Gray (1858), G.J. Romanes (1902), George A Piersol (1907), Dr.Grant (1943), J.Parson Schaffer (1952), Wood Jones (1953), R.J Last & Sinnatamby (1954)), Earnest Gardner et al (1960), Sir.Solly Zuckerman (1961), R.J.Bergman (1988) and N.Antony Moore (1997) have said that frequently the facial artery arose from the external carotid as a single stem with the lingual artery which was mentioned as ‘common linguofacial trunk’. But they have not mentioned about the incidence of such common trunk.

Dr.Grant (1943) observed the common linguofacial trunk in 20% of his study in 211 specimens.

In the present study, the common linguofacial trunk was observed in 13 hemifaces (30.95%). This observation is higher than that observed by Dr.Grant. It was observed to be occurring bilaterally in 5 cadaveric heads (23.8%); unilaterally in 3 cadaveric heads (14.5 %). This observation has not been by any of the above scientists.

High origin of facial artery

George A Piersol (1907) said that the facial artery may arise from the external carotid artery above the level of the angle of jaw.

Ronald A Bergman said about the occasional occurrence of origin of facial artery above its usual position when it descends beneath the angle of the jaw.

In the present study, 1/42 hemiface (2.19%), the facial artery arose just above the angle of mandible. This observation is in par with the above anatomists.

Dr.Grant (1943) observed the incidence of common linguofacial trunk inferiorly or high from the external carotid.

In the present study, in1/42 hemiface (2.19%), the facial artery arose as a single stem with the lingual artery 0.5cm above the greater cornu of the hyoid bone that it appeared as though the lingual artery was originating from the facial. This observation almost coincides with that of Dr.Grant. (Fig. 2D)

Hypoplastic / Rudimentary facial artery

Henry Gray (1858), George A Piersol (1907), Henry Hollinshead (1961), Lumberty BGH Cormack (1994) have mentioned about hypoplastic facial artery which extended only upto the angle of the mouth.

Renan Uflacker tells about hypoplastic facial artery entirely replaced by its largest submental branch.

Pinar Y.A et al (2005) reported hypoplastic facial artery in 1/50 (2%) of his cases.

In the present study, such type was not found to occur in any specimen.

Ronald A Bergman reported frequently occurring rudimentary facial artery in 43% of the cases studied where the facial did not terminate as angular artery but may end as submental or labial or as alar nasi artery.

Loukas M et al (2006) have reported rudimentary facial artery in 4/284 (1.4%) of the cases studied where the facial artery ended by without giving any significant branch in the face.

In the present study, in 1/42 (2.19%) hemiface the branches in the face were observed of very thin caliber, the submental branch being the last largest branch from the facial artery. This observation coincides with Ronald A Bergman but for the low incidence. It differs from that of Loukas M et al. (Fig.3D)

Distance of facial artery crossing the mandibular margin from the angle of the mandible

Magden O et al (2004) have said that the facial artery cross the mandibular margin at 26.6 mm distance from the mandibular angle.

In the present study, the facial artery crossed the mandible at an average distance of 3 cms from the angle of mandible.

This observation almost coincides with Magden O et al. (Fig.4D)

BRANCHES OF FACIAL ARTERY

Submental artery

Distance of origin of submental artery from the origin of facial artery

Magden O et al (2004) reported the distance mentioned above to be 27.5mm (2.75cms).

The present study reveals the distance of origin of submental artery from the facial artery as 3.45 cms (34.5 mm).

This observation is relatively higher than that observed by Magden O et al (Fig.5D)

Distance of origin submental artery from the mandibular margin

Magden O et al reported that the origin of submental artery from the mandibular margin was at 5 mm.

In the present study, the distance of origin of submental artery from the mandibular margin was 5mm on an average which coincides with the observation made by Magden O et al. (Fig.6D)

Distance of origin of submental artery from the angle of mandible

Magden O et al observed the above mentioned distance as 23.8mm (2.38cms).

In the present study the distance between the origin of submental artery from the angle of mandible was observed as 2.99 cms (29.9 mm) which is slightly higher than Magden O et al. (Fig.7D)

Length of the submental artery

Magden O et al quoted the length of submental artery as 58.9mm (5.89cms).

In the present study, the length of the submental artery was observed to be 7.2 cms (72 mm).

This observed value is higher than that reported by Magden O et al. (Fig.8D)

Relation of submental artery to the submandibular gland

Solly Zuckerman (1961) reports that the submental artery runs underneath the submandibular gland.

In the present study, 41/42 hemifaces showed that the submental artery ran deep to the submandibular gland which coincides with the observation of the above anatomist.

Magden O et al (2004) observed that the submental artery was found to run superficial to the submandibular gland in 25/26 cases and in 1/25 case, it was found to pass through the gland.

In the present study, the submental artery ran superficial to the gland in 1/42 specimens (2.17%). This finding is contrary to the observation made by Magden O et al.

Two inferior labial arteries:

Infra labial (sublabial) artery.

GJ Romanes (1902) mentions about frequently occurring inferior labial arteries.

George A Piersol (1907) tells about 2 inferior labial arteries in which one runs along the ramus of the mandible anastamosing with the mental and submental arteries and other runs between the mucosa and the orbicularis oris of lower lip anastamosing with fellow of the opposite side.

J Parsons Schaffer (1952) mentions about the additional inferior labial artery which he names as sublabial artery that runs to the region just below the lower lip.

Wood Jones (1953) said about the two inferior labial arteries namely the mental and coronary arteries.

Earnest Gardner et al (1960) said that the inferior labial artery was two on each side.

Henry Hollinshead (1961) also said about the two inferior labial arteries, the lower arising from the facial below the alveolar border of the mandible and coursing farther from the free margin of the lip and less close to the mucosa.

Russell T Woodburne (1961) also has told about the 'second inferior labial' or 'infralabial' artery running in the sulcus between the lower lip and the chin.

Edizer et al (2003) observed that the sublabial artery occurred in 71% (10/14) of the cadavers he dissected.

In the present study, the two inferior labial arteries were found in 30.95% (13/42).

This value is less than that of Edizer et al. (Fig.12D)

It was found to anastomose with the mental branch of inferior alveolar artery in 5 specimens (11.9%).

Length of infralabial (sublabial) artery

Edizer et al (2003) observed that the length of sublabial artery as 2.34 cms (23.4mm).

In the present study, the length of sublabial artery was measured to be 2.95 cms on an average which is slightly above that of Edizer et al. (Fig. 13D)

Distance of origin of infra (sublabial) artery from the angle of the mouth

Edizer et al (2003) measured the distance between the infralabial artery and the angle of the mouth as 2.76 cms (27.6mm).

In the present study, the distance between the infralabial artery and the angle of the mouth was observed as 2.12 cms (21.2mm) which is slightly less than that observed by the above scientist. (Fig.14D)

Inferior labial artery

Single inferior labial artery

Henry Gray (1858), G.J Romans (1902), George A Piersol (1907), J Parson Schaffer (1952), Russell T Woodbourne (1961), Richard S Snell (9163), W.J Hamilton (1976), Keith L Moore (1980), Lamberty BGH Cormack (1994), A.S Moni (1999), Schulte et al (2001) have mentioned about single inferior labial artery (coronary artery). But they have not given any statistical data regarding this incidence.

In the present study, single inferior labial artery was found in 29/42 hemifaces (69.05%).

Edizer et al (2003) and the scientists mentioned above said that inferior labial artery (the main artery of the lower lip) branched off from the facial artery in all cases.

In the present study, it was observed that the inferior labial artery always arose from the facial artery.

This observation coincides with the observation made by the above mentioned anatomist.

Length of inferior labial (coronary) artery

Edizer et al (2003) observed the length of the inferior labial artery as 52.3mm (range 16 to 98mm).

In the present study, the length of the inferior labial artery varied from 3.5 cms to 9cms, the average being 5.79cms. This observation coincides with the observation of Edizer et al. (Fig.9D)

It was observed that the right sided inferior labial arteries measured on an average 5.92cms (3.5cms to 7.9cms). The left sided inferior labial arteries

measured on an average 5.65cms (4cms to 9cms). The right sided inferior labial arteries were relatively longer than the left sided inferior labial arteries.

Distance of origin of inferior labial artery from the angle of the mouth and the level of origin of inferior labial artery.

Pinar YA et al (2005) observed in their study that the inferior labial artery arose from the facial artery at a level:

Above the angle of the mouth in 8% (4/50).

Inferior to the angle of the mouth in 22% (11/50) 'and'

At the angle of the mouth in 60% (30/50).

In the present study, the inferior labial artery arose at a level:

Below the angle of the mouth in 66.7% (28/42) which is a higher incidence compared to that of Pinar YA et al and it arose corresponding to the angle of the mouth in 33.3% (14/42) specimens which differs from the observation made by the above scientist. (Fig.10D)

Edizer et al (2003) observed the distance of origin of inferior labial artery from the angle of the mouth as 2.39cms (23.9mm).]

In the present study, it was observed that the average distance between the inferior labial artery and the angle of the mouth was observed to be 2.3 cms (1 cm to 4.6 cms) irrespective of the level of origin. This finding coincides with the observation made by Edizer et al. (Fig.11D)

Superior labial artery

Number and level of origin of superior labial artery

Henry Gray (1858), GJ Romanes (1902), George A Piersol (1907), J Parson Schaffer (1952), RJ Last (1954), Earnest Gardner (1960), Henry Hollinshead (1961), Russell T Woodburne (1961), Richard S Snell (1963), WJ Hamilton (1976), Antony Moore (1993), Lamberty BGH Cormack

(1994) and AS Moni (1999) mentioned about the single superior labial artery. **Schulte et al (2001)** observed that the superior labial artery was single in all the cases.

Magden O et al (2004) observed that the superior labial artery was single in 90% of his cases.

In the present study, it was found that the superior labial artery was single in all the 42 adult specimens.

This observation coincides with the observation made by all the above anatomists, but differs from that of Magden O et al.

Schulte et al observed that the origin of superior labial artery was superior to the vermilion border at an oral commissure in 94% of his specimens.

Pinar YA et al (2005) said that the superior labial artery originated:

Superior to the angle of the mouth in 34/37 (72.3%).

At the angle of the mouth in 13/47 (27.7%).

In the present study, the superior labial artery arose:

At the level angle of the mouth in 7/42 (16.66%) which is less than that observed by Pinar YA et al

Superior to the angle of the mouth in 30/42 (71.43%) which coincides with the observation of Pinar YA et al, but differs from Schulte et al. (Fig.15D)

Below the angle of the mouth in 5/42 (11.9%) which was not quoted by any of the above scientists.

Distance of origin of superior labial artery from the angle of the mouth

Magden O et al (2004) observed the distance between the origins of superior labial artery as 1.21 cm (12.1mm).

In the present study, it was observed 1.65 cms overall which is slightly higher than the value reported by the previous scientific worker. (Fig.17D)

Distance between the origin of superior and inferior labial arteries

Koh KS et al (2003) observed the distance between the origin of superior and inferior labial arteries as 3.09cms.

In the present study, this distance measured 1.9 cm on an average which differs from that observed by the above anatomist.(Fig.19D)

Distance of origin of superior labial artery from the mandibular margin

Magden O et al (2004) observed the distance between the origin of superior labial artery and the mandibular margin as 4.64cms (46.4mm).

In the present study, the overall distance between the origin of the superior labial artery and the mandibular margin was found to be 3.52 cms. This is lesser than the value observed by Magden O et al (Fig.18D)

Length of the superior labial artery

Ran W et al (1998) said that the superior labial artery measured 90mm (9cms) in length.

Magden O et al (2004) have given the length of superior labial artery as 4.54cms (45.4m).

In the present study, the average length of the superior labial artery was 7.14 cms.

This observation is lesser than that observed by Ran W et al (1998) and higher than that revealed by Magden O et al (2004). (Fig.20D)

Ronald A Bergman (1998) mentions about sometimes poorly developed or absent superior and inferior labial arteries usually replaced by contralateral vessel.

In the present study no such case was observed.

Septal branch

Henry Gray (1858), GJ Romanes (1902), George Piersol (1907), J. Parson Schaffer (1952), Earnest Gardner (1960), Henry Hollinshead (1961), Lamberty BGH Cormack (1994) have mentioned about the septal branch arising from the superior labial artery. But they have not furnished any statistical data regarding this branch.

Park C et al (1994) confirmed the existence of septal branch from the superior labial artery and its use in flap construction.]

Pinar YA et al (2004) confirms the presence of columellar branch from the superior labial artery in 49/50 specimens (98%).

In the present study, the origin of septal branch was from superior labial artery in 40/42 specimens (95.24%) which almost coincides with the observation made by Pinar YA et al.

In the present study, it was observed that in 2 specimens (4.76%) it originated from the inferior alar branch which itself is a branch of lateral nasal branch.

Magden O et al observed that the septal branch in 90% of his cases.

In the present study, it was observed to be a single branch in all the 42 specimens.

This observation differs from that made by Magden O et al.

Length of the septal branch

Magden O et al observed the length of the septal branch as 1.8cm (18mm).

In the present study, the length of the septal branch measured on an average 1.1 cm which is less than that observed by the above anatomist. (Fig.21D)

Distance between the origin of superior labial artery and the septal branch.

Magden O et al (2004) observed the distance between the origin of septal branch and the superior labial artery as 3.33cms (33.3m).

In the present study, the average distance between the origin of superior labial artery and the septal branch was measured to be 3.53 cms.

This observation almost coincides with the observation made by Magden O et al. (Fig.22D)

Inferior alar branch

Magden O et al (2004) observed the alar branch of the superior labial artery which ran in the groove between the ala of the nose and the upper lip was a single branch.

In the present study, the alar branch was always found to be a single branch in all 42 hemifaces.

Lamberty BGH Cormack (1994) mentions about the alar branch arising directly from the facial artery instead of its superior labial artery. But there is no statistical data available.

In the present study, the inferior alar branch originated from the superior labial artery in 34/42 specimens (80.95%) whereas the inferior alar arose from the lateral nasal artery in 5/42 hemifaces (11.91%) and from the facial artery in 3/42 hemifaces (7.14%).

This observation coincides with the observation made by **Lamberty BGH Cormack.**

Length of the inferior alar branch

Magden O et al (2004) observed that the average length of the inferior alar artery as 1.48cm (14.8mm).

In the present study, the length of the inferior alar artery was found to be 1.53 cm on an average which almost coincides with the observation of the above anatomist. (Fig.23D)

Distance between the origin of superior labial and inferior alar arteries

Koh KS et al (2003) observed the distance between the superior labial and inferior alar artery as 2.52cms (25.2mm).

In the present study it was found to measure on an average 2.36 cms which is almost in par with the observation made by the above anatomist. (Fig.24D)

Distance between the origin of inferior alar artery and the lateral nasal artery

Koh KS et al (2003) observed that the distance between the origin of inferior alar and the origin of lateral nasal branch as 1.53cm (15.3mm) in the cases of inferior alar from the lateral nasal artery.

In the present study, in 5 cases, where the inferior alar branch was from the lateral nasal artery, the distance between their origins was observed as 1.96 cm (19.6m). This observed value is slightly higher than that observed by Koh KS et al. (Fig.25D)

Other branches of facial artery:

Tonsillar branch:

Henry Gray (1858), George A Piersol (1907), J.Parson Schaffer (1952) have mentioned about the tonsillar branch arising from the ascending palatine

artery which is a branch of facial artery. But they have not given any statistical data.

In the present study it was found that the tonsillar branch arose from with ascending palatine in 7/42 specimens (16.67%). In the rest of the specimens it was a separate branch.

Premasseteric Branch:

Henry Gray (1858) in the Text Book of Gray's Anatomy describes the inconstant premasseteric branch in the face. **Gronroos (1902), George A Piersol (1907), Toldt (1921), Lamberty BGH Cormack (1994), Renan Uflacker (1993)** have mentioned about the premasseteric branch. But they have not given any statistical data.

In the present study, the premasseteric branch was found in 12/42 specimens (28.5%).

Beuntaro Adaichi (1928) has observed the premasseteric branch to be as strong as or even stronger than facial artery in 3% of his cases. He observed it to exist as a small vessel in unspecified number of cases.

In the present study, the stronger premasseteric branch was not observed in any case which differs from Beuntaro Adaichi.

Ascending palatine artery:

George A Piersol (1907), J Parson Schaffer (1952), Renan Uflacker (1993) have mentioned about the ascending palatine artery arising directly from the external carotid artery. But they have not given any statistical data.

Ronald A Bergman (1998) quoted that the ascending palatine artery may arise:

From the facial artery in 70%.

From the external carotid in 20%.

From the ascending pharyngeal in 8%.

From the lingual artery in 1%.

From the occipital artery in 1%.

In the present study, it was observed that in 41/42 specimens (97.6%) the ascending palatine artery arose from the facial artery and in 1 specimen (2.4%) it was found to arise from the lingual artery. This observation almost coincides with observation of Ronald A Bergman but for the slightly higher incidence.

Parotid branch:

Lamberty BGH Cormack (1994) illustrated direct branches to parotid gland, buccal region and the platysma in his text book.

In the present study, tiny parotid branch was observed in 6/42 specimens (14.2%).

Buccal Branch

Zhao Y.P. et al (2002) found buccinator branches by doppler sonography in 92.4%.

In the present study tiny buccal branches were observed in 4/42 specimens (9.5%) which is far less than that observed by the above scientist.

Branching pattern of facial artery

Nakajima et al (2002) classified the anatomical variation of facial artery into three types. On the basis of anatomy of lateral nasal artery which was determined as the artery running towards the alar base. According to him

Facial artery bifurcated as lateral nasal and superior labial at the angle of the mouth in 22/25 specimens (88%).

Facial artery became angular artery after branching off into superior labial and lateral nasal arteries sequentially in 2 cases (8%).

Facial artery became the angular artery after branching off into the superior labial artery, and the lateral nasal artery then branched off from the superior labial artery in 1 case (4%).

Loukas M et al (2006) categorized facial artery into five types (A to E) in the specimens he observed.

Type A (135/284) i.e. 47.5%. Facial artery bifurcates into superior labial and lateral nasal, the latter giving the superior and inferior alar and ending as angular artery.

Type B (110/284) i.e. 38.7%. Similar to type A, but lateral nasal ends as superior alar, angular being absent.

Type C (24/284) i.e. 8.4%. Facial artery terminates as superior labial artery.

Type D (11/284) i.e. 3.8%. Angular artery arises directly from facial trunk rather than as termination of lateral nasal artery with the facial artery ending as superior alar artery.

Type E (4/284) i.e. 1.4%. Facial artery ended as rudimentary twig without giving any significant branches.

In the present study,

In 18/42 specimens (42.85%) the facial artery gave the superior labial and lateral nasal branch and continued as angular artery **(Type A)**. This corresponds to the observation of **Nakajima et al** in 8% cases but the incidence in the present study is more. This observation coincides with Type A of **Loukas M et al**.

In the present study in 5/42 specimens (11.9%) the facial artery continued as angular artery after giving a common branch which divided in to superior labial and lateral nasal branches **(Type B)**. This does not correspond to any of the types described by the above researchers.

Facial artery gave origin to superior labial and lateral nasal branches in succession but the angular artery was absent in 10/42 specimens (23.8%) **(Type C) in the present study**. This corresponds to **Nakajima's** observation in 88% and **Type B** of **Loukas M et al** observed in 38.7%. The incidence varies from that observed by both these scientists.

In 4/42 cases (9.5%) the facial artery continued as angular artery after giving the superior labial artery. The lateral nasal arose from the superior labial artery **(Type D) in the present study.** This corresponds to **Nakajima's** observation in 4% cases and does not correspond to any type reported by **Loukas M et al**.

In the present study the facial artery ended as angular artery after giving superior labial artery **(Type E)** was observed in 4.8% which not been reported by any of the above scientists.

In the present study the facial artery ending as superior labial artery, the lateral nasal and the angular being absent was observed in 2.4% **(Type F)** which corresponds to **Type C of Loukas M et al** in 8.4% of his cases. But incidence in the present study is low.

The facial artery ended as inferior alar branch **(Type G) in the present study** was observed in 4.8% specimens which has not been reported by any of the above scientific workers.

Termination of facial artery

Midy O et al (1996) have given 4 types of facial vascularisation has regards its mode of termination as labial, angular, nasal and abortive. But he has not given any statistical data about this.

Termination of facial artery as angular artery (Fig.26D)

Niranjan NS (1988) observed that the facial artery terminated as angular artery in 34(68%).

Lamberty BGH, Cormack (1994) quoted this in part of 22% of his cases.

Nakajima et al (2002) gives termination of facial artery as angular artery in 3% of his cases.

Koh KS et al (2003) quotes angular branch in 36.3% of their cases.

Pinar YA et al (2005) observe the termination as angular facial vessel in 22%.(11 cases)

Loukas M et al (2006) observe this mode of termination in 51.3% of his cases.

In the present study the facial artery terminated as angular artery in 29/42 specimens (69%) which coincides with the observation of Niranjan et al and is almost in par with Loukas M et al. It is a higher incidence when compared to Koh KS et al and Pinar YA et al.

Termination of facial artery as lateral nasal artery (Fig.27D) This was observed by: **Mitz et al (1973)** in 80%, **Niranjan NS (1988)** in 26% (13 cases), **Lamberty BGH, Cormack (1994)** in 78%, **Nakajima et al (2002)** in 88% (22/25 cases), **Koh KS et al (2003)** in 44%, **Pinar YA et al (2005)** in 60% (30/50 cases), **Loukas M et al (2006)** in 38% (110/284 cases). **In the Present study (2006)** this was found in 23.8% (10/42 cases) which almost coincides with the observation made by Niranjan et al but differs from the others.

Termination of facial artery as superior labial artery (Fig.28D) This was observed by **Niranjan NS (1988)** in 4% (2/50 cases), **Lamberty BGH, Cormack (1994)** part of 22%, **Pinar YA et al (2005)** in 4% (2/50 cases), **Loukas M et al (2006)** in 8.4% (24/284 cases) . **In the Present study (2006)** the superior labial artery was found to be the terminal artery in 2.4% (1/42 cases) which is lesser than that observed by the above scientists.

Termination of facial artery as inferior alar artery (Fig.29D)

Niranjan NS (1988) 2% (1/50 cases),**Pinar YA et al (2005)** 12% (6/50 cases), **In the present study (2006)** in 4.8% (2/42 cases), the facial artery terminated as inferior alar artery which is higher than that made by Niranjan et al and lesser than the observation of Pinar YA et al

Termination of facial artery as submental artery

Henry Gray (1858) mentions about it but no statistical data is available.

In the present study no such observation was made.

Symmetrical branching pattern of facial artery (Fig.30D)

Niranjan NS (1988) 68% (17/25 cases), **Koh KS (2003)** 54.5%, **Pinar YA (2005)** 68% (17/25 cases), **In the present study (2006)** symmetrical branching pattern was observed 23.8% (10/42 cases) which is lesser than the observation made by the above plastic surgeon.

Foetal cadaveric study

Common linguo-facial trunk

Kozielac and Jozwa (1977) have reported the occurrence of common linguo facial trunk in 43% of their study with 110 human foetuses.

In the present study in all the specimens the facial artery arose as a separate trunk from the external carotid. This observation differs from that of Kozielac and Jozwa.

Long course of facial artery

Niranjan (1988) has reported 10% of his 25 cases having long course of facial artery. **Ronald A Bergman** mentions about the larger facial artery which may replace the frontal branches of the ophthalmic artery.

In the present study in 1/8(12.5%) the facial artery was found to extend to the forehead beyond the medial angle of the eye.

This observation coincides with the observation of the above scientists but differs in that the present observation is in the foetal cadavers.

Kozielac and Jozwa reports 42% of foetal specimens showed the facial artery not reaching medial angle of the eye, ending as superior labial in 20% and inferior labial in 22%.

In the present study the facial artery ended as superior labial artery in 25% which is a lower value than sited above.

Histological study

Onderoglu S(1999) observed that the facial artery was surrounded by adipose tissue except in one specimen and that there was not a fibrous canal or a cleft at the angle of the mouth in the modiolus. In the present study it was observed that the facial artery was surrounded mostly by fatty or fibro-fatty tissue and on one side by skeletal muscle fibres.

Clinical study

It was observed in the clinical cases that the presence of numerous small vessels in the region of the tumour only shows the extensive anastomoses among the arteries in the facial region. The tracing of the facial artery only upto its trunk in the case of mandibular tumour reveals that a single tumour feeding vessel could not be localized. Hence embolisation of the tumour feeding vessel could not be carried out in these cases. However, the branching pattern could be studied by special catheterisation of the main trunk or the individual branches of the facial artery in the future.

CONCLUSION

A study about the facial artery was carried out in 42 adult human specimens and 8 foetal hemifaces for finding out the different types of origin and the branching pattern. Variation in its branching with specific importance to the submental and the perioral branches was observed.

Separate origin of facial artery from the external carotid was observed in 69.05% and as common linguofacial trunk in 30.95%. The other branches like tonsillar, ascending palatine, glandular, submental branches were also observed normally in the neck, the infra(sub) labial, inferior labial, superior labial and the lateral nasal branches from the facial artery in the face, the angular being the terminal branch of the facial artery were also observed in the present study.

The present study was carried out having in mind the various facial landmarks used by the surgeons in mobilizing the skin flaps in the nasolabial, nasal septal and lip regions so also the musculocutaneous flaps in the submental region.

Observations in the present study like the high origin of the facial artery from the external carotid and a long course of facial artery extending to the forehead are additional information to the plastic surgeon who plans the vascular flap designs. Many observations regarding the submental, labial and perioral branches coincided with the observations made by the pioneers in this field in the recent days.

New patterns of branching with the facial artery ending as angular artery or inferior alar artery with the absence of lateral nasal artery will be an eye opener for the plastic surgeons who can mobilize the nasolabial flaps not following the usual conventional patterns.

The ascending palatine artery arising from the lingual artery is one of the rare findings. Observations about the occurrence of other rare and abnormal branches of facial artery like the premasseteric branch or the presence of parotid and buccal branches will definitely serve the surgeons in the field of facial reconstructive surgery in creating new true cutaneous flaps.

A lookout for the caliber persistent labial artery on the clinical side was made but of no avail. This information will definitely alert the general and the plastic surgeons while coming across such cystic pulsatile tumours of the lips which is usually mistaken for a tumour.

I hope that this 'Study of the facial artery and its branches in the South Indian subjects' will definitely be of use to the anatomists and the plastic surgeons in the future and I hope further studies regarding this will enlighten us with much more precious information which are welcome in this world of cosmetic surgeries of face.

“Smile, without which you are not fully dressed”

“Perceive! Conceive! Believe! And Achieve!”

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Fig.1(Oa) Termination of facial artery

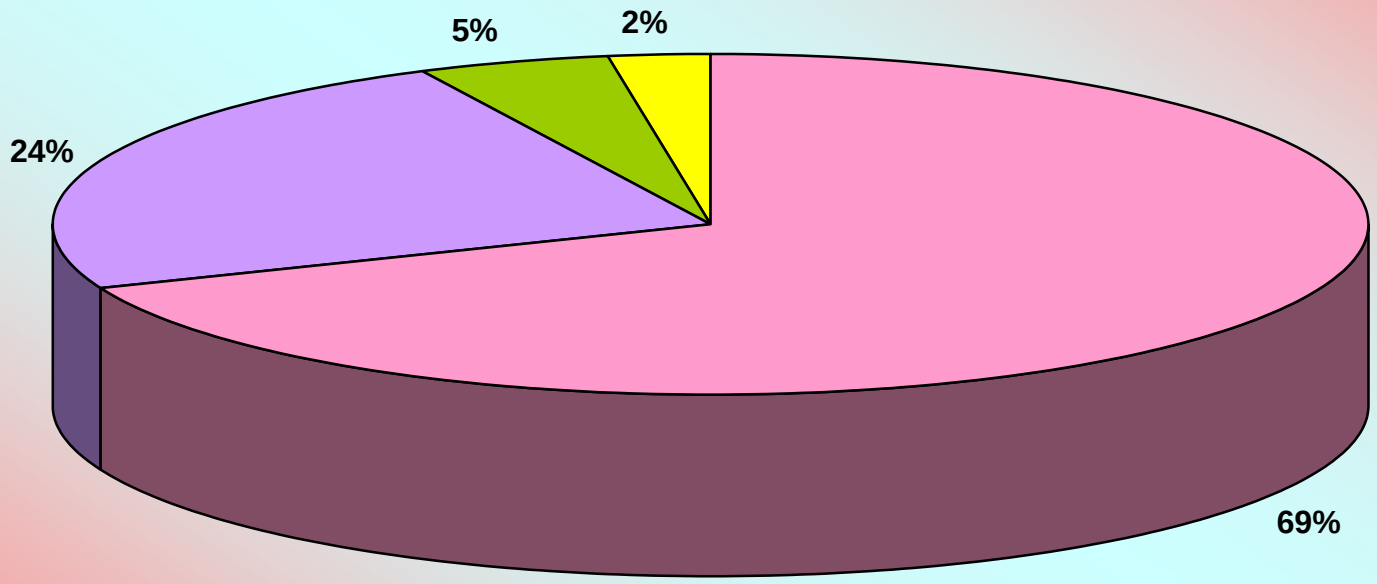


Fig.1 (O)
Mode of Origin of facial artery from the external carotid artery

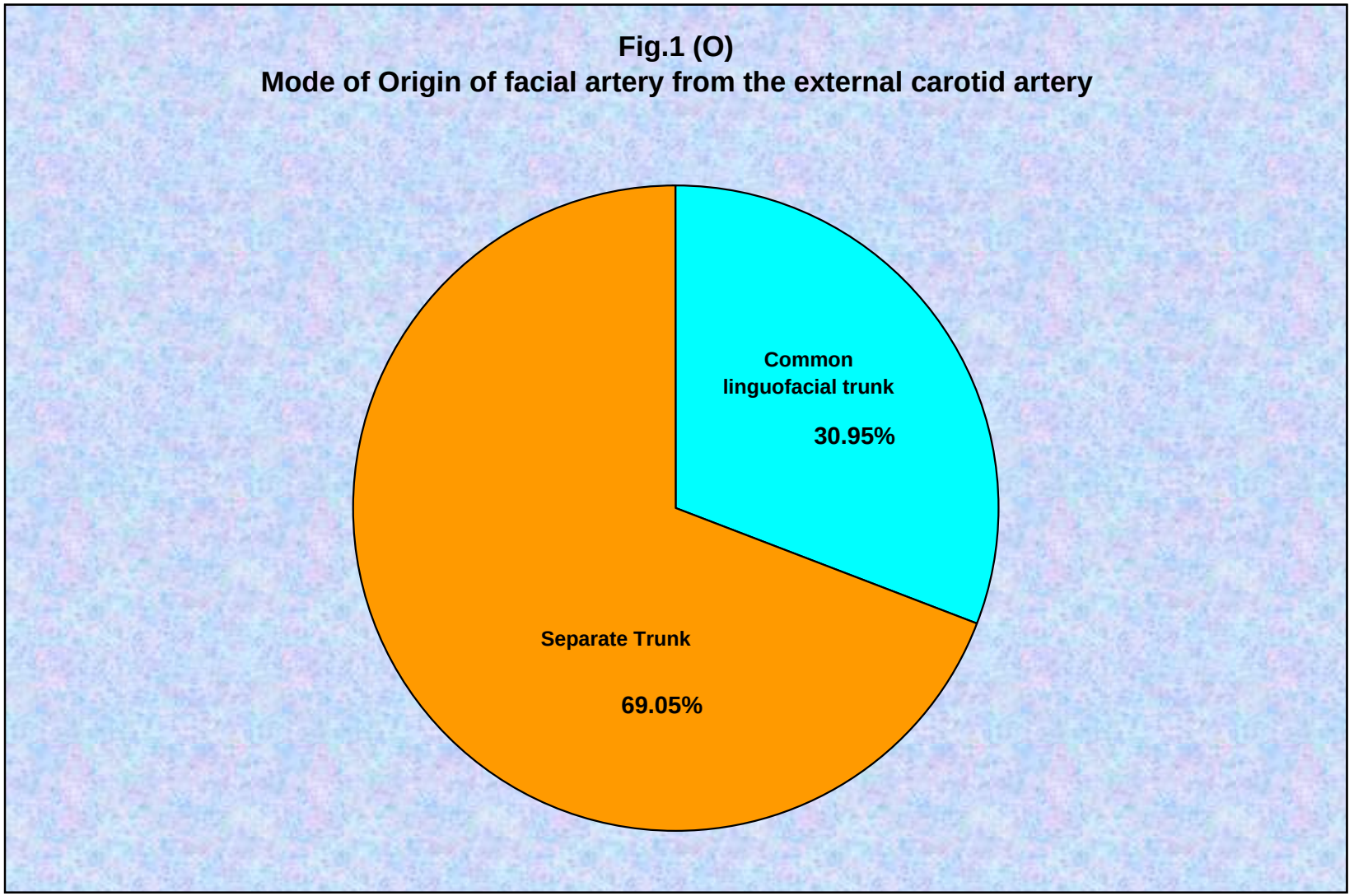


Fig. 9(D) LENGTH OF INFERIOR LABIAL ARTERY

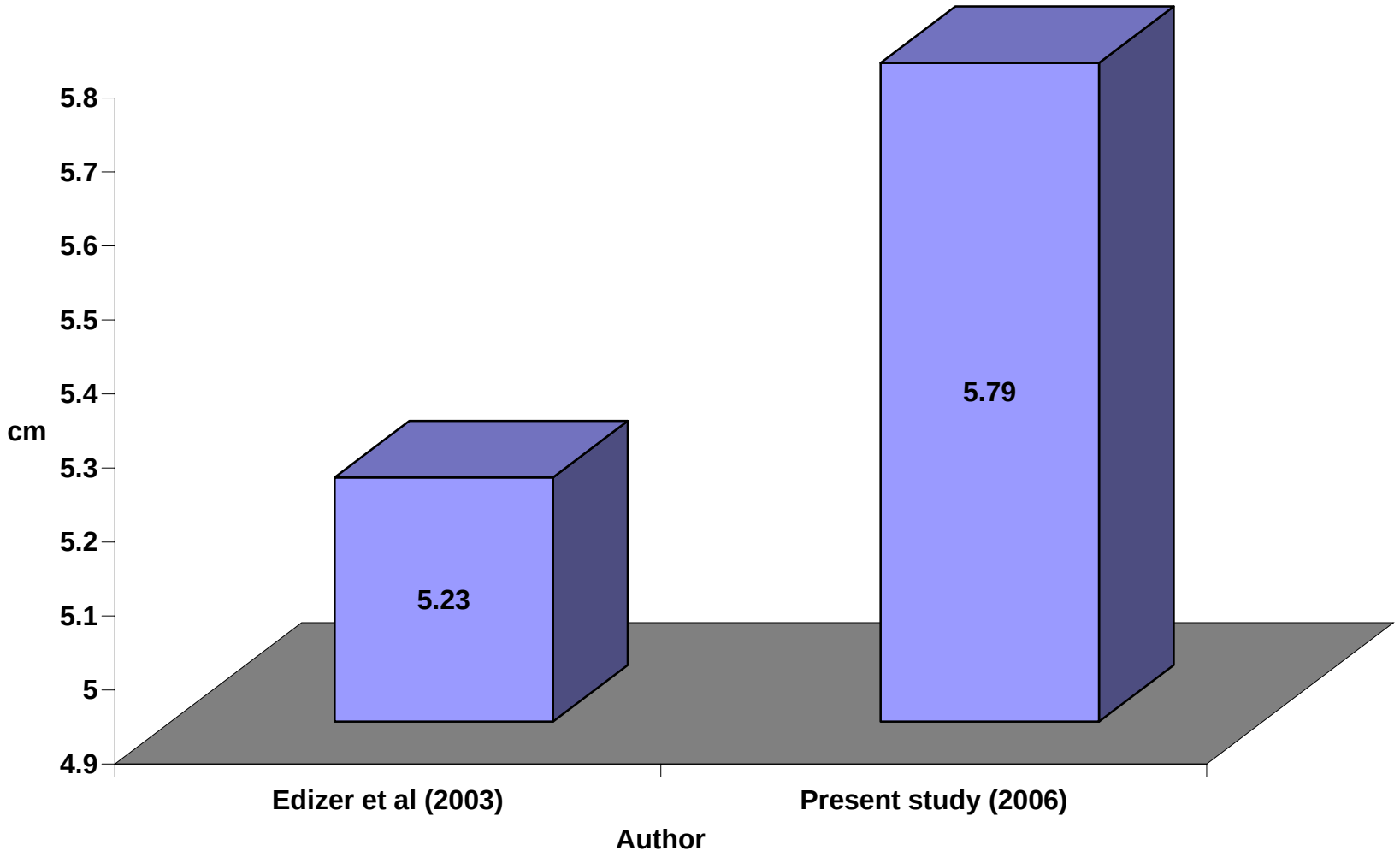


Fig.10(D) Level of inferior labial artery

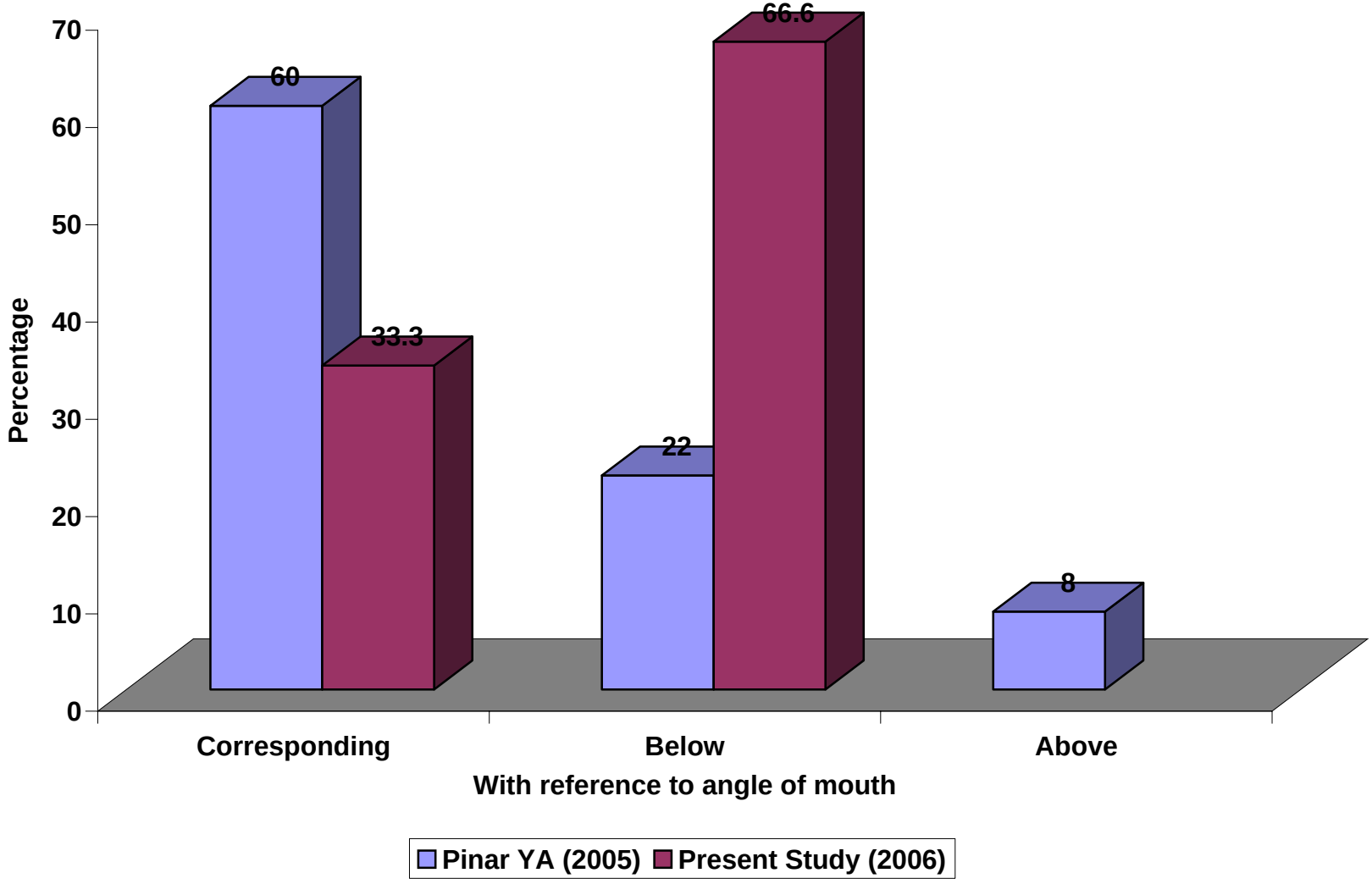


Fig.11(B) Distance of origin of inferior ladial artery from the angle of the mouth

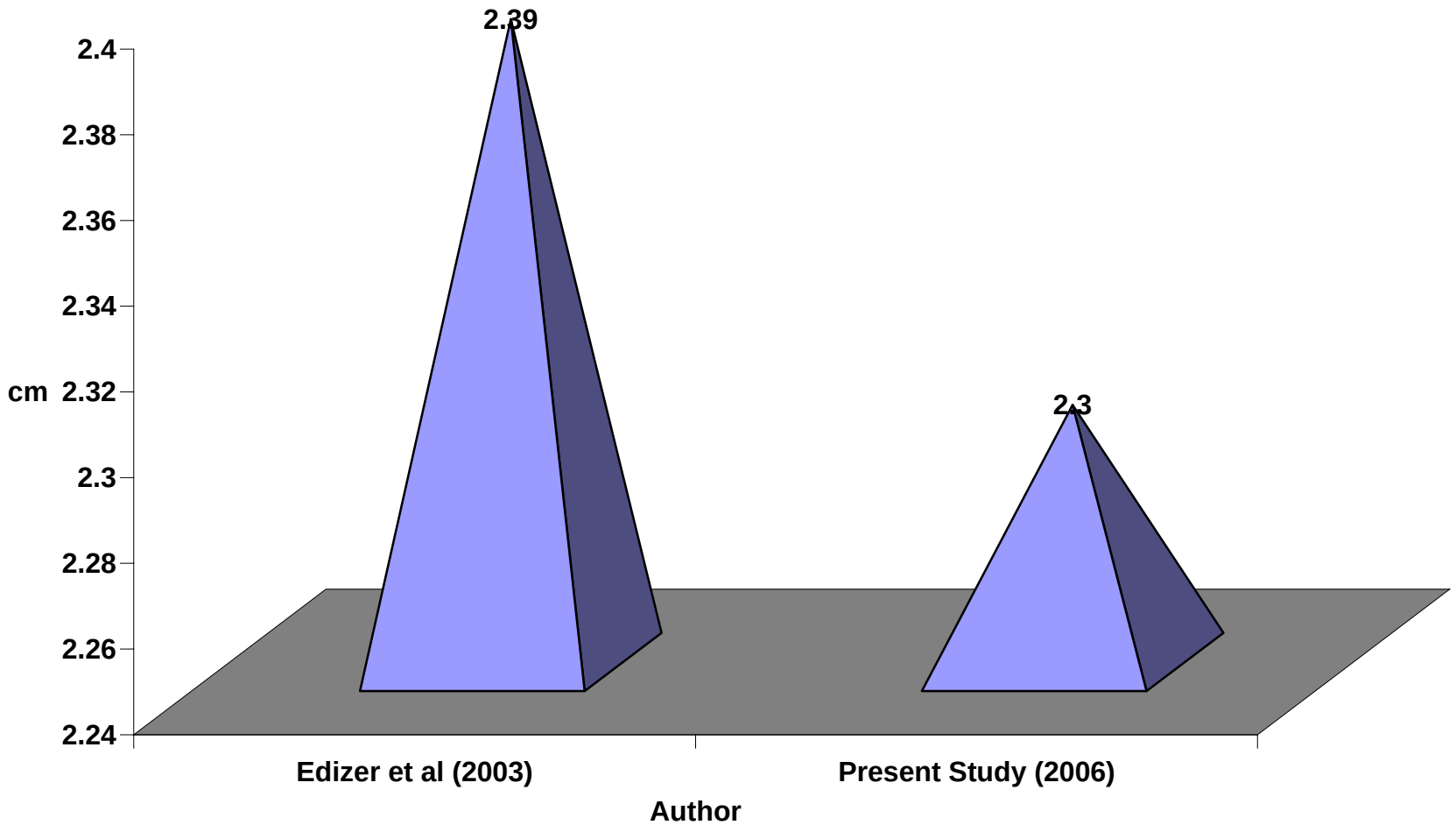


Fig.12(D) Incidence of sublabial artery

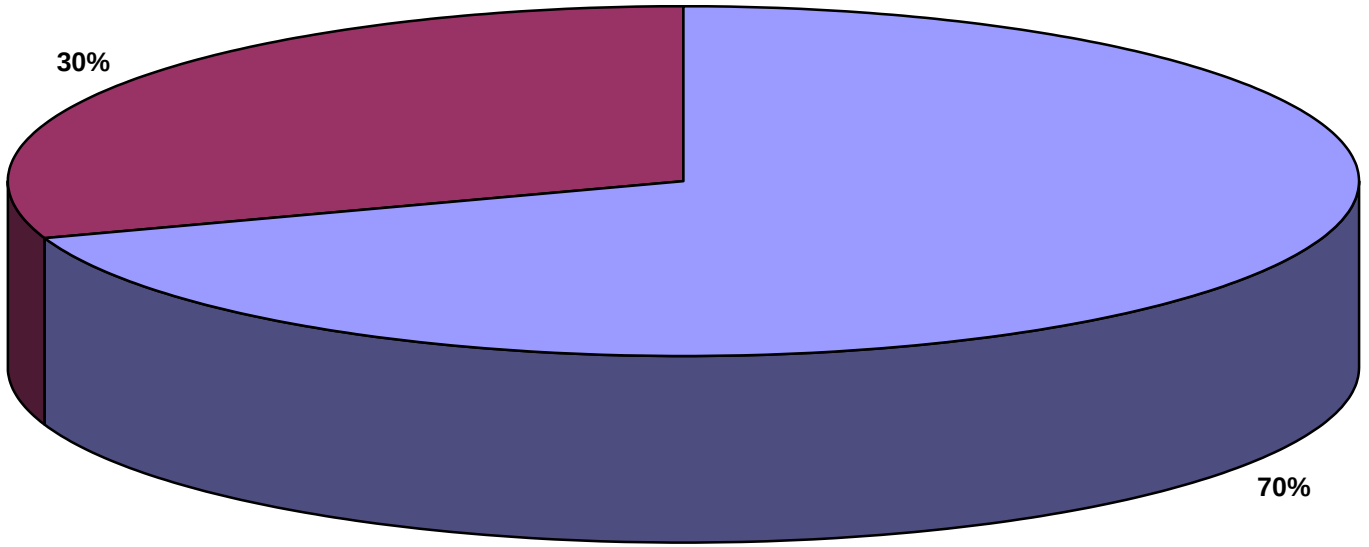


Fig.27(D) Termination of facial artery as lateral nasal artery

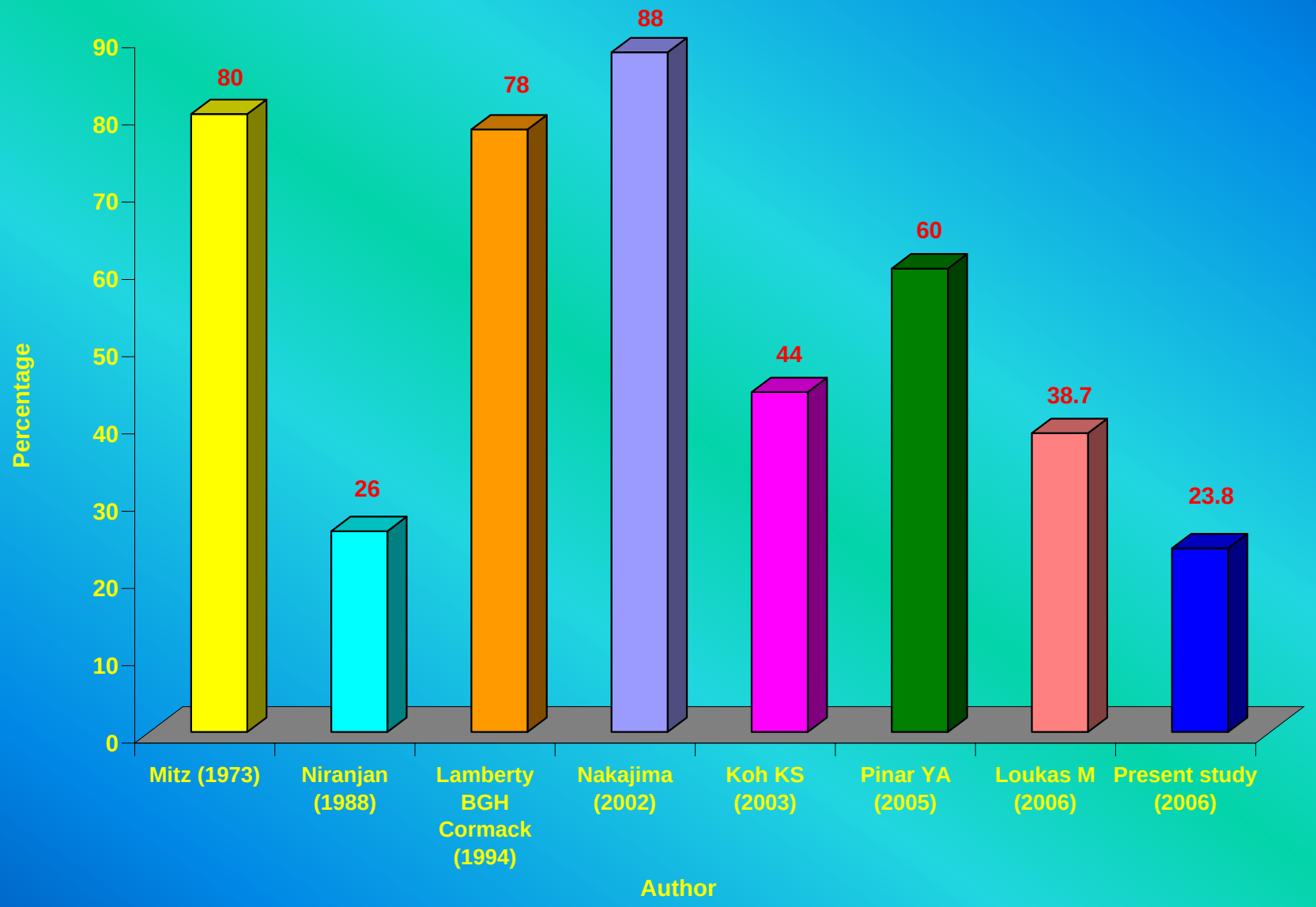
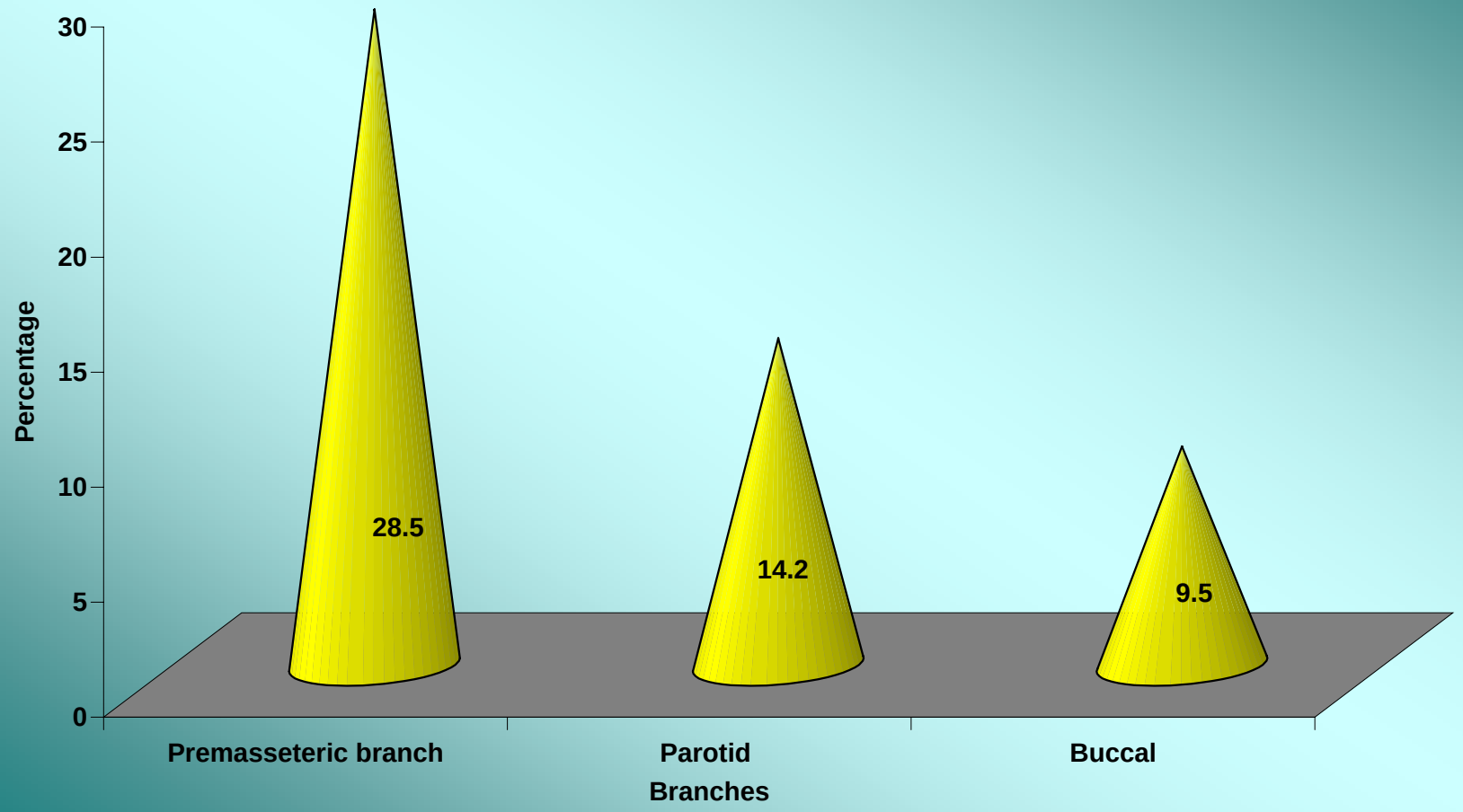


Fig.26(D) Unusual branches of facial artery



Angular	69
	23.8
	4.8
	2.4

Angular	Lateralnasa	Inferior ala	Superior labial
69	23.8	4.8	2.4

Common linguofacial trunk	30.95%
Separate Trunk	69.05%

Dr.Grant (1943)	20%
Present Study (2006)	30.95%

Ronald A.Bergman (1988)	43%
Loukas M. et al. (2006)	1.40%
Present study (2006)	2.19%

Magden O (2004)	2.66
Present study (2006)	3

Angular	69
Lateralnasal	23.8
Inferior alar	4.8
Superior labial	2.4

Magden O (2004)	2.75
Present study (2006)	3.45

Magden O (2004)	5
Present study (2006)	5

Magden O (2004)	2.38
Present study (2006)	2.99

Madgen O (2004)	5.89
Present study (2006)	7.2

	Superficial to SM gland	Deep to SM gland	Through SM gland
Zuckermann (1961)	0%	100%	0%
Madgen O (2004)	96%	0%	4%
Present study (2006)	0%	100%	0%

Edizer et al (2003)	5.23					
Present study (2006)	5.79					
	Correspon	Below	Above			
Pinar YA (2005)	60	22	8			
Present Study (2006	33.3	66.6				
Edizer et al (2003)	2.39					
Present Study (2006	2.3					
Edizer et al (2003)	71					
Present Study (2006	30.9					
			Premasset	28.5		
			Parotid	14.2		
Edizer et al (2003)	2.34		Buccal	9.5		
Present Study (2006	2.95					
Edizer et al (2003)	2.76					
Present Study (2006	2.12					
Schulte et al (2001)	94					
Pinar YA (2005)	72.3					
Present study (2006)	71.4					
Pinar YA (2005)	27.7					
Present Study (200	16.66					
Magden O (2004)	1.21		Magden O	4.64		
Present study (2006)	1.65		Present stu	3.52		
					Koh KS (20	1.53
					Present stu	1.96
Koh KS (2003)	3.09		Ran W et a	9		
Present study (2006)	1.9		Magden O	4.5		
			Present stu	7.1		
Magden O (2004)	1.8		Magden O	3.33		
Present study (2006)	1.1		Present stu	3.53		
Magden O (2004)	1.48		Koh KS (20	2.52		
Present study (2006)	1.53		Present stu	2.36		

Niranjan (1	68
Nakajima (	3
Koh KS (20	36.3
Pinar YA (2	22
Loukas M	51.3
Present stu	69

Mitz (1973)	80
Niranjan (1	26
Lamberty E	78
Nakajima (	88
Koh KS (20	44
Pinar YA (2	60
Loukas M (	38.7
Present stu	23.8

Niranjan (1	4
Pinar YA (2	4
Loukas M (	8.4
Present Stu	2.4

Niranjan (1	2
Pinar YA (2	12
Present Stu	4.8

Niranjan (1	68
Koh KS (20	54.5
Pinar YA (2	68
Present Stu	23.8