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Clinical and Colour Doppler Evaluation of the Vascular Anatomy of the Island Nasolabial Flap Based on A Central Subcutaneous Pedicle

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ABSTRACT

Background: The centrally-pedicled nasolabial flap provides supple soft-tissue lining and adequate flexibility to the cheek, which facilitates excellent mouth opening on a long-term basis. The ease of harvest and negligible aesthetic morbidity makes it a viable option instead of superiorly or inferiorly based nasolabial flap. Though facial artery being an important vessel, its Doppler sonographic features are not well known in the anterior face. With colour Doppler as moving blood is encountered, the vessel *lights up*, even if the vessel is too small to be resolved on the gray-scale image. Considerable confusion does exist about the pattern of its blood supply and is generally misconstrued as a random pattern flap, based on the facial artery. This study is designed to resolve the dilemma regarding vascular basis for centrally-pedicled nasolabial flap using a Colour Doppler as a pre-operative diagnostic modality.

Keywords: Centrally-pedicled nasolabial flap, ultrasonography, colour Doppler.

INTRODUCTION

The nasolabial fold is something of an enigma. The superior extent of the fold is at the junction of the alar nasi, the cheek, & the upper lip. The fold then extends inferiorly in either a straight convex, or concave shape & ends below & lateral to the corner of the mouth.The nasolabial flap was first described in the works of Sushruta in 600 BC.The first single stage, de-epithelized nasolabial flap was described by Wallace (1966)[1] for the closure of a palatal defect. In order to avoid the bulk of the deep epithelized pedicle in the tunnel and to provide more mobility, a one-step arterialized island flap was designed by Rose(1981)[2].Hagan and Walker(1988)[3]introduced the nasolabial musculocutaneous flap, based on the cadaveric study where they found the existence of muscle perforator vessels to the subcutaneous tissue in nasolabial area & suggested that musculocutaneous flap will be much more reliable than a subcutaneous pedicle & thus can be advanced upto 5cms.[4]

Pogrel *et al* carried out cadaveric dissection study to investigate the anatomy of nasolabial fold with a view to explain the problems of surgical softening or elimination of fold using sixteen cadavers. They have concluded that nasolabial fold is defined by the structures that support the buccal fat pad and hold it above the fold. This appears to be a combination of muscle bundles that run both across and parallel to the fold and also by fibrous septae supporting the fat pad.[5]

One of the more remarkable developments in ultrasound instrumentation is color flow imaging,

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Fig 1: Frontal view of individual showing markings of the nasolabial flap with central pedicle.

Fig 2: Three quarter view with markings of centrally pedicled nasolabial flap on right side.

which superimposes a blood flow image on gray-scale ultrasound image, permitting visual assessment of blood flow. Color flow imaging is an essential component of ultrasound vascular diagnosis, and for that reason, the proper use of this modality is very important.

There are certain advantages of colour flow imaging. When moving blood is encountered, the vessel "lights up," even if the vessel is too small to be resolved on the gray-scale image. Because vessels stand out in vivid color, they may be located and followed much more easily than with gray-scale instruments. Another major advantage is the depiction of blood flow throughout entire vascular segments, rather than only within the Doppler volume.

Considering these advantages, we used the Colour Doppler for assessing the vascular anatomy of the centrally-based nasolabial flap in the normal individuals, as vascular supply of this flap has still not been mentioned & proved.[6]

Fig 3: Three quarter view with markings of centrally pedicled nasolabial flap on left side.

AIMS

The objectives of our study were:

1. To effectively utilize the Color Doppler ultrasonography in the assessment of the vascular anatomy of the centrally-based nasolabial flap.
2. To utilize this investigation modality to help in raising the centrally based-nasolabial flap beforehand.

Table 1: Color Doppler findings of the vascular supplyof the central pedicle on both right and left sides of the designed nasolabial flap in ten individuals.

Sr No.	Sl No.	Age	Sex	Side	Inference
1	1	24	M	R	I-La
	2	24	M	L	S-La
2	3	24	M	R	I-La
	4	24	M	L	I-La
3	5	25	F	R	S-La & I-La
	6	25	F	L	S-La
4	7	23	M	R	I-La
	8	23	M	L	S-La
5	9	26	M	R	I-La
	10	26	M	L	FD < 1 mm
6	11	24	F	R	S-La
	12	24	F	L	FD < 1 mm
7	13	24	M	R	I-La
	14	24	M	L	I-La
8	15	25	F	R	S-La
	16	25	F	L	I-La
9	17	25	M	R	S-La
	18	25	M	L	S-La
10	19	22	F	R	FD < 1 mm
	20	22	F	L	I-La

Table 2: Inferences of the vascular supply of the central pedicle based on Colour Doppler findings.

Inference	**No. of cases**	**%**
I-La	9	45.0
S-La	7	35.0
S-La & I-La	1	5.0
FD < 1 mm	3	15.0
Total	20	100.0

Table 3: Comparison of the vascular anatomy of the central pedicle among male & female individuals on both right and left sides.

	Female		Male		Total	
Inference	No.of sides	%	No.of sides	%	No.of sides	%
I-La	2	25.0	7	58.3	9	45.0
S-La	3	37.5	4	33.3	7	35.0
S-La & I-La	1	12.5	0	-	1	5.0
FD < 1 mm	2	25.0	1	8.3	3	15.0
Total	8	100.0	12	100.0	20	100.0

MATERIALS & METHOD

The study comprised of 10 normal individuals without any positive medical history between the age of 20-30. The individuals were selected randomly.

The markings were made as follows with the ruler:

1. Horizontally from commissure of the mouth to the inferior border of pinna.
2. Another marking was made following the nasolabial crease from the lateral border of the nose till about 1 cm superior to the inferior border of mandible. This marking forms the medial margin of the proposed nasolabial flap & was roughly situated about 1 cm lateral to the commissure of the mouth.
3. At the intersection of the two markings, over the horizontal line about 0.5 cm away from the medial marking, a circle was drawn of diameter of 1cm which will form a tangent to the medial marking. This circle formed the central pedicle of the proposed nasolabial flap.
4. Another marking was made laterally following the medial margin, tangent to the circle & meeting the medial marking at the tips sharply superiorly & inferiorly. (**Fig.1, Fig.2 & Fig.3**).
5. The colour Doppler study of the marked nasolabial flap was carried out using single colour Doppler machine & single operator.
6. The facial artery was traced using colour Doppler superiorly as it emerges over the face superiorly till the base of the central pedicle of the flap.
7. The lateral nasal artery & the angular artery were traced with the color Doppler inferiorly till the central pedicle.
8. The transverse facial artery was then traced lateral to medial at the lateral extent of the flap till the central pedicle.
9. Then superior & inferior labial arteries were traced at their division from the facial artery till the central pedicle.
10. The same markings were made on the opposite side of the face.
11. The maximum velocity, minimum velocity, pulsality index(PI),resistance index (RI) & flow diameter (FD) of the found artery within the central pedicle were recorded.
12. The same parameters were recorded on the contralateral side.

RESULTS

In our study, out of 10 healthy volunteers, two of them did not show main trunk of the facial artery within the central pedicle of the intended nasolabial flap on left side .Also, the superior & the inferior labial arteries were not detected within the central pedicle in same two volunteers & in one volunteer, though on the right side, main trunk of facial artery was detected within the central pedicle as a predominant pedicle, superior labial & inferior labial arteries were not detected (**Table1**). The

main reason of inability of sonographic probe to detect these arteries was the flow diameter (FD)less than 1mm.

Thus, the inferior labial artery was the predominant artery supplying the central pedicle of the designed flap in 45% of the volunteers including both right and left sides while superior labial artery contributed as the predominant arterial supply in 35% of the volunteers **.** However, in only 5% of the volunteers, both superior & inferior labial arteries were the predominant arteries within the central pedicle while in 15% of the cases, ultrasonographic probe was unable to detect the predominant arterial supply as superior/inferior labial artery within the designed central pedicle **(Table 2 & Graph 1)**.

Regarding gender differences, in males, inferior labial artery was the predominant arterial supply within central pedicle in 58.3% while in females it contributed to about 25% **,** while superior labial artery contributed to about 37.5% in females and 33.3% in males **(Table 3).** Comparing the left and right sides, inferior labial artery was the predominant arterial supply in 50% of the volunteers and superior labial artery in 30% on right side**,**while on the left side, superior and inferior labial artery individually were predominant arteries in 40% of the volunteers respectively **(Table 4).**

DISCUSSION

The present study was carried out in Department of Oral Maxillofacial & Reconstructive surgery, College of Dental Sciences, Davangere, Karnataka, India. A flap is defined as movement of adjacent tissue from one location to another with a direct vascular supply. Classically, movement occurs by advancement, rotation, or transposition of tissue.[7,8] Flaps have been classified in several ways. The most common methods of classification are by location, blood supply, and tissue movement. Based on *blood supply,* flaps have been classified as **random** and **axial pattern flaps**. *Random pattern flaps* are flaps based on the rich perforating vascular plexus of the skin. They are not necessarily based on named blood vessel. *Axial pattern flaps*, on the other hand, are based and dependent upon a named artery for the majority of their blood supply. Most axial pattern flaps have a degree of randomness to the distal portion of the flap.

With the increasingly widespread application of reliable microvascular free tissue transfer techniques for oral cavity reconstruction, the routine need for a variety of local and regional flaps has decreased. The use of the nasolabial flap in reconstruction of local head and neck defects has proved to be efficacious and reliable. Providing ample tissue from an adjacent donor site, the nasolabial flap has proven the workhorse of alar & lateral nasal reconstruction[9].The nasolabial flap is employed as a one-staged method of repair for defects of the upper lip, nasal ala, septum, and columella as well as for intraoral defects of the floor of the mouth, tongue, and gingival sulcus. A two-staged procedure has also been described.[4,10-12]The facial and infraorbital arteries are frequently cited in anatomic descriptions of the nasolabial flap.[10-14]

Owing to a dual blood supply from both facial and ophthalmic arteries, the flap can be either superiorly or inferiorly based. For intra-oral use, inferiorly based flaps are effective. The naming of a specific vessel, in this case the facial artery, suggests that the flap has a formal “axial” blood supply.[15]

Color Doppler sonography has been developed to identify vasculatures and to enable evaluation of the blood flow velocity and vessel resistance together with surrounding morphology. Though it has been used for the diagnosis of vasculature in the cervical lymph nodes, it has been rarely used in the past for other organs in the maxillofacial region. Zhao *et al* have studied the facial artery in the maxillofacial region using Doppler sonography which is an important vessel in this area.[16]

The facial artery arises from the external carotid artery. The main trunk swings superficially at the region of the submandibular gland and runs beyond the inferior border of the mandible. Then it runs along the anterior border of the masseter muscle. Thereafter it changes its course forward and gives out the inferior and superior labial arteries, which lie close to the junction of the lips.[17,18]

Because the facial artery runs superficially, it can be well demonstrated on Doppler

sonography. Authors examined the healthy volunteers to clarify the blood flow of the facial artery in the anterior face by using high-frequency colour Doppler sonography. The Doppler sonography of healthy volunteers revealed that the main trunk of the facial artery was easily demonstrated just anteriorly to the anterior border of the masseter muscle. The superior and inferior labial arteries were relatively small in diameter. In the scan along the buccinator muscle, arteries were visible anteriorly to the buccinator muscle. The detection rates were 100% for the main trunk and the superior and inferior labial branches in both right and left sides.[16]

However in our study, out of 10 healthy volunteers, in two of them on the left side main trunk of the facial artery within the central pedicle of the intended nasolabial flap was not detected. Also, the superior & the inferior labial artery were not detected within the central pedicle in same two volunteers (**Table1**) & in one volunteer, though on the right side, main trunk of facial artery was detected within the central pedicle as a predominant vessel, superior labial & inferior labial arteries were not detected. The main reason of inability of sonographic probe to detect these arteries was the flow diameter (FD) being less than 1mm.

Thus, the inferior labial artery was the predominant artery supplying the central pedicle of the designed flap in 45% of the volunteers including both right and left sides while superior labial artery contributed as the predominant arterial supply in 35% of the volunteers whereas in only 5% of the volunteers, both superior & inferior labial arteries were the predominant arteries within the central pedicle & in 15% of the cases, ultrasonographic probe was unable to detect the predominant arterial supply as superior/inferior labial artery within the designed central pedicle (**Table 2 & Graph 1**).

Comparison between the male & female volunteers showed that in males, inferior labial artery was the predominant arterial supply within central pedicle in 58.3% while in females it contributed to about 25%, while superior labial artery contributed about 37.5% in females and 33.3% in males. The inability to detect the superior labial & inferior labial arteries in certain volunteers can also be due to their relatively small diameter and wide anatomic variations in their course which may not be sometimes present within the designed central pedicle. Also, another reason for the low detection rate due to low flow diameter may be due to the fixed scanning direction along the buccinator muscle in this region.

CONCLUSION

Based on the findings of the color Doppler study and the study by Hynes B.*et al*, centrally pedicled nasoolabial flap has an “axial” pattern of blood supply. But this axiality of vascular supply within the central pedicle is not consistent as depicted by the colour Doppler study.

So based on the results, it can be concluded that centrally-pedicled nasolabial flap, can have either superior labial artery/inferior labial artery as its predominant vessel within the central pedicle and it can be refuted that centrally-pedicled nasolabial flap is a “random” pattern flap. As the sample size is limited, further Colour Doppler studies on larger number of individuals are required to confirm the results.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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