# Determination of Blood Flow in Superficial Arteries of Human Face using Doppler Ultrasonography in Young Adults

Nedal Iqbal[1], Khubaib Shahid[2], Muhammad Imtiaz[3], Faiqua Yasser[4], Ayesha Ashraf[5] and Muhammad Zain ul Abdin[6]

1. Department of Oral Biology, Fatima Memorial Hospital-College of Medicine & Dentistry, Lahore, Pakistan
2. Department of Radiology, Fatima Memorial Hospital, Lahore, Pakistan
3. Department of Oral & Maxillofacial Surgery, Fatima Memorial Hospital-College of Medicine & Dentistry, Lahore, Pakistan
4. Department of Oral Pathology, Institute of Dentistry, CMH Lahore Medical College, Lahore, Pakistan
5. Children's Hospital & The Institute of Child Health, Lahore, Pakistan
6. Department of Pathology, Sahara Medical College, Narowal, Pakistan

*Correspondence: nedaliqbal@gmail.com

**Keywords:** blood flow, superficial arteries, Doppler Ultrasonography, human face

doi: 10.37978/tijfs.v5i1.339

Submitted: September 8, 2020
Accepted: November 16, 2020
Published Online: January 22, 2021

**How to cite this:** Iqbal, N., Shahid, K., Imtiaz, M., Yasser, F., Ashraf, A. and Abdin, M.Z.u. 2021. Determination of Blood Flow in Superficial Arteries of Human Face using Doppler Ultrasonography in Young Adults. Int J Front Sci, 5(1).

CC BY

**Significance:**
Human face is highly vascular region and vascularity to the skin and other organs is an important indicator of health and disease. Change in blood flow maybe affected in various pathologies. Blood flow in superficial arteries of face has not yet been described, therefore this study was designed to establish baseline blood flow values in arteries of face.

## Abstract

**Background:** Human face is highly vascular region and vascularity to the skin and other organs is an important indicator of health and disease. Change in blood flow is affected by aging, diabetes, high blood triglycerides, cigarette smoking etc. With so many factors that can alter blood flow in the skin, normal blood flow is important to know for comparison to diseased state. Blood flow in superficial arteries of face has not yet been described, therefore this study was designed to establish baseline blood flow values in arteries of face.

**Materials and Methods:** Blood flow of right and left side was assessed at level of facial and infraorbital artery. Categorical variables were presented in form of frequency and percentages was done by using Mann-Whitney U. Wilcoxon Signed Ranks test was used to compare left and right facial and infra orbital arteries.

**Results:** Peak systolic velocity of right and left facial artery had a significant difference having right side mean of 67.02±12.48 and left side mean as 72.67±11.69. Facial artery diameter of right and left side also had significant difference with mean of 0.14±0.02 and 0.15±0.02 respectively.

**Conclusion:** No difference was found between vascularity in male & female and left or right side. The study might be useful to establish normal baseline values of various parameters on both sides of face in male and female adults. This study may become important reference for future studies measuring blood flow and even progression of vascular diseases may be assessed by indexes developed on the basis of these studies.

## Introduction

Human face is highly vascular region and is the key for maintenance of healthy tissue conditions. (1) The blood flow to the skin and other organs is an important indicator of health and disease. Change in blood flow is affected by aging, diabetes, high blood triglycerides, cigarette smoking, and other contributors to inflammation. (2-3) Compromised vascularity may lead to alterations in bone strength and remodeling capacity. (4-5) Mandibular and maxillary hypo perfusion and ischemia are particular important problems in the elderly patients and in those undergoing radiotherapy. (4) It is important to know blood flow in health and diseased state, as there are so many factors that can alter blood flow. This vascular flow measurement may also help in facial reconstruction after trauma or during surgery. (6)

Face is mainly supplied by branches of external carotid artery, and small area of nose and forehead is supplied by branch arising from branch of internal carotid artery. Major arterial supply of the facial skin is the facial artery and gets contribution from maxillary artery. (7) Facial artery arises from the external carotid artery just above the tip of greater cornu of hyoid bone, follows the inferior border and enters the face. It provides blood to the muscles of the facial expression. The infraorbital artery branches off the maxillary artery, emerges through the infraorbital foramen, supplies the maxilla, teeth, lower eyelid, nose and upper lip. (8) Mental artery is the terminal branch of the inferior alveolar artery, this artery emerges from the mental foramen to supply facial muscles and skin of the chin. (9)

The facial blood flow can be measured by various invasive and non-invasive methods. These methods include venous occlusion plethysmography, doppler ultrasound, laser doppler blood flow, thermostrom, hertzman photoelectric plethysmography and radioactive isotopes. (10)Doppler ultrasound is common, non-invasive and radiation free technique for measuring blood flow in vasculature. (11)

Limited literature is available, it's important to know the blood, ethic variation. Facial blood flow in superficial arteries has not yet been described and presently ultrasound is the technique to measure blood flow in the skin non-invasively and hence selected to be used on volunteers in present study.

## Materials and Methods

After the approval of the study for ethical considerations from the Institutional Review Board of Fatima Memorial Hospital-College of Medicine and Dentistry, this cross sectional study was conducted in the Radiology and Oral Biology department on 50 (25 males and 25 females)

dental technologists or dental students of age range 18-30 years. Individuals having history of trauma on face, muscular hypertrophy, facial asymmetry, temporomandibular joint disorder and any inflammatory diseases were excluded from the study.

A notice for volunteer recruitment was displayed on notice boards of the college, stating study title along with the purpose of the study (annexure-I). The individuals who were willing to participate were explained the procedure and informed consent was obtained (annexure-II). Demographic data was noted (name, age and gender). A thorough history was taken and volunteer with above mentioned problem were excluded from the study. A consent form for inclusion into study was filled and an appointment were arranged at Radiology department to where an ultrasound of face was arranged.

Facial and infraorbital arteries (right and left sides) were analyzed by using Color Doppler Ultrasound with linear probe of frequency 7-10 Hz transducer, Model Voluson S6. Facial artery was analyzed by placing the transducer with a thin layer of gel at the intersection border of mandible with the anterior border of the messeter muscle. Infraorbital artery was studied below the infraorbital margin. Data regarding arteries diameter, peak systolic and end diastolic velocity, resistance index and pulsatality index were collected. Demographic information was also recorded.

Data was entered and analyzed in SPSS version 25. Descriptive analysis was performed on all of the variables. Categorical variables were presented in the form of frequency and percentages. Normality was assessed by using Kolmogorov Simonov's test. Comparison between left and right facial and infraorbital arteries was done by using Wilcoxon Signed Ranks test. Data was stratified according to gender and Mann Whitney U test was performed post stratification. P-value less than 0.05 was considered significant.

**Results:**

In this study 50 volunteers participated with the mean age of 23.70±3.77 years, mean height of 65.36±3.83 [AK1] inches and mean weight of 65.99±12.27 kg. In which half of the participants were female with mean age of 22.88±3.43 years, mean height of 63.43±2.58 inches and mean weight of 60.96±9.83kg. Half of them were male with mean age of 24.52±3.97 years, mean height of 67.29±3.95 inches and mean weight of 71.01±12.59 kg.

In overall volunteers there were 48 right handed and two were left handed males. Left and right facial artery was present in all individuals while there was only one female in which infraorbital artery of both sides were not found.

All other male and female individuals were able to provide peak systolic velocity, diastolic velocity, systolic diastolic index, resistance index, pulsatality index and diameters of right and left side parameters.

Table. *1* shows the descriptive statistics of vascular status of facial artery. No significant difference between right and left facial arteries was seen except peak systolic velocity and diameter of facial artery. peak systolic velocity showed a significant difference having right side mean of 67.02±12.48 and left side mean as 72.67±11.69 (p-value =0.049). The diameter of facial artery of right and left side also had a significant difference with mean of 0.14 ± 0.02 and 0.15 ± 0.02 respectively (p-value = 0.001).

**Table 1: Descriptive statistics of vascular status of facial artery**

| Facial artery | Left | Confidence interval | Right | Confidence interval | P-value |
|---|---|---|---|---|---|
| facial peak systolic velocity | 67.02±12.48 | 63.47-70.57 | 72.67±11.69 | 69.34-75.99 | 0.049 |
| | 67.02(15.75) | | 72.62(16.56) | | |
| facial diastolic velocity | 14.64±5.97 | 12.95-16.34 | 14.52±4.89 | 13.13-15.9 | 0.912 |
| | 13.82(9.34) | | 13.17(7.20) | | |
| facial systolic diastolic index | 5.38±1.64 | 4.92-5.85 | 5.12±1.19 | 4.7-5.46 | 0.091 |
| | 4.99(2.33) | | 5.05(1.72) | | |
| facial resistance index | 0.79±0.05 | 0.78-0.814 | 0.78±0.10 | 0.756-0.814 | 0.955 |
| | 0.800(0.09) | | 0.80(0.08) | | |
| facial pulsatility index | 2.20±0.59 | 2.03-2.37 | 2.24±0.55 | 2.08-2.39 | 0.883 |
| | 2.05(1) | | 2.09(1) | | |
| facial diameter | 0.14±0.02 | 0.133-0.147 | 0.15±0.02 | 0.148-0.163 | 0.001 |
| | 0.14(0.02) | | 0.16(0.04) | | |

**Table 2: Descriptive statistics of vascular status of infraorbital artery**

| Infra orbital artery | Left | Confidence Interval | Right | Confidence Interval | P-value |
|---|---|---|---|---|---|
| IO peak systolic velocity | 28.05±7.98 | 25.57-30.32 | 31.18±12.60 | 27.75-34.61 | 0.197 |
| | 27.50(8.89) | | 30.41(16.31) | | |
| IO diastolic velocity | 5.63±2.60 | 4.89-6.37 | 5.50±2.43 | 4.79-6.17 | 0.643 |
| | 5.52(2.67) | | 5.38(2.93) | | |
| IO systolic diastolic index | 5.37±1.90 | 4.83-5.19 | 5.39±1.44 | 4.98-5.80 | 0.821 |
| | 4.86(2.32) | | 5.37(1.80) | | |
| IO resistance index | 0.080±0.08 | 0.77-0.82 | 0.08±0.07 | 0.786-0.82 | 0.357 |
| | 0.78(0.12) | | 0.81(0.09) | | |
| IO pulsatality index | 2.32±0.74 | 2.11-2.53 | 2.12±0.66 | 1.95-2.30 | 0.388 |
| | 2.22(0.99) | | 2.13(0.73) | | |
| IO diameter | 0.05±0.17 | 0.048-0.058 | 0.06±0.02 | 0.053-0.068 | 0.176 |
| | 0.05(0.02) | | 0.05(0.04) | | |

Table. *2* shows the descriptive statistics of vascular status of IO artery. There was no significant difference between right and left IO arteries. IO peak systolic velocity of 28.05±7.98 for right and 31.18±12.60 for left (p= 0.197).

**Table 3: Gender wise comparison of facial artery**

| Facial artery | Gender | | | | P-value |
|---|---|---|---|---|---|
| | Male | Confidence Interval | Female | Confidence Interval | |
| facial peak systolic velocity left | 67.67+14.31 | 61.7-73.5 | 66.37+10.605 | 61.99-70.77 | .691 |
| | 67.02(13.49) | | 67.02(15.52) | | |
| facial peak systolic velocity right | 74.45+12.42 | 69.32-79.58 | 70.89+10.88 | 66.40-75.38 | .327 |
| | 72.67916.37) | | 68.27(15.76) | | |
| facial diastolic velocity left | 15.36+6.58 | 12.64-18.07 | 13.92+5.33 | 11.74-16.14 | 0.977 |
| | 14.65(10.57 ) | | 13.059(7.24) | | |
| facial diastolic velocity right | 14.71+4.95 | 12.66-16.75 | 14.34+4.93 | 12.30-16.38 | 0.977 |
| | 13.12(9.61) | | 13.239(5.15) | | |
| facial systolic diastolic index left | 5.40+1.72 | 4.68-6.11 | 5.37+1.59 | 4.72-6.03 | 0.907 |
| | 5.14(2.92) | | 4.95(1.88) | | |
| facial systolic diastolic index right | 5.14+1.25 | 4.62-5.65 | 5.11+1.15 | 4.64-5.59 | 0.907 |
| | 5.13(1.74) | | 4.92(1.61) | | |
| facial resistance index left | 0.79+0.066 | 0.76-0.81 | 0.80+0.04 | 0.78-0.82 | 0.566 |
| | 0.78(0.13) | | 0.800(0.06) | | |
| facial resistance index right | 0.79+0.06 | 0.77-0.82 | 0.77+0.13 | 0.71-0.82 | 0.808 |
| | 0.800(0.09) | | 0.810(0.08) | | |
| facial pulsatility index left | 2.22+0.689 | 1.94-2.51 | 2.18+0.49 | 1.98-2.38 | 0.861 |
| | 2.05(1) | | 2.04(0) | | |
| facial pulsatility index right | 2.26+ 0.60 | 2.02-2.51 | 2.21+0.51 | 1.99-2.42 | 0.823 |
| | 2.17(1) | | 2.08(1) | | |
| facial diameter left | 0.14+0.021 | 0.14-0.15 | 0.13+0.13 | 0.12-0.14 | 0.08 |
| | 0.15(0.02) | | 0.13(0.04) | | |
| facial diameter right | 0.16+0.02 | 0.14-0.17 | 0.15+0.02 | 0.14-0.16 | 0.230 |
| | 0.16(0.03) | | 0.15(0.03) | | |

Table. 3 and 4 show gender wise comparison of facial and infra orbital arteries. Mean±SD for facial and infra orbital arteries are presented in this table. Pulsatality index of infra orbital artery of right side was significantly different for male and females with mean of 2.29±0.68 and 1.96±0.52 respectively (p =0.047).

**Table 4: Gender wise comparison of infra orbital artery**

| Infra orbital artery | Gender | | | | P-value |
|---|---|---|---|---|---|
| | Male | Confidence Interval | Female | Confidence Interval | |
| IO peak systolic velocity left | 28.06+8.11 | 25.25-31.95 | 27.49+7.98 | 24.20-30.79 | 0.303 |
| | 27.50(7.48) | | 25.83(10.66) | | |
| IO peak systolic velocity right | 32.90+11.03 | 28.35-37.46 | 29.46+13.03 | 24.08-34.83 | 0.19 |
| | 31.18(14.84) | | 29.69(10.45) | | |
| IO diastolic velocity left | 6.06+2.74 | 4.93-7.19 | 5.19+2.49 | 4.19-6.20 | 0.377 |
| | 5.52(3.42) | | 5.52(1.99) | | |
| IO diastolic velocity right | 5.64+2.66 | 4.54-6.73 | 5.33+2.22 | 4.41-6.24 | 0.484 |
| | 5.42(3.12) | | 4.81(2.86) | | |
| IO systolic diastolic index left | 5.16+1.56 | 4.51-5.80 | 5.58+2.21 | 4.66-6.49 | 0.823 |
| | 4.99(2.69) | | 4.86(2.26) | | |
| IO systolic diastolic index right | 5.54+1.45 | 4.94-6.13 | 5.24+1.45 | 4.64-5.84 | 0.466 |
| | 5.39(1.95) | | 5.23(1.72) | | |
| IO resistance index left | 0.79+0.09 | 0.75-0.82 | 0.18+0.08 | 0.77-0.84 | 0.431 |
| | 0.78(0.13) | | 0.79(0.10) | | |
| IO resistance index right | 0.81+0.07 | 0.78-0.84 | 0.80+0.07 | 0.77-0.83 | 0.922 |
| | 0.81(0.09) | | 0.81(0.07) | | |
| IO pulsatality index left | 2.30+0.74 | 1.99-2.60 | 2.34+0.57 | 2.02-2.65 | 0.0869 |
| | 2.18(1.09) | | 2.269(0.9) | | |
| IO pulsatality index right | 2.29+0.68 | 2.01-2.57 | 1.96+0.52 | 1.74-2.17 | 0.047 |
| | 2.35(1.01) | | 2.09(0.48) | | |
| IO diameter left | 0.05+0.17 | 0.04-0.06 | 0.05+0.18 | 0.04-0.06 | 0.62 |
| | 0.05(0.02) | | 0.05(0.02) | | |
| IO diameter right | 0.05+0.02 | 0.047-0.066 | 0.06+0.13 | 0.05-0.07 | 0.322 |
| | 0.05(0.04) | | 0.05(0.03) | | |

**Discussion**

The blood supply of region is important for the health of tissues. Therefore, it is important to know the characteristic of the vascularity of a particular area. Doppler ultrasound aids in analyzing total blood flow characteristics

Doppler ultrasound aids in analyzing total blood flow characteristics. In this study we demonstrated characteristics map of facial areas using facial ultrasound. To our knowledge, there is no published data available yet which can provide baseline values regarding vascularization of face in young adults. Nagase et al analysed on Doppler ultrasound the facial artery next to mandibular base, the mean diameter of about (0.27 cm) 2.7mm. (12) In another study, the diameter of same artery had a mean of (0.21) 2.14mm. In our study the mean diameter of right and left facial artery is found to be 0.16 cm and 0.15 cm respectively. No statistically difference was found among this parameter in males and females. Zhai YP et al (13) found similar results that there was no significant difference in all measured values of indexes of right and left side.

Jacobovicz et al reinforced the use of Resistance index as this parameter gives estimation of peripheral resistance of blood flow enabling hemodynamic analysis. (14) Tucunduva observed in his study the average value of RI was 0.81± 0.05 mm.15 In our study it was 0.78± 0.01 mm for right side and 0.79± 0.05 mm for left side and no statistically difference was between male and female in this index. Tucunduva found Peak Systolic Velocity to be 45.31mm, whereas in our study it was 67.67± 11.69 mm on right side and 63.47± 12.48 mm on left side. (15)

In our study infraorbital artery showed an average diameter of 0.05±0.17mm on right side and 0.06±0.02mm on left side, this parameter as observed by Taucunduva found an average diameter of about 0.01 mm (SD 0.24). [15] Peak systolic velocity of the same artery on right and left side was found to be 28.05±7.98mm and 31.18±12.60mm respectively, Taucunduva study found it be 15.55mm (SD 13.06).

In our study one female individual infraorbital artery of both sides were not found. This can be explained by the fact given by Ericiti et al that in 75% of cases infraorbital was located on the line which is connecting the lateral palpebral commissure lateral to the ala of the nose and remaining 25% of the are located outside this triangle. (16)

## Conclusion

This study show that investigated parameters show no difference between male & female and left or right side. The study might be useful to establish normal baseline values of various parameters on both sides of face in male and female adults. This study may become important reference for future studies measuring blood flow and even progression of vascular diseases may be assessed by indexes developed in the basis of these studies. This knowledge will be helpful not only for dentists but for plastic surgeons and other physicians as well for preoperative planning and intraoperative management. Limitation of the study was the non-availability of intra oral US probe, which preclude other measurements.

**Conflict of interest:** Authors do not have any conflict of interest to declare.

**Disclosure:** None

**Human/Animal Rights:** No human or animal rights are violated during this study.

**References**


1. Von Arx T, Tamura K, Yukiya O, Lozanoff S: The Face - A Vascular Perspective. A literature review. Swiss Dent J. 2018 May, 14:382-392. 10.4103/bc.bc_20_19. eCollection
2. Matthias Jacob, Daniel Chappell, Bernhard F. Becker: Regulation of blood flow and volume exchange across the microcirculation. Critical Care. volume, 1186:13054-016. https://doi.org/10.1259/dmfr.20150097
3. Rafique MU, Rubnawaz Q, Khan AH, et al.: Vascular Reactivity during Cardiopulmonary Bypass in Patients at. Punjab Institute of Cardiology &Shalamar Hospital Lahore, Pakistan. The International Journal of Frontier Sciences, 1, 12-18. 2017, 1:
4. Marina B, Raul R, Neto T, Arthur C, Eduardo M , Emiko S and Claudio F: Ultrasound analysis of mental artery flow in elderly patients: a case-control study. DentomaxillofacRadiol. 2015 Dec 44, https://doi.org/10.1259/dmfr.20150097
5. Iqbal S, Aslam A, Ahmed S, et al.: Spectrum of Mandibular Fractures in a Tertiary Care Hospital of Karachi. The. International Journal of Frontier Sciences, 4. 2020, 4:
6. AlirezaMohammadkarim, ManijheMokhtari-Dizaji, Ali Kazemian, HazhirSaberi: Hemodynamic analysis of radiation-induced damage in common carotid arteries by using Color Doppler ultrasonography. Ultrasonography. 2018 Jan, 37:43-49.
7. Jerrold S: Resting Blood Flow in the Skin: Does It Exist, and What Is the Influence of Temperature, Aging, and Diabetes?. J Diabetes Sci Technology. 2012 May, 6:674-684. https://doi.org/10.1177%2F193229681200600324
8. Tania M, Yakup T, Selman D: Facial anatomy. Clinics in Dermatology. 2014, 32:14-32.
9. Kim HS, Lee KL, Gil YC, Hu KS, Tansatit T, Kim HJ: Topographic Anatomy of the Infraorbital Artery and Its Clinical Implications for Nasolabial Fold Augmentation. PlastReconstr Surg. 2018 Sep, 42:273-280. 10.1097/PRS.0000000000004704
10. Neil S Norton: Netter's Head & Neck Anatomy for dentistry. Elsevier, 2017.
11. Yong-Wook C: Use of ultrasound Doppler to determine tooth vitality in a discolored tooth after traumatic injury: its prospects and limitations. Restor Dent Endod. 2014:39. https://doi.org/10.5395/rde.2014.39.1.68
12. Nagase T, Kobayashi S, Sekiya S, Ohmori K: Anatomic evaluation of facial artery and vein using color Doppler ultrasonography. Ann Plast. Surg. 1997, 39:64-7.
13. Zhai YP, Ariji Y, Gotoh M, Kurita K, Natsume N, Ma XC and Ariji E: Oral Surg Oral Med Oral Pathol Oral RadiolEndod. 2002 Feb, 93:195-201.
14. Jacobovicz J, Tolazzi AR, Timi JR: Doppler ultrasound evaluation of facial transverse and infraorbital arteries: inflence of smoking and aging process. Aesthetic Plast Surg. 2007, 3:526-31. 10.1007/s00266-006-0171-z
15. Tucunduva MJ, Tucunduva-Neto R, Mauro Saieg, Andre-LC, de Freitas C: Vascular mapping of the face: B-mode and doppler ultrasonography study. 10.4317%2Fmedoral.20754
16. Ercikti N, Apaydin N, Kirici Y: Location of the infraorbital foramen with reference to soft tissue landmarks. SurgRadiol Anat. 2017, 39:11-15. 10.1007/s00276-016-1683-0