# Relationship between dental arch width and vertical facial morphology in untreated Indian population

Dr.Waseem Khan[1], Dr.Aniruddha Munde[2], Dr.Alok Ranjan[3], Dr.Viraj Kharkar[4], Dr.Harsh Mishra[5], Dr.Vaishali Mall[6]


## ABSTRACT

### Introduction

Facial growth pattern is an important factor in planning orthodontic treatment properly. Knowledge of arch forms is important for an orthodontist, as it is related to future treatment outcome. Factors such as age, sex, and ethnicity are also important. The purpose of present study was to evaluate the dental arch dimensions in a different facial pattern in regional population, to evaluate correlation in the facial pattern with dental arch width to evaluate the differences in dental arch width between male and female subjects.

### Materials

The present study was conducted on 120 untreated subjects comprising of 60 males and 60 females aged between 16 to 38 years. The Jarabak's ratio (posterior facial height/anterior facial height) was measured on cephalograms of each patient. Maxillary and mandibular inter-canine, first inter-premolar, second inter-premolar and first inter-molar widths were measured on study models of each patient.

### Results

There was no significant correlation between dental arch width and vertical facial pattern in regional population. In males, arch width is greater in canine, premolar and molar region than females.

### Conclusion

It was concluded that dental arch width is not associated with the vertical facial pattern but it is associated with gender. Thus, using individualized arch wires according to gender is suggested during orthodontic treatment.



## Keywords

Dental arch-width, vertical facial height, vertical facial morphology


### Introduction

Facial growth pattern is an important factor in planning orthodontic treatment properly as it influences the anchorage system and growth prediction of maxillofacial structures. Knowledge of arch form is also important in clinical orthodontics as it is related to the treatment outcome. It is generally accepted among orthodontists that a relationship exists between dental arch width and vertical facial


1. Associate Professor, Department of Orthodontics, Bharati Vidyapeetham (Deemed to be University) dental college and hospital, Navi Mumbai
2. Assistant Professor, Department of Orthodontics, Dr.HSRSM Dental college and hospital, Hingoli
3. Assistant Professor, Department of Orthodontics, Bharati Vidyapeeth (Deemed to be University) dental college and hospital, Navi Mumbai
4. Associate Professor, Department of Oral and maxillofacial surgery, Bharati Vidyapeetham (Deemed to be University) dental college and hospital, Navi Mumbai
5. Associate Professor, Department of Orthodontics, Bharati Vidyapeetham (Deemed to be University) dental college and hospital, Navi Mumbai
6. Associate Professor, Department of Orthodontics, Bharati Vidyapeetham (Deemed to be University) dental college and hospital, Navi Mumbai

**Correspondence:**

Dr. Waseem Khan, Associate Professor, Department of Orthodontics, Bharati Vidyapeeth (Deemed to be University) dental college and hospital, Navi Mumbai, India Email: drwaseemzkhan@gmail.com , Orchid ID:0000-0002-7131-4803 Cell Phone: +918275220928


Bangladesh Journal of Medical Science Vol. 23 Special Issue 2024

DOI: https://doi.org/10.3329/bjms.v23i10.71731

morphology. According to Ricketts et al (1982)[1], Enlow and Hans (1996)[2] and Wagner and Chung (2005)[3], a long face individual usually has narrower arch dimensions and a short face individual has wider arch dimensions. Therefore, the question arises is there any relation between vertical facial morphology and dental arch width. Also, there is any difference in arch widths between male and female. Several studies have been conducted on this topic, but their results were inconclusive. According to the study conducted by Howes (1957)[4] individuals with steep mandibular plane (MP) generally had larger teeth and narrower and shorter arches than individuals with flat mandibular plane when measured from the buccal cusp tips of the maxillary first premolars. Isaacson et al (1971)[5] concluded that subjects with longer faces presented with a decrease in maxillary inter-molar width. But they did not distinguish between males and females.

In terms of the difference in arch width between males and females, Wei conducted a study in which he evaluated PA cephalograms of Chinese adults and noted gender differences in maxillary and mandibular inter-canine widths. According to Eroz et al[6] in children, males had significantly larger inter-molar widths when compared with females. C.Matthew Forster[7] compared the relationship between dental arch width and vertical facial morphology.

The extreme types of vertical facial dysplasia have been described as hypo divergent and hyper divergent[8] or short face syndrome (SFS) and the long face syndrome (LFS)[9].

It is suggested that individualized arch wires should be used during orthodontic treatment but nowadays preformed arch wires are used by orthodontist without considering the facial type, gender, and ethnicity. The purpose of the present study was to evaluate the dental arch dimensions in the different facial patterns in regional population, to evaluate correlation in the facial pattern (Jarabak's ratio) with dental arch width in a regional population of Marathwada and to evaluate the differences in dental arch width between male and female subjects.

## MATERIALS AND METHODS

The present study was conducted on 120 untreated subjects comprising of 60 males and 60 females ages between 16 to 38 years. The lateral cephalograms and study models for the purpose of the study were obtained from the records of patients visiting the Department of Orthodontics and Dentofacial Orthopaedics. Subjects were selected on the basis of following inclusion and exclusion criteria.

### Inclusion criteria-

- A full dentition except third molars.
- Pre-treatment lateral cephalograms.
- Maxillary and mandibular dental casts available.

### Exclusion criteria-

- Previous orthodontic treatment.
- Edentulous spaces.
- History of trauma.
- Significant cuspal wear.
- Extensive restorations or prosthetics.
- Anterior and posterior crossbites.
- Severe crowding (>9 mm) or spacing (>9 mm).

The Jarabak's ratio (posterior facial height/anterior facial height) was measured on cephalograms of each patient. Then subjects were divided into three groups i.e. 1) average growth pattern (Jarabak's ratio - 62-65%), 2) Horizontal growth pattern (Jarabak's ratio <61%), 3) vertical growth pattern (Jarabak's ratio >65%). Maxillary and mandibular inter-canine (from cusp tip of one side canine to cusp tip of opposite side canine) , first inter-premolar (from buccal cusp tip of one side 1st premolar to buccal cusp tip of opposite side 1st premolar), second inter-premolar (from buccal cusp tip of one side 2nd premolar to buccal cusp tip of opposite side 2nd premolar) and first inter-molar (from mesio-buccal cusp tip of one side 1st molar to mesio-buccal cusp tip of opposite side 1st molar) widths were measured on study models of each patient. Vernier calliper was used to measure the parameters: inter-canine width, first inter-premolar width, second inter-premolar width, first inter-molar width.

### Statistical analysis and methods

Data was collected using a structured proforma. Data entered in MS excel sheet and analysed by using SPSS 23.0 version IBM USA.

Quantitative data were expressed in terms of Mean

and Standard Deviation Comparison of mean and SD between two groups was done by using the unpaired t-test to assess whether the mean difference between groups is significant or not

Descriptive statistics of each variable was presented in terms of Mean, standard deviation, standard error of the mean. Comparison of mean and SD between all groups was done by using one-way ANOVA test. If ANOVA comes significant, then Post Hoc Tukey's HSD test was carried out to assess whether the mean difference between a pair of a group is significant or not

A p value of <0.05 was considered as statistically significant whereas a p-value <0.001 was considered as highly significant.

## RESULTS

Table 1 shows the mean and standard deviation values of arch dimension measurements of male and female subjects. As seen, males have larger means for dental arch width as compared to the female subjects. Table 2 shows a significant correlation between arch width and gender except in mandibular inter-canine and 1st inter-premolar width and maxillary inter-molar width.

The arch width measurements of horizontal, average and vertical growth pattern groups are presented in Table 3 which statistical analysis does not show significant correlation between growth pattern and dental arch widths except in maxillary first premolar, maxillary and mandibular first molar region which showed significant results.

**Table 1:**

| Parameter | N | Mean | SD | Std. Error | Range | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| Age | 120 | 19.53 | 3.07 | 0.28 | 23 | 15 | 38 |
| Intercanine width Maxillary | 120 | 35.18 | 2.95 | 0.27 | 13 | 28 | 41 |
| Intercanine width Mandibular | 120 | 26.46 | 2.36 | 0.21 | 9 | 22 | 31 |
| 1st interpremolar width Maxillary | 120 | 41.86 | 3.15 | 0.28 | 13 | 36 | 49 |
| 1st interpremolar width Mandibular | 120 | 34.75 | 2.68 | 0.24 | 14 | 27 | 41 |
| 2nd interpremolar width Maxillary | 120 | 46.96 | 3.23 | 0.29 | 17 | 39 | 56 |
| 2nd interpremolar width Mandibular | 120 | 40.19 | 2.65 | 0.24 | 12 | 34 | 46 |
| Intermolar width Maxillary | 120 | 51.84 | 3.32 | 0.3 | 17 | 43 | 60 |
| Intermolar width Mandibular | 120 | 44.87 | 3.18 | 0.29 | 18 | 36 | 54 |
| Jabarak's Ratio (%) | 120 | 67.36 | 8.4 | 0.76 | 44.00 | 52.00 | 96.00 |

**Table 2:**

| Parameter | SEX | N | Mean | SD | t | P | Inference |
|---|---|---|---|---|---|---|---|
| Intercanine width Maxillary | Female | 60 | 34.53 | 2.67 | -2.457 | 0.015 | Significant |
| | Male | 60 | 35.83 | 3.1 | | (<0.05) | |
| Intercanine width Mandibular | Female | 60 | 26.63 | 2.17 | 0.772 | 0.442 | Not significant |
| | Male | 60 | 26.3 | 2.53 | | (>0.05) | |
| 1st interpremolar width Maxillary | Female | 60 | 41.01 | 2.77 | -3.048 | .003 | Significant |
| | Male | 60 | 42.71 | 3.30 | | (<0.05) | |

| Parameter | SEX | N | Mean | SD | t | P | Inference |
|---|---|---|---|---|---|---|---|
| 1st interpremolar width Mandibular | Female | 60 | 34.46 | 2.78 | -1.157 | 0.250 | Not significant |
| | Male | 60 | 35.03 | 2.57 | | (>0.05) | |
| 2nd interpremolar width Maxillary | Female | 60 | 46.08 | 3.0 | -3.099 | 0.002 | Significant |
| | Male | 60 | 47.85 | 3.23 | | (<0.05) | |
| 2nd interpremolar width Mandibular | Female | 60 | 39.35 | 2.88 | -3.648 | .000 | Significant |
| | Male | 60 | 41.03 | 2.1 | | (<0.05) | |
| Intermolar width Maxillary | Female | 60 | 51.33 | 3.21 | -1.689 | 0.094 | Not significant |
| | Male | 60 | 52.35 | 3.37 | | (>0.05) | |
| Intermolar width Mandibular | Female | 60 | 44.35 | 2.92 | -1.470 | 0.144 | Not Significant |
| | Male | 60 | 45.2 | 3.38 | | (>0.05) | |

## Table 3:

| Parameter | Growth pattern | N | Mean | SD | F | P | Inference |
|---|---|---|---|---|---|---|---|
| Intercanine width Maxillary | Horizontal | 65 | 35.03 | 2.89 | 0.581 | 0.561(>0.05) | Not significant |
| | Average | 23 | 35.78 | 2.37 | | | |
| | Vertical | 32 | 35.06 | 3.45 | | | |
| | Total | 120 | 35.18 | 2.95 | | | |
| Intercanine width Mandibular | Horizontal | 65 | 26.86 | 2.39 | 2.192 | 0.116 (>0.05) | Not significant |
| | Average | 23 | 26.21 | 2.1 | | | |
| | Vertical | 32 | 25.84 | 2.37 | | | |
| | Total | 120 | 26.46 | 2.36 | | | |
| 1st interpremolar width Maxillary | Horizontal | 65 | 42.55 | 2.7 | 4.071 | 0.02 (<0.05) | Significant |
| | Average | 23 | 41.56 | 2.48 | | | |
| | Vertical | 32 | 40.68 | 4.04 | | | |
| | Total | 120 | 41.86 | 3.15 | | | |
| 1st interpremolar width Mandibular | Horizontal | 65 | 35.13 | 2.54 | 2.778 | 0.066 (>0.05) | Not significant |
| | Average | 23 | 34.95 | 2.49 | | | |
| | Vertical | 32 | 33.81 | 2.93 | | | |
| | Total | 120 | 34.75 | 2.68 | | | |
| 2nd interpremolar width Maxillary | Horizontal | 65 | 47.52 | 3.32 | 2.141 | 0.122 (>0.05) | Not significant |
| | Average | 23 | 46.3 | 2.03 | | | |
| | Vertical | 32 | 46.31 | 3.6 | | | |
| | Total | 120 | 46.96 | 3.23 | | | |
| 2nd interpremolar width Mandibular | Horizontal | 65 | 40.66 | 2.64 | 2.665 | 0.074 (>0.05) | Not significant |
| | Average | 23 | 40.0 | 2.23 | | | |
| | Vertical | 32 | 39.37 | 2.81 | | | |
| | Total | 120 | 40.19 | 2.65 | | | |
| Intermolar width Maxillary | Horizontal | 65 | 52.63 | 3.1 | 4.466 | 0.014 (<0.05) | Significant |
| | Average | 23 | 51.26 | 3.0 | | | |
| | Vertical | 32 | 50.65 | 3.62 | | | |
| | Total | 120 | 51.84 | 3.32 | | | |

| Parameter | Growth pattern | N | Mean | SD | F | P | Inference |
|---|---|---|---|---|---|---|---|
| Intermolar width Mandibular | Horizontal | 65 | 45.58 | 2.83 | 8.11 | 0.01 (<0.05) | Significant |
| | Average | 23 | 42.65 | 3.45 | | | |
| | Vertical | 32 | 44.65 | 3.01 | | | |
| | Total | 120 | 44.77 | 3.18 | | | |

## DISCUSSION

Every individual has a unique dento-facial pattern and consists of many variations. Evaluating the relationship between the dental arch and vertical facial morphology is necessary in order to understand the variation in size and shape of the dental arches. Ethnic differences are also an important aspect to be considered in orthodontic treatment, thus this study was conducted to evaluate ethnic variations in arch width.

Research has established the importance of vertical dimension. According to the study by Ricketts et al (1982)[1], Enlow and Hans (1996)[2] it has been suggested that a subject with a low MP-SN angle often has a shorter face and wider arch dimensions and a high MP-SN angle tends to have a long face and narrower arch dimensions. A well-established sexual dimorphism in the arch dimensions has been found to exist in the vertical plane in studies conducted by Wei (1970)[10], Christie (1977)[12], Eroz et al (2000)[6] and Forster et al (2008)[7]. They found that males had sufficiently larger arch widths as compared with females. Jarabak's and Siriwat (1985)[13], Bishara and Jakobsen (1985)[14] had also found a sexual dimorphism to exist among various facial types.

In the present study, subjects were divided into three groups 1) average growth pattern (Jarabak's ratio -62-65 %), 2) Horizontal growth pattern (Jarabak's ratio <61%), 3) vertical growth pattern (Jarabak's ratio >65%)[11].

For maxillary and mandibular arches, there was a statistically significant relationship between dental arch width and gender at the maxillary canine, first premolar, second premolar and first molar region except in mandibular inter-canine and 1st inter-premolar width and maxillary inter-molar width. In males, arch width is more as compared to females. Similar findings have also been reported by the Eroz et al (2000)[6] and Forster et al (2008)[7].

The arch width measurements of horizontal, average and vertical growth pattern show that in majority cases the vertical group had smaller mean arch widths as compared to horizontal and average growing subjects, but the statistical analysis does not show a significant correlation between growth pattern and dental arch widths. Dental arch width means decrease as Jarabak's ratio value increases in all regions except in Maxillary and mandibular 2nd inter-premolar width and mandibular inter-molar width in these regions arch widths in average growing subjects is slightly greater than horizontal growing subjects. The majority of the studies show a significant correlation between vertical facial pattern and arch width but the present study did not show a significant correlation between vertical facial morphology and arch width. This non-significant correlation between three groups and arch widths may be due to ethnic variation or may be due to small sample size.

## CONCLUSION

Based on the results and discussions above, it can be concluded that;

1) The dental arch widths of males were found to be wider than females among untreated adult's population.

2) Vertical facial morphology did not show a relationship with arch width of upper and lower dental arches at the canine, first premolar, second premolar, and first molar regions.

**Consent for Publication**: The author reviewed and approved the final version and has agreed to be accountable for all aspects of the work, including any accuracy or integrity issues.

**Disclosure:** The author declares that they do not have any financial involvement, association, or entity directly or indirectly with the subject matter or materials presented in this editorial. This includes honoraria, expert testimony, employment, ownership of stocks or

options, patents, or grants received or pending royalties.

**Data Availability**: The data is exclusively available from the principal author for research purposes only.

**Authorship Contribution**: All authors contributed significantly to the work, whether in the conception, design, utilization, collection, analysis, and interpretation of data or all these areas. They also participated in the paper's drafting, revision, or critical review, gave their final approval for the version that would be published, decided on the journal to which the article would be submitted, and made the responsible decision to be held accountable for all aspects of the work.

## References


1. Ricketts RM, Roth RH, Chaconas SJ, Schulhof RJ, Engel GA. Orthodontic diagnosis and planning. Rocky Mountain Data Systems, Denver 1982.
2. Enlow DH, Hans MG. Essentials of facial growth. Philadelphia: WB Saunders 1996.
3. Wagner DM, Chung CH. Transverse growth of the maxilla and mandible in untreated girls with low, average, and high MP-SN angles: a longitudinal study. American journal of orthodontics and dentofacial orthopaedics. 2005 Dec 1;128(6):716-23.
4. Howes AE. Arch width in the premolar region—still the major problem in orthodontics. American Journal of Orthodontics and Dentofacial Orthopaedics. 1957 Jan 1;43(1):5-31.
5. Isaacson JR, Isaacson RJ, Speidel TM, Worms FW. Extreme variation in vertical facial growth and associated variation in skeletal and dental variations. Angle Orthod 1971; 41:219-30.
6. Eroz UB, Ceylan I, Aydemir S. An investigation of mandibular morphology in subjects with different vertical facial growth patterns. Aus Orthod J 2000; 16:16-22.
7. Forster CM, Chung CH. The relationship between dental arch width and vertical facial morphology in untreated adults. Eur J Orthod 2008; 30:288-97.
8. Shirin L, Begum T, Kabir MS, Mohammed Noor NF, Samsudin HZ, Basri R, Abdullah JY, Islam A. Facial dimension on three-dimensional computed tomography in patients with epilepsy: A preliminary study. Bangladesh J Med Sci. 2023 Jan;22(1):97-104.
9. Qadeer M, Jaafar S, Khamis MF, Alam MK, Arshad AI, Saeed MQ, Khan H. A systematic scoping review of dental anomalies associated with cleft lip and palate patients. Bangladesh J Med Sci. 2023 Jan;22(1):22-31.
10. Wei SH. Craniofacial width dimensions. Angle Orthod 1970; 40:141-47.
11. Jarabak's J.R, Fizzell J.A: Technique and treatment with light wire edgewise appliance. CV Mosby: St. Louis; 1972.
12. Christie TE. Cephalometric patterns of adults with normal occlusion. Angle Orthod 1977; 47:128-35.
13. Siriwat PP, Jarabak's JR. Malocclusion and facial morphology is there a relationship? An epidemiologic study. Angle Orthod 1985; 55:127-38.
14. Bishara SE, Jakobsen JR. Longitudinal changes in three normal facial types. Am J Orthod 1985; 88:466-502.
15. Khera AK, Singh GK, Sharma VP, Singh A. Relationship between dental arch dimensions and vertical facial morphology in class I subjects. Journal of Indian Orthodontic Society. 2012 Jan1;46(6):316-24.