



## Original Research Article

## Correlation of dental arch width and alveolar arch width with facial divergence

Bharti Goyal<sup>1\*</sup>, Sudhir Munjal<sup>2</sup>, Ankit Sikri<sup>1</sup>, Abhishek Sharma<sup>1</sup>, Jasmeet Ryait<sup>3</sup>,  
Rishu Gautam<sup>4</sup>

<sup>1</sup>Dept. of Orthodontics, Guru Nanak Dev Dental College & Research Institute, Patiala, Punjab, India

<sup>2</sup>Dept. of Orthodontics, Dasmesh Institute of Research and Dental Sciences, Faridkot, Punjab, India

<sup>3</sup>Dept. of Orthodontics, Baba Jaswant Singh Dental College, Ludhiana, Punjab, India

<sup>4</sup>Private Practice, Ludhiana, Punjab, India



## ARTICLE INFO

## Article history:

Received 24-08-2022

Accepted 25-09-2023

Available online 28-12-2023

## Keywords:

Hyperdivergent  
Normodivergent  
Alveolar

## ABSTRACT

**Introduction:** Dentofacial skeletal anomalies occur as a result of a differential growth of the lower facial skeleton to upper facial skeleton resulting in malocclusion in transverse, vertical and sagittal plane.

**Aim and Objectives:** To correlate different Vertical facial types with Dental arch width and Alveolar arch width for the patients in North Indian sub population.

**Materials and Methods:** Lateral cephalograms and study models of 150 untreated adults were selected and divided into 3 groups: Group I (Normodivergent), Group II (Hypodivergent) and Group III (Hyperdivergent) on the basis of (SN-MP angle, FMA, Gonial angle & Jarabak's ratio). Dental arch width and Alveolar arch width were measured on maxillary and mandibular casts by using digital caliper.

**Results:** All the 3 groups were compared by using ANOVA followed by Post Hoc Turkey HSD test. Significant ( $p < 0.05$ ) correlation was seen for parameters of Dental arch width and Alveolar arch width in both maxillary and mandibular arches with Facial divergence.

**Conclusion:** Dental and Alveolar arch width were maximum in hypodivergents followed by normodivergents and minimum in hyperdivergents in both maxillary and mandibular arches. Therefore, during orthodontic treatment it is suggested to use individualized arch wires according to each patients pretreatment arch form and widths.

This is an Open Access (OA) journal, and articles are distributed under the terms of the [Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License](https://creativecommons.org/licenses/by-nc-sa/4.0/), which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: [reprint@ipinnovative.com](mailto:reprint@ipinnovative.com)

## 1. Introduction

Arch dimensions and arch forms are 2 prime factors in case assessment, diagnosis and treatment planning. The association of malocclusion and facial form has been a focus of orthodontist since early 20<sup>th</sup> century. Facial growth and development are of deep concern for an orthodontists because the amount and direction of growth will significantly alter the need for orthodontic treatment.<sup>1</sup> In the vertical plane, 3 basic types of facial morphology exist: short, average and long. Person with

long face have excessive vertical facial growth which is usually associated with an anterior open bite, increased SN-MP angle, increased Gonial angle and increased maxillo-mandibular plane angle. The short face types have reduced vertical growth associated with deep overbite, reduced facial heights, reduced SN-MP angle and reduced FMA.<sup>2</sup> Average face lies between these two types.

In the present day orthodontic practice, newer techniques and materials have introduced for orthodontists convenience and patient comfort with greater precision; preformed archwires have gained popularity. The shape of preformed archwires especially superelastic nitinol wires can't be

\* Corresponding author.

E-mail address: [Bhartigoyal26@gmail.com](mailto:Bhartigoyal26@gmail.com) (B. Goyal).



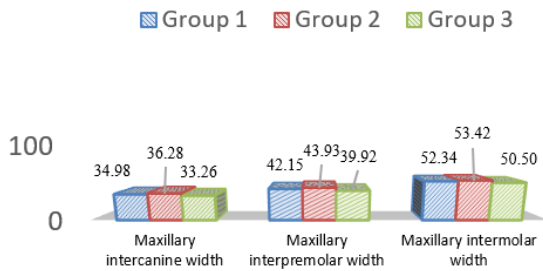
**Table 1:** Dental casts measurements used in the study and their definitions.

S. No.	Variable	Abbreviation	Definition
<b>(i) Dental Arch Width</b>			
1	Maxillary Inter canine Width	(UC-C)	The distance between the cusp tips of the right and left canines or the center of the wear facets in cases of attrition.
2	Maxillary Inter premolar Width	(UP-P)	The distance between the cusp tips of the right and left first premolars.
3	Maxillary Inter molar Width	(UM-M)	The distance between the mesiobuccal cusp tips of the right and left first molars.
4	Mandibular Inter canine Width	(LC-C)	The distance between the cusp tips of the right and left mandibular canines.
5	Mandibular Inter premolar Width	(LP-P)	The distance between the cusp tips of the right and left mandibular first premolars.
6	Mandibular Inter molar Width	(LM-M)	The distance between the most gingival extension of the buccal groove on the first molars or, when the grooves had no distinct terminus on the buccal surface, between points on the groove located at the middle of the buccal surfaces.
<b>(ii) Alveolar Arch Width</b>			
1	Maxillary Canine Alveolar Width	(UAC-C)	The distance between two most prominent points viewed occlusally in canine alveolar region above the cusp tips of the maxillary right and left canines.
2	Maxillary Premolar Alveolar Width	(UAP-P)	The distance between two most prominent points viewed occlusally in premolar alveolar region above the interdental contact point of the maxillary first and second premolars.
3	Maxillary Molar Alveolar Width	(UAM-M)	The distance between two most prominent points viewed occlusally in molar alveolar region above the mesiobuccal cusp tips of the maxillary first molars.
4	Mandibular Canine Alveolar Width	(LAC-C)	The distance between two most prominent points viewed occlusally in canine alveolar region above the cusp tips of the mandibular right and left canines.
5	Mandibular Premolar Alveolar Width	(LAP-P)	The distance between two most prominent points viewed occlusally in premolar alveolar region above the interdental contact point of the mandibular first and second premolars.
6	Mandibular Molar Alveolar Width	(LAM-M)	The distance between two most prominent points viewed occlusally in molar alveolar region above the buccal groove of the mandibular first molars.

had narrower dental and alveolar arch width than hypodivergents.

Post Hoc Turkey HSD test shows that Dental arch width and Alveolar arch width decreases significantly ( $p < 0.05$ ) from hypodivergents to hyperdivergent (Table 3).

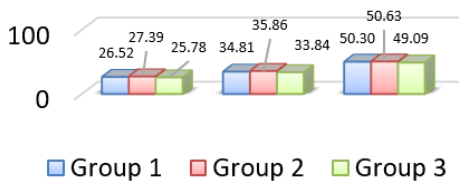
### DENTAL ARCH WIDTH MAXILLA



Graph 1: Intergroup comparison of mean values of dental arch width in maxilla.

Significant decrease in Maxillary intercanine width, Interpremolar width and Intermolar width from hypodivergents to hyperdivergents.

### DENTAL ARCH width MANDIBLE



Graph 2: Intergroup comparison of mean values of dental arch width in mandible

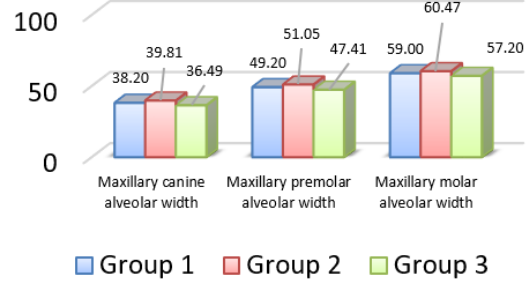
Significant decrease in Mandibular intercanine width, Interpremolar width and Intermolar width from hypodivergents to hyperdivergents.

Significant decrease in Maxillary canine alveolar width, Premolar alveolar width and Molar alveolar width from hypodivergents to hyperdivergents.

### 5. Discussion

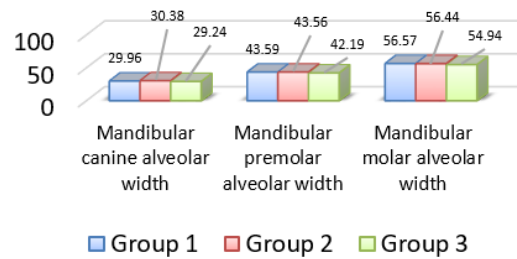
Larger variations found in vertical dimension will affect the clinician’s approach to successful diagnosis, treatment planning and biomechanics. Intergroup comparisons were done between normodivergent, hypodivergent and hyperdivergent subjects for dental arch width, alveolar arch width, arch length and sagittal facial types by using one

### ALVEOLAR arch WIDTH MAXILLA



Graph 3: Intergroup comparison of mean values of alveolar arch width in maxilla.

### ALVEOLAR arch WIDTH MANDIBLE



Graph 4: Significant decrease in Mandibular canine alveolar width, Premolar alveolar width and Molar alveolar width from hypodivergents to hyperdivergents.

way analysis of variance (ANOVA) followed by Post Hoc Turkey HSD test. The results drawn from present study showed that there was a statistically significant ( $p < 0.05$ ) inverse relationship between vertical facial morphology and dental arch width at canine, first premolar and first molar region in both maxillary and mandibular arches. These findings were supported by Nasby et al (1972),<sup>5</sup> Khera et al (2012),<sup>6</sup> Prasad et al. (2013),<sup>7</sup> Grippaudo et al. (2013),<sup>8</sup> Jumani, Erum & Ahmed (2014),<sup>9</sup> Alghamadi & Tashkandi (2022)<sup>10</sup> and Yamamoto, Tanikawa & Yamashiro (2023).<sup>11</sup> Statistically significant ( $p < 0.05$ ) inverse relationship found between vertical facial morphology and alveolar arch width at canine, first premolar and first molar region in both maxillary and mandibular arches. These findings were supported by Christie (1977),<sup>12</sup> who found that short-faced men had greater maxillary and mandibular widths than normal, Chen et al. (2007),<sup>13</sup> Tricoveluri et al. (2013)<sup>14</sup> & Ponraj et al. (2016).<sup>15</sup> Musculature has been considered as a possible link in this close relationship between the transverse dimension and vertical facial morphology.

**Table 2:** Intergroup comparison of dental arch width and Alveolar arch width using Anova

Parameter	Group 1 (N=52)			Group 2 (N=54)			Group 3 (N=44)			ANOVA	
	Mean	±	S.D.	Mean	±	S.D.	Mean	±	S.D.	F-Value	P-Value
Maxillary Inter canine Width UC-C	34.98	±	2.81	36.28	±	3.75	33.26	±	2.94	10.725	<0.001*
Maxillary Inter premolar Width UP-P	42.15	±	2.97	43.93	±	3.26	39.92	±	3.12	20.030	<0.001*
Maxillary Inter molar Width UM-M	52.34	±	3.36	53.42	±	3.34	50.50	±	2.59	10.492	<0.001*
Mandibular Inter canine Width LC-C	26.52	±	2.16	27.39	±	2.52	25.78	±	2.13	6.094	<0.003*
Mandibular Inter premolar Width LP-P	34.81	±	4.47	35.86	±	3.04	33.84	±	2.41	4.170	<0.017*
Mandibular Inter molar Width LM-M	50.30	±	2.87	50.63	±	2.43	49.09	±	2.68	4.357	<0.015*
Maxillary Canine Alveolar Width UAC-C	38.20	±	2.43	39.81	±	3.29	36.49	±	2.45	17.318	<0.001*
Maxillary Premolar Alveolar Width UAP-P	49.20	±	3.14	51.05	±	3.51	47.41	±	2.94	15.605	<0.001*
Maxillary Molar Alveolar Width UAM-M	59.00	±	3.50	60.47	±	3.38	57.20	±	2.77	12.222	<0.001*
Mandibular Canine Alveolar Width LAC-C	29.96	±	2.08	30.38	±	2.47	29.24	±	1.87	3.355	<0.038*
Mandibular Premolar Alveolar Width LAP-P	43.59	±	1.78	43.56	±	3.16	42.19	±	2.35	4.713	<0.010*
Mandibular Molar Alveolar Width LAM-M	56.57	±	2.45	56.44	±	2.74	54.94	±	2.56	5.725	<0.004*

**Table 3:** Intergroup comparison of dental arch width and alveolar arch width using post hoc turkey HSD test.

Parameter	Group 1 vs Group 2		Group 1 vs Group 3		Group 2 vs Group 3	
	Mean diff	P-value	Mean diff	P-value	Mean diff	P-value
Maxillary Inter canine Width UC-C	-1.30	0.096	1.72	<0.027*	3.02	<0.001*
Maxillary Inter premolar Width UP-P	-1.78	<0.011*	2.23	<0.002*	4.01	<0.001*
Maxillary Inter molar Width UM-M	-1.08	0.185	1.84	<0.014*	2.91	<0.001*
Mandibular Inter canine Width LC-C	-0.87	0.127	0.74	0.255	1.61	<0.002*
Mandibular Inter premolar Width LP-P	-1.05	0.262	0.97	0.363	2.02	<0.013*
Mandibular Inter molar Width LM-M	-0.32	0.808	1.21	0.070	1.53	<0.014*
Maxillary Canine Alveolar Width UAC-C	-1.61	<0.009*	1.71	<0.009*	3.31	<0.001*
Maxillary Premolar Alveolar Width UAP-P	-1.86	<0.010*	1.79	<0.020*	3.65	<0.001*
Maxillary Molar Alveolar Width UAM-M	-1.47	0.057	1.80	<0.021*	3.27	<0.001*
Mandibular Canine Alveolar Width LAC-C	-0.42	0.586	0.72	0.240	1.14	<0.029*
Mandibular Premolar Alveolar Width LAP-P	0.03	0.998	1.40	<0.020*	1.37	<0.022*
Mandibular Molar Alveolar Width LAM-M	0.13	0.963	1.63	<0.007*	1.50	<0.014*

Strong or thick mandibular elevator muscle in short face individuals might be the reason for increased dental arch width and alveolar arch width in hypodivergents. This muscular hyperfunction causes an increased mechanical loading of the jaws which in turn may cause an induction of sutural growth and bone apposition which then results in increased transverse growth of the jaws and bone bases for the dental arches. Benington, Gardener & Hunt (1999) evidenced that large masticatory muscles are associated with brachycephalism and vice versa.<sup>16</sup> Van Spronsen et al (1992) found that long-faced subjects have significantly smaller masseter and medial pterygoid muscles than normal subjects.<sup>17</sup> Satiroglu, Arun & Isik (2005)<sup>18</sup> ultrasonographically measured masseter muscle thickness and found that individuals with thick masseter had a vertically shorter facial pattern and individuals with thin masseter had a long face.

Also the direction of mandibular growth is influenced by the tongue base position, as the anterior tongue pressure might influence on the rotation of mandibular corpus. Because of the lowered positioning of tongue, the balance between the tongue and buccinators muscle (buccinators mechanism) might be disturbed and this can be a reason for the arch constriction in maxilla. Mandible also constricts along with maxilla since maxillary and mandibular arches are mutual counterparts according to Enlows counterpart principle.

## 6. Conclusion

1. Maxillary and mandibular dental arch width (intercanine width, interpremolar width and intermolar width) were maximum in hypodivergents followed by normodivergents and minimum in hyperdivergents.
2. Maxillary and mandibular alveolar arch width (canine alveolar width, premolar alveolar width and molar alveolar width) were maximum in hypodivergents followed by normodivergents and minimum in hyperdivergents.
3. Since dental arch width and alveolar arch width were found to be associated with facial divergence; therefore, during orthodontic treatment, it is suggested to use individualized arch wires according to each patients pretreatment arch form and widths.

## 7. Limitations and Further Scope

The possible short-comings and limitations include errors in tracing, digitizing and measurements. Measurement accuracy is sensitive to human errors and is governed by sensitivity of measuring instruments. There were likely unavoidable magnification differences among different cephalometric films.

This study can be further carried out by dividing the samples into different sex group, so that further discussion

of study can ease the clinicians to individualize the archwires among males and females for better treatment and results.

## 8. Source of Funding

None.


## 9. Conflict of Interest

None.

## References

1. Mangla R, Singh N, Dua V, Padmanabhan P, Khanna M. Evaluation of mandibular morphology in different facial types. *Contemp Clin Dent*. 2011;2(3):200–6.
2. Peterson TM, Rugh JD, Mciver JE. Mandibular rest position in subjects with high and low mandibular plane angles. *Am J Orthod*. 1983;83:318–20.
3. Patel VJ, Bhatia AF, Mahadevia SM, Italia S, Vaghamsi M. Dental arch form analysis in Gujarati males and females having normal occlusion. *J Ind Orthod Soc*. 2012;46(6):295–9.
4. Lee RT. Arch width and form: a review. *Am J Orthod Dentofac Orthop*. 1999;115(3):305–13.
5. Nasby JA, Isaacson RJ, Worms FW, Speidel TM. Orthodontic extractions and the facial skeletal pattern. *Angle Orthod*. 1972;42(2):116–22.
6. Khera AK, Singh GK, Sharma VP, Singh A. Relationship between dental arch dimensions and vertical facial morphology in class I subjects. *J Ind Orthod Soc*. 2012;46(4):316–24.
7. Prasad M, Kannampallil ST, Talapaneni AK, George SA, Shetty SK. Evaluation of arch width variations among different skeletal patterns in South Indian population. *J Nat Sci*. 2013;4(1):94–102.
8. Grippaudo C, Oliva B, Greco AL, Sferra S, Deli R. Relationship between vertical facial patterns and dental arch form in class II malocclusion. *Progress in Orthod*. 2013;14:1–7.
9. Jumani SS, Erum G. Correlation of vertical facial morphology and dental arch width in untreated Pakistani adults. *Int J Dent Health Sci*. 2014;1:890–9.
10. Alghamdi M, Tashkandi N. Relationship between Dental Arch Parameters and Mandibular Plane Angle. *J Adv Med Dent Sci Res*. 2022;10(5):105–27.
11. Yamamoto S, Tanikawa C, Yamashiro T. Morphologic variations in the craniofacial structures in Japanese adults and their relationship with sex differences. *Am J Orthod Dentofac Orthop*. 2023;163(4):93–103.
12. Christie TE. Cephalometric patterns of adult with normal occlusion. *Angle Orthod*. 1977;47(2):128–35.
13. Chen F, Terada K, Wu L, Saito I. Dental arch widths and mandibular-maxillary base width in Class III malocclusions with low, average and high MP-SN angles. *Angle Orthod*. 2007;77(1):36–41.
14. Tricoveluri S, Singh JR, Rayapudi N, Karra A, Begum M, Challa PL. Correlation of Masseter Muscle Thickness and Intermolar Width - An Ultrasonography Study. *J Int Oral Health*. 2013;5(2):28–34.
15. Ponraj RR, Korath VA. Relationship of Anterior Alveolar Dimensions with Mandibular Divergence in Class I Malocclusion - A Cephalometric Study. *J Clin Diagn Res*. 2016;10(5):29–33.
16. Benington PC, Gardener JE, Hunt NP. Masseter muscle volume measured using ultrasonography and its relationship with facial morphology. *Eur J Orthod*. 1999;21(6):659–70.
17. Van Spronsen P, Weijs WA, Valk J, Prah Andersen B, Ginkel V. A comparison of jaw muscle cross-sections of long-face and normal adult. *J Dent Res*. 1992;71(6):1279–85.
18. Satiroglu F, Arun T, Isik F. Comparative data on facial morphology and muscle thickness using ultrasonography. *Eur J Orthod*. 2005;27(6):562–7.

**Author biography**

**Bharti Goyal**, Reader  <https://orcid.org/0000-0003-2705-8280>

**Sudhir Munjal**, Professor and Head

**Ankit Sikri**, Professor

**Abhishek Sharma**, Reader

**Jasmeet Ryait**, Reader

**Rishu Gautam**, Private Practitioner

**Cite this article:** Goyal B, Munjal S, Sikri A, Sharma A, Ryait J, Gautam R. Correlation of dental arch width and alveolar arch width with facial divergence. *J Contemp Orthod* 2023;7(4):304-310.