Evaluation in Arch Width Variations among Different Skeletal Patterns in District Solan Population

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Abstract

Introduction The facial growth pattern differs from individual to individual, and the variations in it are quite high. The assessment of relationship of dental arch dimensions with the facial growth pattern is essential for proper diagnosis and treatment planning.
Aim The purpose of this study was to evaluate and compare the dental and alveolar arch widths in patients with varying facial growth patterns in Distt. Solan population.
Materials and Methods Pretreatment lateral cephalograms and dental study models of 45 patients with age group between 16 and 30 years were included in the study. Patients were divided into three groups: group I (normodivergent), group II (hypodivergent), and group III (hyperdivergent) on the basis of y-axis, Jarabak ratio, and SN-MP (Sella-Nasion–mandibular plane) angle. Interpremolar and intermolar dental and alveolar arch widths were measured and compared for all the three groups.
Results The results showed that the dental and alveolar arch widths were increased in hypodivergent patients and decreased in hyperdivergent patients, which was not statistically significant.
Conclusion It was concluded that the dental and alveolar arch dimensions increased as the facial pattern became horizontal.

Keywords
- normodivergent
- hypodivergent
- hyperdivergent
- interpremolar arch widths
- intermolar arch widths

Introduction

Improving the aesthetics of the face is one of the main reasons for a patient seeking orthodontic treatment. This can only be achieved by thorough diagnosis, which involves intra- and extraoral measurements of the face and dental arches.[1] The dental arches change due to intervention in treatment as well as with growth and development. The proper identification of a patient's arch form is an important characteristic of attaining a stable, functional, and aesthetic result of orthodontic treatment, and failing in preserving the arch form might increase the chances of relapse.[2] Arch form is the position and relationship of teeth to each other in all three dimensions.[3] Several studies have shown the relationship of arch forms and dimensions, particularly the arch widths with other dentoskeletal features.[4]

Dental arch widths and facial forms are key factors for ascertaining success and of orthodontic treatment. It is credited that a relationship is there between arch widths and facial forms.[2] Facial morphology has been believed to be the outcome of each person's genotypic and its phenotypic expression. Three basic types of facial morphology exist: normodivergent, hypodivergent, and hyperdivergent. Hypodivergent patients (brachyfacial) are characterized by wider arch dimensions, and hyperdivergent patients (dolichofacial) are characterized by narrower arch dimensions according to Ricketts et al (1982).[5] The two paramounts of vertical facial dysplasia were also explained as hypodivergent and hyperdivergent growth pattern by Schudy (1964)[6] or short- and long-face syndrome by Opdebeeck and Bell (1978).[7] The maxillary and mandibular dental arches can be considered as kind of ribbons, adapted to altering jaw relationships to maintain normal association between the arches for esthetic and function.[8]

Schudy (1964)[6] recommended use of anterior cranial base (Sella-Nasion [SN] plane) as reference line to establish the inclination of the mandibular plane (MP). A patient with a high SN-MP angle (steep MP) has a tendency of longer face, and one with a smaller SN-MP angle (flat MP) tends to have a shorter face. Howes (1957)[9] reported that increased MP angle

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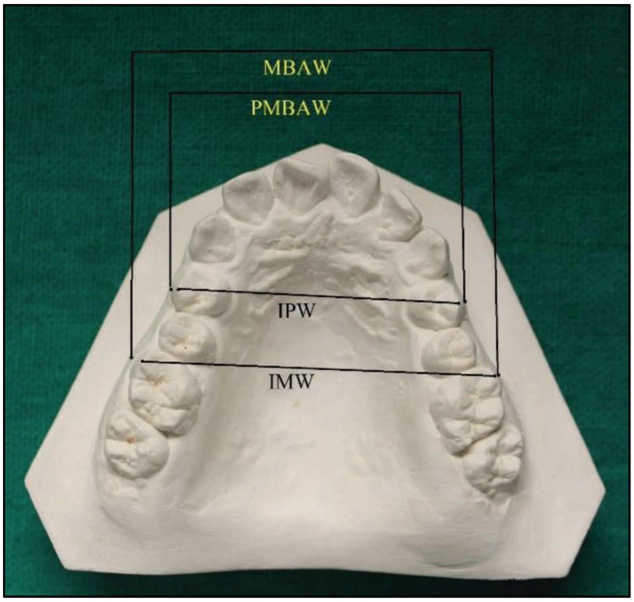

Fig. 2 Interpremolar and intermolar dental and alveolar arch width (maxilla).

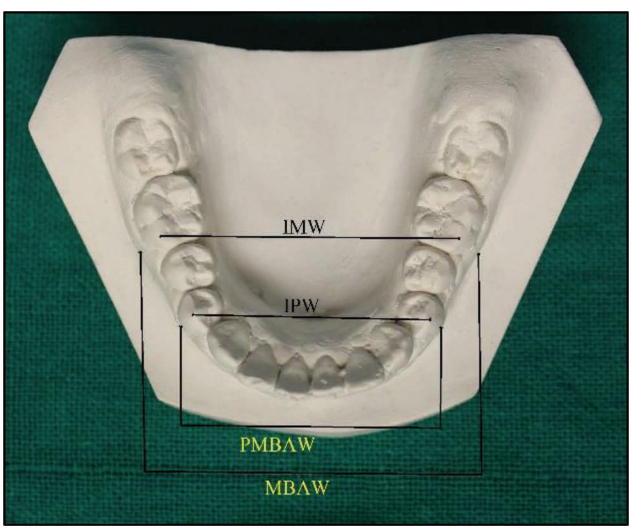

Fig. 3 Interpremolar and intermolar dental and alveolar arch width (mandibular). IMW, intermolar dental arch width; IPW, interpremolar dental arch width; MBAW, molar basal arch width; PMBAW, premolar basal arch width.

Statistical Analysis

The data so obtained were applied for the statistical analysis using statistical package program SPSS software version 10.2 (IBM; New York, United States). Descriptive statistics, including the mean and standard deviation (SD) values, were calculated for all the parameters in each group. Analysis of variance (ANOVA) test was carried out to show the intergroup comparisons. Post hoc tests were done for multiple comparisons.

Results

The study was conducted on dental casts' model of 45 patients who were separated into three groups, that is, group I (hyperdivergent), group II (normodivergent), and group III (hypodivergent), with 15 in each group on the basis of SN-MP angle, J ratio, and y-axis. The two measurements from each maxilla and mandible were carried out on the casts' models using a vernier calliper.

The descriptive statistics showed that the mean interpremolar dental arch width was found to be highest in normodivergent group (43.03 mm) than in hypodivergent group (42.06 mm) and lowest in hyperdivergent group (41.96 mm) for maxillary study models as depicted in ►**Table 2**. The descriptive statistics showed that mean intermolar dental arch width was found to be highest in normodivergent group (52.86 mm) than in hypodivergent group (52.70 mm) and lowest in hyperdivergent group (52.46 mm) for maxillary study models, as depicted in ►**Table 2**.

The descriptive statistics showed that mean interpremolar alveolar arch width was found to be highest in normodivergent group (51.13 mm) than the hypodivergent group (49.16 mm) and lowest in hyperdivergent group (48.46 mm) for maxillary study models as depicted in ►**Table 2**. The descriptive statistics showed that mean intermolar alveolar arch width was also found to be highest in normodivergent group (59.13 mm) than the hypodivergent group (58.86 mm) and lowest in hyperdivergent group (58.06 mm) for maxillary study models as depicted in ►**Table 2**.

The descriptive statistics showed that the mean interpremolar dental arch width was found to be highest in normodivergent group (35.93 mm) than in hypodivergent group (35 mm) and lowest in hyperdivergent group (34.50 mm)

Table 2 Descriptive statistics for maxillary arch

Parameters	Hyperdivergent (*n* = 15)		Normodivergent (*n* = 15)		Hypodivergent (*n* = 15)		ANOVA *p*-Value
	Mean SD	Standard error	Mean SD	Standard error	Mean SD	Standard error	
IPW Mx	41.967 ± 3.02	0.782	43.033 ± 3.58	0.925	41.96 ± 3.90	1.007	0.660
IMW Mx	52.46 ± 3.44	0.888	52.86 ± 3.73	0.965	52.70 ± 4.43	1.145	0.961
PMBAW Mx	48.46 ± 3.58	0.925	51.13 ± 3.61	0.934	49.16 ± 3.83	0.990	0.133
MBAW Mx	58.06 ± 4.61	1.192	59.13 ± 2.94	0.761	58.86 ± 3.96	1.022	0.740

Abbreviations: ANOVA, analysis of variance; IMW, intermolar dental arch width; IPW, interpremolar dental arch width; MBAW, molar basal arch width; PMBAW, premolar basal arch width; SD, standard deviation.

for mandibular study models as depicted in ►**Table 3**. The descriptive statistics showed that mean intermolar dental arch width was found to be highest in normodivergent group (46.06 mm) than in hypodivergent group (45.76 mm) and lowest in hyperdivergent group (45.70 mm) for mandibular study models as depicted in ►**Table 3**.

The descriptive statistics showed that mean interpremolar alveolar arch width was found to be highest in normodivergent group (44.20 mm) than the hypodivergent group (42.80 mm) and lowest in hyperdivergent group (42.06 mm) for mandibular study models as depicted in ►**Table 3**. The descriptive statistics showed that mean intermolar alveolar arch width was also found to be highest in normodivergent group (55.43 mm) than the hypodivergent group (54.30 mm) and lowest in hyperdivergent group (54.26 mm) for mandibular study models as depicted in ►**Table 3**.

ANOVA statistics was done to compare the arch dimensions among the three groups. The results showed that the interpremolar and intermolar dental and alveolar arch widths were not statistically significant ($p > 0.05$) when intergroup comparison was made, as depicted in ►**Tables 2** and **3**. For the multiple comparisons, post hoc test was done by Tukey HSD method. The results for multiple comparisons showed that no statistical difference was found to be significant ($p > 0.05$) when the interpremolar and intermolar dental and alveolar arch widths of the three groups were compared, as depicted in ►**Table 4**.

Discussion

Vertical facial pattern is an important element of orthodontic assessment. It is an essential criterion for each orthodontist to understand the association between vertical facial height and dental arch width for proper diagnosis and treatment planning.[16]

The facial growth pattern differs from individual to individual, and the variations in it are quite high. The assessment of relationship of dental arch dimensions with the vertical facial pattern is essential to understand the differential in size and shape of dental arches. It has been suggested that an individual with a greater SN-MP angle have a tendency of longer face and narrower arch dimensions and in individual with a reduced SN-MP angle predominantly has a shorter face and wider arch dimensions (Ricketts et al [1981],[5] Enlow and Hans [1996][17]). This study was conducted to interpret and collate the interpremolar and intermolar dental and alveolar arch dimensions in patients with varying growth patterns. Forty-five patients were selected for this study. These were divided into three groups with 15 in each: group I (hyperdivergent), group II (normodivergent), and group III (hypodivergent) on the basis of J ratio, y-axis, and SN-MP angle. J ratio was used because it is a reliable measurement, constructed from anatomic landmarks (Bishara and Jacobsen [1985][18]), and the chance of human error is also minimized by using a ratio instead of linear parameter.

Table 3 Descriptive statistics for mandibular arch

Parameters	Hyperdivergent (*n* = 15)		Normodivergent (*n* = 15)		Hypodivergent (*n* = 15)		ANOVA *p*-Value
	Mean SD	Standard error	Mean SD	Standard error	Mean SD	Standard error	
IPW Md	34.50 ± 3.09	0.798	35.93 ± 3.98	1.028	35.00 ± 3.31	0.856	0.525
IMW Md	45.70 ± 4.13	1.068	46.06 ± 3.57	0.921	45.76 ± 3.45	0.891	0.960
PMBAW Md	42.06 ± 3.00	0.775	44.20 ± 2.71	0.701	42.80 ± 2.85	0.738	0.129
MBAW Md	54.26 ± 3.12	0.806	55.43 ± 2.63	0.681	54.30 ± 3.33	0.860	0.496

Abbreviations: ANOVA, analysis of variance; IMW, intermolar dental arch width; IPW, interpremolar dental arch width; MBAW, molar basal arch width; PMBAW, premolar basal arch width; SD, standard deviation.

Table 4 Multiple comparisons post hoc

Parameters	Normo vs. hypo		Hyper vs. hypo		Normo vs. hyper	
	Mean diff.	*p*-Value	Mean diff.	*p*-Value	Mean diff.	*p*-Value
IPW Mx	1.066	0.687	1.000	0.997	0.966	0.734
IMW Mx	0.166	0.992	0.233	0.985	0.400	0.957
PMBAW Mx	2.666	0.129	0.700	0.862	1.966	0.319
MBAW Mx	1.066	0.736	0.800	0.841	0.266	0.981
IPW Md	1.433	0.503	0.500	0.919	0.933	0.745
IMW Md	0.300	0.974	0.066	0.999	0.366	0.961
PMBAW Md	1.400	0.382	0.733	0.115	2.133	0.764
MBAW Md	1.166	0.550	0.033	1.000	1.133	0.569

Abbreviations: IMW, intermolar dental arch width; IPW, interpremolar dental arch width; MBAW, molar basal arch width; PMBAW, premolar basal arch width.

Four arch width computations were included for the maxillary and mandibular study models: interpremolar dental arch width, intermolar dental arch width, interpremolar alveolar arch width, and intermolar alveolar arch width.

The results showed that in maxillary and mandibular arches there is an inverse correlation among the morphology of face and dental arch widths (►**Tables 2, 3**). The mean interpremolar, intermolar dental and interpremolar, intermolar alveolar arch width in both maxillary and mandibular arches were found to be highest in hypodivergent patients and least in hyperdivergent patients, which was not found to be statistically significant. This is in conformance with the researches done by Uysal et al (2005),[15] Khera et al (2012),[8] Ribeiro et al (2012),[19] Grippaudo et al (2013),[20] Bhutta et al (2013),[1] Shahroudi and Etezadi (2013),[21] Prasad et al (2013),[22] Bălan et al (2014),[23] Nayer et al (2015),[24] Traldi et al (2015),[25] Gupta and Makhija (2016),[26] Perez et al (2016),[27] Aditi et al (2017),[28] and Nagrajmurthy (2017).[29]

However, the data from this study presented an antithetical fashion between SN-MP angle and dental arch widths, the relationship was less strong, which showed that the SN-MP angle might not be only one of the contributing factors.[21]

ANOVA (►**Table 2**) shows that arch widths decreased with an increase in SN-MP angle. Isaacson et al (1979)[10] reported that steep MP individuals generally had narrower maxillary first intermolar width than flat MP individuals. They suggested that the backward rotation of mandible in high SN-MP cases cause an increase in facial height that tends to lengthen the musculature, resulting in narrowing of the dental arch. Conversely, the low SN-MP cases cause a decrease in facial height that tends to permit maxillary teeth to move toward buccoversion, resulting in widening of the dental arch. Nasby et al (1972)[11] also reported that backward rotating mandibles (hyperdivergent pattern) were associated with narrower intermolar widths. Various authors reported that patients with greater vertical dimensions have tendency of posterior teeth to be more buccally inclined, whereas those with reduced vertical dimensions have tendency of posterior teeth toward more lingual inclination, as per studies by Isaacson et al (1971),[10] Schudy et al (1971),[30] Schendel et al (1976),[31] and Janson et al (2004).[32]

When multiple comparisons (►**Table 4**) were made between all the three groups, it was found out that transverse dimensions increase as the facial pattern becomes more horizontal (hypodivergent), which was not statistically significant in this study. This finding can be attributed to the muscle pattern of the individual, which has been regarded as the feasible link in their close association between transverse dimensions and vertical facial morphology.

Various researches have demonstrated the effect of masticatory muscles on craniofacial growth.[33–35] The general concord is that patients with strong or thick mandibular elevator muscles have a tendency of manifesting wider transverse head dimensions (Ringqvist [1973],[36] Ingervall and Helkimo [1978],[37] Weijs and Hillen [1984],[34] Hannam and Wood [1989],[38] Kiliaridis and Kälebo [1991],[39] van Spronsen et al [1991],[40] Bakke et al [1992],[41] Kiliaridis [1995][42]). Strong musculature of mastication is habitually associated with a brachyfacial pattern (short face). This muscular hyper function causes a greater mechanical loading of the jaws. This may cause an initiation of growth at sutures and bone apposition, which consequently causes enhanced transverse growth of the dental arches and bone bases.[43] On the contrary, van Spronsen et al[44] reported that individuals with long face have significantly smaller masseter and medial pterygoid muscles than normal individuals (Satirğlu et al,[35] Weijs and Hillen,[45] Kiliardis and Kälebo,[39] and Benington et al[46]).

Morphologic features related to masticatory functions, and facial types have been correlated with thickness of cortical bone of the mandible and buccolingual inclination of the first and second molars. The activity of muscles of mastication has effects on occlusion, form of dental arches, and shape of mandible. Mandibular molars erupt lingually and then buccally incline by the tongue pressure and masticatory function setting in a position of equilibrium between lingual and buccal pressures.

When the lingual volume of patients with long face is same as that of short-face ones, their molars sustain a great pressure despite the narrowed arch and verticalization occur as a consequence. The thickness of buccal cortical bone is greater in short-face patients than in long-face ones, and during the masticatory function, teeth are reinforced by this enormous bone structure, paramounting to a lingual inclination more than that in patients with mean and vertical facial types.[33]

The prediction of the interarch width helps us in situations such as cross bites, ectopically positioned teeth, transpositions, scissors bite, impacted teeth, missing teeth, etc., where we cannot determine exact interarch widths and fabricate customized arch wires for the patients.[22] Thus to acquire a improved arch form, it is advisable to attain more posttreatment solidity; hence, the purpose of most studies on dental arch forms is to reveal whether the preformed arch wires can be ligated in all patients.[20] The limitations of this research must be recognized because variation among individuals faced and dental arch dimensions are certainly a multifactorial phenomenon.[47]

Conclusion

The following conclusions were drawn from this study:

- The maxillary and mandibular interpremolar dental and alveolar width was highest in hypodivergent individuals and least in hyperdivergent individuals.
- The maxillary and mandibular intermolar dental and alveolar width was highest in hypodivergent individuals and least in hyperdivergent individuals.
- The transverse dimensions increase as the facial pattern becomes more horizontal.

Conflict of Interest
None declared.

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