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ORIGINAL ARTICLE

EVALUATION OF ARCH WIDTH VARIATIONS AMONG SKELETAL VERTICAL PATTERNS

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ABSTRACT

Objective: *This study aimed to compare arch widths among individuals with different vertical skeletal patterns at Peshawar Dental College, Peshawar.*

Materials and Methods: *A cross-sectional comparative study was conducted at the Orthodontics department, Peshawar Dental College, from July 2022 to February 2023. Ninety patients were selected using non-probability consecutive sampling, divided into normodivergent, hypodivergent, and hyperdivergent groups. Arch width measurements were taken on plaster dental casts, and facial patterns were classified based on the Frankfort mandibular plane angle.*

Results: *Mean age was 23.58 ± 6.64 years, and wide lower arches were predominant. Statistically significant differences were found in maxillary total arch length (p=0.03) and mandibular posterior intermolar width (p=0.04). Hyperdivergent individuals exhibited narrower maxillary inter-canine (p<0.001), maxillary inter-molar (p=0.010), and mandibular inter-molar (p<0.001) widths compared to hypodivergent and normodivergent subjects. No significant differences were observed in mandibular inter-canine width.*

Conclusion: *The vertical skeletal pattern significantly influences arch width in both arches, except for mandibular inter-canine width. Arch widths tend to be narrower in high-angle cases.*

Keywords: *Arch width, vertical skeletal pattern, facial patterns, orthodontics, Peshawar Dental College*

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INTRODUCTION

Since the early 20th century, orthodontists have emphasized the association between malocclusion and facial morphology.[1] The effectiveness and durability of orthodontic treatments rely on variables such as dental arch width and facial form.[2] The arrangement and alignment of teeth in three dimensions, known as arch form, play a crucial role in treatment outcomes. Hawley proposed that the ideal arch width corresponds to an equilateral triangle, where the base represents the inter-condylar width.[3] Lower anterior teeth are arranged along a circular arc determined by the combined width of lower incisors and canines, while premolars and molars align with the second and third molars toward the center.[4]

Ricketts highlighted the potential link between an individual's facial morphology and the arrangement of their dental arches.[5] This identified correlation carries substantial importance in orthodontics, especially during crucial phases like diagnosis and treatment planning. The dimensions and structure of dental arches are integral to orthodontic practice, impacting key factors such as tooth space availability, the aesthetic appeal of dental alignment, and the enduring stability of the dentition over time.[6]

The shape of the dental arch is shaped by the underlying bone structure, and ensuring stability in the arch form is a primary goal in orthodontics, although it remains inadequately understood.[7] The inclination of the arch form to return to its initial state emphasizes the importance of the patient's current arch form as a reliable indicator for predicting future form and stability.[8] While

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existing knowledge hints at links between craniofacial structures, arch forms, and dimensions, the strength of these connections lacks clear documentation in the literature, and variations among individuals are not unusual.[9]

The rationale for this study is the scarcity of literature examining the connection between arch dimensions and vertical dimension or face types. The available data are inadequate for establishing correlations between face types and arch dimensions or arch forms. This study aims to fill this gap by investigating potential associations and assessing their strength. There is also a lack of research on the local population. The results may vary across populations due to ethnic and genetic factors.

The objective was to compare arch widths in various vertical skeletal patterns in patients reporting to Peshawar Dental college, Peshawar.

METHODOLOGY

This cross-sectional comparative study was conducted at Orthodontics department, Peshawar dental college, Peshawar, Pakistan, from July 2022 to February 2023, using a non-probability consecutive sampling technique on 90 patients. Among them, 30 were normodivergent, 30 were hypodivergent, and 30 were hyperdivergent. Inclusion criteria included cases with no prior history of orthodontic treatment, individuals aged 13 to 35 years, a full complement of teeth up to the second permanent molars with normal inclined canine (assessed on clinical ground), Pakistani nationality, both genders, and clear cephalograms. Exclusion criteria comprised severe crowding (exceeding 7 mm), dental anomalies, prior dentoalveolar surgery or maxillofacial trauma, craniofacial syndromes, and dental arch asymmetry beyond 2 mm.

The calculated sample size was 12 (4 per group) participants, determined using OpenEpi at a 95% confidence level and 90% power of the test, based on an inter-canine width of 31.72±0.4mm in the high-angle group and 33.35±0.8mm in the low-angle group from a previous study.[10] However, for the normality assumption, we will use a sample size of 90 (30 per group).

Facial patterns were classified based on the Frankfort mandibular plane angle: normodivergent (FMA, 22-28 degrees), hyperdivergent (FMA, above 29 degrees), and hypodivergent (FMA, less than 22 degrees). Arch width was measured on plaster dental casts of the participants between the tip of the canines (intercanine width) and the central fossa of the first molar (intermolar width) in both arches, using a vernier caliper with a least count of 0.01 mm.[10] (Fig 1) All measurements were conducted by a single examiner. Statistical analysis of the data was performed using R software version 4.1.3. Mean and standard deviation (SD) were computed for continuous data such as age, inter-canine, and intermolar width. One-way ANOVA was conducted to compare arch width among vertical patterns. The analysis was stratified with respect to gender. The level of significance was set at $p < 0.05$.

RESULTS

The mean age of the participants was 23.58 ± 6.64 years. Table 1 provides the distribution of age and gender among the 90 participants. For instance, 49 (54.44%) participants were female, and 41 (45.56%) participants

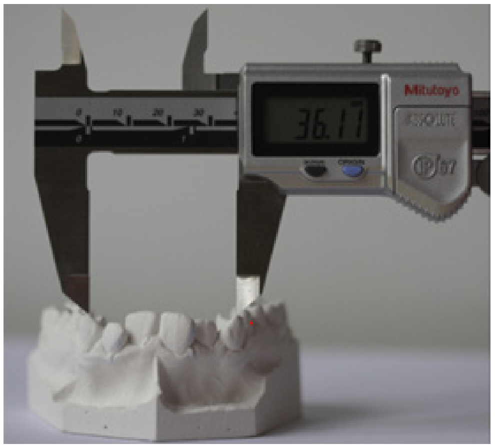

Fig 1: Measuring arch width on plaster model with vernier caliper

TABLE 1: DISTRIBUTION OF AGE AND GENDER OF THE PARTICIPANTS

Characteristic	Inclusion Criteria
Gender, n(%)	
female	49 (54.44)
male	41 (45.56)
Vertical pattern, n(%)	
Hyperdivergent	30 (33.33)
Hypodivergent	30 (33.33)
Normodivergent	30 (33.33)
Age group(years)	
13-20	35 (38.89)
21-35	55 (61.11)

TABLE 2: MEAN OF INTER-CANINE AND INTER-MOLAR WIDTH IN BOTH JAWS

Characteristic	Mean±SD
Maxillary inter-canine width (mm)	33.83 ± 2.76
mandibular inter-canine width(mm)	26.43 ± 3.65
Maxillary inter-molar width (mm)	57.02 ± 2.70
mandibular inter-molar width(mm)	53.72 ± 3.69

TABLE 3: COMPARISON OF ARCH WIDTHS AMONG VERTICAL SKELETAL PATTERN

Characteristic	Hyperdivergent, N = 30	Hypodivergent, N = 30	Normodivergent, N = 30	F-statistics	p-value*
Maxillary inter-canine width (mm)	32.59 ± 2.26	33.50 ± 2.60	35.41 ± 2.69	9.71	<0.001
mandibular inter-canine width(mm)	25.59 ± 2.74	26.27 ± 5.17	27.43 ± 2.18	1.98	0.14
Maxillary inter-molar width (mm)	55.83 ± 3.04	57.48 ± 2.24	57.75 ± 2.41	4.88	0.010
mandibular inter-molar width(mm)	52.12 ± 2.23	55.98 ± 4.01	53.05 ± 3.51	10.97	<0.001

*ANOVA test, P<0.05 was significant level

TABLE 4: COMPARISON OF ARCH WIDTHS AMONG VERTICAL SKELETAL PATTERN STRATIFIED BY GENDER

Gender	Characteristic	Hyperdivergent	Hypodivergent	Normodivergent	F-statistics	p-value*
Male (n=41)	Maxillary inter-canine width (mm)	32.89 ± 2.16	33.93 ± 1.97	34.30 ± 2.06	1.75	0.2
	mandibular inter-canine width(mm)	25.97 ± 3.09	26.92 ± 4.62	28.50 ± 2.09	1.77	0.2
	Maxillary inter-molar width (mm)	55.96 ± 3.00	56.74 ± 2.76	57.89 ± 2.34	1.66	0.2
	mandibular inter-molar width(mm)	52.24 ± 1.89	55.89 ± 4.70	54.25 ± 2.90	4.28	0.021
Female (n=49	Maxillary inter-canine width (mm)	32.29 ± 2.39	33.13 ± 3.07	36.14 ± 2.86	8.81	<0.001
	mandibular inter-canine width(mm)	25.20 ± 2.40	25.71 ± 5.70	26.71 ± 1.99	0.71	0.5
	Maxillary inter-molar width (mm)	55.70 ± 3.19	58.14 ± 1.46	57.66 ± 2.52	4.21	0.021
	mandibular inter-molar width(mm)	51.99 ± 2.60	56.06 ± 3.44	52.25 ± 3.73	7.54	0.001

*ANOVA test, P<0.05 was significant level

were male. Similarly, each vertical pattern category (Hyperdivergent, Hypodivergent, Normodivergent) constituted 30 (33.33%) participants. In terms of age groups, 35 (38.89%) participants were in the 13-20 years range, while 55 (61.11%) participants fell into the 21-35 years category.

Table 2 presents the mean and standard deviation of specific width measurements in both the maxillary and mandibular jaws. Notably, the width is larger in the maxilla for both inter-canine (33.83 ± 2.76 mm) and inter-molar measurements (57.02 ± 2.70 mm) compared to the mandible (Inter-canine: 26.43 ± 3.65 mm, Inter-molar: 53.72 ± 3.69 mm).

The results presented in Table 3 offer insights into the comparison of arch widths among individuals with distinct vertical skeletal patterns, namely Hyperdivergent, Hypodivergent, and Normodivergent. In terms of Maxillary Inter-canine Width, Hyperdivergent individuals exhibit a narrower measurement (32.59 ± 2.26 mm) compared to their Hypodivergent (33.50 ± 2.60 mm) and Normodivergent (35.41 ± 2.69 mm) counterparts, with statistically significant differences observed (p< 0.001). However, Mandibular Inter-canine Width shows no statistically significant variations among the three groups, with measurements of 25.59 ± 2.74 mm, 26.27 ± 5.17 mm, and 27.43 ± 2.18 mm for Hyperdivergent, Hypodivergent, and Normodivergent individuals, respectively (p= 0.14). Maxillary Inter-molar Width, Hyperdivergent individuals exhibit a narrower width (55.83 ± 3.04 mm) compared to Hypodivergent (57.48 ± 2.24 mm) and Normodivergent (57.75 ± 2.41 mm) individuals, with statistically significant differences observed (p= 0.010). Similarly, for Mandibular Inter-molar Width, Hyperdivergent individuals present a narrower measurement (52.12 ± 2.23 mm) compared to Hypodivergent (55.98 ± 4.01 mm) and Normodivergent (53.05 ± 3.51 mm) individuals, with statistically significant differences (p< 0.001). In summary, the findings suggest that the vertical skeletal pattern influences arch widths, particularly in the maxillary region, with significant variations observed in maxillary inter-canine, maxillary inter-molar, and mandibular inter-molar widths among individuals with different vertical patterns. However, no significant differences were found in mandibular inter-canine width.

Table 4 presents a comparison of arch widths among individuals with different vertical skeletal patterns, stratified by gender. For male participants (n=41), the analysis revealed non-significant differences (p= 0.2) in Maxillary Inter-canine Width, Mandibular Inter-canine Width, Maxillary Inter-molar Width, and Mandibular Inter-molar Width among Hyperdivergent, Hypodivergent, and Normodivergent groups. However, a significant difference (p-value = 0.021) was found in Mandibular Inter-molar Width. In contrast, for female participants (n=49), statistically significant differences were observed in Maxillary Inter-canine Width (p<0.001), with Hyperdivergent individuals (32.29 ± 2.39 mm) having narrower widths compared to Hypodivergent (33.13 ± 3.07 mm) and Normodivergent (36.14 ± 2.86 mm) individuals. No significant differences were found in Mandibular Inter-canine Width (p=0.5). For Maxillary Inter-molar Width, a significant difference (p= 0.021) was observed, and Hyperdivergent individuals (55.70 ± 3.19 mm) had a narrower width compared to Hypodivergent (58.14 ± 1.46 mm) and Normodivergent (57.66 ± 2.52 mm) individuals. Additionally, Mandibular Inter-molar Width showed significant differences (p=0.001), with Hyperdivergent individuals (51.99 ± 2.60 mm) having a narrower width compared to Hypodivergent (56.06±3.44 mm) and Normodivergent (52.25 ± 3.73 mm) individuals.

DISCUSSION

The objective of this study is to assess the association between vertical facial height and arch widths among untreated adults in Peshawar. This research specifically enrolled individuals who had not undergone prior orthodontic treatment to minimize potential effects on the vertical development of the dentoalveolar process or the dimensions of mid-face structures. The study included 90 samples, which were stratified into three groups based on facial angle: High angle, average angle, and low angle. This categorization enables an assessment of the association between facial patterns and dental arch widths.[11]

Our findings indicate that the vertical skeletal pattern has a significant association with arch width in both arches, except for mandibular inter-canine width. Arch widths tend to be narrow in high angle cases.[12] A previous study conducted in Karachi on 110 subjects regarding the relationship of vertical cephalometric parameters and arches reported a negative perfect correlation (r= -0.96).[13] These results are consistent with our findings.

In a another investigation by Amber et al.[14] noteworthy variations were observed in inter-canine widths across low, normal, and high angle classes, and these differences were statistically significant with a p-value below 0.05. Similarly, in a study conducted by Raghdal et al.[15], notable differences were noted in arch widths concerning skeletal classes. However, it is crucial to emphasize that in our ongoing study, the assessment of differences in inter-molar arch widths in relation to high, normal, and low Subnasale-Menton (SNMP) angle classes revealed no statistical significance, indicated by a p-value exceeding 0.05.

Another study investigated the correlation between dental arch widths and vertical facial types in untreated South Indian adults. Findings revealed significant gender differences, with males having larger arch widths than females (P < 0.05). Additionally, there was a notable decrease in inter-arch width as the MP-SN angle increased in the South Indian population.[10]

Kageyama et al.[16] found no correlation between mandibular arch form and facial types. The low prevalence, attributed to anteroposterior displacement and/or rotation of the mandible in vertical malocclusions, may be due to increased muscular forces on the lower arch, including perioral and intraoral muscles.

A study compared dental arch dimensions and forms across different vertical facial patterns in a cross-sectional comparative design conducted at the Aga Khan University Hospital, Karachi on 140 patients. Wide lower arches were predominant across all face types, while wide upper arches were prevalent in hypo- and hyperdivergent subjects.5 These findings support our study.

CONCLUSION

Based on our findings, it can be concluded that the vertical skeletal pattern has a significant association with arch width in both arches, except for mandibular inter-canine width. Notably, arch widths tend to be narrower in high-angle cases.

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2. Shahab Adil	Supervision, reviewing and final approval of the version to be published.
3. Zafar Ul Islam	Interpretation of data, data analysis and reviewing it critically.
4. Hasan Ali Raza	Review in the draft critically for important intellectual concept.
5. Sana Naz	Drafting of the work.
6. Ghazala	Literature search, data collection and analysis.