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Research Article

Relationship Between Arch Width and Vertical Facial Morphology in Untreated Adults of Jodhpur Population

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ABSTRACT

Aims and objectives: The purpose of the present study was to investigate if dental arch widths are correlated with vertical facial types by means of Jarabak ratio and to find the standard norms and relationship between arch width and facial pattern for the population under study and also to examine the differences in dental arch widths between male and female untreated adults.

Materials and methods: The study is set up in Vyas Dental College & Hospital, Jodhpur. This study included 140 untreated adults of Jodhpur population aged between 18 to 48 years of age and having angle Class I malocclusion who visited the Department of Orthodontics and Dentofacial Orthopaedics. Lateral Cephalograms were taken and study casts were made for each individual using a standardized and specified technique. For each subject Jarabak ratio was calculated. Dental cast measurements were performed and intercanine, interpermolar, and intermolar widths were measured

Statistical analysis: The arch widths of males and females were analysed and the differences between them were tested for significance using a Student's two tailed t -test. Pearson correlation analysis was used to determine the statistical significance of the relationships between Jarabak ratio and dental arch width.

Results: It was clearly demonstrated that males had significantly larger dental arch widths than females ($P < 0.05$). The high Jarabak ratio group had larger arch widths than the low Jarabak ratio group for most measurements.

Conclusions: The study concluded that the dental arch widths in males were significantly greater than those in females. In both males and females, as Jarabak ratio increased, arch width tended to increase. Since dental arch width is associated with gender and facial vertical morphology, using individualized arch wires according to each patient's pre-treatment arch form and widths is suggested during orthodontic treatment.

Keywords: Jarabak ratio; Intercanine width; Intermolar width, Jodhpur Population.

INTRODUCTION

Factors such as age, sex, and ethnic group play a pivotal role in proper orthodontic treatment plan; with adjuvant important factor is the facial growth pattern and its several clinical characteristics[1]. It is an accepted fact among clinicians is that a relationship exists between vertical facial morphology and the dental arch width. Schudy advocated the use of the anterior cranial base (SN) as the reference line to determine the steepness of the mandibular plane (MP)[2,3]. A subject with a high MP – SN angle (steep MP) tends to have a longer face, and one with a low MP– SN angle (flat MP) often has a shorter face[4,5]. A long-face individual usually has narrower transverse dimensions (dolichofacial) and a short face individual has wider transverse dimensions (brachyfacial)[4,5,6]. It therefore rises a query of the relationship between vertical facial morphology and dental arch width. Also, is there any difference in arch widths between both sex? Plethora of several studies were inconclusive for example most of these studies used MP-SN angle as a measure of vertical facial pattern but due to natural cranial variation, there may be variation in the anterior cranial base (SN), which may tip up or down[7]. For example, Howes found that steep MP individuals generally had larger teeth and narrower and shorter arches than flat mandibular plane individuals when measured from the buccal cusp tips of the maxillary first premolars[8]. Isaacson et al. reported that subjects with longer faces presented with a decrease in maxillary intermolar width[9]. However, they did not distinguish between males and females. Nasby et al. (1972) noted that the mean maxillary and mandibular arch circumference and mandibular intermolar width were greater in subjects with low MP – SN angles when compared with those with high MP – SN angles.

The purpose of the present study was to investigate if dental arch widths are correlated with vertical facial types (Jarabak ratio) and an attempt was made to find out a definite relationship between vertical facial pattern and dental arch width. Relationship between vertical facial morphology and arch width has been found for different ethnic and racial groups previously. Most investigators have concluded that there are significant differences between the diverse ethnic and racial groups, and many standards have been developed for different ethnic

groups. All these studies indicate that normal measurements for one group should not be considered normal for every other race or ethnic group[14]. This will help in making individualized arch wires according to each patient's pretreatment arch form and width for this population type.

MATERIALS AND METHODS

The study is set up in Vyas Dental College and Hospital. This study included 140 untreated adults of Jodhpur population aged between 18 to 48 years of age and having angle Class I malocclusion visiting the Department of Orthodontics and Dentofacial Orthopaedics and the subjects were included in the study as per the inclusion and exclusion criterias. ***Inclusion criteria*** included a full dentition except third molars, pre-treatment lateral cephalogram, and maxillary and mandibular dental casts available. ***Exclusion criteria*** included previous orthodontic treatment, edentulous spaces, history of trauma, significant cuspal wear, extensive restorations or prosthetics, anterior and posterior crossbites, and crowding (>5 mm) or spacing (>5 mm).

Cephalometric analysis

For each subject the following two cephalometric parameters will be measured and Jarabak ratio will be calculated

a) Anterior facial height (AFH, Na-Me)

b) Posterior facial height (PFH, S-Go)

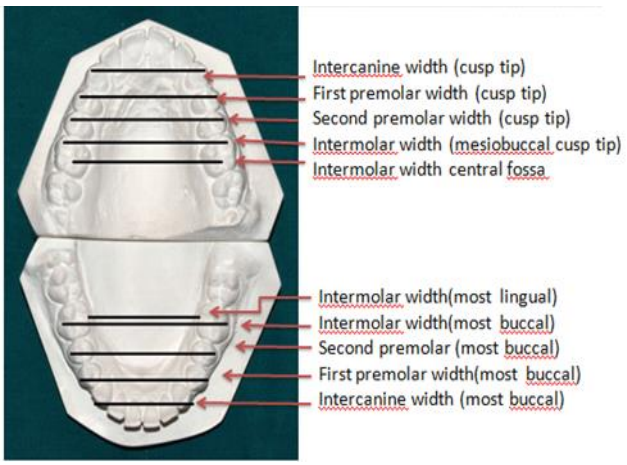


Figure 1: Measurement on a Dental Cast

Dental cast analysis

Upper and lower impressions will be made for each subject and dental cast measurements will be performed using a digital calliper accurate to 0.01 mm. The following maxillary and mandibular dimensions will be measured and following measurements will be calculated

a) Intercanine width (Cusp tip and widest labial aspect)

b) First and second interpremolar widths (Cusp tip and widest labial aspect)

c) Intermolar width (mesiobuccal cusp, central fossa, widest buccal, and narrowest lingual aspact)

d) Tooth size- arch length discrepancy

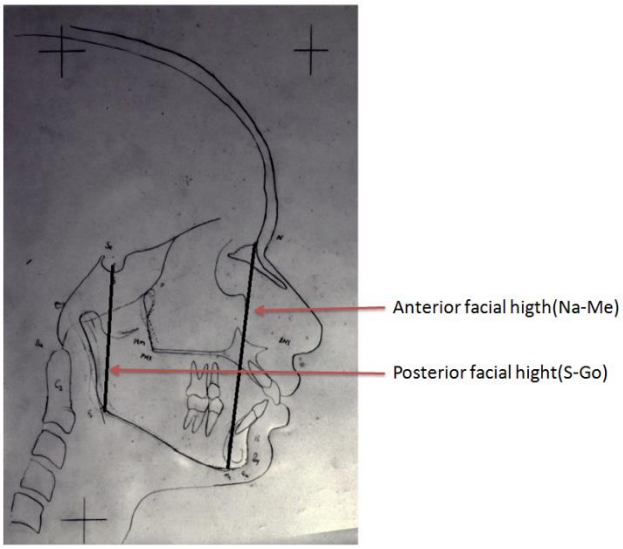


Figure 2: Measurement on a lateral cephalogram

RESULTS

Statistical data analysis

Descriptive statistics, including the mean and SD & test of significance were calculated for all measurements. A Student's two - tailed t -test was used to determine if the differences in measurements between the male and female groups were significant. Pearson's correlation coefficient was determined. Moreover, regression analyses were carried out to determine the degree to which Jarabak ratio variation was predicted by dental arch width in males and females separately. Significance for all statistical tests was determined at $P < 0.05$.

Table 1 shows the descriptive statistics of the population under study. Table 2 shows the correlation between Jarabak ratio and intercanine width, interpremolar width, and intermolar width of maxillary and mandibular arches. The relation between intercanine width of maxillary arch for males ($p = 0.013$) was very highly significant ($p \leq 0.01$). In Male population the relation between Jarabak ratio and 2nd Premolar width of maxillary arch ($p = 0.032$), inter molar width of maxillary arch ($p = 0.049$) intermolar width mandibular arch ($P= 0.05$) was significant ($p \leq 0.05$). In female population the Intercanine width of maxillary arch

(p=0.001), inter 1st premolar width (0.001), inter second premolar width (p = 0.002) and inter molar width (p = 0.003) was very highly significant (p ≤ 0.01) and intersecond premolar width of mandibular arch (p=0.05) was significantly related to the Jarabak's ratio (p ≤ 0.05).

Table 3 shows the comparison between male and female population of the intercanine widths, inter premolar and intermolar widths of the maxillary and mandibular arch. It was clearly demonstrated that in maxillary arch inter premolar width (p = 0.01) and inter molar (p = 0.001) was highly significant (p ≤ 0.01) and inter canine width (p = 0.038) was significant. In Mandibular arch inter molar width (p = 0.002) was highly significant (p ≤ 0.01) and inter premolar width (p = 0.043) was significant (p ≤ 0.05). Table 4 (Male population) and Table 5 (female population) shows the comparison of intercanine and intermolar widths in high, medium and low Jarabak ratio groups. The high Jarabak ratio group had larger arch widths than the low Jarabak's ratio group for most measurements. Table 6 shows the Regression analysis of Jarabak ratio versus hypothetical predictors and it shows the highly significant value (p ≤ 0.01) for all the measurements in both arches and in both sexes.

Table 1: Description of the sample.

	Male (n=70)		Female (n=70)	
	Mean	**SD**	**Mean**	**SD**
Age (Years)	19.7000	4.25407	19.6133	3.69036
Jarabak ratio	64.9199	7.03310	64.7139	6.53051
ANB (Degrees)	1.7857	1.30654	2.2933	1.39277
Maxilla				
Spacing (mm)	2.1964	1.19675	2.1552	.74526
Crowding (mm)	2.0405	.82671	2.0978	.96390
Mandible				
Spacing (mm)	1.8182	.90202	1.7632	.83945
Crowding (mm)	2.1102	.91476	2.0714	1.04198

Table 2: Correlation of jarabak ratio with intercanine width, interpremolar width and intermolar width of maxillary and mandibular arch in males and females

	Male			Female		
	r	**p**	**N**	**r**	**p**	**N**
Maxilla						
Intercanine width (Cusp tip)	.293	.013*	70	.452	.000*	70
Intercanine width (Widest labial aspect)	.264	.026*	70	.358	.001*	70
First premolar width (Cusp tip)	.136	.259	70	.371	.001*	70
First premolar width (Widest labial aspect)	.184	.125	70	.403	.000*	70
Second premolar width (Cusp tip)	.171	.154	70	.348	.002*	70
Second premolar width (Widest labial aspect)	.256	.032*	70	.317	.005*	70
Intermolar width (Mesiobuccal cusp tip)	.223	.063	70	.331	.003*	70
Intermolar width (Central fossa)	.231	.049*	70	.332	.003*	70
Intermolar width (Buccal widest)	.230	.054*	70	.295	.010*	70
Intermolar width (Lingual narrowest)	.118	.327	70	.313	.006*	70
Mandible						
Intercanine width (Cusp tip)	.001	.988	70	.170	.142	70
Intercanine width (Widest labial aspect)	.025	.981	70	.123	.289	70
First premolar width (Cusp tip)	.123	.310	70	.126	.277	70
First premolar width (Widest labial aspect)	.152	.207	70	.101	.388	70
Second premolar width (Cusp tip)	.155	.198	70	.007	.946	70
Second premolar width (Widest labial aspect)	.192	.109	70	.298	.050*	70
Intermolar width (Mesiobuccal cusp tip)	.118	.329	70	.040	.732	70
Intermolar width (Central fossa)	.107	.377	70	.048	.749	70
Intermolar width (Buccal widest)	.224	.05*	70	.016	.891	70
Intermolar width (Lingual narrowest)	.031	.795	70	.040	.728	70

Table 3 Maxillary and mandibular arch width measurements (millimeters).

	Male (n=70)		Female (n=70)		Significance (P)
	Mean	SD	Mean	SD	
Maxilla					
Intercanine width (Buccal cusp tip)	34.5760	3.14864	33.8967	2.74738	.168
Intercanine width (Widest labial aspect)	37.3792	3.19314	36.3325	2.82151	.038
First premolar width (Buccal cusp tip)	40.7096	3.44590	39.1419	3.50033	.007**
First premolar width (Widest labial aspect)	43.7917	3.60482	42.1596	3.87560	.010*
Second premolar width (Buccal cusp tip)	45.6021	3.64338	43.6976	3.99901	.003**
Second premolar width (Widest labial aspect)	48.4241	4.06970	46.6160	4.18177	.009**
Intermolar width (Mesiobuccal cusp tip)	50.8060	4.10445	48.6472	4.22156	.002**
Intermolar width (Central fossa)	46.6716	3.93766	44.7728	3.89148	.004**
Intermolar width (Buccal widest)	55.0561	4.02267	52.7989	4.28874	.001**
Intermolar width (Lingual narrowest)	40.6807	3.22506	38.3055	3.54879	.000**
Mandible					
Intercanine width (Buccal cusp tip)	26.9347	2.51087	26.7888	2.75920	.740
Intercanine width (Widest labial aspect)	28.8773	2.54350	28.4905	2.18491	.327
First premolar width (Buccal cusp tip)	33.5083	3.20369	32.8217	2.80927	.172
First premolar width (Widest labial aspect)	36.4440	3.50136	35.7437	3.22809	.212
Second premolar width (Buccal cusp tip)	38.3923	3.79149	37.1505	3.52811	.043*
Second premolar width (Widest labial aspect)	41.5180	4.07021	40.2807	3.64801	.056*
Intermolar width (Mesiobuccal cusp tip)	44.0519	3.57983	42.2507	3.02042	.001**
Intermolar width (Central fossa)	40.4154	3.39618	38.6831	2.82738	.001**
Intermolar width (Buccal widest)	48.6971	3.61571	46.8636	3.45017	.002**
Intermolar width (Lingual narrowest)	35.2646	3.04818	33.1519	2.85852	.000**

Table 4 Arch width measurements in millimeters for High, average, and Low Jarabak ratio males.

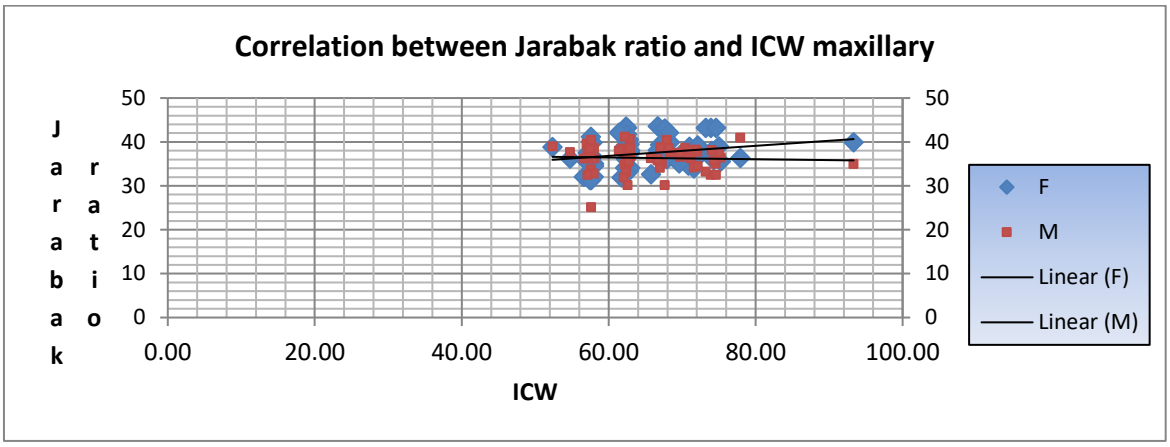
	64% more (n=30)		59-63% (n=20)		54-58% (n=20)	
	Mean	SD	Mean	SD	Mean	SD
Maxilla						
Intercanine width (Buccal cusp tip)	35.3867	3.04043	35.1740	3.31923	32.7620	2.44919
Intercanine width (Widest labial aspect)	38.1362	3.02185	37.8370	3.38757	35.7860	2.79600
First premolar width (Buccal cusp tip)	41.0320	3.43186	41.7350	3.54343	39.2007	2.98705
First premolar width (Widest labial aspect)	44.4413	3.46393	44.7875	3.66437	41.8215	3.10706
Second premolar width (Buccal cusp tip)	46.1453	3.56353	46.5760	3.38662	43.8135	3.53878
Second premolar (Widest labial aspect)	49.4653	4.02180	48.9535	3.71343	46.3330	3.88079
Intermolar width (Mesiobuccal cusp tip)	51.7037	3.75679	51.6915	3.66621	48.5740	4.34222
Intermolar width (Central fossa)	47.5287	3.43507	47.3745	3.55698	44.6830	4.45010
Intermolar width (Buccal widest)	55.8510	3.67092	56.1975	3.29432	52.7225	4.38678
Intermolar width (Lingual narrowest)	41.1467	3.31197	41.2060	3.17408	39.4565	2.95702
Mandible						
Intercanine width (Buccal cusp tip)	27.4003	2.56704	27.4470	2.08755	25.7240	2.51352
Intercanine width (Widest labial aspect)	29.2310	2.74485	29.2605	2.13414	27.9635	2.49175
First premolar width (Buccal cusp tip)	34.1527	3.19392	34.2870	2.82965	31.7630	3.03249
First premolar width (Widest labial aspect)	37.3623	3.45088	36.9975	2.89967	34.5130	3.51540
Second premolar width (Buccal cusp tip)	39.1407	3.52232	39.2140	3.51118	36.4480	3.91995
Second premolar width (Widest labial aspect)	42.4763	3.70666	42.1905	3.62969	39.4080	4.40512
Intermolar width (Mesiobuccal cusp tip)	44.6860	3.24485	45.2760	3.15615	41.8765	3.64882
Intermolar width (central fossa)	41.0227	3.28779	41.4575	3.08476	38.4625	3.18313
Intermolar width (Buccal widest)	49.6250	3.30500	49.6555	2.94320	46.3470	3.74200
Intermolar width (Lingual narrowest)	35.7407	3.26000	35.9945	2.79392	33.8205	2.56934

Table 5: Arch width measurements in millimeters for High, average, and Low Jarabak ratio females.

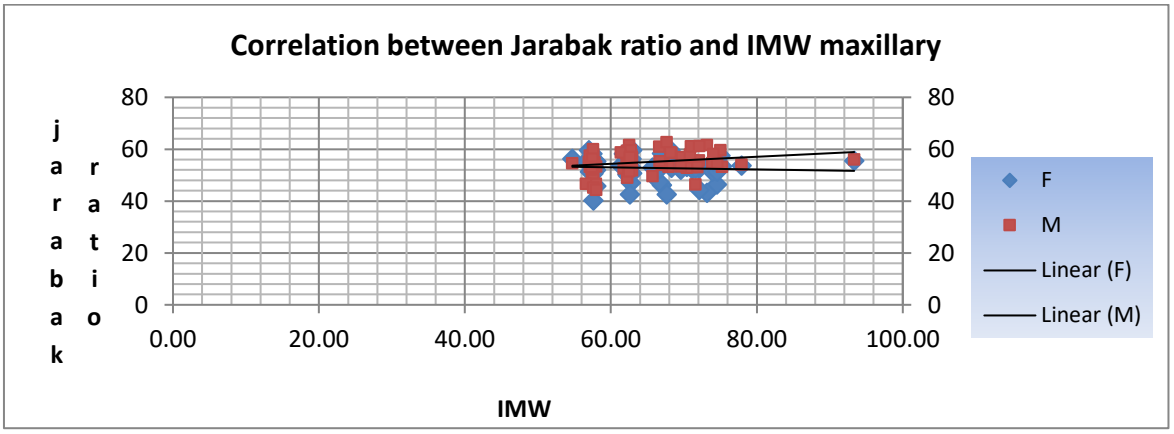
	64% more(n=30)		59-63%(n=20)		54-58%(n=20)	
	Mean	SD	Mean	SD	Mean	SD
Maxilla						
Intercanine width (Buccal cusp tip)	35.4410	1.95262	33.0332	3.07638	32.6595	2.29475
Intercanine width (Widest labial aspect)	37.6010	2.28999	35.7932	2.94943	35.1040	2.73884
First premolar width (Buccal cusp tip)	40.7020	2.72986	38.6370	3.68804	37.4330	3.45133
First premolar width (Widest labial aspect)	44.0260	2.80393	41.4976	4.08551	40.1875	3.90455
Second premolar width (Buccal cusp tip)	45.4203	2.92647	43.1124	4.35125	41.8450	4.06793
Second premolar width (Widest labial aspect)	48.3047	2.75622	46.0684	4.65845	44.7675	4.53950
Intermolar width (Mesiobuccal cusp tip)	50.4320	2.97163	48.0340	4.24680	46.7365	4.87678
Intermolar width (Central fossa)	46.4320	2.74055	44.2704	3.75743	42.9120	4.62162
Intermolar width (Buccal widest)	54.3013	3.49563	52.5472	4.00463	50.8600	5.01242
Intermolar (Lingual narrowest)	39.7087	2.90905	38.0364	3.19812	36.5370	4.08871
Mandible						
Intercanine width (Buccal cusp tip)	28.0510	3.10492	25.8892	2.00426	26.0200	2.37911
Intercanine width (Widest labial aspect)	29.4983	2.04064	27.9576	1.70823	27.6450	2.41268
First premolar width (Buccal cusp tip)	34.1363	2.33168	32.4264	2.65219	31.3440	2.88459
First premolar width (Widest labial aspect)	37.1530	2.66537	35.1696	3.00372	34.3475	3.56704
Second premolar width (Buccal cusp tip)	38.4033	3.11963	36.9211	3.21318	35.5580	3.92010
Second premolar width (Widest labial aspect)	41.5187	2.95714	40.0360	3.49709	38.7295	4.24317
Intermolar width (Mesiobuccal cusp tip)	43.4850	2.53531	42.0072	2.75526	40.7035	3.33585
Intermolar width (Central fossa)	39.6908	2.29846	38.5728	2.85923	37.3095	3.02317
Intermolar width (Buccal widest)	48.0773	2.66080	46.2036	2.81570	45.8680	4.64742
Intermolar width (Lingual narrowest)	34.1832	2.69216	33.0724	2.62406	31.7045	2.85859

Table 6 Regression analysis of Jarabak ratio versus hypothetical predictors.

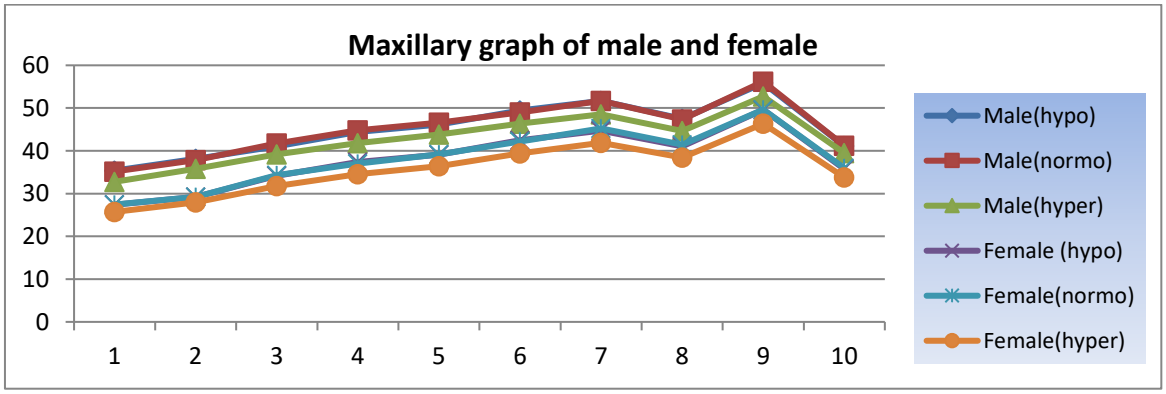
	Male (n=70)		Female (n=70)	
	R square (P)		R Square (P)	
Maxilla				
Intercanine width (Buccal cusp tip)	.994	.000	.983	.000
Intercanine width (Widest labial aspect)	.997	.000	.996	.000
First premolar width (Buccal cusp tip)	.999	.000	1.000	.000
First premolar width (Widest labial aspect)	.999	.000	.997	.000
Second premolar width (Buccal cusp tip)	.998	.000	.996	.000
Second premolar width (Widest labial aspect)	.997	.000	.995	.000
Intermolar width (Mesiobuccal cusp tip)	1.000	.000	.977	.000
Intermolar width (Central fossa)	1.000	.000	.996	.000
Intermolar width (Buccal widest)	.999	.000	.997	.000
Intermolar width (Lingual narrowest)	.999	.000	.999	.000
Mandible				
Intercanine width (Buccal cusp tip)	.998	.000	1.000	.000
Intercanine width (Widest labial aspect)	.998	.000	.999	.000
First premolar width (Buccal cusp tip)	.999	.000	1.000	.000
First premolar width (Widest labial)	.990	.000	1.000	.000
Second premolar width (Buccal cusp tip)	.999	.000	.998	.000
Second premolar width (Widest labial aspect)	.999	.000	.995	.000
Intermolar width (Mesiobuccal cusp tip)	.999	.000	.999	.000
Intermolar width (Central fossa)	.999	.000	1.000	.000
Intermolar width (Buccal widest)	.998	.000	.999	.000
Intermolar width (Lingual narrowest)	1.000	.000	1.000	.000



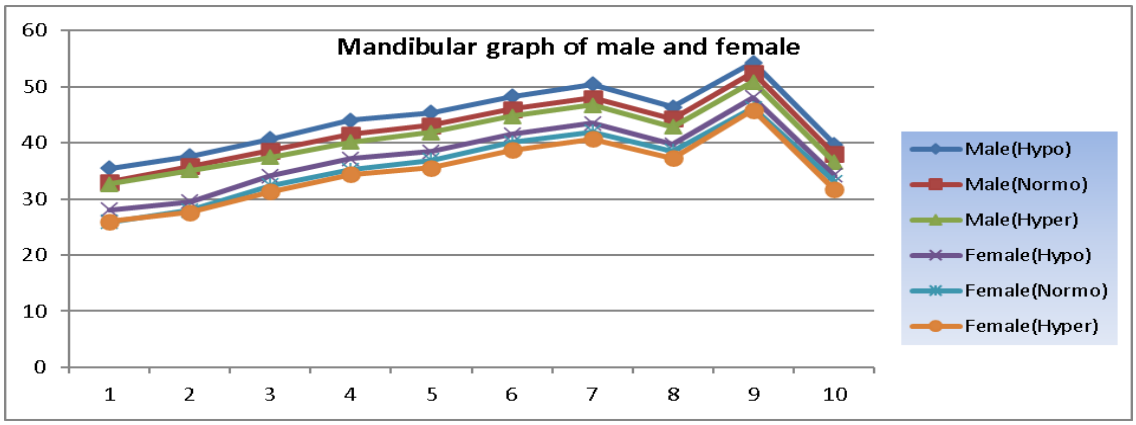
Graph 1: Correlation between jarabak ratio and ICW MAX



Graph 2: Correlation between jarabak ratio and IMW MAX.



Graph 3: Correlation of arch width of maxillary arch between hypodivergent, normodivergent, and hyperdivergent. (male and female)



Graph 4: Correlation of arch width of mandibular arch between hypodivergent, normodivergent, and hyperdivergent.(male and female)

DISCUSSION

The objectives of this study were to investigate if any relationship exists between dental arch width and the vertical facial pattern determined by the Jarabak ratio, and to examine the differences in dental arch widths between male and female untreated adults. Factors such as age, sex, and ethnic group are important in making a proper orthodontic treatment plan; another important factor is the facial growth pattern and its several clinical characteristics[1].

Lateral cephalograms and dental casts were obtained from 140 untreated adults between 18 and 48 years of age with no crossbite, minimal crowding, and spacing. The results of this study were analysed with regression line fit plots. The sample was drawn randomly from a group of untreated subjects, allowing the use of this analysis. Because the independent variable (Jarabak Ratio) and all of the predictor measurements were continuous variables, it was more appropriate to analyse the data with regression analysis rather than ANOVA. The jarabak ratio (The ratio of posterior face height (PFH, S – Go) to anterior face height (AFH, Na – Me) is another measurement for vertical facial morphology not based on the mandibular plane[29]) was used as the measurement of vertical facial morphology in the present study. However, due to natural cranial variation, there may be variation in the anterior cranial base (SN), which may tip up or down. Only skeletal Class I (as determined by ANB angle) subjects were examined because more dental compensation is expected in skeletal Class II or III subjects, which might obscure the relationship between vertical facial morphology and transverse dental arch widths. The present study investigated untreated adult males and females separately. It has previously been demonstrated that males and females exhibit different skeletal facial dimensions[12,24,28,30,] as well as differences in maxillary and mandibular arch widths[11]. Unfortunately, any of the earlier studies that examined arch width and mandibular plane angle combined the genders[8,9,10,31]. In addition, the present sample was limited to non-growing, adult individuals, unlike many of the previous investigations that included only growing children[9,10,26]. Ideally, this type of study should be conducted using patients with ideal dentitions without any crowding or spacing. However, due to difficulties in finding ideal untreated subjects and subsequent limitations in sample size, those with crowding and spacing up to 5 mm were included. For the maxillary arch, there was a statistically significant direct relationship between the Jarabak ratio and Intercanine width for both males and females, however there was significant correlation between maxillary inter-premolar and intermolar width with jarabak's ratio only for males. For the mandibular arch, it was found that males had a statistically significant correlation between jarabak ratio and intercanine, inter1st- premolar width whereas for females only intermolar width and not the intercanine width showed such positive corelation. For both males and females, as arch width increased, Jarabak ratio increased. Nasby et al. (1972), who demonstrated narrower mandibular intermolar widths in high-angle children, the present data did support such a relationship between mandibular intermolar width and Jarabak ratio[10]. Wagner and Chung (2005) found that while the growth of the maxilla plateaus at about 14 years of age, the skeletal width of the mandible continues to grow, at least in low- and average angle groups[6]. It is conceivable that as the mandible continues to increase in width, the mandibular molars compensate by inclining lingually and thereby maintaining the intermolar width. In fact, a number of authors have suggested that individuals with increased vertical dimensions have posterior teeth that tend to be more buccally inclined, whereas those with decreased vertical dimensions have posterior teeth that tend toward more lingual inclination[1,32,33]. Musculature has been considered as a possible link in this close relationship between the transverse dimension and vertical facial morphology. In fact, a number of studies have illustrated the influence of masticatory muscles on craniofacial growth. The general consensus is that individuals with strong or thick mandibular elevator muscles tend to exhibit wider transverse head dimensions[24,34,36,38]. Strong masticatory musculature is often associated with a brachyfacial pattern (short face). This muscular hyperfunction causes an increased mechanical loading of the jaws. This, 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. Several studies investigating masseter thickness have also illustrated an effect on the inclination of posterior teeth such that subjects with short faces generally exhibit increased masseter muscle mass, which may result in posterior teeth that are more lingually inclined[35,37,38]. Dental arch width is certainly a multifactorial phenomenon[31]. The data from the present study showed a direct relation between Jarabak ratio and dental arch widths. Moreover, in agreement with Eroz et al. (2000), the results demonstrated that the male arch widths were significantly greater than female arch widths[13]. This highlights the importance of using individualized arch wires according to pretreatment arch form and width for each patient during orthodontic treatment.

CONCLUSION

On completion of the study, the following conclusions can be drawn from the findings of the present study

1. The dental arch widths in males were significantly greater than those in females.

2. For both males and females, as arch width increased, Jarabak ratio increased.

3. Since dental arch width is associated with gender and facial vertical morphology, using individualized arch wires according to each patient's pre-treatment arch form and widths is suggested during orthodontic treatment.

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