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RESEARCH ARTICLE

Differences in Dental Arch Dimensions in a Sample of Kurdish Population among Different Occlusal Categories (*Ex Vivo* Study)

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ABSTRACT

It is essential to know dental arch dimensions to provide accurate diagnosis and treatment planning to ensure the satisfactory outcome of orthodontic treatment. The aim of the present study was to measure and compare dental arch dimensions of a Kurdish sample in Erbil city with normal and different classes of malocclusion. Arch width and length were measured by an electronic digital caliper on a total of 150 orthodontic models of school students aged 16–20 years of different occlusal relationships (Class I normal occlusion, Class I, Class II division I, Class II Division II, and Class III malocclusions). The results showed that (1) girls have smaller arch parameters than boys; (2) Class II division II malocclusion showed a significantly smaller upper inter canine width, arch length, incisor molar distance, and incisor canine distance when compared to all other groups; (3) the upper inter premolar and inter molar width were significantly narrower in Class II division I malocclusion than of normal occlusions and Class III malocclusion and also narrower in Class I malocclusion than in normal occlusions for both arches; (4) the arch length was significantly longer in Class II division I when compared to Class II division II, Class I malocclusions ($P < 0.01$), Class III malocclusion and Class I normal occlusion ($P < 0.05$), and (5) no statistically significant differences were found in all the arch dimensions for Class III malocclusion when compared with the normal occlusion. In conclusion, girls had smaller arch dimension than boys and Class II Division II malocclusion showed smaller arch in all dimensions while Class II division I malocclusion revealed narrower arch width and longer arch length.

Keywords: Arch length; Arch width; Dental arch dimension; Malocclusion; Orthodontics

INTRODUCTION

It is an important to have data concerning relevant human group for purposes of clinical diagnosis and planning of treatment. The ethnic differences in arch dimensions should be considered during treatment, especially in prosthodontics and orthodontics where arch shape can be modified appreciably (Burris and Harris, 2000).

Several studies were carried out on arch width and transverse craniofacial development to evaluate changes due to growth, treatment, and relapse (Knott, 1972). Some studies investigated the transverse morphology and growth of Class II division 1 and Class II division II compared to Class I (Staley et al., 1985; Lux et al., 2003). Very few studies, however, included the four types of anteroposterior occlusion groups in their comparisons (Kook et al., 2004).

Researchers around the world had studied tooth size and dental arch dimensions of different populations. Scant researches have been done on dental casts of the Kurdish population to determine the clinical significance of maxillary and mandibular tooth size measurements and dental arch dimension in orthodontic diagnosis and treatment planning (Mahmood, 2012).

It is well documented in the literature that using preformed archwires for orthodontic patients, regardless of their arch form, will lead to post-treatment instabilities in the form of relapse (Engel, 1979). Accordingly, there have to be shifts from using preformed archwires routinely for all patients to selecting specific archwires for individual patients, depending on his or her arch form and malocclusion adaptability. Several researchers had been trying to classify the dental arch forms. It is accepted that the dental arch is shaped and confined by the supporting bone configurations and it is affected by the eruption of teeth and the surrounding muscular forces (Moorrees, 1959), especially in modern orthodontic techniques, in which preformed super elastic archwires are frequently used. Clinically, instead of one preformed archwire, it is more reasonable to have several types of preformed archwires available and

to identify the patient's pretreatment arch form according to race and malocclusion (Kook et al., 2004).

Dental casts are still considered a vital diagnostic tool in orthodontic practice. They facilitate the analysis of tooth size and shape; alignment and rotations of the teeth, arch width, length, form and symmetry, and the occlusal relationship (Hashim and Al-Ghamdi, 2005).

Hence, the aim of the present study was to compare the arch dimension between the different categories of occlusion and genders in Class I normal occlusion groups.

MATERIALS AND METHODS

The study sample was obtained from students of secondary schools selected randomly after dividing the city into four geographical areas (North, South, East, and West), a total of 4258 (2213 boys, and 2045 girls) were examined from 15 schools, eight schools for males, and seven schools of females, within period of 1 month.

The ethical approvals for conducting the study and sample selection were obtained from the Ethical Committee of research in College of Dentistry/Hawler Medical University. Permission has been taken from the school principal before starting the examination. Informed consent to participate and maintain confidentiality was observed. Before data collection researcher explained, the objectives of this study were to students and requested consent for participation in the study. The following inclusion criteria were used:

1. Kurdish student from Kurdish parents living in Erbil city
2. Complete permanent dentition excluding the second and third molars
3. All teeth are fully erupted to the occlusal plane.

Out of 4258 examined students 150 were selected according to special criteria, the selected samples were furthered more divided into five subgroups of 30 (15 boys and 15 girls) based on angle classification groups.

The subjects in this study were classified to the different groups of occlusion based on the categories of occlusion coincident with the skeletal categories. Occlusal relationships were classified according to Angle's classification (1899) of molar position in centric occlusion, whereas the skeletal diagnosis was made on the basis of ANB angle values on lateral cephalometric using Al-Sahaf standards of Iraqi adult**s** (Al-Sahaf, 1991). The following criteria were adopted for the normal occlusion cases:

- Normal ANB angle (2–4°)
- Class I molar relationship which was selected according to "Angle classification"
- There is no tipping or rotation of any tooth and no spacing or crowding
- Normal overjet and overbite (3–4 mm) (Luffingham and Campbell, 1974)
- No midline deviations in the maxillary or mandibular dental arches.

In our sample, the criteria for the Class I malocclusion were that the molar relationship should follow the criteria of Angle's' Classification for Class I occlusion and ANB angle of 2–4°, but with crowding more than 3 mm.

The sample criteria for Class II malocclusion were that the molars relationship should follow the criteria of Angle's classification for Class II and having ANB angle greater than 4° and depending on maxillary central incisor position according to the British Standards Institute classification (1983) classified into Class II division 1 and Class II division 2, while in the sample criteria for Class III malocclusion, the molar relationship should follow the criteria of Angle's' classification for Class III malocclusion and ANB angle <2°.

Complete dental impressions were obtained for the upper and lower arches, using alginate (Zhermack, Italy) with perforated plastic tray that had been disinfected. The impressions were poured with yellow stone (Zhermack, Italy).

The following representative measurements of arch width were obtained: Inter-canine distance (ICD), inter-premolar distance, and intermolar distance while the arch length measurements were the canine vertical distance (CVD) and the molar vertical distance (MVD).

Measurements for dental arch length and width were taken from the study casts using an electronic digital caliper (Hogetex, Germany) accurate up to 0.01 mm with some reference points were marked on the models by means of a 6H sharp pencil, as shown in Figure 1.

An intra-examiner calibration was carried out twice by the researcher, with time lapse of 2 weeks between the two measurements to overcome the memory bias; these were the first reading and the second reading. For inter-examiner calibration, the same measurements were carried out by a well-trained dentist for the same models, this was the third reading and it is compared to the first reading.

t-value of intra-examiner and inter-examiner readings revealed non-significant differences between the mean values of all measurements.

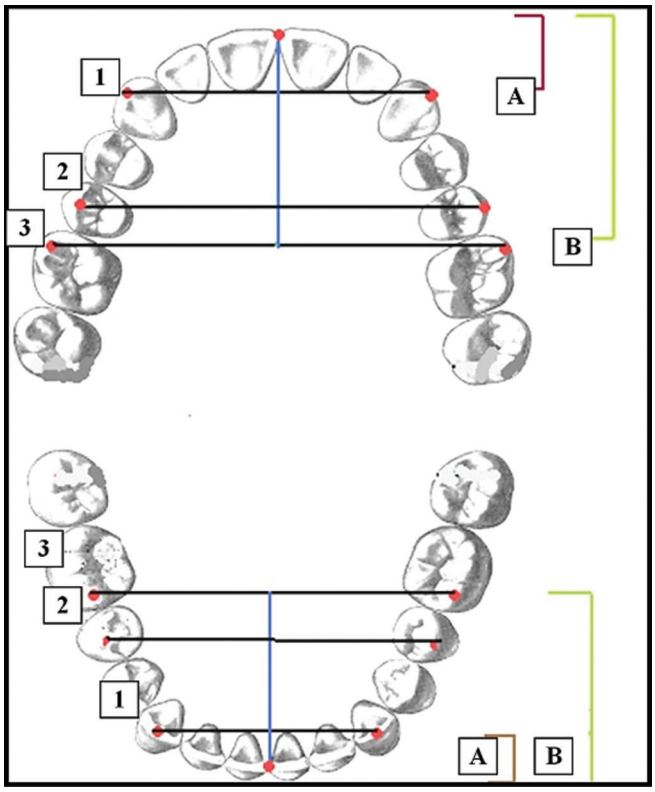

Figure 1: Linear arch dimensions measurements
Arch width: 1 (intercanine), 2 (inter-premolar), 3 (inter-molar)
Arch length: A (canine-vertical), B (molar-vertical), (Researcher)

RESULTS AND DISCUSSION

The finding of the present study for Class I normal occlusion in Tables 1 and 2 showed a significant difference in the maxillary and mandibular inter-premolar, inter-molar distance, and CVD with greater mean value in boys. According to Younes (1984), this may be attributed to the smaller and smoother bony ridge and alveolar process of girls and the average weakness of musculature in girls that play an important role in facial breadth measurements, width and height of the dental arch.

Cassidy et al. (1998) found a high degree of sexual dimorphism among siblings, with boys having arch widths, depths, and segment measurements 3–5% higher than their female counterparts.

Tables 3 and 4 show the results of ANOVA and LSD *post hoc* test which pinpoint the differences of means between each two groups of the skeletal classes. The lower ICD in the current study was smaller in Class II Division II when compared to Class II Division I and our result agreed with other studies that compared the two types of Class II malocclusion (Walkow and Peck, 2002; Uysal et al., 2005).

In the current study, the mandibular widths tended to be slightly smaller in subjects with Class I malocclusion

Table 1: The general distribution of the sample

Groups	Male	Female	Total No.
Class I normal (control)	15	15	30
Class I malocclusion	15	15	30
Class II division I malocclusion	15	15	30
Class II division II malocclusion	15	15	30
Class III malocclusion	15	15	30
Total No.	75	75	150

Table 2: Comparison between boys and girls for arch dimensions in the upper and lower dental arches in Class I normal occlusion group

Variable	Male		Female		*t*-test	*P*-value
	Mean	S.D	Mean	S.D.		
Upper arch						
Inter-canine distance	34.82	1.53	34.16	1.58	1.17	0.25
Inter-premolar distance	47.79	2.59	46.00	1.70	2.23	0.034*
Intermolar distance	53.74	2.79	51.28	2.12	2.72	0.011*
Canine vertical distance	9.29	1.06	8.22	1.22	2.56	0.016*
Molar vertical distance	28.49	2.15	27.33	2.75	1.29	0.21
Lower arch						
Inter-canine distance	26.42	1.91	25.75	1.60	1.03	0.31
Inter-premolar distance	40.30	2.60	38.22	1.78	2.56	0.016*
Intermolar distance	46.28	3.18	43.67	1.40	2.63	0.023 *
Canine vertical distance	5.95	0.76	5.23	0.89	2.39	0.024*
Molar vertical distance	24.34	1.71	23.55	2.06	1.14	0.26

*Significant at $P<0.05$. **Highly significant at $P<0.01$. N.B: All dimensions are in mm

than those with normal occlusion, with differences for interpremolar ($P = 0.048$) and intermolar ($P = 0.049$) dimensions attaining significant levels, similar results were reported by Alvaran et al. (2009).

The current study showed that the maxillary interpremolar widths in Class II division I and division II were significantly smaller than that in the other classes. Similar results were reported for Class II division 1 when compared with Class I normal occlusion (Staley et al., 1985; Sayin and Turkkahraman, 2004).

The differences between the maxillary intermolar widths were significantly larger in normal occlusion when compared with Class II division I and II subjects. In the mandible, the same tendency is fond, but group differences were not statistically significant. The same results were reported for Class II division 1 when compared with Class I normal occlusion in other studies (Staley et al., 1985; Lux et al., 2003).

Table 3: ANOVA table for the arch widths and arch lengths of all skeletal classes

Variable	Class I Normal		Class I Mal.		Class II Div. I		Class II Div. II		Class III		F-test	*P*-value
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Upper arch												
Inter-canine distance	34.49	1.57	34.14	2.56	33.74	2.30	32.62	2.55	34.13	1.83	3.28	0.013*
Inter-premolar distance	46.89	2.34	45.33	2.65	43.74	2.58	44.08	3.16	46.95	3.15	8.76	0.000**
Intermolar distance	52.51	2.73	50.34	3.05	49.32	2.82	50.40	2.40	52.57	3.38	7.48	0.000**
Canine vertical distance	8.75	1.25	8.61	2.02	9.94	1.86	4.96	1.54	8.07	1.53	37.75	0.000**
Molar vertical distance	27.91	2.50	29.41	2.57	30.72	2.99	24.19	2.02	26.90	2.14	30.75	0.000**
Lower arch												
Inter-canine distance	26.09	1.76	25.52	1.93	26.78	2.11	25.69	1.54	26.64	2.07	2.62	0.037*
Inter-premolar distance	39.26	2.43	37.93	2.76	39.08	2.48	39.04	2.22	38.99	3.10	1.24	0.298
Intermolar distance	44.97	2.76	43.61	2.61	44.65	2.22	44.77	2.06	44.91	3.27	1.35	0.253
Canine vertical distance	5.59	0.89	5.33	1.66	6.68	1.45	5.24	1.01	5.06	1.30	7.47	0.000**
Molar vertical distance	23.95	1.90	23.90	2.84	25.35	1.94	22.85	2.24	23.13	1.97	5.85	0.000**

*Significant at *P*<0.05. **Highly significant at *P*<0.01. N.B: All dimensions are in mm

Table 4: LSD *post hoc* test of arch widths and arch lengths for all skeletal classes

Variable	Class I Normal and Class I Mal.	Class I Normal and Class II Div.I	Class I Normal and Class II Div.II	Class I Normal and Class III	Class I Mal. and Class II Div.I	Class I Mal. and Class II Div.II	Class I Mal and Class III	Class II Div.I and Class II Div.II	Class II Div. I and Class III	Class II Div. II and Class III
	P-value	*P*-value	*P*-value	*P*-value	*P*-value	*P*-value	*P*-value	*P*-value	*P*-value	*P*-value
Upper arch										
Inter-canine distance	0.53	0.18	0.001*	0.52	0.48	0.01*	0.99	0.05*	0.49	0.008**
Inter-premolar distance	0.032*	0.000**	0.000**	0.94	0.029*	0.08	0.027*	0.64	0.000**	0.000**
Intermolar Distance	0.004**	0.000**	0.005**	0.93	0.18	0.93	0.003**	1.15	0.000**	0.004**
CVD	0.74	0.006**	0.000**	0.11	0.002**	0.000**	0.21	0.000**	0.000**	0.000**
MVD	0.02*	0.000**	0.000**	0.11	0.009*	0.000**	0.000**	0.000**	0.000**	0.000**
Lower arch										
Inter-canine distance	0.25	0.16	0.42	0.26	0.011*	0.73	0.023*	0.03*	0.77	0.054
Inter-premolar distance	0.048*	0.79	0.74	0.69	0.09	0.1	0.12	0.95	0.89	0.94
Intermolar Distance	0.049*	0.63	0.77	0.92	0.13	0.09	0.06	0.85	0.7	0.84
CVD	0.44	0.001**	0.29	0.11	0.000**	0.78	0.42	0.000**	0.000**	0.59
MVD	0.94	0.01*	0.06	0.15	0.01*	0.07	0.18	0.000**	0.000**	0.62

*Significant at *P*<0.05. **Highly significant at *P*<0.01. N.B: All dimensions are in mm

In 1984, Bjork et al. stated that a narrow maxilla in Class II is likely to be a key factor in the development of the malocclusion. Narrow maxillary arch widths among Class II subjects have been attributed to airway obstruction and mouth breathing (Seto et al., 2001), habits (Warren et al., 2001), and abnormal muscle function (Brader, 1972). Adolescents with Class II malocclusion have narrow maxillary arch widths (Lux et al., 2003; Alvaran et al., 2009).

Both the maxillary CVD and MVD in Class II division I malocclusions were longer than that of other classes, this finding agreed with that reported by Buschang et al. (1994) especially for girls group.

While in the Class II division II malocclusions it was shorter than it is in all the other classes, which is an expected result, considering the proclination of the maxillary central incisors in Class II division 1 and the retroclination in Class II division II malocclusions.

Furthermore, in this study, similar findings are seen in the lower MVD and CVD in Class II division I malocclusions as they were longer than the other classes, one possible reason for this may be that Class II division I malocclusions cases typically have significantly more overjet so that the lower incisors teeth may have more room to Procline resulting in increased the lower arch length.

The upper molar-vertical distance in the current study is increased in Class I malocclusion when compared with the normal group. This result is in accordance with the finding of Howe et al. (1983), but in disagreement with the studies carried out by Radnzic, 1988; and Al-Timimy, 2000, and these may be attributed to the differences in age groups, ethnic groups, and landmarks and procedures used in their study.

CONCLUSIONS

Based on the findings, it can be concluded that there were a significant reductions in the inter molar and inter premolar widths for Class I malocclusion when compared with the normal group in both arches and Class II division I malocclusion showed a significantly narrower upper inter premolar and inter-molar width when compared to normal occlusions and Class III malocclusion and longer arch length when compared to all other groups in both arches while a Class II division II malocclusion showed a significantly smaller upper inter canine width, arch length, incisor molar, and incisor canine when compared to all other groups.

Further studies are recommended to determine the arch forms and facial forms in the normal and different types of malocclusion in a Kurdish sample.

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