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Inter-arch Tooth Size Relationships among Different Occlusion Groups of Iraqi Population

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الخلاصة

الأهداف :كان هدف هذه الدراسة هو تحديد العرض الانسي الوحشي للأسنان الدائمة و نسبة حجم الأسنان بين الفكين و مقارنة هده المتغيرات بين الجنسين وبين سوء الإطباق المختلفة والإطباق الطبيعي للمراهق العراقي في مدينة الموصل. **المواد والطرق**: اخذ ١٤١ قالب جبسي لطلاب المدارس بعمر١٣ -١٦ سنة من العلاقات الاطباقية المختلفة (الصنف الأول ذو الإطباق طبيعي، وسوء الإطباق من الصنف الثاني (قسم ١ و٢) والصنف الثالث).قيس عرض الأسنان الانسي الوحشي باستعمال ورنية الأسنان. المتوسط والانحراف المعياري حسبا لجميع المتغيرات واجري التحليل الإحصائي باستخدام اختبار الطالب t ،تحليل التباين، اختبار مدى تحليل" دنكن" المتعدد المديات ومعامل ارتباط Pearson. **النتائج:** بالرغم من أن الذكور كان عندهم عرض اكبر لأغلب الأسنان من أولئك في الإناث، لكن البعض من هذه المقاييس كانت غير مختلفة خصوصا في الصنف الأول ذو الإطباق الطبيعي، بينما أهم الاختلافات بين الجنسين وجدت في الصنف الثاني قسم ١. اظهر الصنف الأول للإطباق الطبيعي ميل نحو الأسنان الصغيرة مقارنة بأصناف سوء الإطباق خصوصا في مجموعة الذكور بينما اظهر الصنف الثالث من سوء الإطباق ميل نحو الأسنان الكبيرة مقارنة بأصناف الإطباق الأخرى خصوصا في مجموعة الإناث.الصنف الأول ذو الإطباق الطبيعي امتلك أعلى نسبة للأسنان الأمامية من دلك في الصنف الثالث من سوء الإطباق و أعلى نسبة للأسنان الكلية من ذلك في مجموعات سوء الإطباق في الإناث ،بينما في الذكور كانت نسبة الأسنان الكلية اصغر في الصنف الثاني قسم ١من ذلك في الصنف الأول ذو الإطباق الطبيعي . لايوجد اختلاف بين الجنسين لنسب الأسنان في كل أصناف الإطباق ماعدا الصنف الثاني قسم ٢ من سوء الإطباق. **الاستنتاجات:** استنتج بان لكل مجتمع علاقات معينة لحجم الأسنان بين الفكين وهناك معيار للعرض الانسي الوحشي لبعض الأسنان خصوصا في الصنف الثاني قسم ١ و هذه النسب قد تكون إحدى العوامل المهمة المسببة لسوء الإطباق ،وهكذا فان هذه الدراسة أثبتت الحقيقة بان تحليل بالتون يجب أن يؤخذ بنظر الاعتبار أثناء التشخيص والعلاج التقويمي.

ABSTRACT

Aims: The aim of this study was to determine the mesiodistal tooth width of the permanent dentition, interarch tooth size ratios and to compare these variables between genders and among different malocclusion and normal occlusion groups for Iraqi adolescent in Mosul City. **Materials and Methods:** 141 orthodontic models of school students aged 13 – 16 years of different occlusal relationships (class I normal occlusion, class II (division 1 and 2) and class III malocclusion). Mesiodistal width of teeth were measured by using dental vernier. The mean and standard deviation were calculated. Student's t –test, analysis of variance, Duncan's multiple analysis range test and Pearson's correlation coefficient were used for the statistical analysis. **Results:** Although the males had a larger mesiodistal width of most of the teeth than those in the females, but some of these measurements were not significantly different particularly in class I normal occlusion, while the most significant gender differences were found in class II division 1. Class I normal occlusion showed a tendency toward small teeth than the malocclusion groups particularly in males group, while the class III malocclusion showed a tendency toward larger teeth than the other occlusal categories specially in females group. The class I normal occlusion had a higher anterior tooth ratio than that in class III malocclusion and a higher overall tooth ratio than that in the malocclusion groups in females. While in males the overall tooth ratio was smaller in class II division 1 than that in class I normal occlusion. No gender difference for the tooth ratios in all occlusal categories except in class II division 2 malocclusion. **Conclusions:** It was concluded that interarch tooth size relationships are population specific and there is a gender specific for mesiodistal width of some teeth particularly in class II division 1, and these ratios may be one of the important factors in the cause of malocclusion, thus, this study proved the fact that Bolton's analysis should be taken into consideration during orthodontic diagnosis and therapy.

Key words: Tooth width, interarch ratio, malocclusion, normal occlusion.

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INTRODUCTION

A proper balance should exist between the mesiodistal tooth size of the maxillary and mandibular arches to ensure proper

occlusion[1-3]. The size mismatch between the maxillary and mandibular dentition can lead to generalized spacing or crowding or deviation from class I occlusion in the posterior region[4-6].

There have been several studies suggesting methods of defining and measuring tooth size discrepancies[7,8], but the best – known study of tooth size disharmony in relation to treatment of malocclusion was by Bolton[9] who developed two ratios for estimating tooth size discrepancy by measuring the summed mesiodistal widths of the mandibular to maxillary anterior teeth (anterior ratio) and the total widths of all lower to upper teeth from first to first molar (overall or total arch ratio).

Tooth size variations exist among various ethnic groups[10-17], therefore, different diagnostic standards should be established for each racial group in order to provide an effective diagnostic standard.

A comparative study between Jordanians, Iraqi, Yemenites, and Caucasians reported that Jordanians and Iraqi had larger teeth than the other population[18], the later study, however, didn't discuss the differences in the tooth size between different malocclusions.

Various studies have investigated gender[11,19-23] and malocclusion[24-35] differences in the intermaxillary tooth ratios. Arja *et al*.,[19] reported some gender differences, but they couldn't demonstrate any differences between class I and II malocclusion. Another study confirmed the gender difference, but also showed the mesiodistal dimensions of upper teeth to be bigger in class I compared with class II (division 1 and 2) and class III. On the other hand, Akyale *et al*.,[31] demonstrated no significant difference between the two sexes and among the three malocclusion groups. There are no data available about the inter arch tooth size discrepancies among different malocclusion groups for Iraqi population in Mosul city.

The objectives of this study were: 1) to determine mesiodistal tooth width, anterior and overall Bolton ratios in normal occlusion and different malocclusion for Iraqi sample in Mosul City. 2) to compare the mesiodistal width, anterior and overall Bolton ratios between two genders in normal occlusion and different malocclusions groups. 3) to compare the mesiodistal width, anterior and overall Bolton ratios among normal occlusion and malocclusions groups. 4) to explore if there is might be a correlation between anterior, overall Bolton ratios and mesiodistal width of permanent dentition.

MATERIALS AND METHODS

The samples for this study consisted of 101 Iraqi students with varying malocclusion and 40 students with class I normal occlusion. All subjects were born and living in Mosul city and were between 13 and 16 years of age. After dental classification, the distribution of the sample were as follows: class I normal occlusion (20 male and 20 female); class II division 1 (20 male and 20 female); class II division 2 (16 male and 15 female) and class III (15 male and 15 female).

The inclusion criteria for the subjects were as follows: All permanent teeth had erupted and were present from right first molar through left first molar. No severe mesiodistal and occlusal tooth abrasion. No residual crown or crown – bridge restoration. No tooth deformity. No record of restoration or stripping of incisors and canine teeth.

In addition, the class I normal occlusion had the following criteria: normal occlusion (Angle class I molar and canine relationship). Harmonious overjet and over bite (2±0.5 mm). No crowding or spacing. No transverse discrepancies.

On the dental cast, each tooth from the maxillary and mandibular right first molar to the left first molar was measured at the largest mesiodistal dimensions to the nearest 0.01 mm, using dental vernier (Müncher model, Dentaurum 042 – 751, Germany) and the same examiner made all measurements.

All statistical analyses were performed using the Stastical Package for Social Sciences (SPSS for windows 98, version 10.0 SPSS Inc., Chicago). The mean and standard deviation for each variable in the different groups of malocclusion and class I normal occlusion were calculated. Comparisons between females and males were made for each variable using Student's *t* – test at $p \leq 0.05$. Analysis of variance was used to determine whether significant dif-

ferences existed among the groups. Duncan's multiple range test were done for test the significance differences at $p \leq 0.05$ among different type of malocclusion and normal occlusion groups. The compared variables were mesiodistal tooth widths, the sum of the six anterior teeth in both arches, the sum of the 12 teeth in both arches, the Bolton's anterior and overall ratios.

Pearson's correlation were done for the Bolton anterior and overall ratios with the other variables in different occlusal categories, for more precision in estimating the degree of significance of "r", the value of probability for "r" in correspondence with the sample size was established and hence we can say whether "r" is significant at $p \leq 0.05$ level or highly significant at $p \leq 0.01$ level.

RESULTS

Table (1)shows the comparison of the mesiodistal tooth width of the maxillary and mandibular permanent dentition between the males and females group in class I normal occlusion. Although the males had greater mesiodistal tooth than females in most of the teeth but the differences were not statistically significant except the mesiodistal width of the lower first molar which was significantly greater in males than that in females.

Table (1): Comparison of mesiodistal width of upper and lower teeth between males & females groups in Class I normal occlusion group.

Tooth	side	Total		Males (N=20)		Females (N=20)		*p* -alue
		Mean	SD	Mean	SD	Mean	SD	
Maxillary arch								
central incisor	**R**	8.32	.439	8.34	.442	8.30	.455	.820
	L	8.34	.419	8.39	.493	8.29	.318	.569
Lateral incisor	**R**	6.37	.376	6.39	.316	6.36	.454	.850
	L	6.36	426.	6.39	.387	6.33	.487	.754
canine	**R**	7.46	.467	7.45	.517	7.48	.419	.844
	L	7.46	466.	7.44	.489	7.48	.455	.851
First premolar	**R**	6.59	391.	6.59	.462	6.60	.298	.966
	L	6.70	373.	6.65	.393	6.77	.353	.443
Second premolar	**R**	6.32	464.	6.27	.476	6.38	.461	.551
	L	6.32	468.	6.23	.465	6.44	.464	.243
First molar	**R**	9.90	448.	9.97	.364	9.83	.543	.425
	L	9.87	445.	9.95	.473	9.78	.407	.329
Mandibular arch								
central incisor	**R**	5.10	266.	5.09	.242	5.12	.304	.777
	L	5.12	335.	5.05	.339	5.21	.323	.240
Lateral incisor	**R**	5.69	369.	5.64	.302	5.68	.443	.765
	L	5.75	391.	5.68	.345	5.77	.442	.572
canine	**R**	6.46	345.	6.45	.336	6.39	.355	.648
	L	6.59	364.	6.54	.299	6.59	.448	.723
First premolar	**R**	6.84	479.	6.82	.492	6.88	.485	.774
	L	6.85	374.	6.89	.409	6.83	.339	.678
Second premolar	**R**	6.79	407.	6.70	.439	6.90	.348	.192
	L	6.75	400.	6.74	.409	6.78	.393	.783
First molar	**R**	10.68	507.	10.90	.424	10.09	1.14	.009*
	L	10.72	579.	10.92	.551	10.13	1.29	.045*

* Significant difference at $p \leq 0.05$; **All measurements in millimeter.

Tables (2) and (3) demonstrates the comparison of the mesiodistal tooth width between males and females in class II (division 1 and 2) and class III malocclusion for upper and lower arch respectively. In class II division 1, the males had greater mesiodistal width of most of the teeth than those in females except the upper first premolar, upper left lateral incisor, second premolar, lower left lateral incisor and first molar.

While in class II division 2, the male had greater mesiodistal width in the upper central incisor and upper right canine, lower first molar, lower right central incisor, lower right canine and lower left lateral incisor. In class III malocclusion, the only significant difference between males and females was found in the upper left canine and premolar.

Table (2): Comparison of mesiodistal width for upper teeth between males & females in different types of malocclusions.

Tooth**	Side	Gender•	Class II div.1			Class II div.2			Class III		
			Mean	SD	*P* *value	Mean	SD	*P* * value	Mean	SD	*P* * value
Central incisor	R	M	8.72	.555	.010*	8.83	.578	.023 *	9.04	.514	.751
		F	8.18	.499		8.17	.520		8.96	.475	
	L	M	8.68	.593	.017*	8.95	.568	.018 *	9.01	.498	.932
		F	8.17	.479		8.24	.576		9.03	.348	
Lateral incisor	R	M	6.95	.560	.032*	6.84	.754	.785	7.16	.461	.302
		F	6.41	.719		6.75	.438		6.85	671.	
	L	M	6.77	.519	.143	6.77	.498	.940	6.88	.561	.708
		F	6.41	.737		6.75	.423		6.76	.751	
Canine	R	M	8.09	.609	.014*	8.09	.512	.027 *	8.19	.418	.339
		F	7.52	.561		7.53	.454		7.92	.628	
	L	M	8.07	383	.004*	8.06	.517	.079	8.16	.285	.045*
		F	7.50	.580		7.62	.439		7.78	.399	
First pre-molar	R	M	6.94	.408	.103	6.91	.496	.682	6.97	.508	.300
		F	6.67	.420		6.81	.505		7.27	.597	
	L	M	6.93	.262	.181	6.88	.296	.591	6.76	.472	.047*
		F	6.76	.409		6.98	.479		7.38	.646	
Second premolar	R	M	6.76	.309	.054	6.56	.608	.559	6.46	..460	.188
		F	6.47	.456		6.41	.354		6.82	.584	
	L	M	6.59	.437	.930	6.63	.533	.520	6.50	.338	.318
		F	6.57	.519		6.49	.385		6.70	.429	
First molar	R	M	10.74	.598	.047*	10.21	.722	.600	10.29	.616	.697
		F	10.30	.549		10.02	.757		10.43	.827	
	L	M	8.72	.488	.018*	10.12	.642	.469	10.64	.498	.323
		F	8.18	.434		9.89	.641		10.34	.622	

* Significant difference at $p \leq 0.05$; ** All measurements in millimeter. • Number of males in Class II div.1=20, ClassII div 2=16, ClassIII=15; Number of females in Class II div.1=20, Class II div 2=15, ClassIII=15.

Table (3): Comparison of mesiodistal width for lower teeth between males and females in different types of malocclusions.

Tooth**	Side	Gender •	Class II div.1			Class II div.2			Class III		
			Mean	SD	*P** value	Mean	SD	*P** value	Mean	SD	*p** value
Central incisor	R	M	5.48	.291	.007*	5.56	.466	. 036*	5.48	. 369	.700
		F	5.09	.419		5.21	.284		5.31	. 337	
	L	M	5.43	.426	. 046*	5.56	. 478	.081	5.54	. 241	. 672
		F	5.08	.475		5.24	.313		5.43	. 338	
Lateral incisor	R	M	5.95	.363	.024*	6.05	651	.256	6.10	. 289	.185
		F	5.60	.437		5.80	.329		5.70	. 469	
	L	M	5.92	.484	.117	6.17	.527	.012*	6.20	. 295	. 255
		F	5.62	.491		5.71	.478		5.84	.420	
Canine	R	M	6.96	.339	.000*	7.03	.317	. 041*	7.11	.349	. 162
		F	6.39	.424		6.51	. 423		6.69	. 325	
	L	M	7.02	.365	.000*	7.10	.316	.066	7.29	.442	. 342
		F	6.30	.293		6.55	. 345		6.91	. 296	
First premolar	R	M	7.01	.438	.019*	7.13	. 569	. 310	7.15	. 533	. 148
		F	6.68	.518		6.58	225.		7.29	. 609	
	L	M	7.02	.348	. 005*	7.12	. 521	. 283	7.34	.399	. 350
		F	6.53	.509		6.71	.356		7.30	. 739	
Second premolar	R	M	7.10	.318	.007*	7.09	. 516	. 091	7.28	. 439	. 870
		F	6.68	.458		6.58	.528		7.15	.504	
	L	M	7.11	.297	. 021*	7.12	. 433	. 130	7.27	. 508	. 735
		F	6.76	.472		6.73	. 500		7.07	. 520	
First molar	R	M	11.05	.552	.052	10.85	.568	. 035*	11.10	. 551	. 634
		F	10.63	.571		10.14	.522		11.07	.764	
	L	M	11.09	.598	.155	11.16	.585	. 012*	11.19	.584	. 827
		F	10.77	.581		10.19	. 473		11.11	.764	

*Significant difference at $p \leq 0.05$; **All measurements in millimeter; • Number of males in Class II div.1=20, ClassII div 2=16, ClassIII=15; Number of females in Class II div.1=20, Class II div 2=15, ClassIII=15.

Tables (4) and (5) shows the comparison of mesiodistal width of the maxillary and mandibular teeth among different malocclusions and normal occlusion groups in the males and females groups respectively.

Generally, the class I normal occlusion had a lower mean for the mesiodistal width of most teeth than the malocclusion groups. While the class III malocclusion showed a higher values for most of the variables particularly in the males group.

Table (4) : Comparison of mesiodistal tooth width among different malocclusion and normal occlusion groups in males.

	Tooth	side	Class I (n=20)		Class II div.1(n=20)		Class II div.2(n=16)		Class III (n=15)		*p* value
			mean	Duncan	mean	Duncan	Mean	Duncan	mean	Duncan	
Maxillary arch	Central incisor	R	8.34	a	8.72	ab	8.74	ab	9.04	b	.020
		L	8.39	a	8.68	ab	8.91	b	8.99	b	.051
	Lateral incisor	R	6.39	a	6.95	bc	6.68	ab	7.26	c	.001
		L	6.39	a	6.77	ab	6.71	ab	7.04	b	.017
	Canine	R	7.45	a	8.09	b	8.18	b	8.20	b	.001
		L	7.44	a	8.07	b	8.14	b	8.24	b	.000
	First premolar	R	6.59	a	6.93	ab	6.89	ab	7.13	b	.057
		L	6.65	a	6.93	a	6.86	a	6.92	a	.184
	Second premolar	R	6.27	a	6.76	b	6.57	ab	6.49	ab	.052
		L	6.23	a	6.59	ab	6.67	b	6.52	ab	.084
	First molar	R	9.97	a	10.75	b	10.31	ab	10.40	ab	.005
		L	9.95	a	10.74	b	10.23	a	10.77	b	.000
Mandibular arch	Central incisor	R	5.09	a	5.48	b	5.56	b	5.48	b	.002
		L	5.05	a	5.43	b	5.56	b	5.54	b	.006
	Lateral incisor	R	5.64	a	5.95	ab	6.05	b	6.10	b	.028
		L	5.68	a	5.92	ab	6.17	b	6.20	b	.014
	Canine	R	6.45	a	6.96	b	7.03	b	7.11	b	.000
		L	6.54	a	7.02	b	7.10	b	7.29	b	.000
	First premolar	R	6.82	a	7.01	a	7.13	a	7.15	a	.315
		L	6.89	a	7.02	ab	7.12	ab	7.34	b	.097
	Second premolar	R	6.70	a	7.10	b	7.09	b	7.28	b	.008
		L	6.74	a	7.11	b	7.12	b	7.27	b	.011
	First molar	R	10.90	a	11.05	a	10.85	a	11.10	a	.625
		L	10.92	a	11.09	a	11.16	a	11.19	a	.655

*Different letters horizontally mean significant difference at $p \leq 0.05$. All measurements in millimeter.

Table (5) : Comparison of mesiodistal tooth width among different malocclusion and normal occlusion groups in females group.

	Tooth	side	Class I (n=20)		Class II div.1(n=20)		Class II div.2(n=15)		Class III (n=15)		*P* value
			mean	Duncan	mean	Dun-can	Mean	Dun-can	mean	Dun-can	
Maxillary arch	**Central incisor**	R	8.30	A	8.18	a	8.36	a	8.86	b	.040
		L	8.29	A	8.17	a	8.40	a	8.93	b	.005
	Lateral incisor	R	6.36	A	6.14	a	6.88	a	6.80	a	.167
		L	6.33	A	6.41	a	6.75	a	6.68	a	.384
	Canine	R	7.48	Ab	7.52	ab	7.43	a	7.93	b	.154
		L	7.48	A	7.50	a	7.48	a	7.78	a	.424
	First pre-molar	R	6.60	A	6.67	a	6.73	a	7.17	b	.028
		L	6.77	A	6.76	a	6.91	ab	7.27	b	.060
	Second premolar	R	6.38	Ab	6.47	ab	6.36	a	6.80	b	.156
		L	6.44	A	6.58	a	6.44	a	6.68	a	.594
	First molar	R	9.83	A	10.30	a	9.85	a	10.37	a	.109
		L	9.77	A	10.30	b	9.70	a	10.27	b	.012
Mandibular arch	**Central incisor**	R	5.12	A	5.09	a	5.21	a	5.31	a	.000
		L	5.21	a	5.08	a	5.24	a	5.43	a	.000
	Lateral incisor	R	5.74	A	5.60	a	5.80	a	5.70	a	.001
		L	5.83	A	5.62	a	5.71	a	5.84	a	.012
	Canine	R	6.46	A	6.39	a	6.51	a	6.69	a	.000
		L	6.65	Bc	6.30	a	6.55	ab	6.91	c	.000
	First pre-molar	R	6.88	Ab	6.68	a	6.58	a	7.29	b	.003
		L	6.81	A	6.53	a	6.71	a	7.30	b	.014
	Second premolar	R	6.90	Ab	6.68	a	6.58	a	7.15	b	.088
		L	6.75	A	6.76	a	6.73	a	7.07	a	.404
	First molar	R	10.41	A	10.63	ab	10.14	a	11.07	b	.000
		L	10.47	Ab	10.77	bc	10.19	a	11.11	c	.000

*Different letters horizontally mean significant difference at $p \leq 0.05$. All measurements in millimeter.

As shown in Table (6), anterior teeth ratio was not significantly different among different malocclusion and normal occlusion group in males. While in females group, the class I normal occlusion had a higher value than that in class III. The overall ratio was significantly smaller in class II division 1 when compared with class I normal occlusion in males. While in females group, the class I normal occlusion had a higher value than that in malocclusion groups. The males had a higher overall teeth ratio when compared with females in class II division 2 as demonstrated in Table (7), while the other types of malocclusion and normal occlusion showed no significant difference in the anterior and overall teeth ratio between males and females.

Table (6) : Comparison of Bolton ratios among normal occlusion and malocclusion groups in males and females.

Variable	Type of occlusion	Males				Female			
		Mean	SD	*P* value	Duncan	Mean	SD	*p* value	Duncan
Sum of upper anterior teeth	Cl I	44.39	2.23	.001	A	44.24	2.08	.000	A
	Cl II 1	47.27	2.78		B	44.19	3.02		A
	Cl II 2	47.35	2.33		B	45.30	1.78		AB
	Cl III	48.77	2.46		B	46.98	2.62		B
Sum of lower anterior teeth	Cl I	34.45	1.39	.000	A	35.00	1.95	.201	A
	Cl II 1	36.76	1.74		B	34.08	1.99		A
	Cl II 2	37.47	2.08		B	35.03	1.96		A
	Cl III	37.72	1.47		B	35.88	1.73		A
Sum of upper 12 teeth	Cl I	90.05	4.23	.000	A	90.03	3.55	.000	A
	Cl II 1	95.97	3.95		B	91.28	4.88		A
	Cl II 2	94.88	4.47		B	91.29	4.03		A
	Cl III	96.99	3.47		B	95.54	4.87		B
Sum of lower 12 teeth	Cl I	83.42	3.27	.001	A	83.23	3.09	.050	A
	Cl II 1	87.26	2.96		B	82.12	4.34		A
	Cl II 2	87.82	4.03		B	81.96	4.47		A
	Cl III	89.05	3.74		B	86.87	4.79		B
Bolton anterior ratio	Cl I	77.70	2.80	.523	A	79.15	3.01	.096	B
	Cl II 1	77.85	2.68		A	77.20	2.71		AB
	Cl II 2	79.15	2.35		A	77.32	2.56		AB
	Cl III	77.39	1.88		A	76.30	2.24		A
Bolton overall ratio	Cl I	92.68	1.72	.061	B	92.47	1.71	.001	B
	Cl II 1	90.96	1.65		A	89.99	1.83		A
	Cl II 2	92.58	2.02		AB	89.78	1.93		A
	Cl III	91.82	1.83		AB	90.85	1.38		A

*Vertically for each variable means with the different letter are significantly different at $p \leq 0.0$; Number of males in Class I=20, Class II div.1=20, ClassII div 2=16, ClassIII=15; Number of females in Class I=20, Class II div.1=20, Class II div 2=15, ClassIII=15.

Table (7) : Comparison of Bolton ratio between males and females in normal occlusion and malocclusion groups.

	Type of occlusion	Males		Females		*p* value
		Mean	SD	Mean	SD	
Sum of upper anterior teeth	Cl I	44.39	2.23	44.24	2.08	.864
	Cl II 1	47.27	2.78	44.19	3.02	.008
	Cl II 2	47.35	2.33	45.30	1.78	.025
	Cl III	48.77	2.46	46.98	2.62	.385
Sum of lower anterior teeth	Cl I	34.45	1.39	35.00	1.95	.395
	Cl II 1	36.76	1.74	34.08	1.99	.001
	Cl II 2	37.47	2.08	35.03	1.96	.020
	Cl III	37.72	1.47	35.88	1.73	.200
Sum of upper 12 teeth	Cl I	90.05	4.23	90.03	3.55	.993
	Cl II 1	95.97	3.95	91.28	4.88	.008
	Cl II 2	94.88	4.47	91.29	4.03	.138
	Cl III	96.99	3.47	95.54	4.87	.927
Sum of lower 12 teeth	Cl I	83.42	3.27	83.23	3.09	.881
	Cl II 1	87.26	2.96	82.12	4.34	.001
	Cl II 2	87.82	4.03	81.96	4.47	.019
	Cl III	89.05	3.74	86.87	4.79	.986
Bolton anterior ratio	Cl I	77.70	2.80	79.15	3.01	.208
	Cl II 1	77.85	2.68	77.20	2.71	.522
	Cl II 2	79.15	2.35	77.32	2.56	.318
	Cl III	77.39	1.88	76.30	2.24	.510
Bolton overall ratio	Cl I	92.68	1.72	92.47	1.71	.747
	Cl II 1	90.96	1.65	89.99	1.83	.142
	Cl II 2	92.58	2.02	89.78	1.93	.014
	Cl III	91.82	1.83	90.85	1.38	.657

* Significant difference at $p \leq 0.05$; Number of males in Class I=20, Class II div.1=20, ClassII div 2=16, ClassIII=15; Number of females in Class I=20, Class II div.1=20, Class II div 2=15, ClassIII=15.

The correlation of the anterior and overall tooth size ratio with the mesiodistal width of the maxillary and mandibular teeth in normal occlusion and malocclusion groups were presented in Table (8).

Table (8): Correlation between anterior, overall Bolton ratio and mesiodistal width of teeth in normal occlusion and malocclusion groups.

	Tooth	Side	Cl I		Cl II div.1		Cl II div.2		Cl III	
			Anterior ratio	Overall ratio	Ante-rior ratio	Overall ratio	Anterior ratio	Overall ratio	Anterior ratio	Overall ratio
Maxillary arch	**Central incisor**	**R**	-.206	-.268	-.290	-.111	-.008	.249	-.483*	-.057
		L	-.383*	-.416*	-.290	-.164	.150	.251	-.696**	-.242
	Lateral incisor	**R**	-.494**	-.499**	-.484**	-.245	.008	-.002	-.371	.091
		L	-.444	-.307	-.552**	-.263	.009	.063	-.299	.038
	Canine	**R**	-.158	-.270	-.270	-.193	.169	.221	-.366	.193
		L	-.337	-.273	-.372*	-.235	.185	.341	-.076	.272
	First premolar	**R**	- .134	-.227	-.273	-.148	.136	-.090	.342	.261
		L	-.023	-.260	-.303	-.163	.052	-.308	.197	.139
	Second premolar	**R**	-.131	-.474	-.147	-.185	-.062	-.173	-.192	-.277
		L	-.059	-.400*	-.132	-.163	-.119	-.210	-.078	-.444
	First molar	**R**	-.086	- .421*	.161	-.049	.361	.087	.046	-.161
		L	-.056	-.483*	.262	.138	.225	.069	.145	.105
Mandibular arch	**central incisor**	**R**	.298	.109	.094	.121	.462	.479*	-.275	.321
		L	.057	-.144	.220	.147	.249	.389	-.091	.156
	Lateral incisor	**R**	.589**	.197	.017	.054	.494*	.367	-.155	.149
		L	.332	-.103	.110	.024	.495*	496. *	.078	.348
	Canine	**R**	.102	-.088	-.141	-.016	.511*	.476*	.561*	.497*
		L	.361	-.008	-.098	.053	.583**	.478*	.393	.504*
	First premolar	**R**	-.230	-.085	-.141	.139	.358	.126	.220	.318
		L	-.298	-.139	-.085	.280	.341	.368	.076	.316
	Second premolar	**R**	-.213	-.132	-.174	.127	.314	.319	.110	.382
		L	-.224	-.165	-.015	.252	.294	.438	.076	.404
	First molar	**R**	-.333	.088	-.135	.180	.034	.443	-.324	.115
		L	-.454*	-.084	-.265	.149	.137	.532*	-.367	.164
Sum of upper anterior teeth			-.404*	-.407*	-.444*	-.233	.119	.266	-.483*	.059
Sum of upper 12 teeth			-.277	-.481	-.310	-.200	.154	.095	-.221	.003
Sum of lower anterior teeth			.371*	-.012	.040	.075	.561**	.535*	.136	.440
Sum of lower 12 teeth			-.070	-.076	-.078	.166	.435	.532*	.012	.400
Anterior ratio			1.000	.521**	1.000	.639**	1.000	.676**	1.000	.539*
Overall ratio			.521**	1.000	.639**	1.000	.676**	1.000	.539*	1.000

* Significant difference at $p \leq 0.05$; **Significant difference at $p \leq 0.01$.

DISCUSSION

Discrepancies in tooth size should be known at the initial diagnosis and treatment planning stages, if perfect results in orthodontic finishing are to be achieved. The treatment alternative for the tooth size discrepancies include restoration of a relatively small teeth, interproximal stripping of a relatively large teeth, modification of crown angulation or inclination and extraction[36].

The low standard deviation of values in the Iraqi sample demonstrates low variability, this might be attributed to the strict selection of harmonious cast and to the high accuracy of the vernier calipers (0.01mm) used in this study, this is in agreement with Nourallah *et al*.[14].

The anterior ratio in many studies[11,12,25,29,38] is some what higher than Bolton ratio[9], because of greater morphological variability in upper incisor width than that calculated by Bolton on models in patient with an ideal occlusion, this may also be the case in the present study for the anterior inter –arch ratio in class I normal occlusion in females group. Furthermore, the overall ratio in this study in class I normal occlusion for the males and females groups was higher than Bolton ratio[9]. It is relevant to mention the well –known the effect of premolar extractions on the ideal Bolton ratios and is the consequence of the effect on a ratio of reducing the absolute sums of the tooth widths in the same way that the ratio is different for the total arch because lower second premolars are an average, slightly larger than upper premolar[11].

The mean values of anterior and overall ratios were not statistically significant between the two genders in class I normal occlusion, class II division 1 and class III malocclusion groups, this confirm the findings of other studies[14,20,23].

Xia and Wu[39] found no significant difference for tooth size ratios between the normal occlusion and malocclusion groups, this confirm the findings of the present study for the anterior ratio in males and also confirm the findings in females except the class III that showed smaller anterior ratio than that in class I normal occlusion,this is disagreement with Nie and Lin[25] who demonstrated that a significant difference was found for intermaxillary tooth size ratios among different malocclusion groups with the ratios showing that class III > class I > class II. In this study, the anterior and overall tooth ratios among the different malocclusions showed no significant differences. This findings was in agreement with other studies[11,24,30,31,40]. Alkofide and Hashim[27] also reported no difference in the incidence of tooth size discrepancies among the different malocclusion groups except for the anterior ratio in class III malocclusion.

Although mesiodistal crown width of the most teeth in males group were larger than females .This agree with the previous studies[14,20,23,25], but some of these measurements were not significantly different particularly in class I normal occlusion.

The most significant gender differences for the mesiodistal teeth width were found in class II division 1. The exact reason for this difference is not well understood. This could be due to sex –linked inheritance and sex –hormonal influence.

Generally, the class I normal occlusion showed a lower mean values for the mesiodistal width of all the teeth than the malocclusion groups, although the difference was not significant in some of measurements in males and females groups. On the other hand, the class III malocclusion showed a higher value for most of the mesiodistal width than other types of malocclusion and normal occlusion group, this is in agreement with Lavelle[3] and Xia and Wu[39].

The correlational results revealed that the anterior ratio had significant correlation with the sum of the mesiodistal width of the upper anterior teeth in class I normal occlusion, class II division 1 and class III, while in class II division 2, the anterior ratio correlated with the sum of the mesiodistal crown width of the lower anterior teeth, this indicates that the anterior teeth ratio associated with the variation of upper anterior teeth rather than lower anterior teeth in all types of occlusion categories except class II division 2, this support the findings of other studies[25,37,38] who found that greater morphologic variability in upper incisor width are believed to affect the anterior ratio.

CONCLUSIONS

These findings indicated that population specific standards for interarch tooth size relationships are necessary for clinical assessment. The males showed a tendency of having a significantly larger teeth than females particularly in class II division 1 malocclusion group. Class III malocclusion showed a tendency toward a significantly larger teeth than the other occlusion categories especially in females group. In contrast, class I normal occlusion showed a tendency toward a significantly smaller teeth than the malocclusion groups particularly in males group. The overall tooth ratio in class I normal occlusion was significantly higher than class II division 1 in males and higher than the malocclusion groups in females. In addition, the anterior tooth ratio was significantly higher in class I normal occlusion than in class III malocclusion in females group. No gender difference for the anterior and overall tooth ratio in all occlusal categories except in class II division 2. The anterior tooth ratio associated with the variation of upper anterior teeth.

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