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Original article

A COMPARISON OF MORPHOMETRIC PARAMETERS OBSERVING TOOTH SIZE DISCREPANCIES AND ARCHWIDTH AMONG THE INDIAN AND IRANIAN POPULATION- A PILOT APPROACH.

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ABSTRACT

Background- Origin and the gender have a definitive role to play in the growth and development of an individual. The Bolton's ratio and arch width parameters are such parameter which are taken into consideration while treating malocclusion. A definite relationship between the two arches is often hampered due to the discrepancy in the above mentioned parameters. There are definite differences in the developmental milestones between the males and females, the malocclusions also do show differences when these parameters are considered. The reports based on the differences in these parameters based on the malocclusion, gender and ethnicity altogether are scanty and hence this must be taken into consideration as a part of research which can help orthodontist to render better treatment understanding of these core concepts. **Aims and objectives-**The aims and objectives of the present study were to determine and compare the anterior and overall Bolton's ratios and arch width between Iranian and Indian population with Class I, Class II Division I and Class II Division II malocclusion and also determine the level of sexual dimorphism that exists. **Materials and methods-** A total of 40 cases were considered segregated as per the malocclusion, gender and the ethnic origin. The Bolton's ratio and the arch width at the canine, premolar and molar region were measured to analyze the level of sexual dimorphism and differences among the population if it existed. The measurements were done twice in a span of two weeks by a single observer and the mean observations were considered to avoid intraobserver bias. The sum of the 12 teeth in both arches, the Bolton's anterior and overall ratios, the intercanine width, interpremolars, and intermolar widths from all the measured points using Student's *t*-test. Analysis of variance was used to determine whether significant differences existed between the groups. The statistical analysis was done using SPSS version 18(Statistical Package for the Social Sciences). **Results-** There was a definitive sexual dimorphism exhibited when both the population samples were considered together and it was statistically significant with $p<0.001$. There were some strong inclinations towards particular population that showed a higher value for the parameters when the males and females were considered separately but the observations were inconclusive with definitive reason and were statistically insignificant. **Conclusion –** Bolton's ratio and arch width are definitive parameters that can render to treatment planning and can also aid as a forensic information as there are definitive differences exhibited by the genders. A careful record of the interarch relationships along with the above parameters can aid in better diagnosis and treatment planning.

Introduction

The transverse discrepancies of the dental arches can be corrected by different modes of treatment options rendered by modern orthodontics[1]. Numerous studies showed that the range of malocclusions which showed transverse discrepancies of the arch bases as well as the width pf the dental arches has been treated[2-4]. The interarch discrepancy or the archwidth discrepancy was observed as one of the simplest and effective

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Table 1:
Distribution of cases as per the malocclusion, gender and origin

Classification of malocclusion	Number of males		Number of Females		Total
	Indian	Iranian	Indian	Iranian	
Class I	8	7	8	7	30
Class II division I	6	4	6	4	20
Class II division II	4	3	5	3	15

morphometric parameter for analyzing the transverse congruency of the dental arches. Researchers have shown that there do exist a difference between the maxillary and mandibular interarch width in terms of intermolar width[5]. A strict relationship between the tooth size and the arches always led to an ideal intercuspation[6]. Reports have also shown that tooth size discrepancy vary among different malocclusions[7,8]. Sexual dimorphism was seen in the differences of tooth size by few authors among the maxillary and mandibular arches[9,10]. Ethnic origin and gene pool do play a pivotal role in the formation of malocclusions, the difference in the tooth sizes and the tooth size ratios were found to be significantly different among the negroid, mongoloids and Caucasians[11,12]. Numerous researches have been so far published considering various ethnic groups, malocclusions and gender discretely, our study attempted in throwing a light that whether the above considerations when compiled together can play a role in the formation of discrepancies.The aims and objectives of the present study were to determine and compare the anterior and overall Bolton ratios and arch width between Iranian and Indian population with Class I, Class II Division I and Class II Division II malocclusion and also determine the level of sexual dimorphism that exists.

MATERIALS AND METHODS

A total of 40 sets of alginate impressions were obtained from patients with different malocclusions (Class I, Class II Division I, Class II Division II malocclusions). The informed consents were obtained from the patients prior to the procedure and the research has been approved by the institutional ethics committee(IEC). The impressions were poured using type III dental stone (Orthokal). The subjects were distributed according to sex, ethnic origin andmalocclusion. (Table 1)

The inclusion criteria for subjects were

1. All fully erupted teeth.
2. Permanent dentition with no caries, restorations or anomalies.
3. No previous Orthodontic Treatment.
4. Absence of Scissorbite or crossbite.

Parameters considered in the study:

Bolton's Ratio-(Figure 1)

The mesiodistal width of all the teeth from 1st molar to the 1st molar of the contralateral side was measured on

Table –2
COMPARISON OF THE INDIAN AND IRANIAN GROUPS IN FEMALES AND MALES SEPARTELY: INDEPENDENT T TEST

		NATIONALITY	N	Mean	Std. Deviation	t	df	P VALUE
FEMALE	Bolton's anterior	INDIAN	19	2.294737	1.015148	-0.389	24.111	0.7
		IRANIAN	15	2.393333	0.38446			
	Bolton's overall	INDIAN	19	2.901579	1.178814	-0.041	22.957	0.968
		IRANIAN	15	2.913333	0.397971			
	Intercanine	INDIAN	19	32.52105	3.543159	-1.539	32	0.134
		IRANIAN	15	34.05333	1.686868			
	inter premolar	INDIAN	19	35.3579	2.759693	0.664	32	0.512
		IRANIAN	15	34.81333	1.764275			
	inter molar	INDIAN	19	42.25263	1.975508	-0.375	31.4	0.71
		IRANIAN	15	42.46667	1.341996			
MALE	Bolton's anterior	INDIAN	18	2.027778	1.297874	-0.617	30	0.542
		IRANIAN	14	2.271429	0.793656			
	Bolton's overall	INDIAN	18	2.988889	1.988168	-0.259	30	0.797
		IRANIAN	14	3.135714	0.816755			
	Intercanine	INDIAN	18	34.92222	2.141895	0.511	30	0.613
		IRANIAN	14	34.51429	2.358571			
	inter premolar	INDIAN	18	37.56667	2.768521	-0.227	30	0.822
		IRANIAN	14	37.75	1.345505			
	inter molar	INDIAN	18	45.40556	3.5181	0.025	30	0.98
		IRANIAN	14	45.37857	2.115212			

Table-3

Comparison of the male and female in the Indian and Iranian population separately: independent t test.

1.1.1.	1.1.2.	1.1.3. GENDER	1.1.4. N	1.1.5. Mean	1.1.6. Std. Deviation	1.1.7. t	1.1.8. df	1.1.9. P VALUE
1.1.10. INDIAN	1.1.11. Bolton's anterior	1.1.12. FEMALE	1.1.13. 19	1.1.14. 2.294737	1.1.15. 1.015148	1.1.16. 0.699	1.1.17. 35	1.1.18. 0.489
		1.1.19. MALE	1.1.20. 18	1.1.21. 2.027778	1.1.22. 1.297874			
	1.1.23. Bolton's overall	1.1.24. FEMALE	1.1.25. 19	1.1.26. 2.901579	1.1.27. 1.178814	1.1.28. -0.164	1.1.29. 35	1.1.30. 0.871
		1.1.31. MALE	1.1.32. 18	1.1.33. 2.988889	1.1.34. 1.988168			
	1.1.35. Intercanine	1.1.36. FEMALE	1.1.37. 19	1.1.38. 32.52105	1.1.39. 3.543159	1.1.40. -2.477	1.1.41. 35	1.1.42. 0.018*
		1.1.43. MALE	1.1.44. 18	1.1.45. 34.92222	1.1.46. 2.141895			
	1.1.47. inter premolar	1.1.48. FEMALE	1.1.49. 19	1.1.50. 35.3579	1.1.51. 2.759693	1.1.52. -2.43	1.1.53. 35	1.1.54. 0.02*
		1.1.55. MALE	1.1.56. 18	1.1.57. 37.56667	1.1.58. 2.768521			
	1.1.59. inter molar	1.1.60. FEMALE	1.1.61. 19	1.1.62. 42.25263	1.1.63. 1.975508	1.1.64. -3.385	1.1.65. 35	1.1.66. 0.002*
		1.1.67. MALE	1.1.68. 18	1.1.69. 45.40556	1.1.70. 3.5181			
1.1.71. IRANIAN	1.1.72. Bolton's anterior	1.1.73. FEMALE	1.1.74. 15	1.1.75. 2.393333	1.1.76. 0.38446	1.1.77. 0.521	1.1.78. 18.494	1.1.79. 0.609
		1.1.80. MALE	1.1.81. 14	1.1.82. 2.271429	1.1.83. 0.793656			
	1.1.84. Bolton's overall	1.1.85. FEMALE	1.1.86. 15	1.1.87. 2.913333	1.1.88. 0.397971	1.1.89. -0.922	1.1.90. 18.554	1.1.91. 0.368
		1.1.92. MALE	1.1.93. 14	1.1.94. 3.135714	1.1.95. 0.816755			
	1.1.96. Intercanine	1.1.97. FEMALE	1.1.98. 15	1.1.99. 34.05333	1.1.100. 1.686868	1.1.101. -0.609	1.1.102. 27	1.1.103. 0.548
		1.1.104. MALE	1.1.105. 14	1.1.106. 34.51429	1.1.107. 2.358571			
	1.1.108. inter premolar	1.1.109. FEMALE	1.1.110. 15	1.1.111. 34.81333	1.1.112. 1.764275	1.1.113. -5.012	1.1.114. 27	1.1.115. <0.001**
		1.1.116. MALE	1.1.117. 14	1.1.118. 37.75	1.1.119. 1.345505			
	1.1.120. inter molar	1.1.121. FEMALE	1.1.122. 15	1.1.123. 42.46667	1.1.124. 1.341996	1.1.125. -4.459	1.1.126. 27	1.1.127. <0.001**
		1.1.128. MALE	1.1.129. 14	1.1.130. 45.37857	1.1.131. 2.115212			

* - Significant ($p < 0.05$) ** - Highly significant($p<0.001$)

Table – 4:
COMPARISON OF INDIAN AND IRANIAN IN EACH CLASS SEPARTELY: STUDENTS T TEST

		NATIONALITY	N	Mean	Std. Deviation	t	df	P VALUE
CLASS I	Bolton's anterior	INDIAN	16	2.6	1.281666	0.268	19.776	0.791
		IRANIAN	14	2.507143	0.489056			
	Bolton's overall	INDIAN	16	3.314375	1.960367	0.055	18.885	0.957
		IRANIAN	14	3.285714	0.670083			
	Intercanine	INDIAN	16	34.0875	3.387403	-1.183	28	0.247
		IRANIAN	14	35.29286	1.861126			
	inter premolar	INDIAN	16	36.75625	2.317173	0.525	28	0.603
		IRANIAN	14	36.34286	1.939752			
	inter molar	INDIAN	16	43.21875	2.973935	-0.275	25.518	0.786
		IRANIAN	14	43.46429	1.859118			
CLASS II DIV I	Bolton's anterior	INDIAN	12	1.675	1.215899	-0.503	18	0.621
		IRANIAN	8	1.925	0.851469			
	Bolton's overall	INDIAN	12	2.683333	1.646944	-0.366	15.107	0.719
		IRANIAN	8	2.875	0.620484			
	Intercanine	INDIAN	12	34.40833	3.067264	1.25	18	0.227
		IRANIAN	8	32.8875	1.863512			
	inter premolar	INDIAN	12	37.29167	3.674101	-0.114	18	0.911
		IRANIAN	8	37.45	1.667333			
	inter molar	INDIAN	12	45.04167	4.164669	0.094	18	0.926
		IRANIAN	8	44.875	3.388953			
CLASS II DIV II	Bolton's anterior	INDIAN	9	2.044444	0.335824	-2.775	14	**0.015***
		IRANIAN	7	2.457143	0.229907			

	Bolton's overall	*INDIAN*	*9*	*2.633333*	*0.339117*	*-0.142*	*14*	*0.889*
		IRANIAN	*7*	*2.657143*	*0.325869*			
	Intercanine	*INDIAN*	*9*	*32.02222*	*2.446823*	*-1.718*	*14*	*0.108*
		IRANIAN	*7*	*33.82857*	*1.47503*			
	inter premolar	*INDIAN*	*9*	*34.71111*	*2.404394*	*0.082*	*14*	*0.936*
		IRANIAN	*7*	*34.61429*	*2.266737*			
	inter molar	*INDIAN*	*9*	*43.12222*	*1.622327*	*-0.576*	*14*	*0.574*
		IRANIAN	*7*	*43.54286*	*1.177366*			

* - Significant ($p < 0.05$)

FIGURE 1

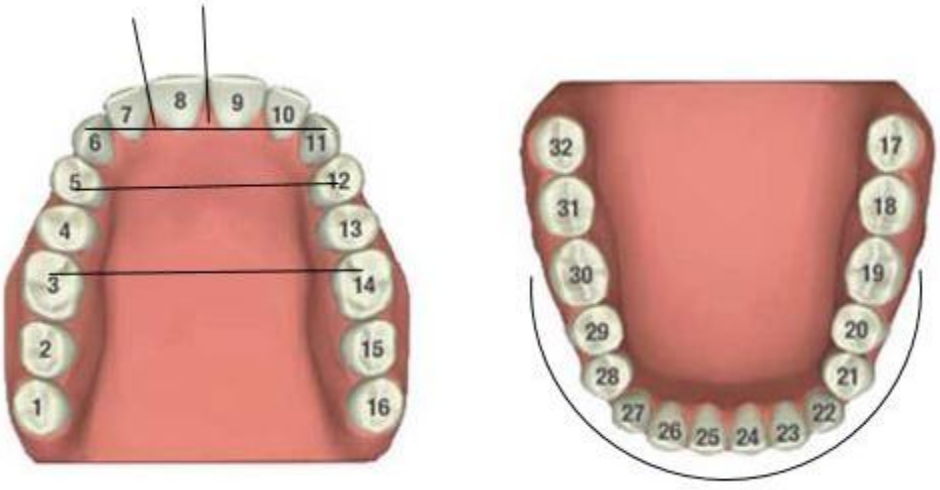

Figure 1: Measurement of Bolton's ratio and arch width (Inter canine, inter premolar, inter molar)

Table 5:

COMPARISON OF THE MALE AND FEMALE IN EACH OF THE CLASSES: STUDENTS T TEST

		GENDER	N	Mean	Std. Deviation	t	df	P VALUE
CLASS I	Bolton's anterior	FEMALE	15	2.2	0.944155	-2.11	28	**0.044***
		MALE	15	2.913333	0.90701			
	Bolton's overall	FEMALE	15	2.648667	0.879341	-2.655	28	**0.013***
		MALE	15	3.953333	1.688138			
	Intercanine	FEMALE	15	33.39333	3.172306	-2.71	28	**0.011***
		MALE	15	35.90667	1.68458			
	inter premolar	FEMALE	15	35.57333	2.193323	-2.85	28	**0.008***
		MALE	15	37.55333	1.557868			
	inter molar	FEMALE	15	42.17333	1.687969	-2.865	28	**0.008***
		MALE	15	44.49333	2.642906			
CLASS II DIV I	Bolton's anterior	FEMALE	10	2.58	0.813497	5.185	18	**≤0.001****
		MALE	10	0.97	0.549849			
	Bolton's overall	FEMALE	10	3.4	1.177568	2.452	18	**0.025***
		MALE	10	2.12	1.156431			
	Intercanine	FEMALE	10	34.07	2.800813	0.437	18	0.667
		MALE	10	33.53	2.725212			
	inter premolar	FEMALE	10	35.99	2.087236	-2.264	18	**0.036***
		MALE	10	38.72	3.190193			
	inter molar	FEMALE	10	41.88	1.674515	-6.576	18	**≤0.001****
		MALE	10	48.07	2.460826			
CLASS II DIV II	Bolton's anterior	FEMALE	9	2.3	0.415331	0.956	14	0.356
		MALE	7	2.128571	0.256348			
	Bolton's overall	FEMALE	9	2.788889	0.214735	2.18	9.33	0.056

		MALE	*7*	*2.457143*	*0.355233*			
	Intercanine	*FEMALE*	*9*	*31.9*	*2.516446*	*-2.057*	*14*	*0.059*
		MALE	*7*	*33.98571*	*1.000714*			
	inter premolar	*FEMALE*	*9*	*33.38889*	*2.207059*	*-3.296*	*14*	***0.005****
		MALE	*7*	*36.31429*	*0.861063*			
	inter molar	*FEMALE*	*9*	*43.15556*	*1.665917*	*-0.47*	*14*	*0.646*
		MALE	*7*	*43.5*	*1.110555*			

* - Significant (p< 0.05) ** - Highly significant (p<0.001)

study models using a digital vernier caliper (Aerospace).

Tooth size ratio as described by Bolton is calculated as follows:

Anterior Ratio = (<Sum of mesiodistal width of mandibular six anterior teeth> ÷< Sum of mesiodistal width of maxillary six anterior teeth>) X 100%

Overall Ratio = (<Sum of mesiodistal width of mandibular 12 teeth> ÷ < Sum of mesiodistal width of maxillary 12 teeth>) X 100%

Anterior Ratio = (<Sum of mesiodistal width of mandibular six anterior teeth> ÷ < Sum of mesiodistal width of maxillary six anterior teeth>) X 100%

Arch Width-(Figure 1)

The arch width between canines, premolars, and first molars of the maxillary cast were measured using the same device mentioned above.

The arch width between each tooth and its analog was measured at three points: the distance between the buccal cusp on the right side to the buccal cusp on the left side, distance between the central fossa to central fossa, and the distance between the lingual cusp to the lingual cusp.

For the first molars, the measurements were made from the mesiobuccal and mesiolingual cusps to the mesiobuccal and mesiolingual cusps of the molar of the contralateral side.

The measurements were done twice in a span of two weeks by a single observer and the mean observations were considered to avoid intraobserver bias. The following observations were later compared on the grounds of gender, ethnic origin, as well as the malocclusions inherited by the subjects.

STASTISTICAL ANALYSIS

The sum of the 12 teeth in both arches, the Bolton's anterior and overall ratios, the intercanine width, interpremolars, and intermolar widths from all the measured points using Student's *t*-test.Analysis of variance was used to determine whether significant differences existed between the groups. The statistical analysis was done using SPSS version 18(Statistical Package for the Social Sciences).

RESULTS

The study aimed at comparing the different morphometric parameters within the genders in the two nationalities presenting with different malocclusions. The different observations were categorized broadly based on gender, nationality and malocclusions under the different parameters.

Bolton's Ratio:

A. According toNationality:

The Bolton's anterior ratio and the overall ratio showed a higher inclination towards the Iranians compared to Indian in both the genders. However, the values were found to be statistically insignificant. (Table 2)

B. According to gender:

The Bolton's anterior ratio showed a higher inclination towards the females in both the population, whereas upon calculating the overall ratio, the males showed a higher value in both the population. But the observations were found to be statistically insignificant.(Table 3)

C. According to malocclusions:

The three types of malocclusions which were considered were Class I, ClassII Division I and ClassII div II. On considering the Class I malocclusion the Indians showed a greater value ofBolton's anterior and overall ratios as compared to Iranians. On considering the Class I malocclusion of the overall sample it was seen that the males showed a higher Bolton's anterior and overall ratio and it was found to be statistically significant ($p<0.05$) However in class II malocclusions the Iranians showed a greater value of Bolton's anterior and overall ratio over Indian population. Interestingly in class II Division II the Bolton's anterior ratio of the Iranian exhibited statistically significant difference over Indians ($p < 0.05$). The females exhibited a statistically significant higher Bolton's anterior and overall ratio ($p<0.05$).(Table 4,5)

Arch width

A. According to gender and nationality:(Table 2,3)

The arch width at interpremolar and intermolar region showed a definite sexual dimorphism with a higher values of the males in both the populations and, the difference was found to be statistically significant and the level of significance was higher in the Iranians ($p<0.001$). But upon considering the intercanine arch width only the differences in the Indians was found to be statistically significant ($p<0.05$).

B. According to malocclusions:(Table 4,5)

In these subjects the intercanine arch width were found to be higher in Iranians in case of Class I malocclusion, Indians in case of Class II Division I and Indians in cases with Class II Division II respectively. But the level of differences observed among the populations were found to be statistically non-significant. However, when the overall males and females were considered with Class I malocclusion the males showed a significant higher arch width (intercanine, interpremolar and intermolar) with a $p<0.05$. The interpremolar arch width of the males were found to be statistical significantly higher compared to females in the cases with Class II malocclusion. In Class II Division I cases the intermolar arch width was found to be statistically higher and significant in the males ($p<0.001$), whereas no significant differences of intermolar arch width were observed in cases with Class II Division II.

DISCUSSION

The tooth size discrepancy and the arch width plays a pivotal role in orthodontic diagnosis and research and correcting the discrepancy related to tooth size and archwidth helps an orthodontist in rendering esthetics

to the patient. The Bolton's ratio is one such morphometric parameter which is based on the ratios derived from the mesiodistal width of the teeth in maxillary and mandibular arches (1st molar to 1st molar of contralateral side)[13,14]. The measurement of arch width dimension has been conducted in anthropology for various purposes.[15]. In an old study done by Lundstrom et al where they studied the archwidth dimensions of 319 samples and found a large biological dispersion in the ratio of tooth width. It was also observed that the arch width has a definitive impact on the tooth alignment, vertical and horizontal relationship of the teeth.[16].

In our study when the males and females were compared for the Bolton's ratio there was a statistically significant difference that was noticed, our findings were in consistent with the findings of the previous studies where the researchers have considered all types of malocclusions[17]. This could be because of the difference or discrepancy in the mesiodistal width of the males which was found more than the females in the selected sample. There are previous studies which showed that the Bolton's anterior and the overall ratio differed between the genders in different class of malocclusions[18,19,20]. However in our study when the class II Div II cases were evaluated there was no statistical significant difference noticed, this could be because of the limitation in the sample size and this was in consistent with the observations of a previous study where they found no significant differences between male and females in the different types of malocclusion[21]. Few studies analyzed the various tooth size ratios in the different malocclusions corresponding to the skeletal characteristics among populations but only Bolton's anterior ratio showed a statistical significant difference, in our observations we found there was a consistent and significant difference among the genders in class I and Class II Div I cases. Therefore, it can be ascertained that the differences are population specific[17,22]. The arch width dimensions were compared among genders in the two different populations and it was found that the male showed a greater dimension and the values were statistically significant. This could be because of the built of the male which shows excess dimensions compared to the females. Arch widths were measured to determine sexual dimorphism in two different malocclusions i.e. Class I, Class III and it was found that there was a definite inclination of the higher values towards the male except with the intercanine parameter[23]. But in our study we found the same result in Class II cases. A possible explanation for this sudden deviation could not be ascertained. When overall samples were pooled it was found that the intermolar arch width was significantly high in males in Class II Div I cases, our observations are in agreement with the study conducted on the Americans[24]. Hence it can be hypothesized that though there in no commonality in the origin but gender do play a role in determing the arch width discrepancies. When the arch width at the canine, premolar and molar region were compared between the Indians and the Iranians it was found that among the males the Indians showed a higher value in the intercanine and intermolar region whereas in females reverse phenomena was noticed but all the values were statistically insignificant. This variation can be due to the irregular sample size which was considered in the study.

CONCLUSION

The above observations based on the fine parameters showed that consistently the males have the higher dimension compared to females. Hence exhibited a definite sexual dimorphism in both the population. The class I samples were highest among the three types of malocclusion considered in the study and showed that all the parameters exhibited a significant difference among males and the females. The Bolton's anterior ratio proved to be a significant parameter which differentiated among the genders in all the cases of malocclusion considered. But when the females and males were taken into consideration separately there was no significant difference between Indian and Iranian population. There were no significant differences among Indian and Iranians when a particular parameter was observed under a particular class of malocclusion but there was a significant difference among the population in Bolton's anterior ratio value in cases with Class II Div II malocclusions. The origin of a particular race does play a role in normal growth and development and so the malocclusions.

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