ORIGINAL ARTICLE

RELATIONSHIP OF DENTAL CROWDING TO TOOTH SIZE AND ARCH DIMENSIONS IN CLASS I NORMAL & CLASS I MALOCCLUSION SAMPLE

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ABSTRACT

Various studies have been conducted to find the cause of crowding in Class I m*alocclusion, however causes vary from one population to another. The aim of this study was to determine the relationship of crowding to mesio-distal tooth size and arch dimension in subjects with Class I normal and Class I malocclusion amongst both genders in subjects of Pakistani descent*

Subjects of Pakistani descent from both genders were assigned to two different categories based on crowding. Both categories had Class I molar relationship on occlusion. The crowded category had a minimum of 7mm of crowding or more and the non-crowded category had crowding or spacing not exceeding 1mm. Casts were obtained and measured for individual mesio-distal tooth size and bucco-lingual arch widths at selected points. Data was analyzed by calculating mean, variance, standard deviation and applying student's T test.

The results showed that the difference in arch width was statistically significant along all points of measurement between crowding and non-crowding group in both the genders with the crowding group having smaller arch dimensions in both the genders. There were more statistically significant differences in tooth size among females, with teeth in the crowded category being larger, however this was not true for all teeth.

The results suggest that crowding is more likely to be due to smaller arch widths in males, whereas in females both small arch width and large teeth are to be blamed.

Key Words: *Crowding, Non-crowding, Tooth-size, Arch-width, Class I malocclusion.*

INTRODUCTION

Dental crowding can be defined as a discrepancy between tooth size and arch size that results in malocclusion.[1] The causes of crowding have not totally been understood but evolutionary reduction in jaw size and tooth size has been implicated.[2] Evolutionary decrease in jaw size without corresponding reduction in tooth size has been reported as the major culprit to dental crowding.[3] A modern refined diet, with its lack in providing muscular stimulation and interbreeding among different ethnic populations since the advent of modern day travel and immigration is also reported as a reason for dental crowding.[4] Although the contribution of evolution in the development of dental crowding cannot be overlooked, the fact remains that dental crowding is the most common form of malocclusion and is the most common reason why people seek orthodontic treatment.[5] Extraction of selected teeth[6] arch expansion[7] and inter-enamel stripping[8] are a few techniques that canbe commonly utilized alone or in combination to address the problem of crowding. The real task is to analyze and pinpoint exactly which component of the dento-alveolar anatomy is to be blamed. Opinion has remained divided over this topic with numerous investigators blaming normal tooth size anchored in small arches as a cause of crowding.[9,10] While another study implicated large tooth size as a single contributing factor in crowding.[11] While some held the opinion that both large tooth size and small jaw size contribute equally to crowding.[1,12] The relationship of crowding to tooth size and arch width is not very well documented in the Pakistani population. It is imperative to conduct a study which may provide important information about the characteristics of Class I malocclusion and

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can be useful in developing treatment strategies. Thus the objective of the study is to determine the cause of crowding in Class I malocclusion in both genders by measuring and comparing mesio-distal width of teeth in crowded and non-crowded arches and comparing arch widths in crowded and non-crowded arches.

METHODOLOGY

This study was cross-sectional and was carried out from June 2013 – June 2014 in 4 educational institutions, different hospitals and private dental practices of Karachi. Clearance was obtained to conduct this study from the administrative boards of the educational institutions, hospitals and proprietors of private dental practices. Subjects were examined under consent, which was obtained from the subjects not only for clinical examination but also subsequent impression taking. Clinical examination was carried out to select participants for two different categories in a separate area. First category, the non-crowded one, included Class I molar, canine and incisor relationship with crowding, spacing and/or midline discrepancy not exceeding 1mm. A second category, the crowded one, had Class I molar on occlusion and crowding of 7mm

TABLE 1: COMPARISON OF TOOTH SIZE

Male						Female				
Crowding			Non-Crowding			Crowding		Non-Crowding		
Maxillary Right										
Tooth*	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**P- Value**	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**P Value**
16	10.6	0.47	10.5	0.82	0.63	10.3	0.43	10.0	0.50	0.32
15	6.8	0.36	6.7	0.48	0.35	6.7	0.53	6.6	0.43	0.16
14	7.1	0.55	6.9	0.47	0.40	7.1	0.62	6.7	0.40	0.008†
13	8.0	0.54	7.8	0.41	0.42	7.9	0.53	7.7	0.35	0.19
12	7.0	0.42	6.9	0.56	0.59	7.1	0.58	6.9	0.52	0.08
11	9.0	0.56	8.8	0.45	0.20	8.7	0.56	8.6	0.52	0.64
Maxillary Left										
26	10.4	0.52	10.4	0.83	0.48	10.3	0.50	10.0	0.50	0.05
25	7.0	0.40	6.7	0.52	0.07	6.7	0.56	6.6	0.42	0.47
24	7.2	0.49	7.1	0.45	0.40	7.1	0.52	6.8	0.45	0.048†
23	7.9	0.59	7.9	0.48	0.90	7.8	0.51	7.6	0.38	0.14
22	7.1	0.35	6.8	0.50	0.19	7.1	0.67	6.8	0.49	0.01†
21	9.0	0.49	8.8	0.44	0.18	8.7	0.61	8.6	0.52	0.38
Mandibular Left										
36	11.2	0.52	11.0	0.69	0.30	10.8	0.65	10.6	0.60	0.18
35	7.5	0.37	7.1	0.50	0.01†	7.2	0.68	7.1	0.45	0.19
34	7.3	0.36	7.1	0.50	0.07	7.4	0.60	7.0	0.36	0.002†
33	7.0	0.43	6.9	0.33	0.22	6.9	0.43	6.6	0.41	0.02†
32	6.2	0.34	6.1	0.43	0.36	6.2	0.34	6.0	0.36	0.01†
31	5.7	0.37	5.7	0.30	0.98	5.8	0.47	5.4	0.38	0.02†
Mandibular Right										
46	11.2	0.52	10.9	0.61	0.07	10.7	0.65	10.5	0.60	0.33
45	7.5	0.49	7.1	0.47	0.02	7.2	0.58	7.1	0.52	0.48
44	7.4	0.42	7.1	0.49	0.07	7.4	0.45	7.0	0.40	0.00†
43	7.0	0.57	6.9	0.39	0.87	6.8	0.47	6.7	0.42	0.28
42	6.1	0.30	6.1	0.47	0.86	6.2	0.31	5.9	0.32	0.001†
41	5.7	0.40	5.7	0.32	0.97	5.7	0.42	5.5	0.36	0.005†

* Tooth numbering according to FDI system

† Indicates statistical significance (P value < 0.05)

TABLE 2: COMPARISON OF ARCH WIDTHS

	Male					Female				
	Crowding		Non-Crowding			Crowding		Non-Crowding		
	Maxillary Buccal									
	Mean	**Std Dev**	**Mean**	**Std Dev**	**P- Value**	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**P Value**
IM	54.3	2.4	57.9	3.2	0.00†	52.9	1.8	56.2	2.3	0.00†
IP2	46.3	2.8	51.0	3.1	0.00†	46.0	2.2	49.7	2.0	0.00†
IP1	42.0	2.3	45.9	3.1	0.00†	40.8	2.6	44.7	2.2	0.00†
IC	32.7	2.7	37.6	3.6	0.00†	22.5	2.9	25.0	2.6	0.00†
	Maxillary Lingual									
IM	34.0	2.8	37.3	2.5	0.00†	32.7	1.9	36.0	2.0	0.00†
IP2	28.4	1.9	33.1	2.5	0.00†	28.8	2.0	32.2	1.9	0.00†
IP1	23.9	1.9	28.6	3.4	0.00†	23.3	1.5	27.4	1.6	0.00†
IC	22.5	1.7	24.5	2.4	0.00†	22.6	2.1	25.0	2.7	0.00†
	Maxillary Buccal									
IM	52.0	2.5	54.3	2.3	0.00†	50.7	2.1	53.1	2.4	0.00†
IP2	43.1	2.8	46.3	2.4	0.00†	42.7	2.4	45.3	2.3	0.00†
IP1	36.9	2.1	39.8	1.8	0.00†	36.2	3.1	38.9	2.1	0.00†
IC	27.5	2.3	29.4	1.7	0.00†	27.7	2.9	29.4	1.6	0.00†
	Maxillary Lingual									
IM	32.3	2.4	34.7	1.9	0.00†	31.4	1.9	33.4	2.0	0.00†
IP2	27.7	3.0	30.5	2.1	0.00†	26.8	2.6	29.8	1.9	0.00†
IP1	22.7	2.2	26.3	2.1	0.00†	23.1	1.8	26.1	1.7	0.00†
IC	19.0	1.8	20.5	1.7	0.00†	19.4	1.9	20.4	1.3	0.00†

IM= Inter-Molar, IP2= Inter Second Premolar, IP1= Inter First Premolar, IC= Inter-canine

† Indicates statistical significance (p value < 0.05)

or more. All subjects had permanent dentition. Any subjects with history of previous orthodontic treatment, proximal restorations, full or partial veneer crowns, missing teeth (permanent central to permanent first molar), tooth malformation anomalies and of non-Pakistani descent were excluded from this study. 110 (67 female and 43 male) participants who met the selection criteria were called to the Orthodontic department for impressions. Alginate impressions were taken and poured within 15 minutes. Once the casts were made, measurements were carried out to determine the size of mesial-distal tooth width as described by Sim[13]. Lingual arch widths were measured according to the method described by Howe[9] which involves measuring at the lingual cervical region on the mesial-distal midpoint of a tooth to the corresponding point on its antimere. Buccal arch width measurements were carried out using the method described by Mcdoughall.[14] All measurements were taken in millimeters using a digital vernier gauge, the tips of which were machined and tapered to reduce inaccuracies. Measurements were rounded off to the nearest tenth of a millimeter (0.1). Intra examiner reliability was tested by re-measuring 10 randomly selected casts one month after initial assessment and the mean difference was found to be 0.15mm. As variation and dimorphism exist between genders, the data was evaluated separately for males and females in crowding and non-crowding categories. Statistical analysis was carried out to determine mean, variance and standard deviation for mesio-distal tooth size and bucco-lingual arch widths between crowded and non-crowded categories with respect to gender. Student's T-test was used to check statistical significance, if any between these variables. All statistical analysis was done using SPSS 20 software.

RESULTS

Total of 1253 subjects were examined for this study out of which 110, 67 female and 43 male met the selection criteria. 50 subjects met the criteria for the crowded category of which 22 were male (44%) and 28 were female (56%). 60 subjects were selected for the non-crowding category, out of which 21 were males (35%) and 39 females (65%). The age range for

the subjects was 15-23 years with the mean age of 21.4 years.

Mesio-Distal Tooth Size: Difference in mesio-distal tooth size between crowded and non-crowded categories was insignificant for all teeth except mandibular left second premolar in males and first premolars, mandibular incisors, left mandibular canine and left maxillary lateral incisors in females (Table 1).

Arch Width: Difference in arch width between crowded and non-crowded categories was statistically significant for all points of measurement in both the genders, with the crowding category having had smaller dimensions (Table 2).

DISCUSSION

The underlying cause of crowding has been reviewed by several investigators, but the results obtained have remained controversial which has divided the opinion of researchers. Some advocate that larger than normal teeth supported on an average sized alveolar bone base as the cause of crowdingwhile others cite small arch widths as the culprit behind crowding. Results of the current study fell in between those of past investigations into this subject. Although differences in arch width between crowded and non-crowded categories was statistically significant for all points of measurement in both genders (Table 2), differences in mesio-distal tooth size remained insignificant for all teeth except one in males and some teeth in females (Table 1). Waheed-ul-Hamid[10] in a local Pakistani study of 80 patients (40 crowded and 40 non-crowded) described the differences in arch widths between crowded and non-crowded categories as statistically significant and insignificant differences were observed between mesio-distal tooth sizes. Kaundal[12] in a study of 40 Indian patients stated that arch perimeter and inter-molar widths in patients with crowding was decreased compared to patients without crowding, he further reported an increase in total mesio-distal width of teeth mesial to the permanent second molar. However, Kaundal[12] did not clearly define the parameters used to differentiate between crowding and non-crowding nor were inter-premolar or inter-canine widths taken into account as they are brought in a comparison here. Hwang[1] in a study of 164 Korean patients which included 82 crowded casts and 82 well aligned casts, concluded that both large tooth size and small arch widths contributed to Class I dental crowding. Howe[9] recorded mesio-distal tooth diameters and bucco-lingual arch widths of 104 pairs of casts (50 with gross dental crowding and 54 with minimal crowding). He concluded from his study that small arch widths contributed to dental crowding whereas the influence of tooth size was insignificant. Howe also stated that an expansion procedure be carried out to relieve crowding. Mckeown[15], in his study of 65 casts also reported that there was a strong association between arch size and crowding with both variables being inversely related. Mills[16] in his study of 230 males found a statistically significant association between arch widths and dental crowding. He concluded that variation in tooth size was insignificant between persons with crowding and non-crowding. Radznic[17] also reported a strong association between crowding and arch width, however his study was not designed to select crowding sample, there in crowding was defined as a space discrepancy of 3mm or more and crowding was calculated as the difference between arch perimeter and cumulative mesio-distal tooth widths. Although this study mostly agrees with that of Hwang[1] and Howe.[9] However in some areas like differences in arch widths are concerned some differences were however observed. Hwang[1] reported that differences between lingual inter-canine widths between crowded and non-crowded categories were insignificant, with Howe[9] stating similar findings but only for males. The importance of this difference lies in the fact that both investigators[1,9] advocated an expansion appliance that works only at the premolar and molar region and to avoid using the canine as an abutment for an expansion appliance. Considering results of this study (Table 2) such an appliance design may have to be reviewed. Results from this study also showed that the difference in arch widths between crowded and non-crowded arches was greater for the upper arch compared to the lower and males had larger arch widths in crowded and non-crowded cases compared with corresponding measurements for females (Table 2).

When analyzing mesio-distal tooth widths the results of this study were opposite to those of many others. Dorris et al[18] measured mesio-distal diameters of two samples, one with crowding of 4mm and the other with crowding of more than 4mm and the results pointed out larger teeth in the crowding category with differences which were statistically significant. Bughaghis[11] and Ludstrom[19] reported that it is large tooth size rather than small arch width that caused crowding. Bughaghis[11] in a study of 192 Libyan subjects found that the sum of mesio-distal tooth diameters was greater in crowded casts and was statistically significant. However Bughaghis[11] did not measure arch widths at different points of measurement nor were the crowded and non-crowded categories defined similar to the current study. Ludstrom[19] studying 139 casts of 13 year old boys reported that crowding increases as tooth size increases and arch perimeter decreases with increased crowding, Ludstrom's study only gathered data for 13 year old males and was not applied to females. No attempt was made in that study to investigate the relationship of arch width to dental crowding. Hwang[1] stated that all teeth mesial to permanent second molar were larger mesio-distally in crowded arches than innon-crowded arches and this difference was statistically significant. The criteria used in this study was similar to the one used by Hwang[1] but the results produced were different. Although the mean tooth size for all teeth from

permanent central incisor to permanent first molar was larger in the crowding group the difference was not significant in all cases. In the case of males only the left mandibular second premolar was consistently larger in the crowding group than the non-crowding group (Table 1) and this difference was statistically significant. In females statistically significant differences in tooth size existed for all first premolars, left maxillary lateral incisor, mandibular incisors and left mandibular canine (Table 1). The cause for differences in results between the current study and that of Hwang[1] cannot be accurately determined although sample size and racial difference could account for the differences. Somewhat similar results were reported by Fastlitch[20] who stated that the mesio-distal widths of mandibular incisors were greater in females without previous orthodontic treatment. Nordeval[21] also found an association between mesio-distal widths of mandibular incisors and crowding, despite this some fundamental differences existed between this study and that of Fastlitch[20] and Nordeval.[21] Both Fastlitch and Nordeval attempted to find causes for mandibular crowding whereas the current study seeks to find cause/s of crowding in upper and lower arches. Secondly the teeth considered in both previous studies were only the mandibular incisors and although Nordeval compared crowding and non-crowding groups, Fastlitch compared two groups based on previous or no orthodontic treatment. The results in females consistently implicated large permanent first premolars and mandibular incisors as a cause of crowding (Table 1) and maybe this necessitates a tooth mass reduction procedure such as extraction or inter-enamel stripping along with expansion to treat crowding as arch widths in females is smaller on average compared to males whereas the difference in average tooth size between genders remains insignificant for the most part.

This study does have some drawbacks. Firstly a biased selection criterion was used to produce two categories; One with gross dental crowding, and the other with ideal dental arches and relationships. This study was therefore unable to account for reasons behind mild and moderate dental crowding and the ideal modalitiesrequired in treating them. Future investigation into the origins of different levels of crowding whether mild, moderate or severe[22] will further explain the causes of dental crowding and its appropriate treatment methods. Also the strict inclusion criteria used in this study made it difficult to get a sample that was balanced between crowded and non-crowded categories as well as between genders.

CONCLUSION

In comparing tooth size and arch widths between crowding and non-crowding groups, statistically significant differences were observed among several teeth within females, however in males only one tooth showed statistical significance in tooth size, whereas differences in arch widths between crowded and non-crowded categories were statistically significant in both the genders.

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