Dental morphology and crowding in 12-16 year old Iraqi children

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Abstract

Dental casts from one hundred 12-16 year old school children from Salaaldin city were used. The objective of this study was to compare ,combined and individually the mesiodistal (MD) and buccolingual (BL) tooth sizes as well as their respective crown proportions in the permanent dentition in dental arches with moderate, mild and no crowding. The MD and BL tooth sizes of all permanent teeth except second and third molars were measured, and their crown proportion (MD/BL ratio) was estimated. Each dental arch was classified as presenting moderate(-5.1mm or more of discrepancy), mild (-o.1mm and -5mm of discrepancy), and no crowding (zero or a positive discrepancy).Combined and tooth-specific comparisons among the crowding groups for the tooth sizes as well as crown proportions were performed with a multivariate analysis of variance (MANOVA). Combined MD tooth sizes and crown proportions differed among crowding groups. Subsequent individual comparisons indicated differences for MD tooth size of all upper teeth and for lower premolars and central incisors. Differences were also detected for crown proportions of the upper second premolar, canine, and both incisors; as well as for the lower first premolar, canine, and central incisor. No differences were found for the BL tooth sizes among crowding groups. MD tooth sizes and crown proportions from specific teeth are significantly different between dental arches with moderate, mild, and non crowded arches. This study helps to understand the odontometric component of the dental crowding multifactorial origin.

Introduction

The association between dental crowding and tooth size has been studied previously; however, conclusions remain discrepant. Although various studies have reported a significant association between both,[1] others disagree.[9, 13] It is expected that tooth size is not the only determining factor in the origin of crowding. Another factor that has been previously suggested as significant[1,14,15] is crown proportion although others refuted its significance.[3,5,11,12]

Moderate to high correlations between tooth sizes within a dental arch have been previously published[16] and are, at present, widely used by clinicians for prediction of tooth sizes in treatment planning.[17-19] This supports the multivariate character of each tooth in its respective dental arch.[4] Therefore, the selected statistical method must compare all tooth sizes between dental arches not only at an individual level but also simultaneously combined with the other teeth.

Although previous studies have compared the tooth size between dental arches with and without crowding, they have not evaluated it in a multivariate approach. The question of whether or not the observed differences for tooth sizes or crown proportions between arches with different crowding degrees are statistically significant can be most appropriately answered by applying a multivariate test. When multiple dependent variables are intercorrelated and they have to be compared between groups, a multivariate analysis of variance (MANOVA) is the most appropriate test.

The aim of this study was to compare, combined and individually, the mesiodistal (MD) and buccolingual (BL) tooth sizes as well as the crown proportions between dental arches in permanent dentition with moderate, mild, and no crowding. It was theorized that a multivariate approach could give some additional information about the effect of tooth size and crown proportions on dental crowding.

Materials and methods

A representative sample of 100 students from a Salaaldeen secondary school (between 12 and 16 years of age) was randomly selected from 221 students, which fulfilled the following selection criteria: (1)

permanent dentition completely erupted except second and third molars, (2) absence of any orthodontic treatment, (3) clinically evident dental caries, (4) restorations or (5) significant attrition in proximal surfaces, and (6) any anomaly in tooth number, size, or shape. School children considered in this study are typical from Salaadin city in Iraq.

Maximum MD(16) and BL(20)tooth sizes of all permanent teeth from the right to left first molar were measured. Once both tooth sizes were obtained, MD/BL ratio was calculated for each tooth as a representation of the crown proportion.(14) Crowding was defined as the difference in millimeters between the arch perimeter(21) and the MD tooth size sum. Each dental arch was classified as presenting moderate (-5.1 mm or more of discrepancy), mild (-0.1 and -5 mm) of discrepancy, and no crowding (zero or a positive discrepancy).(22) Maxillary and mandibular arches were classified separately.

Duplicate measurements were made by a single calibrated examiner (EB), by means of a sliding caliper (Dentaurum, Pforzheim, Germany) to the nearest 0.1 mm. Second measurements were done after finishing with all the first measurements from right first molar to left first molar in each arch. In doing so, it was expected that the first measurement would not bias the second. When first and second measurements differed by more than 0.2 mm, the tooth was remeasured and this third measurement was then registered. If the difference between both measurements was less than 0.2 mm, then the first measurement was registered. (23,24)

To evaluate systematic error in the measurements, intra- and interexaminer calibration was developed. This consisted of the primary investigator (EB) and an experienced orthodontist (CE), who acted as a gold standard, measuring the same five pairs of models two times, 24 hours apart. Concordance between the groups of measurements was high (Intraclass correlation coefficient, 0.987 and 0.972 for intra- and inter- examiner calibration) and statistically different from zero in both cases ($P < .001$). Measurement errors for intra- and interexaminer calibration, estimated as the mean difference between pairs of measures.

No differences were found between hemiarches; therefore, the average of both hemi arches for the MD and BL tooth sizes was used in all statistical analyses. MANOVA, using Wilk's lambda, were used to compare, first combined and then individually, upper and lower tooth sizes (MD and BL) as well as crown proportions between the three groups. Assumptions of normality within each group (Kolmogorov-Smirnov test), equality of covariance-variance matrixes among groups (Box's test), and multiple correlations between dependent variables (Bartlett's test) were fulfilled. Post hoc multiple comparisons between pairs of groups were conducted through Scheffe's test only when combined and individual significant statistical differences were found.

Results

For the upper arch, the frequency of dental arches according to the crowding severity was 18% with moderate crowding, 43% with mild crowding, and 39% without crowding. For the lower arch, 17%, 41%, and 42% presented moderate, mild, and no crowding, respectively. Mean values for the MD and BL tooth size as well as their respective crown proportions within each crowding group separately by arch are shown in Tables 1 through 3, respectively. When all upper MD tooth sizes were grouped together and analyzed with a MANOVA test (Wilk's lambda), a statistically significant average difference was found among moderate, mild, and non crowded dental arches ($P < .001$); therefore, at least one of the upper MD tooth sizes varied among the groups. Each MD tooth size was compared among groups through subsequent one-way analysis of variance (ANOVA) tests with significant statistical differences for all evaluated teeth from first molar to central incisor ($P = .048$, $P< .001$, $P= .002$, $P= .029$, $P> .001$, $= .003$, respectively).

When all lower MD tooth sizes were grouped together and analyzed with a MANOVA test (Wilk's lambda), a statistically significant average difference was found among moderate, mild, and non crowded dental arches ($P = .001$); therefore, at least one of the lower MD tooth sizes varied among the groups. Again, each MD tooth size was compared among groups through subsequent one-way ANOVA tests with significant statistical differences for the second and first premolar($P= .017$ and $P< .001$, respectively) as well as for central incisor ($P = .001$).

In both dental arches, post hoc pairwise comparisons by Scheffe's test were conducted for those upper and lower MD tooth sizes in which differences among groups were initially obtained (Table 1). Although MD tooth sizes in moderate crowded dental arches were always larger than those in mild crowded dental arches and these were also larger than in non crowded dental arches, statistically significant differences were almost always located between extreme groups, that is, between dental arches with moderate and no crowding (nine out of 15 statistically significant pair-wise comparisons).

Using the same statistical strategy, comparison of the combined BL tooth sizes within both dental arches did not indicate significant statistical differences for the upper arch ($P> .215$) or the lower arch ($P> .098$). In relation to the crown proportions (Peck and Peck index), difference among moderate, mild, and non crowded dental arches were observed for the combined crown proportions ($P < .001$ and $P = .012$ for the upper and lower arches, respectively). On the basis of these results, differences (one-way ANOVA tests) among the crowding groups were observed for the second premolar ($P < .001$), canine ($P = .002$), lateral ($P < .001$), and central incisor ($P = .005$) in the upper arch and for the first premolar ($P = .012$), canine ($P = .002$), and central incisor ($P = .007$) in the lower arch.

Finally, pairwise comparisons by Scheffe's test were performed for those upper and lower crown proportions in which differences among the crowding groups were found (Table 3). For the majority of the evaluated teeth (nine out of 12 statistically significant pairwise comparisons), crown proportions presented larger values in arches with moderate crowding, followed for those in arches with mild crowding and without crowding, respectively. Similar to MD tooth sizes, significant differences were almost always located between extreme groups (seven out of 12 significant pairwise comparisons).

Discussion

This study presents a sample of Arab origin. In previous studies(23-26) with different sample, it has been shown that although some statistically significant differences in tooth size were found compared with Caucasian standards, they were not likely to be clinically significant. Therefore, it could be considered that the present results are likely to be representative for other populations, but this has to be proven.

MANOVA was introduced as a theoretical concept several decades ago.(27) As a multivariate extension of the univariate ANOVA, the MANOVA permits the examination of differences among groups through the simultaneous evaluation of several dependent variables, which are quantitatively measured.(28)

To our knowledge, the MANOVA has not yet been used to evaluate the effect of several odontometric measurements simultaneously on dental crowding. Reasons to use a MANOVA test instead of several individual univariate tests (ANOVAs) or multiple t-tests are to eliminate the need of numerous individual statistical tests, which tend to increase the type-I error level. This decreases the possibility that the found significance would appear just for chance. So, in this case, for the six upper MD tooth sizes, the probability of committing a type-I error with separated univariate tests would be situated between .05 (if all MD tooth sizes were perfectly correlated) and $1-0.95(6) = .26$ (if all MD tooth sizes were not correlated at all).(28) MAN- OVA test offers a unique general test to compare the group differences (degrees of crowding) among all dependent variables (tooth sizes and crown proportion) maintaining a constant significance level (5%).

In addition, individual univariate tests ignore the existing intercorrelation between dependent variables and, therefore, do not use all available information to evaluate the global differences among groups. In fact, when there are complex interrelationships between dependent variables, MANOVA test exhibits a higher potency than separated individual univariate tests because MANOVA test finds combined differences, which could not be detected with the individual univariate tests.

Dental crowding occurs when the space required for the correct alignment of the teeth exceeds the space available in the dental arch.(29) This usually results in rotated, ectopic, or impacted teeth.(29,30) However, currently, there is no widely accepted in a specific classification method or cutoff point to classify dental crowding. Thus, in previous studies crowding was estimated according to (1) the degree of displacement of individual teeth from the general configuration of the dental arch,9 (2) the difference between available and required space (dentoalveolar disproportion),(2,13) (3) the amount of irregularity of the lower incisor,(1,5,11,12) (4) the agreement of visual examinations for independent examiners,(4,10) and (5) the use of intraoral occlusograms.(6)

With the purpose of defining dental crowding, the classification used in this study was based on the theoretical cutoff point (five mm) suggested by Proffit(22) for extraction requirement. This classification was used because of the worldwide use of his book as a leading orthodontic textbook. Once done, differences in tooth sizes and crown proportions between crowding groups could be statistically evaluated.

According to these results, combined upper and lower MD tooth sizes differed between the three crowding groups. In the upper arch, the combined difference among groups was due to all the MD tooth sizes, whereas in the lower arch, difference was only due to premolars and central incisor tooth sizes. An incremental pattern was observed in all evaluated teeth. When the MD tooth size incremented, the amount of exhibited crowding in the dental arch also increased.

From all reviewed studies, only three compared all upper and lower MD tooth sizes. Our findings corroborated those of Doris et al(4) and Chang et al(6) but disagreed with Howe et al.(10) It is interesting to underline that in these three previous studies, comparisons were done only between two groups (dental arches with and without crowding). This study seems to be the first in Iraq presenting differences between varying degrees of crowding.

Contrary to what was expected,(5,11,12) differences for the upper and lower BL tooth sizes were not found when all the BL tooth sizes per arch were combined; therefore, subsequent exploration of individual differences for each tooth size between groups was not warranted . Evaluation of crown proportions between groups indicated combined differences for both dental arches. These differences were caused by individual discrepancies for the second premolar and the three anterior teeth in the upper maxilla and for the first premolar, canine, and central incisor in the lower maxilla. Although an incremental pattern was also observed, it was not so clear as that for the MD tooth sizes. Only three quarters of the evaluated crown proportions exhibited this incremental pattern according to the amount of crowding in the dental arch.

Peck and Peck(14,15) reported that differences observed between arches with and without incisal irregularity (Little's index) could be the cause not only for larger MD tooth sizes but also for shorter BL tooth sizes (which would indicate a general morphological deviation). However, Smith et.al (5) suggested later that the differences were because of method of calculation of the Peck ratio, which includes MD tooth size measurements, which are associated with crowding. Our opinion is that it has to be more than just MD tooth sizes because, according to the present results, the canine crown proportion exhibits differences in both dental arches, whereas their respective MD tooth sizes did not result in statistical differences in the lower arch.

Although, lower central incisor crown proportions fell inside the values recommended by Peck and Peck (88_92%)(14) independently of the crowding degree in the dental arches, significant differences were found between the extreme groups (Table 3). On the opposite side, lower lateral incisor crown proportions were above the normal values (90_95%)(14), but no significant differences between groups were exhibited.

Peck and Peck (15) also recommended that crown proportions for both lower premolars in dental arches without incisor crowding should be normally below 100%. In this study, even though the lower first premolar crown proportions were less than this value in all the crowding groups, significant differences were detected between extreme groups (Table3). Although previous studies have reported a lack of association between the crown proportions and incisor crowding,(3,5,11,12) in this study, crown proportions do seem to differ according to the degree of dentoalveolar discrepancy presented in the dental arch. Therefore, future studies with a larger sample are needed to reevaluate the potential effect on crowding of crown proportions for each tooth.

It must be kept in mind that dental morphology (tooth sizes and crown proportions) is only one of the several factors that may be involved in the etiology of dental crowding. Certainly, other nonodontometric factors interact, which has not been considered in the present approach.

We conclude that the use of the MANOVA test in this study offered a unique general test to compare the odontometric dependent variables (tooth sizes and crown proportion) among dental arches with different crowding degrees. Also, Dental arches with moderate, mild, and no crowding differ most of the times significantly in their MD tooth sizes and crown proportions individually or combined but not in their BL tooth sizes. For the MD tooth sizes, differences among groups existed in all upper teeth and in the lower central incisor, second, and first premolar. For the crown proportions, differences were located in the upper second premolar, canine, lateral, and central incisor as well as in the lower first premolar, canine, and central incisor.

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Table (1): Comparison of the MD tooth sizes between moderate, mild and non crowded dental arches

	Lower arch			**Upper arch**		
MD tooth size	**No crowding**	**Mild crowding**	**Moderate crowding (mm)**	**No crowding**	**Mild crowding**	**Moderate crowding**
First molar	11.55 (0.08)	11.63 (0.06)	11.86 (0.07)	10.83 (0.06) *	10..92 (0.08)	10..92 (0.08) *
Second premolar	7.42 (0.06) *	7.45 (0.06)	7.74 (0.08) *	7.19 (0.05) *	7.29 (0.07) †	7.35 (0.06) *,†
First premolar	7.25 (0.05)	7.38 (0.06) †	7.44 (0.07) *,†	7.43 (0.04) *,†	7.56 (0.06)	8.43 (0.12) *
Canine	7.05 (0.05)	7.25 (0.05)	7.29 (0.08)	8.18 (0.05) *	8.33 (0.06)	8.43 (0.12) *
Lateral incisor	6.08 (0.05)	6.22 (0.04)	6.40 (0.07)	7.24 (0.06) *,†	7.31 (0.08) *,‡	7.41 (0.09) †,‡
Central incisor	5.43 (0.05) *	5.50 (0.04)	5.55 (0.05) *	8.58 (0.06) *	8.87 (0.08) †	8.91 (0.10) *,†

MD indicates mesiodistal.

*,† and ‡ indicate significant statistically difference between pairs of groups (Scheffe's post hoc test): * ,between no crowding and moderate crowding groups; †,between no crowding and mild crowding groups; and ‡, between mild crowding and moderate crowding groups.

Table (2): Comparison of the BL tooth sizes between moderate ,mild and non crowded dental arches

	Lower arch			Upper arch		
MD tooth size	**No crowding**	**Mild crowding**	**Moderate crowding (mm)**	**No crowding**	**Mild crowding**	**Moderate crowding**
First molar	11.08 (0.06	11.12 (0.07)	11.10 (0.08)	11.73 (0.07)	11.74(0.09)	11.80 (0.11
Second premolar	8.78 (0.07)	8.75 (0.06)	8.83 (0.07)	9.76 (0.06)	9.80 (0.09)	9.93 (0.09)
First premolar	8.21 (0.07)	8.22 (0.06)	8.29 (0.09)	9.82 (0.06)	9..91 (0.09)	10.03 (0.08)
Canine	7.29 (0.09)	7.44 (0.07)	7.13 (0.11)	8.25 (0.10)	8.27 (0.10)	8.04 (0.16)
Lateral incisor	6.30 (0.06)	6.34 (0.06)	6.24 (0.07)	6.75 (0.08)	6.75 (0.08)	6.67 (0.13)
Central incisor	6.03 (0.05)	6.00 (0.06)	6.06 (0.08)	7.38 (0.07)	7.41 (0.09)	7.35 (0.12)

BL indicates buccolingual. Values within parenthesis are standard errors of the mean.

Table (3): Comparison of the crown proportion between moderate, mild and non crowded dental arches

	Lower arch			Upper arch		
MD tooth size	**No crowding**	**Mild crowding**	**Moderate crowding (mm)**	**No crowding**	**Mild crowding**	**Moderate crowding**
First molar	104.4 (0.58)	104.7 (0.52)	106.8 (0.68)	92.5(0.54)	93.2 (0.59)	92.9 (0.90)
Second premolar	84.7 (0.71)	85.4 (0.70)	87.9 (1.30)	73.7 (0.46) *	74.4 (0.56) †	74.2 (0.93) *,†
First premolar	88.4 (0.67) *	89.9 (0.89)	90.2 (1.17) *	75.7 (0.45)	76.4 (0.50)	77.5 (0.87)
Canine	97.3 (1.19) *	97.8 (0.89) †	102 (1.47) *,†	98.6 (1.08) *	102.3 (1.13) †	104.6 (2.45) *,†
Lateral incisor	96.9 (0.98)	98.6 (0.98)	102.8 (1.14)	107.2 (1.45) *	107.8 (1.45) †	112.6 (2.44) *,†
Central incisor	90.5 (1.06) *	92.1 (0.88)	91.9 (1.20) *	115 (1.03) *,†	119 (1.6) †	122.1 (1.5) *