ORIGINAL ARTICLE

RELATIONSHIP BETWEEN MAXILLARY AND MANDIBULAR EFFECTIVE LENGTHS AND DENTAL CROWDING IN CLASS II MALOCCLUSIONS

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ABSTRACT

The objective of this study was to determine the frequency of crowding in patients with class II malocclusions and to compare the mean maxillary and mandibular apical base lengths in patients with more than 3mm and less than 3mm of crowding in class II malocclusion patients

This study was a descriptive case series carried out at Islamic International Dental Hospital Islamabad. A total of 95 patients were selected according to the inclusion criteria of a complete (full cusp) bilateral class II molar relationship and presence of all permanent teeth up to the first molars. Patients with an open bite, cross bite, presence of caries or restored teeth were excluded. Measurements were performed on pre-treatment dental casts and lateral cephalograms. Pre-treatment dental casts were used to calculate crowding. The radiographs were traced manually with an acetate paper attached on top and used to calculate the apical base lengths of the maxilla and mandible. The sample was divided into two groups according to severity of mandibular crowding. Group 1 consisted of patients with crowding more than or equal to 3mm. Group 2 consisted of patients with crowding less than 3mm. Data analysis was carried out using Statistical Package for the Social Sciences (IBM SPSS version 20, Chicago, Ill).

Mean mandible length was 124 (± 7.208) and mean maxilla length was 91.60(± 6.772) while mean mandible ALD -2.92 (± 2.866). A comparison of the means with a one sample T-test revealed a P value of 0.000, showing that both the variables were highly significant.

The results of this study demonstrate a significant inverse correlation between maxillary and mandibular effective lengths and the severity of dental crowding.

Key Words: *Class 2 malocclusion, apical base lengths, dental crowding.*

INTRODUCTION

Dental crowding is one of the most prevalent of orthodontic conditions, frequently causing mal-positioned teeth for which patients seek orthodontic treatment. Crowding is defined as a discrepancy between tooth size and arch size that results in malposition and/or rotation of teeth.[1] Crowding of the dentition is usually attributed to discrepancies in tooth size and arch length and arch width.[2-5] The goal of modern orthodontics is to provide the best possible occlusal relationships within the acceptable framework of facial aesthetics and stability of results. Treating the actual cause of crowding and not just treading along the traditional lines of thought where we simply correlate it with reduced arch dimensions would go a long way in achieving this goal.

Dental crowding has been shown by some studies as being prevalent in as much as 57% of the population.[6] Numerous factors such as the direction of mandibular growth, head posture, inclination of teeth and the oral and perioral musculature may affect the development and severity of crowding.[7] Research into the relationship between crowding and cephalometric measurements has been sparse. However, the relationship between the base lengths of the jaws and dental crowding has been demonstrated with positive correlation. Studies have shown that short mandibular body lengths, irrespective of arch dimensions, are associated with crowding of the dentition. It is a correlation which exists as early as the early mixed dentition through to the late mixed dentition.[7] Longitudinal studies have also shown that mandibular crowding increases over time; the increases being greatest during adolescence and slowing down during adulthood.[8,9] Mandibular growth on the other hand, ceases to a great extent after adolescence. Baccetti

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et al reported an increase of 0.5mm (93.5 to 94.0) in the mean value of maxillary apical base length (Co-A) and an increase of 1.0mm (120.5 to 121.5) in the mean value of mandibular base length (Co-Gn); both termed insignificant.[10] Since crowding increases with age regardless of changes in mandibular apical base length, it would make reduced base lengths in childhood a possible indicator for dental crowding in adulthood if a positive correlation existed. Berg's research focused on class I malocclusion patients but more recently, Janson demonstrated weak to moderate correlation between the two variables in class II malocclusions as well.[1]

Among all the factors responsible for dental crowding, previously only the relationship of the arch dimension to crowding has been investigated in Pakistan. Therefore, the aim of this study is to investigate the relationship between dental crowding and apical base lengths of the jaws in class II malocclusions in the Pakistani population. Significant findings in this study could make mandibular retrognathism an important early indicator of crowding, allowing for timely and appropriate intervention.

METHODOLOGY

- Study design: Descriptive case series
- Setting: Islamic International Dental Hospital, Islamabad
- Duration: Six months after the approval of synopsis
- Sample technique: Non-probability consecutive
- Sample size: 95
    - Confidence interval: 95%
    - Anticipated population: 56.66%
    - Absolute precision: 10%
- Inclusion criteria:

1 Complete (full cusp) bilateral class II molar relationship

2 Presence of all permanent teeth up to the first molars

- Exclusion criteria:

1 Open bite – Lack of vertical overlap of the mandibular dentition by the maxillary dentition

2 Cross bite – One or more teeth in the maxillary anterior or buccal segment is lingual to one or more of the opposing teeth in the mandibular arch in maximum intercuspation

3 Presence of caries

4 Presence of restorations.

After approval of the study by the institute's ethical committee, 95 patients were randomly selected according to our selection criteria. Informed consent was taken from all the patients selected for the study.

Measurements were performed on pre-treatment dental casts and lateral cephalograms. Pre-treatment dental casts were used to calculate crowding. Mandibular and maxillary crowding were calculated as the difference between arch perimeter and the sum of the mesio-distal dimensions of the teeth, in millimetres, from the second premolar on one side of the arch to the second premolar on the other side. The mesio-distal dimensions were measured with a digital vernier calliper (Mitutoyo Corp., Kawasaki, Japan). The arch perimeter was measured from the mesial marginal ridge of the permanent first molar on one side to the mesial marginal ridge of the permanent first molar on the other side with a brass wire of 0.5mm diameter.

All the lateral cephalograms were taken by the same operator on Rotograph Plus at 80 kvp, 10 mA and 0.8-second exposure time using 8 × 10 inch Kodak green film with the patient's head in the natural head position. The radiographs were traced manually with an acetate paper attached on top. Tracing was done with a lead pencil in a dark room on a radiograph viewer. A single investigator manually conducted anatomic tracings and location of dento-skeletal landmarks. The base length of the maxilla was taken as the linear distance between the condylion and point A (Co-A). The base length of the mandible was measured as the linear distance between the condylion and gnathion (Co-Gn). The readings were recorded and noted in the data collection proforma by the trainee researcher. Tracings were repeated after a minimum of two months by the trainee researcher and two colleagues for intra and inter operator reliability.

The sample was divided into two groups according to severity of mandibular crowding. Group 1 consisted of patients with crowding more than or equal to 3mm. Group 2 consisted of patients with crowding less than 3mm.

Data analysis was carried out using Statistical Package for the Social Sciences (IBM SPSS version 20, Chicago, Ill). For the quantitative variables; age, mandibular base length and maxillary base length, mean and standard deviation were calculated. For the qualitative variables; sex and crowding, frequency and percentages were calculated. T-test was used to compare mean maxillary and mandibular base lengths. P value of ≤ 0.05 was taken to be significant.

RESULTS

This study was conducted at Islamic International Dental Hospital, Islamabad in which a total of 95 patients were observed to determine the frequency of

TABLE 1: AGE DISTRIBUTION (N=95)

Age (years)	Frequency (n)	Percent
12-16	75	78.9
17-21	12	12.6
22-27	8	8.4

Mean age: 15.61 years, SD ± 3.102

TABLE 2: GENDER DISTRIBUTION (N=95)

Gender	Frequency (n)	Percent
Male	48	50.5
Female	47	49.5

TABLE 3: MAXILLARY LENGTH DISTRIBUTION

Length (mm)	Frequency (n)	Percent
<80	5	5.3
81-90	41	43.2
91-100	39	41.1
>100	10	10.5

Mean maxillary length: 91.60mm, SD ± 6.772

TABLE 4: MAXILLARY CROWDING DISTRIBUTION

ALD (mm)	Frequency (n)	Percent
<-10	5	5.3
-10-0	54	56.8
1-10	35	36.8
>10	1	1.1

Mean maxillary ALD: -0.74 mm, SD ± 6.183

TABLE 5: MANDIBULAR LENGTH DISTRIBUTION

Length (mm)	Frequency (n)	Percent (%)
<110	3	3.2
110-120	27	28.4
121-130	52	54.7
>130	13	13.7

Mean mandibular length: 124mm, SD ± 7.208

TABLE 6: MANDIBULAR CROWDING DISTRIBUTION

ALD (mm)	Frequency (n)	Percent
<-10	2	2.1
-10-0	75	78.9
1-10	18	18.9

Mean mandibular ALD: -2.92mm, SD ± 2.866

TABLE 7: FREQUENCY OF CROWDING (N=95)

ALD (mm)	Frequency (n)	Percent
≤ -3	56	58.9
≥ -2	39	41.1

TABLE 8: COMPARISON OF MEANS

Variable	Mean (SD)		Variable	Mean (SD)	P value*
Mandible length	124 (± 7.21)	x	Mandible ALD	-2.92 (± 2.87)	0.000
Mandible length	124 (± 7.21)	x	Maxilla ALD	-0.74 (± 6.18)	0.245
Maxilla length	91.60 (± 6.78)	x	Maxilla ALD	-0.74 (± 6.18)	0.245
Maxilla length	91.60 (± 6.78)	x	Mandible ALD	-2.92 (± 2.87)	0.000
Maxilla length	91.60 (± 6.78)	x	Mandible length	124 (± 7.21)	0.000

*One sample T-test P <0.05 is significant

TABLE 9: COMPARISON OF AGE WITH CROWDING

Age	ALD ≤ -3 (n=56)	ALD ≥ -2 (n=39)	P value*
12-16 years	43	32	
17-21 years	7	5	0.627
22-27 years	6	2	

*X2 Test, P <0.05 is significant

crowding in patients with class II malocclusions and to compare the mean maxillary and mandibular apical base lengths in patients with more than 3mm and less than 3mm of crowding in class II malocclusion patients and the results were analysed as:

DISCUSSION

The cause of crowding is multifactorial; many attempts have been made to identify the most important factors involved, whether acting individually or in combination. It has been shown through the literature review process that dental diameters,[11-15] dimensions in width and length of dental arches,[2,3,16-18] and the apical bases[19-24] are factors determining crowding in Class I malocclusion. The work presented here however has shown that the length of the apical base is probably one of the main factors responsible for dental crowding in complete class II malocclusion.

Our study shows that mean age was 15.61 years ± 3.102. Forty-eight (50.5%) patients were male while 47 (49.5%) patients were female. Analysis of the frequency of crowding revealed that 56 (58.9%) patients had crowding more than or equal to -3mm while 39 (41.1%) patients had crowding less than or equal to -2mm. Comparison of maxillary and mandibular length with maxillary and mandibular crowding respectively, was analysed as; mean mandible length was 124mm (± 7.208) while mean mandible ALD -2.92mm (± 2.866) and the P value was 0.000 which showed that the mandibular length was highly significant in relation to the crowding. A comparison of the mean mandibular length was also done with the crowding in the maxillary arch. A mean value of 124mm (± 7.208) of the Co-Gn length was calculated, while the mean maxilla ALD was -0.74mm (± 6.183). T-test resulted in a P value of 0.245, showing that both the variables were not significant in relation to each other. A third comparison of the mean maxillary length of the sample, 91.60mm (± 6.772) was made with the mean maxillary ALD -0.74mm (± 6.183). A P value of 0.245 was obtained after application of the T-test, showing that both the variables were insignificant in relation to each other. When the comparison of the mean maxillary length, 91.60mm (± 6.772) was made with the mean mandibular length, 124mm (± 7.208), T-test revealed a P value of 0.000, shows that a strong significance of the two variables in relation to each other.

When maxillary crowding was compared between the two mandibular crowding groups, our results showed increase in mean values for maxillary crowding in the group with mandibular crowding more the -3mm. In addition, there was a positive correlation between maxillary and mandibular crowding. Since, the maxillary and mandibular base lengths are positively correlated with each other; the increase in dental crowding in maxilla will lead to increase in crowding in mandible and vice versa.

No statistically significant changes were observed for maxillary and mandibular arch crowding between the genders. Moreover, our results showed a significant increase in maxillary arch crowding in moderate to severe mandibular crowding group (p=0.000) The Pearson's correlation showed a significant but weak inverse correlation between the maxillary (r=-0.28, p =0.02) and mandibular (r=-0.20, p=0.02) base lengths with maxillary and mandibular crowding respectively. In addition, significant but moderate positive correlation was found between maxillary and mandibular base lengths (r=0.566, p=0.000) and between maxillary and mandibular crowding (r=0.408, p =0.000). The intra-examiner reliability showed a strong correlation for maxillary base length (r=0.99), mandibular base length (r=0.97), mandibular crowding (r=0.97) and maxillary crowding (r=0.98).

Some longitudinal studies have also linked the length of the apical base with Class II malocclusion. Baccetti et al and Bishara et al found that the only value that could be differentiated between groups of patients with optimal occlusion and those with Class II division 1 in the early stage of development was the mandibular length and at a later stage this difference was not significant.[26,27] The results from this data can be used to speculate that a reduced mandibular body length in the early mixed dentition is the main factor contributing to the presence of moderate or severe primary crowding in this type of malocclusion.

Several studies observed that the boundary characteristics, shape, and dimensions of the arches without crowding were more uniform and symmetric, respectively, compared to the arches with severe crowding.[3,28,29] Moreover, it has been demonstrated that in Class II division 1 malocclusions there is an increased tendency of crossbites and transverse discrepancies developing, compared with ideal occlusion.[26,30]

Therefore, based on the findings and considering that there were no observed transverse discrepancies between arches without crowding in our sample work, it is possible to speculate that there is a direct correlation between the dimensions in width of the dental arches and the length of the apical bases. It is therefore a potential area that may be explored with further studies.

Finally, Doris et al reported that the mesio-distal widths of several permanent teeth were uniformly higher in the group with arches that were crowded (>4mm) and that when the accumulated mass of 20 permanent teeth is 140mm or more, the clinician may consider treatment with extractions.[13] These findings and the results of our study may suggest that beyond the arch length analysis, the sum of mesio-distal widths of the teeth and the length of apical base should be considered in the formulation of the orthodontic treatment plan, especially in borderline cases where there may be an element of doubt about extraction of permanent teeth.

CONCLUSION

Subjects with complete Class II malocclusion and moderate to severe mandibular crowding have significantly smaller effective apical base lengths than subjects with the same malocclusion and slight mandibular crowding.

The results of this study demonstrate a significant inverse correlation between maxillary and mandibular effective lengths and the severity of dental crowding.

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