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Original Article

Association between Crowding and the Effective Maxillary and Mandibular Length among Orthodontic Patients of Kathmandu, Nepal.

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ABSTRACT

Background: During orthodontic consultation, the most frequent major complaint of the patients is dental crowding, which is caused by a disparity between the arch length and tooth size.

Objective: The purpose of this study was to evaluate the association between crowding and the effective maxillary and mandibular length in Nepalese orthodontic patients.

Methods: The orthodontic records of 390 people (from January 2018 to December 2020) were randomly selected and classified into three skeletal malocclusions based on the ANB angle (Angle formed by point A and point B at the nasion). Subjects with skeletal malocclusions were subdivided into two groups depending on the degree of crowding in the mandibular arch: Group 1 had crowding of < 3mm, and Group 2 had crowding of >3mm. On pretreatment casts, digital vernier calipers (Digimatic, Precise, India) were used to assess dental arch crowding, whereas, on a pretreatment lateral cephalogram, digital cephalometric analysis (Vistadent OC 1.1, USA) was done to quantify effective maxillary and mandibular length. Inter-group comparisons were assessed using a one-way analysis of variance. The correlation was assessed by Pearson's correlation coefficient ($p \leq 0.05$).

Results: There was a statistically significant difference in effective maxillary and mandibular length among skeletal malocclusions ($p<0.05$). Skeletal Class II malocclusion had the greatest mandibular crowding, while skeletal Class III malocclusion had the least. The effective maxillary and mandibular lengths and dental crowding had a significant but weak inverse correlation, whereas a strong but moderate positive correlation existed between the maxillary and mandibular effective lengths ($r=0.674$) and also between maxillary and mandibular crowding ($r=0.631$).

Conclusion: Effective maxillary length was highest in skeletal class II malocclusion whereas effective mandibular length was highest in skeletal class III malocclusion. The shorter effective maxillary and mandibular lengths showed a weak association with dental crowding.

Keywords: Dental Crowding, Mandibular length, Maxillary length, Skeletal malocclusions

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INTRODUCTION

The most frequent chief complaint of the patient during orthodontic consultation is dental crowding. Dental crowding occurred due to the discrepancy between the arch length and the tooth size, resulting in tooth impaction, rotation, and the emergence of the tooth in an aberrant position. [1,2]

Several factors, such as dental arch length,[3,4] arch width,[4,5] dental proportions,[6] the mesiodistal dimension of the teeth,[7,8] environmental factors[9] and changes in human evolutionary trends,[10] may influence the dental crowding.

Treatment modalities for dental crowding are inter-proximal reduction, extraction, arch expansion, and growth modification.[5] It is critical to understand the contributing factors for dental crowding as well as the clinical characteristics associated with it, as this information aids in the selection of appropriate treatment options and the achievement of stable results.[11,12]

Various cephalometric characteristics can influence the severity of dental crowding. Many studies have found that having a shorter mandibular body length increases the likelihood of dental crowding.[8,13,14] Although several researchers have found a correlation between crowding and jaw length, just a few have looked into and compared the two in diverse skeletal patterns, with contradicting results.[8,13] Furthermore, no similar research has been conducted in the Nepalese population. The link between crowding and skeletal factors must be established to plan for orthodontic treatment. Hence, this study aimed to find out the association between crowding and the effective maxillary and mandibular length among orthodontic patients of Kathmandu, Nepal.

MATERIALS AND METHODS

In this cross-sectional study, orthodontic records of 390 subjects were selected from the Orthodontic department of Tribhuvan University Dental Teaching Hospital and Dental Villa- Orthodontic Center and Speciality Dental Clinic's orthodontic records archive (from January 2018 to December 2020).

Based on the sagittal relationship of the maxilla and mandible, they were categorized into three skeletal malocclusions (130 subjects in each). For skeletal classes I, II, and III, the ANB was set at 1–4°, >5°, and <0° respectively. Each skeletal class was then subdivided into two groups based on the extent of crowding. Crowding of the mandible <3 mm was classified as group 1, whereas crowding >3 mm was classified as group 2.

Sample size for this study was determined by using $n=Z^2pq/d^2$, where Z= 1.96, value of p is taken as 0. 5, q=1-p=0.5, allowable error (d) = 0.05 and n is required sample size. Based on these parameters, the required sample size was 384.16. Hence, a total of 390 patients' records were selected.

Ethical approval was obtained from the Institutional Review Committee of the Institute of Medicine before conducting this study (Ref. 425 (6-11) E^2 077/078).

Only the participants between the age range of 13 to 25 years, with completely erupted permanent teeth up to the first molars with good dental records were included in the study.

The participants with a previous history of orthodontic treatment, any cranial anomalies/syndromes, cracked restorations or crowns, and premature exfoliation/ extraction of primary teeth that may induce secondary crowding were excluded from the study. Any tooth aberration in terms of quantity, size, form, or position was also excluded from the study.

A single examiner (SPG) evaluated the ANB angle, as well as the effective maxillary and mandibular lengths, on pretreatment lateral cephalograms using digital cephalometric analysis (Vistadent OC 1.1 software program, GAC International Inc, Bohemia, New York, USA) (SPG). Points A, N, and B were used to determine the ANB angle (Fig. 1). The effective maxillary and mandibular lengths were measured in millimeters as a linear measurement from Condylion to point A (Co-A) and from Condylion to Gnathion (Co-Gn) (Fig. 2).

Pre-treatment casts were used to estimate dental arch crowding. The difference between available and necessary space was used to compute the tooth size-arch length discrepancy in the maxilla and mandible. A brass wire was used to measure the space available on the dental casts from the mesial aspect of one side's permanent first molar to the other side's permanent first molar.[15] The required space or tooth size was determined using a digital vernier caliper (Digimatic Eco, Precise, India) by measuring the mesiodistal width of each tooth

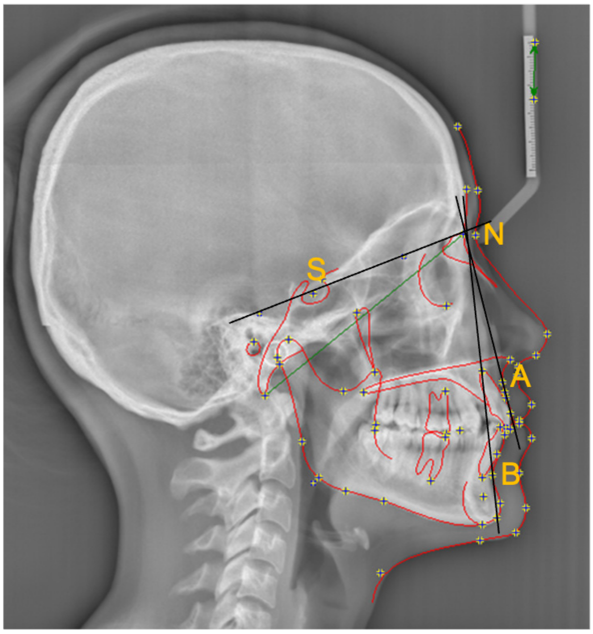

Fig. 1 Measurement of ANB angle on lateral cephalogram

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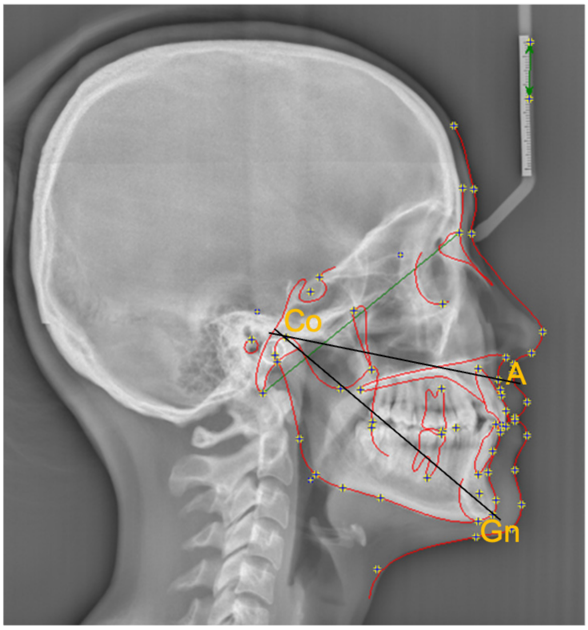

Fig. 2 Measurement of effective maxillary length (Co-A) and effective mandibular length (Co-Gn) on lateral cephalogram

from the second premolar of one side to the contralateral second premolar in millimeters.

All the measurements were performed by a single investigator (SPG). A positive value was assigned to crowding, whereas a negative value was assigned to spacing. One hundred twenty initial casts and 120 lateral cephalograms were randomly selected from the samples and remeasured by the same authors (SPG) 2 weeks after the original data collection to establish intra-examiner reliability.

Data obtained were transferred to a Microsoft Excel spreadsheet. To test for significance, the data were verified and analyzed statistically using Statistical Package for the Social Sciences (SPSS) Statistics Version 21.0 (Armonk, NY: IBM Corp.) with a confidence level set at 95% ($P < 0.05$).

The comparison of effective maxillary and mandibular length among three classes of skeletal malocclusions, between the two mandibular crowding groups, and among the gender of subjects was determined using Analysis of variance (ANOVA). Pearson's correlation was used to assess the intra-examiner reliability and evaluate the relationship between effective maxillary and mandibular lengths with the dental crowding.

RESULTS

Among 390 subjects, 163 (41.8%) were male whereas 227 (58.2%) were female. The distribution of the subjects among skeletal malocclusions and mandibular crowding groups along with their mean age is depicted in Table 1. A comparison of effective maxillary length between different classes of skeletal malocclusions revealed that skeletal class II patients had considerably longer effective maxillary length, although there was no statistically significant difference between mandibular crowding groups or genders (Table 2). Similarly, a comparison of effective mandibular length among different classes of skeletal malocclusions revealed that skeletal class III individuals had considerably longer mandibular length, although there was no statistically significant difference between mandibular crowding groups or genders (Table 3). There was a statistically significant difference between maxillary crowding and mandibular crowding groups but there were no statistically significant differences among different classes of skeletal malocclusions and between genders (Table 4). Mandibular crowding was shown to be substantially higher in skeletal class II subjects and significantly lower in skeletal class III subjects, with no statistically significant difference between the genders (Table 5).

The Pearson correlation of maxillary and mandibular lengths with dental crowding showed significant and weak negative correlation whereas it showed a significant and moderate positive correlation between the maxillary and mandibular crowding and between both the jaw lengths (Table 6). The intra-examiner reliability showed a strong correlation for maxillary crowding (r=0.96), mandibular crowding (r=0.95), maxillary base length (r=0.97) and mandibular base length (r=0.99).

DISCUSSION

This cross-sectional study was conducted to evaluate the relationship between crowding and effective maxillary and mandibular length in different skeletal pattern subjects.

Although there was no significant difference in effective maxillary and mandibular lengths between the two crowding groups in this study, correlation analysis revealed that jaw lengths have a weak negative

Table 1: Distribution of the subjects among skeletal malocclusion and mandibular crowding groups along with their mean age

Skeletal Malocclusions	Number of subjects	Group 1 (Mandibular crowding <3 mm)	Group 2 (Mandibular crowding >3 mm)	Age of the subjects (Mean ± SD)
Skeletal Class I	130	68	62	18.2±2.1 years
Skeletal Class II	130	53	77	17.3±3.7 years
Skeletal Class III	130	84	46	16.9±4.1 years

Table 2: Comparison of effective maxillary length among skeletal malocclusion, mandibular crowding groups, and genders

Effective maxillary length		Mandibular arch crowding (Mean±SD)		p-value (One-way ANOVA)		
Skeletal malocclusion	Gender	Group 1: crowding <3 mm	Group 2: crowding >3 mm	Between skeletal malocclusions	Between Mandibular crowding groups	Among genders
Class I	Male	82.13±3.42	83.4±2.51			
	Female	81.8±2.48	81±1.73			
Class II	Male	86.12±3.21	84±2.51			
	Female	84.33±9.5	83.2±4.91	0.004*	0.87	0.21
Class III	Male	81.23±3.2	82.17±3.21			
	Female	80±11.31	81±12.22			

(*p<0.05= Statistically significant)

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Table 3: Comparison of effective mandibular length among skeletal malocclusion, mandibular crowding groups, and genders

Effective mandibular length		Mandibular arch crowding (Mean±SD)		p-value (One-way ANOVA)		
Skeletal malocclusion	Gender	Group 1: crowding <3 mm	Group 2: crowding >3 mm	Between skeletal malocclusions	Between mandibular crowding groups	Among genders
Class I	Male	112.32±2.54	110.72±2.15			
	Female	110.6±3.36	109.3±2.06			
Class II	Male	108±4.12	107±3.2			
	Female	107±7.93	105±5.24	0.0002*	0.33	0.57
Class III	Male	118±8.33	115±4.62			
	Female	118±6.21	112.33±6.21			

(*p<0.05= Statistically significant)

Table 4: Comparison of maxillary crowding among skeletal malocclusion, mandibular crowding groups, and genders

Maxillary crowding		Mandibular arch crowding (Mean±SD)		p-value (One-way ANOVA)		
Skeletal malocclusion	Gender	<3 mm	>3 mm	Between skeletal malocclusions	Between mandibular crowding groups	Among genders
Class I	Male	2.5±3.12	4.42±2.12			
	Female	1.23±2.33	3.51±3.09			
Class II	Male	2.23±1.52	4.18±2.41			
	Female	-0.91±2.71	6.31±3.31	0.77	0.001*	0.42
Class III	Male	2.12±2.37	7.84±5.31			
	Female	1.45. ±3.21	4.84±5.31			

(*p<0.05= Statistically significant)

Table 5: Comparison of mandibular crowding among skeletal malocclusion and genders

Skeletal malocclusion	Gender	Mandibular arch crowding (Mean±SD)	p-value (One-way ANOVA)	
			Between skeletal malocclusion	Among genders
Class I	Male	3.31±2.41		
	Female	2.84±3.62		
Class II	Male	5.32±4.67		
	Female	6.87±3.62	0.016*	0.89
Class III	Male	1.92±4.41		
	Female	1.62. ±5.33		

(*p<0.05= Statistically significant)

Table 6: Correlation of effective maxillary and mandibular lengths with dental crowding and between maxillary and mandibular crowding and between the jaw lengths by using Pearson correlation.

Variables	r- value	p- value
Maxillary length (Co-A) x Mandibular crowding	-0.311	0.003*
Mandibular length (Co-Gn) x Mandibular crowding	-0.372	0.001*
Maxillary length (Co-A) x Maxillary crowding	-0.432	<0.001*
Mandibular length (Co-Gn) x Maxillary crowding	-0.324	0.004*
Maxillary crowding x Mandibular crowding	0.631	0.002*
Maxillary length (Co-A) x Mandibular length (Co-Gn)	0.674	0.001*

(*p<0.05= Statistically significant)

correlation with dental crowding, but a moderate positive correlation existed between the maxillary and mandibular crowding and also between the jaw lengths. Our findings are in concordance with the study of Sakuda et al,[13] Leighton and Hunter[14] and Turkkahraman and Sayin[16] which showed the severity of crowding increases with the smaller jaw lengths. These findings are also similar to the study by Janson et al[8] who conducted a similar study restricted to class II skeletal malocclusion only. Also in skeletal class II participants, effective maxillary length was greatly increased, while skeletal class III subjects had increased mandibular length. Dhopatkar et al[17] and Khoja et al.[18] had similar conclusions. The jaw lengths did not differ significantly between genders in our study. This is in contrast to the findings of studies by Bacceti et al,[19] and Ursi et al,[20] who concluded that males have longer jaws than females, however, Khoja et al.[18] reported that only males tend to have longer mandibular lengths, not the maxillary length. Rather than longitudinal data, we used cross-sectional sampling in our research. As a result, it lacks sufficient evidence to demonstrate sexual dimorphism at various ages.

In our study, maxillary crowding was increased in moderate to severe mandibular crowding groups. Along with this, both maxillary and mandibular crowding, as well as maxillary jaw length and mandibular jaw length, showed a moderate positive correlation. This is in accordance with the study of Janson et al.[8]

Our study showed no significant difference in maxillary and mandibular crowding between males and females similar to the study done by Doris et al[1] while other studies[21-23] showed contradictory findings showing a greater degree of dental crowding in females compared to males.

In this study, skeletal class II patients had the most mandibular crowding, while skeletal class III subjects had the least. This could be attributed to skeletal class II subjects having shorter mandibular lengths and skeletal class III subjects having longer mandibular lengths. These findings are contradictory with the results of the study conducted by Strujic et al.[24]

Aside from other factors that contribute to crowding, maxillary and mandibular length may play a role, therefore this should be taken into account while deciding the treatment options. To make these findings more conclusive, multicenter collaborative research in a variety of population groups with larger sample size and healthy controls are recommended.

CONCLUSION

Skeletal class II malocclusion has the longest effective maxillary length, while skeletal class III malocclusion has the longest effective mandibular length. The shorter effective maxillary and mandibular length are weakly associated with dental crowding. Jaw lengths and dental crowding don't show sexual dimorphism.

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