Comparison of tooth size and arch width of crowded and uncrowded Class I occlusion in individuals visiting a tertiary care center in Nepal

Manju Pandey[1]*, Umesh Parajuli[1], Anita Dahal[2], Bijayata Shrestha[3]

[1]Department of Orthodontics, College of Dental Surgery, Gandaki Medical College Teaching Hospital and Research Center, Pokhara, [2]Nepal Army Institute of Health Sciences, [3]Department of Oral Pathology, College of Dental Surgery, Gandaki Medical College Teaching Hospital and Research Center, Pokhara, Nepal

ABSTRACT

Introduction: The knowledge of tooth width and arch size is essential for esthetic and orthodontic rehabilitation. Hence, this study was done to assess the extent to which the arch width and mesiodistal tooth size were responsible for the crowding in individuals visiting a tertiary care center in Nepal. **Methods**: This was a cross-sectional study conducted on dental casts which was divided into two groups. The first group consisted 30 casts of normal occlusions (15 males and 15 females) without crowding. The second group consisted same number of casts exhibiting class I malocclusion with crowding. Mesiodistal teeth dimensions and arch width were measured. The data was analyzed using an independent sample t-test with a level of significance set at p<0.05. **Results:** Statistically significant difference in mesiodistal width of the upper central incisor (1st group 8.5±0.33, 2nd group 9.26±0.47; p-value=0.027) and canine (1st group 7.52±1.03, 2nd group 8.14±0.34; p-value=0.012), lower canine (1st group 6.38±0.84, 2nd group 7.12±0.38; p-value=0.005), 1st (1st group 6.63±0.81, 2nd group 7.23±0.46; p-value =0.023) and 2nd (1st group 6.66±0.85, 2nd group 6.97±0.52; p-value=0.035) premolar was observed. Buccal intercanine width of the maxillary and mandibular arch (1st group 38.25± 3.14, 2nd group 36.45 ± 1.44; p-value=0.003 and 1st group 30.88±1.6, 2nd group 25.48± 0.75; p-value=0.05 respectively), maxillary buccal intermolar width (1st group 58.44±5.0, 2nd group 55.75± 1.7; p-value=0.001), mandibular buccal (1st group 56.75± 4.2, 2nd group 55.30±2.12; p-value=0.013) and lingual intermolar width (1st group 32.50±3.4 , 2nd group 28.73±1.88; p-value=0.036) were found to be larger in the first group. **Conclusions:** The results of this study suggest that both the tooth size and arch width has a role in developing crowding.

Keywords: Arch width, class I malocclusion, crowding, tooth size.

***Correspondence:**
Dr. Manju Pandey
Department of Orthodontics
Gandaki Medical College Teaching Hospital and Research Center, Pokhara, Nepal
Email: manzu.pandey@gmail.com
ORCID iD: https://orcid.org/0000-0001-9950-0977

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INTRODUCTION

Dental crowding, the most predominant cause of malocclusion, is defined as any disparity in the relationship between tooth size and jaw size resulting in imbrication and rotation of teeth.[1,2] Tooth size and jaw size must be in harmony to allow proper alignment. It is challenging to obtain an occlusion with optimal overjet, overbite, class I molar, and canine relationships if there are significant variations in this harmony.[1] The relationship between arch dimensions and tooth size has always been a major of interest and investigated by researchers before.[3,4] The relationship of tooth size and arch length dimension with crowding has been studied by various investigators.[1-7]

A biometric study conducted by Doris et al.[5] found that dental arches with crowding of more than 4mm had larger teeth than those with less or no crowding. However, Howe et al.[1] found no difference in tooth sizes between crowded and uncrowded dentitions, but the crowded dentition had smaller arch dimensions than uncrowded dentitions. Differences in tooth size and arch width have been seen in different ethnic backgrounds and malocclusions and Nepalese population is not an exception.[8,9] Many factors such as heredity, growth of the bone, eruption and inclination of the teeth, external influences, function, and ethnic background are seen to have influence in the size and shape of the dental arches.[10,11]

Moreover, there is paucity of study comparing the disparity in arch dimension and mesiodistal tooth dimension in crowded and uncrowded class I occlusion among Nepalese population. So, this study was done to assess the extent to which the arch width and mesiodistal tooth size were responsible for the crowding in patients visiting a tertiary care center in Kaski.

METHODS

This cross-sectional study was conducted in Gandaki Medical College from March 2024 to June 2024 on study models obtained from 60 individuals with age ranging from 15 to 24 years age. Ethical approval for the study was obtained from the institutional review board (Ref. No. 82/080/081-F).

The sample size was calculated using Open Epi software using the mean difference for sample size calculation, mean of maxillary anterior teeth in normal occlusion (45±3.10), and mean of maxillary anterior teeth in crowded occlusion (48.65±3.90).[7] The sample size has been calculated as 23 in each group. The sample size formulae used are as follows:

$$n_1 = \frac{(\sigma_1^2 + \sigma_2^2 / \kappa)\,(Z_{1-\alpha/2} + Z_{1-\beta})^2}{\Delta^2}$$

$$n_2 = \frac{(\kappa^* \sigma_1^2 + \sigma_2^2)\,(Z_{1-\alpha/2} + Z_{1-\beta})^2}{\Delta^2}$$

n_1 = sample size of normal occlusion, n_2 = sample size of crowded occlusion, σ_1 = standard deviation of normal occlusion, σ_2 = standard deviation of crowded occlusion, Δ= difference in group means, κ = ratio = n_2/n_1, $z_{1-\alpha/2}$ = two-sided z value (z=1.96 for 95% confidence interval). $z_{1-\beta}$ = power, considering 95% CI and 80% power of the study.

The inclusion criteria included straight profile, normal overbite and overjet, Class I canine and molar relationships, presence of a complete set of permanent dentitions, absences of proximal restorations, and absence of previous history of orthodontic treatment. The exclusion criteria included the presence of missing or supernumerary teeth, the presence of proximal restoration, class II, III malocclusion and presence of a previous history of orthodontic treatment.

The study included two groups of study models based on the Class I skeletal base relationship. The first group consisted of 30 pairs of study models of Class I normal occlusions (15 males and 15 females) without any abnormal spacing or crowding. 1st group included the study model obtained from dental students of Gandaki Medical College. Informed consent was taken from the participants. The 2nd group consisted of 30 pairs of study models (15 males and 15 females) and exhibited Class I malocclusion with dental crowding (more than 5 mm space deficiency). These samples were selected from the dental cast records in the Department of Orthodontics, Gandaki Medical College. The sampling was done using purposive sampling techniques. The mesiodistal tooth size and arch width of maxillary and mandibular study models of both groups were measured and recorded.

Description of Measurements

Mesiodistal width of all the maxillary and mandibular teeth except second and third molar were measured. Buccal and lingual arch dimensions in the canine and molar regions of both the arch were also measured. The measurements were made by vernier calipers calibrated to 0.1 mm. The measurements were done by single observer. In order to assess the measurement errors, ten study models were selected and measured twice within the interval of one week.

Mesiodistal width: The mesiodistal widths of the teeth was measured in the largest mesiodistal area by vernier callipers calibrated to 0.1 mm. The caliper is held perpendicular to the long axis of the tooth.

Buccal intercanine width (ICW) and intermolar width (IMW): The buccal arch dimension was measured 5 mm apical to the mesiodistal center of the gingival margin of the canine tooth on one side to the same point on the contralateral side. The same procedure was performed in the molar region.[1,6]

Lingual ICW and IMW: On the lingual side, the distance between the midpoint on the cervical region of the canine in one side was measured to the corresponding point on the contra-lateral side. The same procedure was performed in the molar region.[1,6]

The statistical analysis was done using IBM Statistical Package for Social Sciences (SPSS) version 20.0. The comparison of mesiodistal tooth size and arch width between the two groups was done by using independent t- test where, p-value <0.05 was considered to be statistically significant.

RESULTS

The means and standard deviations of the mesiodistal widths of the 12 maxillary and mandibular teeth (first molar to first molar) of crowded and uncrowded class I occlusion groups were compared and is shown in Table 1 and 2 respectively. Statistically significant difference in mesiodistal width of only maxillary central incisor (uncrowded class I occlusion: 8.5±0.33, crowded class I occlusion: 9.26±0.47: p-value=0.027) was observed among the males. Statistically significant difference in mesiodistal width of canine (uncrowded class I occlusion: 7.52±1.03, crowded class I occlusion: 8.14±0.34: p-value =0.012) among maxillary dentition and canine(uncrowded class I occlusion 6.38±0.84, crowded class I occlusion: 7.12±0.38: p-value=0.005), 1st premolar (uncrowded class I occlusion 6.63±0.81, crowded class I occlusion: 7.23±0.46: p-value=0.023) and 2nd premolar (uncrowded class I occlusion 6.66±0.85, crowded class I occlusion: 6.97±0.52: p-value=0.035) among the mandibular dentition, was observed among the females.

Table 1: Comparison of mesiodistal width of maxillary teeth in crowded and uncrowded class I occlusion using independent t-test (measurement in mm) (N=60)

	Male (n=30)			Female (n=30)		
Teeth	Uncrowded Class I (n_1=15) Mean±SD	Crowded Class I (n_2=15) Mean±SD	p-value	Uncrowded Class I (n_1=15) Mean±SD	Crowded Class I (n_2=15) Mean ± SD	p-value
Maxillary central incisors	8.5±0.33	9.26±0.47	0.027*	8.41±0.91	8.81±0.50	0.236
Maxillary Lateral incisors	6.84±0.36	7.76±0.44	0.698	6.70±0.78	7.71±0.40	0.069
Maxillary Canines	7.75±0.53	8.53±0.52	0.642	7.52±1.03	8.14±0.34	0.012*
Maxillary 1st PM	6.89±0.37	7.66±0.53	0.135	6.74±0.88	7.44±0.45	0.125
Maxillary 2nd PM	6.75±0.24	7.25±0.62	0.001*	6.43±0.80	6.76±0.53	0.273
Maxillary 1st Molar	9.73±0.43		0.811	9.91±0.64	10.75±0.69	0.797

*p<0.05 denotes statistical significance

Table 2: Comparison of mesiodistal width of mandibular teeth in crowded and uncrowded class I occlusion using independent t-test (measurement in mm)

	Males			Females		
Teeth	Uncrowded Class I (n_1=15) Mean±SD	Crowded Class I (n_2=15) Mean±SD	p-value	Uncrowded Class I (n_1=15) Mean±SD	Crowded Class I (n_2=15) Mean±SD	p-value
Mandibular central incisor	5.25±0.36	5.75±0.28	0.667	5.26±0.50	5.66±0.26	0.079
Mandibular lateral incisors	5.52±0.34	6.39±0.34	0.51	5.61±0.58	6.3±0.34	0.16
Mandibular Canines	6.58±0.58	7.73±0.50	0.46	6.38±0.84	7.12±0.38	0.005
Mandibular 1st PM	6.68±0.47	7.64±0.52	0.8	6.63±0.81	7.23±0.46	0.023
Mandibular 2nd PM	6.85±0.45	7.62±0.78	0.12	6.66±0.85	6.97±0.52	0.035
Mandibular 1st Molar	10.47±0.66	11.54±0.67	0.36	10.65±1.02	11.21±0.67	0.052

*p<0.05 denotes statistical significance

The comparison of means and standard deviations of maxillary and mandibular arch width (the buccal ICW and lingual ICW, buccal IMW and lingual IMW of crowded and uncrowded class I occlusion groups is shown in table 3 and 4 respectively. A statistically significant difference in the buccal ICW of maxillary and mandibular arch of males (uncrowded class I occlusion: 38.25±3.14, crowded class I occlusion: 36.45±1.44 (p-value=0.003) and uncrowded class I occlusion: 30.88±1.6, crowded class I occlusion: 25.48±0.75 (p-value= 0.05) was found among two groups.

Maxillary buccal ICW (uncrowded class I occlusion: 37.57±3.71, crowded class I occlusion: 34.54±1.4: p-value=0.005), maxillary buccal IMW (uncrowded class I occlusion: 58.44±5.0, crowded class I occlusion: 55.75±1.7: p-value=0.001), mandibular buccal (uncrowded class I occlusion: 56.75±4.2, crowded class I occlusion: 55.30±2.12: p-value=0.013) and lingual IMW (uncrowded class I occlusion: 32.50±3.4, crowded class I occlusion: 28.73±1.88: p-value=0.036) showed statistically significant difference among two groups in females.

Table 3: Comparison of maxillary arch dimension in crowded and uncrowded class I occlusion using independent t-test (measurement in mm)

	Males			Females		
Width	Uncrowded Class I (n_1=15) Mean±SD	Crowded Class I (n_2=15) Mean±SD	p-value	Uncrowded Class I (n_1=15) Mean±SD	Crowded Class I ($n_2$15) Mean±SD	p-value
Buccal ICW	38.25±3.14	36.45±1.44	0.003*	37.57±3.71	34.54±1.4	0.005*
Lingual ICW	24.91±1.5	23.19±1.24	0.216	25.04±1.31	23.38±1.31	0.99
Buccal IMW	57.93±2.9	57.75±3.5	0.511	58.44±5.0	55.75±1.7	0.001*
Lingual IMW	36.06±6.6	35.24±2.67	0.268	37.33±6.5	33.24±1.88	0.095

*p<0.05 denotes statistical significance; ICW- Intercanine width, IMW- Intermolar width

Table 4: Comparison of mandibular arch dimension in crowded and uncrowded class I occlusion using independent t-test (measurement in mm)

	Males			Females		
Width	Uncrowded Class I (n_1= 15) Mean ± SD	Crowded Class I (n_2= 15) Mean ± SD	p-value	Uncrowded Class I (n_1=15) Mean±SD	Crowded Class I (n_2=15) Mean±SD	p-value
Buccal ICW	30.88±1.6	25.48±0.75	0.05*	30.58±1.8	24.34±1.4	0.49
Lingual ICW	20.76±2.26	16.69±1.35	0.11	19.72±1.9	16.99±1.4	0.702
Buccal IMW	57.75±3.5	55.34±3.12	0.732	56.75±4.2	55.30±2.12	0.013*
Lingual IMW	33.12±2.7	32.10±2.1	0.303	32.50±3.4	28.73±1.88	0.036*

*p<0.05 denotes statistical significance; ICW- Intercanine width, IMW- Intermolar width

DISCUSSION

It has been indicated that early permanent dentitions provide the best sample for tooth size measurements. Early adulthood dentitions undergo less mutilation and attrition in most individuals and so the effect of these factors on the actual mesiodistal tooth width will be minimal. Based on previous studies, it was assumed inter-canine and inter-molar widths of the subjects selected in the present study were stable.[12] In this study, we included the dental cast of individuals with the age range of the participants between 15 to 24 years.

The concepts of evolution, heredity, and environmental effects have been proposed to explain the cause of dental crowding. Some investigators have suggested that the reduced facial skeleton size without a corresponding reduction in tooth dimension may be the result of dental crowding.[13] However, other investigators emphasized the effects of heredity, speculating that dental crowding may result from continued inbreeding between different ethnic groups.[1]

Persons with large teeth are more likely to have crowding than those with small teeth.[14] In the present study, we found greater tooth size in the crowded group compared to the uncrowded samples. Similar to our finding, Doris et al.[5], Fastlicht et al.,[15] Lundstrom et al.,[14] Lombardi et al.[16] showed larger certain tooth dimensions in crowded arches. Similar to Doris et al, we found a statistically significant difference in mesiodistal width of maxillary central incisors, 2nd premolars, mandibular canines, first and second premolars. In contrast to our finding, they found larger maxillary lateral incisors and second premolars. Some researchers do not agree with the idea as their findings were not in concordance as ours.[1,17-19]

Comparing the interrelationship of tooth size, arch width, and dental crowding, the investigators found greater correlation between arch width and dental crowding than between tooth size and dental crowding.[1-2,17-21] In this study, we also found greater arch dimension in the uncrowded group compared to the crowded samples, a finding congruent with previous findings.[1-2,17-21] This finding was in conflict with finding of Faruqui et al. who found statistically significant differences in all the variables between the normal, crowded and spaced dental arches.[2] We found a statistically significant difference in maxillary ICW in the investigated groups whereas Khateeb et al. didn't find any difference in the maxillary ICW in the investigated groups.[22] While comparing the arch width dimension between uncrowded and crowded groups, we found statically significant canine width in the maxillary and mandibular arch. The IMW was more significant in mandibular arch.

The limitations of our study included 1) less sample size 2) utilization of limited parameter to determine the arch dimension. Low sample size might have influenced the result of the statistical analysis. The arch dimension parameters like arch length and arch perimeter might also have contributed in dentoalveolar disproportion. Moreover, it cannot be denied that the morphology of tooth can vary, teeth be abnormally small size in cases likes lateral incisors being peg-shaped or conical resulting in spacing. Therefore, our findings cannot be generalized requiring individual assessment and treatment of each arch.[17]

CONCLUSIONS

The results of this study suggest that both the tooth size and arch width have a role in developing dental crowding. Orthodontists aware of this finding will be better prepared to diagnose and plan the treatment of crowding more accurately.

CONFLICTS OF INTEREST: None declared

SOURCE OF FUNDING: None

AUTHORS' CONTRIBUTION

MP designed the research, collected data, MP and BS performed statistical analysis, and prepared the first draft of the manuscript, UP and AD explained and interpreted the data and contributed to preparing the final draft of the manuscript. All authors read and approved the manuscript.

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