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Original Article

Evaluation of arch width among Class I malocclusion, Class II Division 1, Class II Division 2, and Class III malocclusion in central Indian population

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ABSTRACT

Aim & Objectives: to compare the intercanine, intermolar and alveolar width among Class I, Class II div 1, Class II div 2 and Class III malocclusion for arch widths, the width of the maxillary and mandibular arches, gender dimorphism within groups, and gender comparisons in central India population. **Methods:** a cross-sectional study was comprised of patients pre-treatment study casts of 60 Class I, 40 class II div 1, 30 class II div 2 and 30 class III malocclusions. An electronic digital Vernier caliper with fine tips measuring within 0.01 mm (Aerospace) is used in this study to measure the parameters on the maxillary and mandibular study models. All subjects resided in central India with no history of orthodontic treatment. An analysis of variance test was used to compare the different malocclusion groups and genders. **Result:** Among the all comparison groups class I malocclusion group showed maximum maxillary inter canine, inter molar and alveolar width while class III group showed maximum mandibular inter canine, inter molar and alveolar width. Among the participants, all parameter were found increased in male subjects except for the maxillary inter canine width which is found higher in female participants. **Conclusion:** There was a significant difference among all malocclusion groups for the maxillary and mandibular inter canine, inter molar and alveolar width except for mandibular alveolar width. There was no gender dimorphism found within the malocclusions groups.

INTRODUCTION

The attainment of a stable, esthetic and functional arch form is of paramount importance in orthodontics[1]. Diagnosis of arch width and length discrepancies are important diagnostic tools, with the help of which an orthodontist can predict the treatment outcome of a particular case[2]. The evaluation of dental arches is important for proper diagnosis and treatment planning of any orthodontic case as it affects the availability of space, esthetics, and stability of the dentition. These considerations, in association with the anteroposterior movements of the dentition, will also help in the determination of the need for extraction or non-extraction treatment[5]. It is essential for an orthodontist to have knowledge of normal growth and development of dentition and the expected spatial changes in the arches with age. It will help in preventive as well as interceptive orthodontic procedures, which, at times, become necessary to deal with developing malocclusion[3]. Ample factors such as heredity, the growth of the bone, eruption and inclination of the teeth, external influences, function, and ethnic background could affect the size and shape of the dental arches[4]. Dental casts are still considered as a vital diagnostic tool in orthodontic practice. They facilitate the analysis of tooth size and shape;

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alignment and rotations of the teeth, arch width, length, form and symmetry and the occlusal relationship[6].

Transverse dimensions of the maxillary and the mandibular arches play a key role in the esthetics of a pleasing smile. Also, in narrow transverse skeletal problems, the upper molars are compensated naturally in a buccal direction and their lingual cusps hang down below the curve of Wilson, though there may not be a crossbite situation this may lead to an occlusal interference from the palatal cusps of upper molars. Moyers[7] and colleagues showed a greater increase for males than females for both maxillary and mandibular intermolar widths. Staley et al[8] showed that intermolar and intercanine widths of the maxillary and mandibular arches were narrower in the Class II division 1 patients than the normal occlusion individuals in both the sexes. Many analysts had been carried out to predict the intercanine and intermolar widths of the individuals, among these, are the Pont's index, Schwarz analysis and McNamara and Brudon's prediction method. Though nimkarn claimed that all these methods of predicting the arch widths are inaccurate. Chen et al[9] showed the difference between the maxillary and mandibular skeletal base and the intermolar widths between the skeletal Class III and the Class I subjects. Knowledge of arch widths associated with Class II (CII) and Class III (CIII) malocclusions is essential for the determination of treatment goals and likely posttreatment sequel for these malocclusions. However, there is little information available regarding this issue among the central Indian population where there is a relatively large demand for orthodontic treatment.

Materials and Methods:

The study subject will comprise of patients pre-treatment study casts of 60 Class I, 40 class II div 1, 30 class II div 2 and 30 class III malocclusions from the Department of Orthodontics and Dentofacial Orthopaedics, Peoples College of Dental Sciences & Research Centre, Bhanpur, Bhopal, MP. A total of 160 study models with good quality & absence of proximal stripping, interproximal caries or restorations as well as prosthetic crowns or bridges evaluated in the study. The inclusion criteria for CI normal occlusion with class I molar relation, Overjet not more than 4 mm, teeth well aligned within the dental arches with <3 mm of crowding or spacing and no teeth in crossbite. CIId1 group, there should be bilateral CII molar relationship in centric occlusion, with the distobuccal cusp tip of the maxillary first molar occluding with the buccal groove of the mandibular first molar, labially inclined maxillary incisors, and overjet >7.5 mm. One male and one female subject in CIId1 have posterior crossbite. For the CIId2 group, along with bilateral CII molar relationship in centric occlusion, there should be at least one maxillary central incisor inclined lingually, Overjet not more than 5 mm, deep overbite, and no teeth in crossbite. For CIII group, there should be bilateral CIII molar relationship in centric occlusion, with the mesiobuccal cusp tip of the maxillary first molar occluded within 1 mm of the distal marginal ridge of the mandibular first molar and no tooth crowded out of the arch (to avoid confusion in angle classification). Subjects with gross restorations, buildups, crowns, onlays, Class II amalgams, or composite restorations that affect the tooth’s

Table 1: **Distribution of study population according to gender and type of malocclusion**

		Malocclusion Group				Total
		Class I N (%)	**Class2 div1**	**Class2div2**	**Class3**	
Gender	**Male**	27 (45%)	18(45%)	20(66.66%)	28(93.3%)	93(58.1%)
	Female	33(55%)	22(55%)	10(33.33%)	2(6.7%)	67(41.9%)
Total		**60**	**40**	**30**	**30**	**160**

Table 2: **Group wise distribution of descriptive mean & results of ANOVA**

	Class I	**Class2 div 1**	**Class2 div 2**	**Class 3**	**F value**	**P value**
Maxillary inter canine width	35.19(3.76)	34.19(3.17)	34.94(3.10)	34.96(3.39)	6.65	0.00
Maxillary inter molar width	53.84(3.99)	49.69(3.39)	49.97(3.66)	51.67(3.26)	9.67	0.00
Maxillary alveolar width	59.01(3.90)	56.91(3.69)	56.92(3.20)	58.09(3.15)	2.95	0.04
Mandibular inter canine width	26.05(3.60	25.97(2.79)	24.54(3.55)	27.89(3.31)	5.05	0.00
Mandibular inter molar width	50.58(3.48)	50.23(3.17)	50.42(3.15)	53.42(8.68)	3.19	0.03
Mandibular alveolar Width	55.13(3.15)	54.74(4.74)	55.50(3.06)	56.81(3.55)	2.03	0.11

Table 3: **Results of Post hoc analyses (maxillary arch)**

Comparison group		Mean difference	Std error	P value
1.Maxillary inter canine width				
Class 1	Class 2 div 1	3.17	0.75	0.001
	Class 2 div 2	0.77	0.68	0.67
	Class 3	0.69	0.75	0.77
Class 2 div 1	Class 2 div 2	2.39	0.81	0.02
	Class 3	-0.75	0.81	0.79
Class 2 div 2	Class 3	-3.14	0.87	0.01
2. Maxillary inter molar width				
Class 1	Class 2 div 1	2.18	0.79	0.03
	Class 2 div 2	1.69	0.79	0.14
	Class 3	-1.98	0.72	0.12
Class 2 div 1	Class 2 div 2	-0.29	0.85	0.99
	Class 3	-4.16	0.85	0.001
Class 2 div 2	Class 3	-3.87	0.90	0.001
3.maxillary inter alveolar width				
Class 1	Class 2 div 1	2.17	0.70	0.03
	Class 2 div 2	1.18	0.76	0.41
	Class 3	-0.92	.76	0.62
Class 2 div 1	Class 2 div 2	0.01	0.82	1.00
	Class 3	-2.09	0.82	0.06
Class 2 div 2	Class 3	-2.10	0.88	0.09

Table: 4 **Results of Post hoc analyses (mandibular arch)**

Comparison group		**Mean difference**	**Std error**	**P value**
1.mandibular inter canine width				
Class 1	Class 2 div 1	0.08	0.68	1.00
	Class 2 div 2	1.51	0.75	0.19
	Class 3	1.84	0.75	0.07
Class 2 div 1	Class 2 div 2	1.43	0.80	0.29
	Class 3	-1.92	0.81	0.08
Class 2 div 2	Class 3	-3.35	0.87	0.00
2. mandibular inter molar width				
Class 1	Class 2 div 1	0.35	0.98	0.98
	Class 2 div 2	0.16	1.07	0.99
	Class 3	-2.83	1.07	0.04
Class 2 div 1	Class 2 div 2	-0.19	1.16	0.99
	Class 3	-3.19	1.16	0.03
Class 2 div 2	Class 3	-2.99	1.24	0.07
3. mandibular inter alveolar width				
Class 1	Class 2 div 1	0.39	0.75	0.95
	Class 2 div 2	-0.37	0.81	0.97
	Class 3	-1.68	0.82	0.17
Class 2 div 1	Class 2 div 2	-0.77	0.88	0.82
	Class 3	-2.07	0.88	.09
Class 2 div 2	Class 3	-1.30	0.94	0.52

Table 5: **Gender wise distribution of descriptive mean & results of independent sample t-test**

	Gender	**Mean(SD)**	**Mean difference**	**t-value**	**p-valve**
Maxillary inter canine width	Male	33.95(3.5)	-0.50	0.5	0.10
	Female	34.4(3.5)			
Maxillary inter molar width	Male	51.7(3.8)	1.18	0.8	0.06
	Female	50.5(3.5)			
Maxillary alveolar width	Male	57.8(3.4)	0.26	0.8	0.07
	Female	57.5(3.5)			
Mandibular inter canine width	Male	26.3(3.4)	0.50	0.7	0.09
	Female	25.7(3.4)			
Mandibular inter molar width	Male	51.6(5.6)	1.63	0.5	0.11
	Female	50.0(3.3)			
Mandibular alveolar Width	Male	55.8(4.1)	0.90	0.9	0.06
	Female	54.8(2.9)			

Illustrations:

Fig.1 Digital Vernier Calliper

Fig 3. Maxillary Intermolar width

Fig 2. Maxillary Intercanine width

Fig 4. Maxillary Interalveolar width

Fig 5. Mandibular Intercanine width

Fig 6. Mandibular Intermolar width

Fig 7. Mandibular Interalveolar width

mesiodistal diameter, congenital defects or deformed teeth, obvious interproximal or occlusal wear of teeth were excluded.

Total 160 patients pre-treatment casts will be selected for the study from the Department of Orthodontics and

Dentofacial Orthopaedics, Peoples College of Dental Sciences & Research Centre, Bhanpur, Bhopal, MP. An electronic digital Vernier caliper with fine tips measuring within 0.01 mm (Aerospace) is used in this study to measure the parameters on the maxillary and mandibular study models. The calculation is done with the help of calculator after taking all the measurements. All the measurements will be done by a single operator to avoid any inter-observer error.

Data collection procedure: In the first visit, impressions of upper and lower arches of the patients will be taken and casts are poured. Data of each patient will be recorded after which six width measurements are taken on the dental casts of each subject. These measurements are as follows: Maxillary intercanine

width – between the cusp tips of maxillary canines; Maxillary intermolar width – between the mesiobuccal cusp tips of the first molars; Maxillary alveolar width – at the mucogingival junctions above the mesiobuccal cusp tips of the maxillary first molars; Mandibular alveolar width – at the mucogingival junctions below the buccal grooves of the mandibular first molars; Mandibular intermolar width – between the most gingival extensions of the buccal grooves on the first molars or, when the grooves had no distinct terminus on the buccal surface, between points on the grooves located in the middle of the buccal surfaces; Mandibular intercanine width – between the cusp tips of mandibular canines; Mandibular arch widths are subtracted from maxillary arch widths to calculate the maxillary/mandibular arch width differences.

Statistical analysis: All the data collected were tabulated according to groups and subjected to appropriate statistical analysis. The statistical methods employed in the present study are the analysis of variance (ANOVA) with post hoc analysis and Independent sample t-test.

Results

Among the Angles Class I malocclusion 27(45%) were male and 33(55%) were female. In Angles Class II div 1 malocclusions were 18(45%) male and 22 (55%) were female, In Angles Class II div 2 malocclusions were 20(66.66%) male and 10 (33.33%) were female and In Angles Class III malocclusion 28(93.3%) were male and 2(6.7%) female. **(Table-1 & Graph-1)**

ANOVA was performed to compare the mean value of Maxillary inter canine width of maxillary intermolar width, maxillary alveolar width, mandibular inter canine width, mandibular intermolar width, mandibular alveolar width. All the parameters show a statistically significant difference between Class 1, Class II div 1, Class II div 2 and Class 3 malocclusions. (Table-2). Mean standard deviation (SD) of maxillary inter canine width of Class 1, Class II div 1, Class II div 2 and Class 3 malocclusions are 34.96(3.39), 34.19(3.17), 35.19(3.76), 34.94(3.10) respectively ($P<0.05$ $f=6.65$). Mean standard deviation (SD) of maxillary intermolar width of Class 1, Class II div 1, Class II div 2 and Class 3 malocclusions are 53.84(3.99), 49.69(3.39), 49.97(3.66) & 51.67(3.26) respectively ($P<0.05$ $f=49.67$)**.** Mean standard deviation (SD) of maxillary inter alveolar width of Class 1, Class II div 1, Class II div 2 and Class 3 malocclusions are, 58.09(3.15), 56.91(3.69), 56.92(3.20) & 59.01(3.90), respectively ($P<0.05$ $f=2.95$). Mean standard deviation (SD) of mandibular inter canine width of Class 1, Class II div 1, Class II div 2 and Class 3 malocclusions are 27.89(3.31), 25.97(2.79), 24.54(3.55) 26.05(3.60), ($P<0.05$ $f=5.05$)**.** Mean standard deviation (SD) of the mandibular intermolar width of Class 1, Class II div 1, Class II div 2 and Class 3 malocclusions are 50.58(3.48), 50.23(3.17), 50.42(3.15), 53.42(8.68) ($P<0.05$ $f=3.19$). Mean standard deviation (SD) of mandibular inter alveolar width of Class 1, Class II div 1, Class II div 2 and Class 3 malocclusions are 55.13(3.15), 54.74(4.74), 55.50(3.06), 56.81(3.55) ($P>0.05$ $f=2.03$).

Post hoc analyses were conducted given the statistically significant one way ANOVA test. Specifically, Tukey HSD tests were conducted on all possible pairwise contrasts. The following pairs of groups were found to be significantly different ($p < 0.05$) Class I, Class II div 1, Class II div 2 and Class III were compared between each other which shows a significant difference.

Results of Post hoc analyses showed for maxillary inter canine width Class I shows significant difference with Class II div 2 and Class II div 1 shows significant difference with Class II div 2; class II div2 shows significant difference with class III. In maxillary intermolar width Class I shows significant difference with Class III; class II div1 shows significant difference with class III class II div2 shows significant difference with class III. (Table-3)

The result of Post hoc analyses showed for mandibular inter canine width class II div2 shows significant difference with class III. In mandibular intermolar width Class I show significant difference with Class III class II div1 shows significant difference with class III. (Table-4)

Mean of Maxillary inter canine width among male and females are 33.95(3.5), 34.4(3.5). Maxillary intermolar width among male and females are 51.7(3.8), 50.5(3.5). Maxillary alveolar width among male and females are 57.8(3.4), 57.5(3.5). Mandibular inter canine width among male and females are 26.3(3.4), 25.7(3.4). Mandibular intermolar width among male and females are 51.6(5.6), 50.0(3.3). Mandibular alveolar width among male and females are 55.8(4.1), 54.8(2.9) respectively. Independent sample t-test was performed to compare the mean value of Maxillary inter canine width, maxillary intermolar width, maxillary alveolar width, mandibular inter canine width, mandibular intermolar width, mandibular alveolar width among males and females. All the parameters show no statistically significant difference between genders. (Table-5)

Discussion:

The size and shape of arches have considerable implications in orthodontic diagnosis and treatment planning, as it affects the space available, dental esthetics, and stability of the dentition. Unfortunately, most studies investigated the transverse structure of the mandibular-maxillary base in CI and CII malocclusions. Previous studies that compared arch widths in adult subjects having angle CI normal occlusions and CIII malocclusions have left unanswered questions.

A statistical analysis based on data collected from previous arch width studies was used to determine the sample size for the power of the tests. It was concluded that a sample size of approximately 20 subjects for each gender gave adequate power. However, for CIII subjects 34 samples could be obtained due to low prevalence rate.

The age range of the subjects in the present study was between 13 to 20 years of age. Researchers, who studied growth changes in arch width, found that little or no change occurred in the intercanine and the intermolar widths after the age of thirteen years in females and sixteen years in males. Bishara et al also pointed out that limited changes in arch width occurred between 13 and 25 years of age. Therefore, it was assumed that the arch width of the subjects selected in the present study was stable.

The measurements in the present study were made directly on study models by one operator using an electronic digital caliper (AEROSPACE) with fine tips measuring within 0.01 mm. However, other investigators used different methods and devices. Schirmer and Wiltshire and Champagne compared measurements made manually on casts with those made on digitized casts obtained from a photocopier. They concluded that, although photocopies are easy to handle, manually measuring teeth with a calibrated gauge produced the most accurate and reproducible measurements. On the other hand, Bhatia and Harrison

studied the performance of the traveling microscope; an apparatus modified to measure dental casts and found that the method was more precise than some alternatives. Further, Martensson and Ryden investigated a holographic system for measuring dental casts. The method was shown to be more precise than previous methods, and the authors believed that it would also save storage space. However, although the microscope and holographic systems had some advantages, they did not prove to be practical in clinical practice, and they never became popular. The method used in the present study was found to be easy, precise, and more practical.

Results from Table 1 shows the distribution of study population. Among the Angles Class I malocclusion 27(45%) were males and 33(55**%**) were females. In Angles Class II div 1 malocclusion were 18(45**%**)males and22(55**%**) were females, In Angles Class II div 2 malocclusions were 20(66.66**%**) males and 10(33.33**%**)were females and In Angles Class III malocclusion 28(93.3**%**)were males and 2(6.7**%**) females.

In this study, the null hypothesis for arch widths is rejected. The null hypothesis for maxillary/mandibular differences is rejected. The null hypothesis for gender comparisons is accepted for maxillary intercanine and alveolar widths between CI and CIId1, maxillary intermolar and alveolar width between C1 and CIId2, mandibular intercanine, intermolar and alveolar widths between CIII and CIId1 and intercanine width difference in females. Comparison of the results with already published studies shows agreement as well as the conflict in some aspects. This disagreement among studies of comparison of arch widths in CI, CII, and CIII malocclusions may be explained by several factors: Gender dimorphism, ethnic and racial differences, sample selection and size, and age of subjects.

In this study

Maxillary intercanine width- classIIdiv2>classI>classIII>classIIdiv1

Maxillary intermolarwidth- classI>classIII>classIIdiv2>classIIdiv1

Maxillary alveolar width - classIII>classI>classIIdiv2>classIIdiv1

Mandibular intercanine width - classIII>classI>classIIdiv1>classIIdiv2

Mandibular intermolar width - classIII>classI>classIIdiv2>classIIdiv1

Mandibular alveolar width- classIII>classIIdiv1>classI>classIIdiv2

Above five variables shows greater measurement for class III as class III malocclusion is less prevalent In central india and most of the sample is of male patient with less severe malocclusion in which there is well developed maxillary and mandibular arches.

Intercanine widths were investigated in a few of the previous studies, and conflicting results were found. In this study, with genders pooled, none of the group showed the significant difference. This is in contrast with studies by Staley *et al.*[10] and Huth *et al.*[22] but agreed from studies by Sayin and Turkkahraman[19] and Al-Khateeb and Abu Alhaija[23] significant difference is found in the maxillary intercanine width between the CI and CIII groups which is similar with studies by Kuntz *et al.*,[25] Al-Khateeb and Abu Alhaija,[23] Uysal *et al.*[18] Although it contrasts with study of Al-Khateeb and Abu Alhaija,[23] our study also showed that Class II div 1 group has significantly smaller maxillary intercanine width

than other groups. This suggests that maxillary arches are smaller in the intercanine region in CIId1 patients in Indian population.it may also due to digit sucking habit, increased muscles activity (mentalis and buccinators) In our study, CI group showed significantly larger maxillary intermolar width than the CIId1 group. It is in concurrence with studies Staley *et al.*,[8] Huth *et al.*,[22] Sayin and Turkkahraman,[19] Al-Khateeb and Abu Alhaija,[23] Tollaro *et al.*[14] and Lux *et al*.,[17] but differed from studies by Frohlich[17] and Uysal *et al*.[20] CI group also showed significantly larger maxillary intermolar width than CIId2 group. It is in concurrence with a study by Huth *et al.,*[24] but differed from a study by Al-Khateeb and Abu Alhaija.[23] In this study, class 2 division 2 has greater maxillary and mandibular intermolar width than class 2 div 1, which is similar from studies by Huth *et al.,*[24] Al-Khateeb and Abu Alhaija,[23] and Buschang *et al.*[13] Similarly, difference is observed between CI and CIII groups for maxillary intermolar width in this study. Class I has more intermolar width than class III. This result is in coincide with the study by Al-Khateeb and Abu Alhaija,[23] but contras from studies by Chen *et al*.,[9] Kuntz *et al*.,[25] Uysal *et al*.,[20] and Slaj *et al*. This suggested maxillary arches are narrower in the molar region in CIId1 malocclusions in Indian population. Clinicians have speculated that nasal obstruction, finger habits, tongue thrusting, low tongue position and abnormal swallowing, and sucking behavior were reasons for narrower maxillary dental arch widths in CIId1 malocclusions compared with a normal occlusion sample. To achieve CI molar relationship, expansion should be done in the maxillary intermolar region in CII malocclusions. In this study, CI group showed significantly larger maxillary alveolar width than the CIId1 group. It is in concurrence with Staley *et al*.,[10] Huth *et al.,*[24] Uysal *et al*.,[20] Lux *et al*.,[17] but differed from a study by Sayin and Turkkahraman.[19] significant difference is observed in CIII groups for maxillary alveolar width. It agreed from studies by Chen *et al*.,[9] Kuntz *et al.,*25 and Uysal *et al*.[20] This suggested maxillary alveolar base is narrower in CIId1 malocclusions. In cases of crossbite, expansion of maxillary arch should be done to relieve posterior crossbite in CIId1 malocclusion. In this study, the difference is observed in maxillary alveolar width in the order of CI,> CIId2, > CIId1. These results are against with studies by Staley *et al.,*[8] and Huth *et al.*[22] (mandibular intercanine width), Tollaro *et al.*[14] (mandibular intermolar width), Huth *et al.*[22] (mandibular alveolar width) but similar from Sayin and Turkkahraman,[19] Uysal *et al.,*[20] and Walkow and Peck[16] (mandibular intercanine width), by Huth *et al.,*[22] and Uysal *et al.*[20] (mandibular intermolar width), Uysal *et al*.[20] (mandibular alveolar width). However, CI group

showed significantly larger mandibular intercanine and intermolar width than CIII, CIId1, and CIId2 groups. These results are is in concurrence with studies by Al-Khateeb and Abu Alhaija,[23] and Uysal *et al.*[20] (mandibular intercanine width), Uysal *et al*.,[20] Slaj *et al.*[31] (mandibular intermolar width), Huth *et al.*[22] (mandibular alveolar width) but differed from Kuntz *et al.*[22] (mandibular intercanine width), by Chen *et al*.,[9] and Kuntz *et al.*[25] (mandibular intermolar width), Chen *et al*.,[9] Kuntz *et al*.,[25] and Uysal *et al.*[20] (mandibular alveolar width). This showed mandibular arch is wider in the molar region in CIII malocclusion. He concluded that the possible explanation for the increase in arch width seen in CIII dental arches may be the adaptability of the tongue to the decrease in available arch depth reflected in an increased lateral tongue dimension. It may be due to dental compensation because mandibular posterior teeth were buccally inclined in CIII patients. Staley *et al*.,[10] and Bishara *et al* pointed out that it is clinically useful to compare differences between molar widths besides comparing absolute molar widths because, on the basis of such differences, more consistent and interpretable results could be obtained. The CI group showed significantly larger mean intercanine and intermolar width difference than CIId1 and CIII groups. The mean intermolar width difference is positive for CI group and negative for CIId1 and CIII group. Negative intermolar width differences suggested crossbite tendency in CII and CIII malocclusions. According to this study, the crossbite in CIId1 group is due to constricted maxillary with normal mandibular arch while in CIII group, it is due to normal maxillary arch with the enlarged mandibular arch. According to some authors, it is the mesiodistal dimension of mandibular teeth which is responsible for such changes. Sperry *et al* reported that CIII patients often have wider lower teeth than CI and CII subjects. Another possible explanation is that a shorter and larger mandibular arch in subjects with CIII could be a consequence of dental compensation in that patients with that malocclusion tend to have the mandibular incisors inclined to the lingual, and the lateral teeth inclined to the buccal. Early recognition of crossbite tendency would be helpful in interceptive and preventive orthodontics. These findings occurred due to narrow maxillary arch in CIId1 malocclusion and wider mandibular arch in CIII malocclusion in molar region. CI group showed significantly larger mean alveolar width difference than CIId1 group. The mean alveolar width difference is positive for CI, but negative for the CIId1 group. Negative alveolar width difference in CIId1 patient occurred due to narrow maxillary alveolar width.

Gender comparison

In our studies, no significant finding observed in male and female subjects, which is in contrast with other

studies. CI group showed significantly larger maxillary intercanine and alveolar width than the CIId1 group. In contrast, in the female, although maxillary intercanine width is narrower in CIId1 group when compared with CI group, it is not statistically significant. It is in concurrence with a study by Huth *et al.*[24] Similarly, in male subjects, CI normal occlusion showed significantly larger maxillary intermolar and alveolar widths than CIId2 malocclusion. However, although female subjects with CI normal occlusion showed larger maxillary intermolar and alveolar width than CIId2 malocclusion, it is not statistically significant. For mandibular arch widths, males showed significantly larger mandibular intercanine, intermolar and alveolar widths in CIII group than the CIId1 group in contrast to female subjects where the difference is not statistically significant. In male subjects, CI group showed significantly larger mean intercanine width difference than CIII and CII1 groups. In female subjects, no statistically significant difference is observed between the occlusion groups for mean intercanine width difference. These gender comparisons revealed that arch width differences between different types of malocclusions more pronounced in males than in females.

Conclusion: There was no gender dimorphism found within the malocclusions groups. There was a significant difference among all malocclusion groups for intercanine, intermolar and alveolar width in both maxillary and mandibular arc except for the mandibular alveolar width.($p>0.05$). Highest maxillary intercanine, intermolar & alveolar width was found in Class I malocclusion and class II div I showed the least. While highest mandibular intercanine, intermolar & alveolar width was found in Class III malocclusion groups, least intercanine width was found in Class II div 2 and least intermolar & alveolar width was found in Class II div 1 malocclusion.

Conflict of interest

No conflict of interest declared by the authors

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