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

Dolly Patel, Falguni Mehta[1], Nimesh Patel[2], Nishit Mehta[3], Ipist Trivedi[4], Apexa Mehta[5]

Abstract

Objective: To test the hypothesis that there is no difference between Class I (CI) normal occlusion, Class II division 1 (CIId1) and CII division 2 (CIId2), and Class III (CIII) malocclusion with respect to arch widths, width of the maxillary and mandibular arches, gender dimorphism within groups, and gender comparisons. **Materials and Methods:** Samples of 40 CI subjects, 40 CIId1 subjects, 40 CIId2 subjects, and 34 CIII subjects were studied. All subjects were Indians with no history of orthodontic treatment. An analysis of variance and Duncan's test statistically compared the groups and genders. **Results:** CIId1 malocclusion showed the narrowest maxillary arch compared with the other types of malocclusions. CIII malocclusion showed largest mandibular arch than other types of malocclusions. Gender dimorphism is more commonly seen in CI normal occlusion than other types of malocclusions. Gender dimorphism is not observed in CIId1 group. Gender comparisons revealed arch width differences between different types of malocclusions more pronounced in males than in females. The maxillary/mandibular intermolar width difference is positive for CI normal occlusion and negative for CIId1, CIId2, and CIII malocclusions, which suggested, the presence of crossbite tendency in CII and CIII malocclusions. **Conclusion:** The hypothesis is rejected by the findings of this study.

Keywords: Alveolar width, arch width, intercanine width, intermolar width, malocclusion

Introduction

The attainment of a stable, functional and esthetic arch form is of paramount importance in orthodontics.[1] Diagnosis of arch length and width discrepancies are important diagnostic aids, with the help of which an orthodontist can predict the treatment outcome of a particular case.[2] 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, 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] 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 antero-posterior movements of the dentition, will also help in determination of the need for extraction or nonextraction treatment.[5] Dental casts are still considered a vital diagnostic tool in orthodontic practice. They facilitate the analysis of tooth size and shape; alignment and rotations of the teeth, arch width, length, form and symmetry and the occlusal relationship.[6] Knowledge of arch widths associated with Class II (CII) and Class III (CIII) malocclusions is essential for determination of treatment goals and likely posttreatment sequel for these malocclusions. However, there is little information available regarding this issue among the Indian population where there is a relatively large demand for orthodontic treatment.

The objectives of this study was to test the hypothesis that there is no difference between Class I (CI) normal occlusion, Class II division 1 (CIId1) and Class II division 2 (CIId2), and

Department of Orthodontics, AMC Dental College and Hospital, [1]Government Dental College and Hospital, [2]Private Practice, Ahmedabad, [3]Graduate DDS Student, Herman Ostrow of Dentistry of USC, Los Angeles, [4]Private Practice, Ahmedabad, [5]Graduate Student, School of Public Health, Rutgers University, New Jersey, USA

Correspondence: Dr. Nishit Mehta,
Graduate DDS Student, Herman Ostrow of Dentistry of USC,
Los Angeles, USA.
E-mail: drnishitmehta@yahoo.co.in

Access this article online	
Quick Response Code:	Website: www.contempclindent.org
	DOI: 10.4103/0976-237X.166842

How to cite this article: Patel D, Mehta F, Patel N, Mehta N, Trivedi I, Mehta A. Evaluation of arch width among Class I normal occlusion, Class II Division 1, Class II Division 2, and Class III malocclusion in Indian population. Contemp Clin Dent 2015;6:S202-9.

CIII malocclusion with respect to arch widths, width of the maxillary and mandibular arches, gender dimorphism within groups and gender comparisons.

Methods

Study models of 40 subjects (20 males and 20 females in each category) are selected in CI, CIId1, and CIId2 occlusion groups. Study models of 34 subjects (20 males and 14 females) are selected for CIII group. All subjects selected are from Indian population with no history of orthodontic treatment. The minimum age of the subjects chosen for this study is based on earlier evidence reporting no significant change occurring in intermolar widths at permanent first molars and canine arch widths between permanent canines after 13 years in girls and 16 years in boys.[2,7-10] Therefore, in this study, subjects from 13 to 33 years are selected.

The inclusion criteria for CI normal occlusion are first molars bilaterally in CI in centric occlusion, with mesiobuccal cusp tip of the maxillary first molar occluding with the buccal groove of the mandibular first molar, 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. For 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 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).

An electronic digital vernier calliper with fine tips measuring within 0.01 mm (Mitutoyo Corporation, Kawasaki, Japan) is used in this study to measure the parameters on the maxillary and mandibular study models.

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 at 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. Statistical analysis is performed using the Microsoft Office Excel 2007 and IBM SPSS version 22 software. The statistical methods employed in the present study are mean [Tables 1-5], standard deviation [Tables 2-5], analysis of variance (ANOVA) [Tables 6 and 8], and Duncan's multiple range test [Tables 6-8].

Table 1: Ages of subjects in years

Occlusion group	*n*	Mean	Minimum	Maximum
CI male	20	20.5	16.2	32.5
CI female	20	19.7	13.5	33.7
CIId1 male	20	21.7	15.9	29.4
CIId1 female	20	20.7	13.2	27.6
CIId2 male	20	21.1	15.8	28.4
CIId2 female	20	20.4	13.7	27.3
CIII male	20	22.3	16.2	26.3
CIII female	14	21.6	13.4	27.5

CI: Class I; CII: Class II; CIII: Class III; CIId1: Class II division 1; CIId2: Class II division 2

Table 2: Arch widths (mean, SD) in adult CI

Width	Normal occlusion (in mm)			
	Males (*n*=20)		Females (*n*=20)	
	Mean	SD	Mean	SD
Maxilla				
Intercanine width	35.5	2.6	33.7	1.4
Intermolar width	52.2	2.2	48.3	1.7
Alveolar width (at first molars)	58.5	1.9	55.1	1.9
Mandible				
Intercanine width	26.6	1.9	25.4	1.4
Intermolar width	50.7	2.3	46.8	1.7
Alveolar width (at first molars)	55.6	2.1	52.3	1.9
Interarch width difference				
Intercanine difference	8.9	1.4	8.3	1.3
Intermolar difference	1.5	1.1	1.5	1.3
Alveolar difference	2.9	1.8	2.8	1.8

SD: Standard deviation; CI: Class I

Table 3: Arch widths (mean, SD) in adult CIId1

Width	Malocclusion (in mm)			
	Males (*n*=20)		Females (*n*=20)	
	Mean	SD	Mean	SD
Maxilla				
Intercanine width	33.1	2.0	32.8	1.9
Intermolar width	47.3	3.2	46.0	2.0
Alveolar width (at first molars)	54.6	3.0	53.4	2.5
Mandible				
Intercanine width	25.6	1.8	25.6	1.8
Intermolar width	49.7	2.6	48.2	2.2
Alveolar width (at first molars)	55.6	1.9	54.4	1.9
Interarch width difference				
Intercanine difference	7.5	1.2	7.2	1.2
Intermolar difference	−2.4	2.1	−2.3	2.1
Alveolar difference	−1.1	2.0	0.9	1.8

SD: Standard deviation; CIId1: Class II division 1

Table 4: Arch widths (mean, SD) in adult CIId2

Width	Malocclusion (in mm)			
	Males (*n*=20)		Females (*n*=20)	
	Mean	SD	Mean	SD
Maxilla				
Intercanine width	34.8	2.4	32.6	2.2
Intermolar width	49.5	2.5	47.1	2.1
Alveolar width (at first molars)	56.0	1.9	54.6	1.9
Mandible				
Intercanine width	26.4	1.8	25.0	1.3
Intermolar width	49.5	1.9	47.7	2.1
Alveolar width (at first molars)	55.6	1.8	54.1	2.1
Interarch width difference				
Intercanine difference	8.4	1.7	7.6	2.0
Intermolar difference	−0.5	1.5	−0.6	1.2
Alveolar difference	0.4	2.2	0.5	1.6

SD: Standard deviation; CIId2: Class II division 2

Results

Arch width comparison in maxilla

With genders pooled, CIII and CI groups showed significantly larger maxillary intercanine widths than CIId1 group and larger maxillary intermolar and alveolar widths than CIId2 and CIId1 groups. Gender dimorphism occurred in maxillary intermolar and alveolar width in CI occlusion and in maxillary intercanine width in CIId2 occlusion [Table 6].

Arch width comparison in mandible

With genders pooled, CIII group showed significantly larger mandibular intercanine, intermolar, and alveolar width than CI, CIId2, and CIId1 groups. Gender dimorphism did not occur in mandibular intercanine width. However, gender dimorphism can be seen in mandibular intermolar width in CIII, CI, and CIId2 occlusion and in mandibular alveolar width in CIII and CI occlusions [Table 6].

Table 5: Arch widths (mean, SD) in adult CIII

Width	Malocclusion (in mm)			
	Males (*n*=20)		Females (*n*=20)	
	Mean	SD	Mean	SD
Maxilla				
Intercanine width	35.5	2.8	34.1	2.7
Intermolar width	51.0	5.0	49.5	2.1
Alveolar width (at first molars)	58.1	4.9	56.2	1.9
Mandible				
Intercanine width	27.9	2.6	26.9	1.5
Intermolar width	51.9	3.3	49.8	2.9
Alveolar width (at first molars)	58.3	2.9	55.4	2.1
Interarch width difference				
Intercanine difference	7.6	2.0	7.2	2.9
Intermolar difference	−1.0	3.1	−0.3	1.7
Alveolar difference	−0.3	3.4	0.9	1.4

SD: Standard deviation; CIII: Class III

Maxillary minus mandibular arch width differences

With genders pooled, CI group showed significantly larger mean intercanine width difference than CIII and CIId1 group and mean intermolar and alveolar width difference than CIId2, CIII and CIId1 groups. Also, CIId2 and CIII showed significantly larger mean intermolar and alveolar width differences than CIId1 group. Gender dimorphism did not occur in mean intercanine, intermolar and alveolar width difference [Table 6].

Gender differences amongst maxillary and mandibular width and their differences are shown in Tables 7 and 8.

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.[11] Previous studies that compared arch widths in adult subjects having angle CI normal occlusions and CIII malocclusions have left unanswered questions.[12] 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.[12-15] However, for CIII subjects 34 samples could be obtained due to low prevalence rate.

Table 6: Comparison of arch widths in CIII, CIId2, CIId1 malocclusion and CI normal occlusion (genders pooled)

Variable	*P*	Duncan's letter[a]	Mean (mm)	SD (mm)	*n*	Group	Gender dimorphism[b]
Maxilla							
Intercanine width	0.003	A	34.9	2.8	34	CIII	No
		A	34.6	2.2	40	CI	No
		AB	33.7	2.5	40	CIId2	M>F
		A	32.9	1.9	40	CIId1	No
Intermolar width	0.000	A	50.4	4.0	34	CIII	No
		A	50.2	2.8	40	CI	M>F
		B	48.1	2.5	40	CIId2	No
		B	46.7	2.7	40	CIId1	No
Alveolar width	0.000	A	57.3	4.0	34	CIII	No
		A	56.8	2.6	40	CI	M>F
		B	55.3	2.0	40	CIId2	No
		B	54.0	2.8	40	C IId1	No
Mandible							
Intercanine width	0.002	A	27.5	2.7	34	CIII	No
		B	26.0	1.7	40	CI	No
		B	25.7	1.7	40	CIId2	No
		B	25.6	1.8	40	CIId1	No
Intermolar width	0.009	A	51.1	3.2	34	CIII	M>F
		B	49.0	2.5	40	CI	No
		B	48.7	2.8	40	CIId2	M>F
		B	48.6	2.2	40	CIId1	M>F
Alveolar width	0.000	A	57.1	2.9	34	CIII	M>F
		B	55.0	2.0	40	CI	No
		B	54.8	2.1	40	CIId2	No
		B	54.0	2.6	40	CIId1	M>F
Interarch width distance							
Intercanine difference	0.003	A	8.6	1.4	34	CIII	No
		AB	8.0	1.9	40	CI	No
		B	7.4	2.3	40	CIId2	No
		B	7.3	1.2	40	CIId1	No
Intermolar difference	0.000	A	1.5	1.2	34	CIII	No
		B	−0.5	1.4	40	CI	No
		B	−0.7	2.6	40	CIId2	No
		C	−2.3	2.0	40	CIId1	No
Intermolar difference	0.000	A	2.9	1.8	34	CIII	No
		B	0.5	1.9	40	CI	No
		B	2.6	2.8	40	CIId2	No
		C	2.0	1.9	40	CIId1	No

[a]Significant differences: $P \leq 0.05$, groups with same letter do not differ, [b]Significant differences: $P \leq 0.05$, Duncan's test, n=154, SD: Standard deviation; CI: Class I; CIII: Class III; CIId2: Class II division 2; CIId1: Class II division 1

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 dimorphism is rejected, except for mandibular intercanine widths and intercanine, intermolar and alveolar width difference. The null hypothesis for gender comparisons is rejected 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 [Table 7] and intercanine width difference [Table 8] in females. Comparison of the results with already published studies shows agreement as well as conflict in some aspects.

Table 7: Gender differences in arch widths between occlusion groups

Variable	*P*	Duncan's letter[a]	Mean (mm)	SD (mm)	*n*	Group
Maxilla						
Intercanine width	0.000	A	35.5	2.8	20	CIII Male
		AB	35.5	2.6	20	CI Male
		ABC	34.8	2.4	20	CIId2 Male
		ABCD	34.1	2.7	14	CIII Female
		BCD	33.7	1.4	20	CI Female
		CD	33.1	2.0	20	CIId1 Male
		D	32.8	1.9	20	CIId1 Female
		D	32.6	2.2	20	CIId2 Female
Intermolar width	0.000	A	52.2	2.2	20	CI Male
		AB	51.0	5.0	20	CIII Male
		BC	49.5	2.1	14	CIII Female
		BCD	49.1	2.5	20	CIId2 Male
		CD	48.3	1.7	20	CI Female
		DE	47.3	3.2	20	CIId1 Male
		DE	47.1	2.0	20	CIId2 Female
		E	46.0	2.1	20	CIId1 Female
Alveolar width	0.000	A	58.5	1.9	20	CI Male
		AB	58.1	4.9	20	CIII Male
		BC	56.2	1.9	14	CIII Female
		C	56.0	1.9	20	CIId2 Male
		CD	55.1	1.9	20	CI Female
		CD	54.6	1.9	20	CIId2 Female
		CD	54.6	3.0	20	CIId1 Male
		D	53.4	2.5	20	CIId1 Female
Mandible						
Intercanine width	0.001	A	27.9	2.6	20	CIII Male
		AB	26.9	1.5	14	CIII Female
		BC	26.6	1.9	20	CI Male
		BCD	26.4	1.8	20	CIId2 Male
		BCD	25.6	1.8	20	CIId1 Male
		BCD	25.6	1.8	20	CIId1 Female
		CD	25.4	1.4	20	CI Female
		D	25.0	1.3	20	CIId2 Female
Intermolar width	0.000	A	51.9	3.3	20	CIII Male
		AB	50.7	2.3	20	CI Male
		BC	49.8	2.9	14	CIII Female
		BC	49.7	2.6	20	CIId1 Male
		BC	49.5	1.9	20	CIId2 Male
		CD	48.2	2.2	20	CIId1 Female
		D	47.7	2.1	20	CIId2 Female
		D	46.8	1.7	20	CI Female
Alveolar width	0.000	A	58.3	2.9	20	CIII Male
		B	55.6	1.9	20	CIId1 Male
		B	55.6	2.1	20	CI Male

Contd..

Table 7: Contd...

Variable	*P*	Duncan's letter[a]	Mean (mm)	SD (mm)	*n*	Group
		B	55.6	1.8	20	CIId2 Male
		B	55.4	2.1	14	CIII Female
		B	54.4	1.9	20	CIId1 Female
		B	54.1	2.1	20	CIId2 Female
		C	52.3	1.9	20	CI Female

[a]Significant differences: $P \leq 0.05$, groups with same letter do not differ, $n=154$. CI: Class I; CIII: Class III; CIId2: Class II division 2; CIId1: Class II division 1; SD: Standard deviation

Table 8: Gender differences in maxillary minus mandibular arch width differences between occlusion groups

Variable	*P*	Duncan's letter[a]	Mean (mm)	SD (mm)	*n*	Group
Intercanine difference	0.012	A	8.9	1.4	20	CI Male
		AB	8.4	1.7	20	CIId2 Male
		AB	8.3	1.3	20	CI Female
		B	7.6	2.0	20	CIII Male
		B	7.6	2.0	20	CIId2 Female
		B	7.5	1.2	20	CIId1 Male
		B	7.2	1.2	20	CIId1 Female
		B	7.2	2.9	14	CIII Female
Intermolar difference	0.000	A	1.5	1.1	20	CI Male
		A	1.5	1.3	20	CI Female
		B	−0.3	1.7	14	CIII Female
		B	−0.5	1.5	20	CIId2 Male
		B	−0.6	1.2	20	CIId2 Female
		B	−1.0	3.1	20	CIII Male
		C	−2.3	2.1	20	CIId1 Female
		C	−2.4	2.1	20	CIId1 Male
Alveolar difference	0.000	A	2.9	1.8	20	CI Male
		A	2.8	1.8	20	CI Female
		B	0.9	1.4	14	CIII Female
		BC	0.5	1.6	20	CIId2 Female
		BC	0.4	2.2	20	CIId2 Male
		BC	−0.3	3.4	20	CIII Male
		C	−0.9	1.8	20	CIId1 Female
		C	−1.1	2.0	20	CIId1 Male

[a]Significant differences: $P \leq 0.05$, groups with same letter do not differ, $n=154$, SD: Standard deviation; CI: Class I; CIII: Class III; CIId2: Class II division 2; CIId1: Class II division 1

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.

Intercanine widths were investigated in a few of the previous studies, and conflicting results were found. In this study, with genders pooled, CI group showed significantly larger maxillary intercanine width than CIId1 group. This is in concurrence with studies by Staley *et al*.[13] and Huth *et al.*,[14] but differed from studies by Sayin and Turkkahraman[16] and Al-Khateeb and Abu Alhaija.[17] No difference is found in the maxillary intercanine width between the CI and CIII groups which is in concurrence with studies by Kuntz *et al.*,[12] Al-Khateeb and Abu Alhaija,[17] Uysal *et al*.[18] Although it differed from study of Al-Khateeb and Abu Alhaija,[17] our study also showed that CIII group has significantly larger maxillary intercanine width than CIId1 group. This suggests that maxillary arches are narrower in intercanine region in CIId1 patients in Indian population.

In our study, CI group showed significantly larger maxillary intermolar width than CIId1 group. It is in concurrence with studies Staley *et al.*,[13] Huth *et al.*,[14] Sayin and Turkkahraman,[16]

Al-Khateeb and Abu Alhaija,[17] Tollaro *et al.*[19] and Lux *et al*.,[20] but differed from studies by Frohlich[21] and Uysal *et al*.[22] CI group also showed significantly larger maxillary intermolar width than CIId2 group. It is in concurrence with a study by Huth *et al.*,[14] but differed from a study by Al-Khateeb and Abu Alhaija.[17] In this study, no difference is observed CIId1 and CIId2 group for maxillary intermolar width which differed from studies by Huth *et al.*,[14] Al-Khateeb and Abu Alhaija,[17] and Buschang *et al*.[23] Similarly, no difference is observed between CI and CIII groups for maxillary intermolar width in this study. This result is in concurrence with study by Al-Khateeb and Abu Alhaija,[17] but differed from studies by Chen *et al*.,[11] Kuntz *et al*.,[12] Uysal *et al*.,[18] Braun *et al*.,[24] and Slaj *et al*.[25] This suggested maxillary arches are narrower in molar region in CIId1 and CIId2 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 maxillary intermolar region in CII malocclusions.

In this study, CI group showed significantly larger maxillary alveolar width than CIId1 group. It is in concurrence with Staley *et al*.,[13] Huth *et al.*,[14] Uysal *et al*.,[18] Lux *et al*.,[20] and Alarashi *et al*.[26] but differed from a study by Sayin and Turkkahraman.[16] No difference is observed between CI and CIII groups for maxillary alveolar width. It differed from studies by Chen *et al*.,[11] Kuntz *et al.*,[12] and Uysal *et al*.[18] 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, no difference is observed between CI, CIId1, and CIId2 groups for mandibular intercanine, intermolar, and alveolar width. These results are is in concurrence with studies by Staley *et al.,*[13] and Huth *et al.*[14] (mandibular intercanine width), Tollaro *et al.*[19] (mandibular intermolar width), Huth *et al.*[14] (mandibular alveolar width) but differed from Sayin and Turkkahraman,[16] Uysal *et al.,*[22] and Walkow and Peck[27] (mandibular intercanine width), by Huth *et al.,*[14] and Uysal *et al*.[22] (mandibular intermolar width), Uysal *et al*.[22] (mandibular alveolar width). However, CIII group showed significantly larger mandibular intercanine and intermolar width than CI, CIId1, and CIId2 groups. These results are is in concurrence with studies by Al-Khateeb and Abu Alhaija,[17] and Uysal *et al.*[18] (mandibular intercanine width), Uysal *et al*.,[18] Braun *et al.*,[24] Slaj *et al.*[25] (mandibular intermolar width), Huth *et al.*[14] (mandibular alveolar width) but differed from Kuntz *et al*.[12] (mandibular intercanine width), by Chen *et al*.,[11] and Kuntz *et al*.[12] (mandibular intermolar width), Chen *et al*.,[11] Kuntz *et al*.,[12] and Uysal *et al.*[18] (mandibular alveolar width). This showed mandibular arch is wider in molar region in CIII malocclusion. Braun *et al.*[24] 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*.,[13] and Bishara *et al*.[28] 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 enlarged mandibular arch. According to some authors, it is the mesio-distal dimension of mandibular teeth which is responsible for such changes. Sperry *et al*.[29] 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 male subjects, CI group showed significantly larger maxillary intercanine and alveolar width than CIId1 group. In contrast, in 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 study by Huth *et al.*[14] 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 CIId1 group in contrast to female subjects where 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.

Gender dimorphism

Males showed greater maxillary and mandibular intermolar and alveolar widths as compared to females in CI normal occlusion, greater maxillary intercanine and mandibular intermolar width as compared to females in CIId2 malocclusion and greater mandibular intermolar and alveolar widths as compared to females in CIII malocclusion. However, no gender dimorphism is seen in CIId1 malocclusion.

Conclusions

- CIId1 malocclusion showed the narrowest maxillary arch compared with the other types of malocclusions
- CIII malocclusion showed largest mandibular arch than other types of malocclusions
- Gender dimorphism is more commonly seen in CI normal occlusion than other types of malocclusions. Gender dimorphism is not observed in CIId1 group
- Gender comparisons revealed, arch width differences between different types of malocclusions more pronounced in males than in females
- The maxillary/mandibular intermolar width difference is positive for CI normal occlusion and negative for CIId1, CIId2, and CIII malocclusions, which suggested, the presence of crossbite tendency in CII and CIII malocclusions.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Felton JM, Sinclair PM, Jones DL, Alexander RG. A computerized analysis of the shape and stability of mandibular arch form. Am J Orthod Dentofacial Orthop 1987;92:478-83.
2. Saes Y. Maxillary arch dimensions in Saudi and Egypt population sample. Am J Orthod Dentofacial Orthop 1984;85:83-8.
3. Sangwan S, Chawla HS, Goyal A, Gauba K, Mohanty U. Progressive changes in arch width from primary to early mixed dentition period: A longitudinal study. J Indian Soc Pedod Prev Dent 2011;29:14-9.
4. Hassanali J, Odhiambo JW. Analysis of dental casts of 6-8- and 12-year-old Kenyan children. Eur J Orthod 2000;22:135-42.
5. Ronay V, Miner RM, Will LA, Arai K. Mandibular arch form: The relationship between dental and basal anatomy. Am J Orthod Dentofacial Orthop 2008;134:430-8.
6. Hashim HA, Al-Ghamdi S. Tooth width and arch dimensions in normal and malocclusion samples: An odontometric study. J Contemp Dent Pract 2005;6:36-51.
7. Knott VB. Size and form of the dental arches in children with good occlusion studied longitudinally from age 9 years to late adolescence. Am J Phys Anthropol 1961;19:263-84.
8. Sillman JH. Dimensional changes of the dental arches: Longitudinal study from birth to 25 years. Am J Orthod 1964;50:824-42.
9. Knott VB. Longitudinal study of dental arch widths at four stages of dentition. Angle Orthod 1972;42:387-94.
10. DeKock WH. Dental arch depth and width studied longitudinally from 12 years of age to adulthood. Am J Orthod 1972;62:56-66.
11. Chen F, Terada K, Yang L, Saito I. Dental arch widths and mandibular-maxillary base widths in Class III malocclusions from ages 10 to 14. Am J Orthod Dentofacial Orthop 2008;133:65-9.
12. Kuntz TR, Staley RN, Bigelow HF, Kremenak CR, Kohout FJ, Jakobsen JR. Arch widths in adults with Class I crowded and Class III malocclusions compared with normal occlusions. Angle Orthod 2008;78:597-603.
13. Staley RN, Stuntz WR, Peterson LC. A comparison of arch widths in adults with normal occlusion and adults with Class II, Division 1 malocclusion. Am J Orthod 1985;88:163-9.
14. Huth J, Staley RN, Jacobs R, Bigelow H, Jakobsen J. Arch widths in Class II-2 adults compared to adults with Class II-1 and normal occlusion. Angle Orthod 2007;77:837-44.
15. Kohout FJ. Statistics for Social Scientists: A Coordinated Learning System. Malabar, F: Robert E. Krieger; 1986.
16. Sayin MO, Turkkahraman H. Comparison of dental arch and alveolar widths of patients with Class II, Division 1 malocclusion and subjects with Class I ideal occlusion. Angle Orthod 2004;74:356-60.
17. Al-Khateeb SN, Abu Alhaija ES. Tooth size discrepancies and arch parameters among different malocclusions in a Jordanian sample. Angle Orthod 2006;76:459-65.
18. Uysal T, Usumez S, Memili B, Sari Z. Dental and alveolar arch widths in normal occlusion and Class III malocclusion. Angle Orthod 2005;75:809-13.
19. Tollaro I, Baccetti T, Franchi L, Tanasescu CD. Role of posterior transverse interarch discrepancy in Class II, Division 1 malocclusion during the mixed dentition phase. Am J Orthod Dentofacial Orthop 1996;110:417-22.
20. Lux CJ, Conradt C, Burden D, Komposch G. Dental arch widths and mandibular-maxillary base widths in Class II malocclusions between early mixed and permanent dentitions. Angle Orthod 2003;73:674-85.
21. Frohlich FJ. A longitudinal study of untreated Class II type malocclusion. Trans Eur Orthod Soc 1961;37:137-51.
22. Uysal T, Memili B, Usumez S, Sari Z. Dental and alveolar arch widths in normal occlusion, class II division 1 and Class II Division 2. Angle Orthod 2005;75:941-7.
23. Buschang PH, Stroud J, Alexander RG. Differences in dental arch morphology among adult females with untreated Class I and Class II malocclusion. Eur J Orthod 1994;16:47-52.
24. Braun S, Hnat WP, Fender DE, Legan HL. The form of the human dental arch. Angle Orthod 1998;68:29-36.
25. Slaj M, Spalj S, Pavlin D, Illes D, Slaj M. Dental archforms in dentoalveolar Class I, II and III. Angle Orthod 2010;80:919-24.
26. Alarashi M, Franchi L, Marinelli A, Defraia E. Morphometric analysis of the transverse dentoskeletal features of Class II malocclusion in the mixed dentition. Angle Orthod 2003;73:21-5.
27. Walkow TM, Peck S. Dental arch width in Class II Division 2 deep-bite malocclusion. Am J Orthod Dentofacial Orthop 2002;122:608-13.
28. Bishara SE, Bayati P, Jakobsen JR. Longitudinal comparisons of dental arch changes in normal and untreated Class II, Division 1 subjects and their clinical implications. Am J Orthod Dentofacial Orthop 1996;110:483-9.
29. Sperry TP, Worms FW, Isaacson RJ, Speidel TM. Tooth-size discrepancy in mandibular prognathism. Am J Orthod 1977;72:183-90.