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 MEHTA¹, NIMESH PATEL², NISHIT MEHTA³, IPIST TRIVEDI⁴, APEXA MEHTA⁵

Abstract

Objective: To test the hypothesis that there is no difference between Class I (CI) normal occlusion, Class II division 1 (CIId1) and CI 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 CI 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. 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. 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. 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. 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. 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. 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
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. 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 CI 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 CI 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 CII 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 between the buccal grooves of the maxillary 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].

| 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; CIId: Class II; CIII: Class III; CIId1: Class II division 1; CIId2: Class II division 2

| 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
Results

Arch width comparison in maxilla
With genders pooled, CIII and CI groups showed significantly larger maxillary intercanine widths than ClId1 group and larger maxillary intermolar and alveolar widths than ClId2 and ClId1 groups. Gender dimorphism occurred in maxillary intermolar and alveolar width in CI occlusion and in maxillary intercanine width in ClId2 occlusion [Table 6].

Maxillary minus mandibular arch width differences
With genders pooled, CI group showed significantly larger mean intercanine width difference than CIII and ClId1 group and mean intermolar and alveolar width difference than ClId2, CIII and ClId1 groups. Also, ClId2 and CIII showed significantly larger mean intermolar and alveolar width differences than ClId1 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 occlusions.[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.
In this study, the null hypothesis for arch widths is rejected. The null hypothesis for maxillary/mandibular differences 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 6: Comparison of arch widths in CIII, CIId2, CIId1 malocclusion and CI normal occlusion (genders pooled)

| Variable              |  |  |  |  |  |  |  |
|-----------------------|---|---|---|---|---|---|---|
| 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 CIId1 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 M>F   |  |  |  |  |  |  |  |
| 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 |  |  |  |  |  |  |  |

*Significant differences: P<0.05, groups with same letter do not differ, bSignificant differences: P<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
Table 7: Gender differences in arch widths between occlusion groups

| Variable      | $P$  | Duncan’s letter* | 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 | CIIl2 Male     |
|               |      | ABCD             | 34.1      | 2.7     | 14 | CIII Female    |
|               |      | BCD              | 33.7      | 1.4     | 20 | CI Female      |
|               |      | CD               | 33.1      | 2.0     | 20 | CIIl1 Male     |
|               |      | D                | 32.8      | 1.9     | 20 | CIIl1 Female   |
|               |      | D                | 32.6      | 2.2     | 20 | CIIl2 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 | CIIl Female    |
|               |      | BCD              | 49.1      | 2.5     | 20 | CIIl2 Male     |
|               |      | CD               | 48.3      | 1.7     | 20 | CI Female      |
|               |      | DE               | 47.3      | 3.2     | 20 | CIIl1 Male     |
|               |      | DE               | 47.1      | 2.0     | 20 | CIIl2 Female   |
|               |      | E                | 46.0      | 2.1     | 20 | CIIl1 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 | CIIl Female    |
|               |      | C                | 56.0      | 1.9     | 20 | CIIl2 Male     |
|               |      | CD               | 55.1      | 1.9     | 20 | CI Female      |
|               |      | CD               | 54.6      | 1.9     | 20 | CIIl2 Female   |
|               |      | CD               | 54.6      | 3.0     | 20 | CIIl1 Male     |
|               |      | D                | 53.4      | 2.5     | 20 | CIIl1 Female   |
| Mandible      |      |                  |           |         |    |                |
| Intercanine width | 0.001 | A                | 27.9      | 2.6     | 20 | CIII Male      |
|               |      | AB               | 26.9      | 1.5     | 14 | CIIl Female    |
|               |      | BC               | 26.6      | 1.9     | 20 | CI Male        |
|               |      | BCD              | 26.4      | 1.8     | 20 | CIIl2 Male     |
|               |      | BCD              | 25.6      | 1.8     | 20 | CIIl1 Male     |
|               |      | BCD              | 25.6      | 1.8     | 20 | CIIl1 Female   |
|               |      | CD               | 25.4      | 1.4     | 20 | CI Female      |
|               |      | D                | 25.0      | 1.3     | 20 | CIIl2 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 | CIIl Female    |
|               |      | BC               | 49.7      | 2.6     | 20 | CIIl1 Male     |
|               |      | BC               | 49.5      | 1.9     | 20 | CIIl2 Male     |
|               |      | CD               | 48.2      | 2.2     | 20 | CIIl1 Female   |
|               |      | D                | 47.7      | 2.1     | 20 | CIIl2 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 | CIIl1 Male     |
|               |      | B                | 55.6      | 2.1     | 20 | CI Male        |

Contd..
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.,\textsuperscript{13} and Huth et al.,\textsuperscript{14} but differed from studies by Sayin and Turkkahraman\textsuperscript{16} and Al-Khateeb and Abu Alhaija.\textsuperscript{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.,\textsuperscript{12} Al-Khateeb and Abu Alhaija,\textsuperscript{17} Uysal et al.,\textsuperscript{18} Although it differed from study of Al-Khateeb and Abu Alhaija,\textsuperscript{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.,\textsuperscript{13} Huth et al.,\textsuperscript{14} Sayin and Turkkahraman.\textsuperscript{16}
Al-Khateeb and Abu Alhaija, [17] Tollaro et al., [16] 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 Clld2 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 Clld1 and Clld2 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 ClII 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 Clld1 and Clld2 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 Clld1 malocclusions compared with a normal occlusion sample. To achieve Cl molar relationship, expansion should be done in maxillary intermolar region in ClII malocclusions.

In this study, CI group showed significantly larger maxillary alveolar width than Clld1 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 ClII 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 Clld1 malocclusions. In cases of crossbite, expansion of maxillary arch should be done to relieve posterior crossbite in Clld1 malocclusion.

In this study, no difference is observed between CI, Clld1, and Clld2 groups for mandibular intercanine, intermolar, and alveolar width. These results are 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, ClII group showed significantly larger mandibular intercanine and intermolar width than CI, Clld1, and Clld2 groups. These results are 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] This showed mandibular arch is wider in molar region in ClII malocclusion.

Braun et al., [24] concluded that the possible explanation for the increase in arch width seen in ClII 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 ClII 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 Clld1 and ClII groups. The mean intermolar width difference is positive for CI group and negative for Clld1 and ClII group. Negative intermolar width differences suggested suggest crossbite tendency in ClI and ClII malocclusions. According to this study, the crossbite in Clld1 group is due to constricted maxillary with normal mandibular arch while in ClII 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 ClII patients often have wider lower teeth than CI and CI subjects. Another possible explanation is that a shorter and larger mandibular arch in subjects with ClII 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 Clld1 malocclusion and wider mandibular arch in ClII malocclusion in molar region. CI group showed significantly larger mean alveolar width difference than Clld1 group. The mean alveolar width difference is positive for CI, but negative for the Clld1 group. Negative alveolar width difference in Clld1 patient occurred due to narrow maxillary alveolar width.

**Gender comparison**

In male subjects, CI group showed significantly larger maxillary intercanine and alveolar width than Clld1 group. In contrast, in female, although maxillary intercanine width is narrower in Clld1 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 Clld2 malocclusion. However, although female subjects with CI normal occlusion showed larger maxillary intermolar and alveolar width than Clld2 malocclusion, it is not statistically significant.

For mandibular arch widths, males showed significantly larger mandibular intercanine, intermolar and alveolar widths in ClII group than Clld1 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 CII21 malocclusion and greater mandibular intermolar and alveolar widths as compared to females in CII11 malocclusion. However, no gender dimorphism is seen in CII11 malocclusion.

**Conclusions**

- CII11 malocclusion showed the narrowest maxillary arch compared with the other types of malocclusions
- CII11 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 CII11 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 CII11, CII21, and CII11 malocclusions, which suggested, the presence of crossbite tendency in CI and CII11 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. Hassanalji O, 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;92:56-66.
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. Kunz 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 Alhajja 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, Memlii 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 1991;3:137-51.
22. Uysal T, Memlii 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.