Original Article

Assessment of Tip, Torque, and Tooth Size Discrepancies in Angle's Class II Division 2 Malocclusion

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ABSTRACT

Context: Since the introduction of preadjusted edgewise appliances, they are being extensively used all over the world including India. There is a need to establish the tip and torque values for Angle's Class II Division 2 patients to find whether they are comparable or, in variance with those established by Andrews which forms the basis of the orthodontic treatment with most of the most preadjusted edgewise appliance systems. The present study was carried out to study tip, torque, and tooth size discrepancies in patients exhibiting Angle's Class II Division 2 malocclusion with no previous history of orthodontic treatment. **Materials and Methods:** Thirty patients were selected from the outpatient department who were diagnosed as having Angle's Class II Division 2 malocclusion. Alginate impressions of all the thirty patients were made for both maxillary and mandibular arches, and the study models prepared and crown angulation/tip, crown inclination/torque, and tooth size discrepancies using Bolton's analysis were measured. **Results:** The upper incisor torque obtained in the present study was considerably lower than all the other studies compared. The torque value of the second mandibular molar obtained in the present study differed from all the previous studies in being much higher and following the progressively increasing negative inclination seen in all other studies from canine to second molar. The lower incisors in the present study were found to be more upright than all other studies with a higher negative torque. The other studies either showed positive torque for central incisors or mild negative torque for both lower incisors. **Conclusion:** The results of the present study showed some similarities with that of the Andrew's and other studies in the overall pattern of tip and torque values, for example, the positive tip of all maxillary teeth except second molars. The torque values showed a pattern of positive torque for maxillary lateral incisors while negative torque for all the other teeth. However, the values for individual teeth showed many variations.

Keywords: *Angle's Class II Division 2 malocclusion, tip, tooth size discrepancies, torque*

Received: September, 2016.
Accepted: March, 2017.

Introduction

Orthodontists treat various malocclusions of the jaws and aim at establishing esthetic, functional, and harmonious occlusion.[1] The emphasis at present is on treating the face as a whole and not just the occlusion; however, the importance of achieving an ideal occlusion that is in harmony with the face has not diminished since the time of angle. The most comprehensive and exhaustive study to understand the relationship of teeth was undertaken by Andrews in 1964. He made extensive measurements on 120 nonorthodontic normal casts of white North American origin to develop his "six keys to normal occlusion."[2] Ideal occlusion, as we know it today, was described by John Hunter as early as in the 18th century.[3] The six keys of Andrews help the orthodontists to appropriate

Access this article online

Quick Response Code:

Website: www.ijofb.org

DOI: 10.4103/ijofb.ijofb_9_16

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How to cite this article: Jain S, Kiran HJ, Neha K, Bhattacharjee D, Rana S, Nayyar AS. Assessment of tip, torque, and tooth size discrepancies in Angle's class II division 2 malocclusion. Int J Orofac Biol 2017;1:4-12.

the significance of occlusion and have served as a yardstick for critical analysis of treatment results. It shows that, in spite of the voluminous information on occlusion, it could be simply explained and quantified. The presence of disproportionately sized teeth in either maxillary or mandibular arch can make it difficult to obtain an occlusion with good alignment, ideal overjet, ideal overbite, and a Class I molar relationship. In order for the maxillary teeth to be in proper occlusion with the mandibular teeth, a definite proportionality of tooth size should exist. Therefore, the ability to analyze the proportionality of the maxillary and mandibular teeth is an important diagnostic tool at the initial stages of treatment.[4] The findings of Andrew's study on 120 nonorthodontic models served as the foundation for the development of straight wire appliance.[5] This started the era of preadjusted edgewise appliances. Since the introduction of preadjusted edgewise appliances, they are being extensively used all over the world including India. There is a need to establish the tip and torque values for Angle's Class II Division 2 patients to find whether they are comparable or in variance with those established by Andrews which forms the basis of the orthodontic treatment with most of the most preadjusted edgewise appliance systems. The present study was carried out to study tip, torque, and tooth size discrepancies in patients exhibiting Angle's Class II Division 2 malocclusion with no previous history of orthodontic treatment. In addition, the data were compared to that of original research values of Andrews with the research question whether the tip and torque values obtained in our study were comparable or in variance with the data generated by Andrew's study.

Aims and objectives

1. To evaluate the tip and torque values of patients with Angle's Class II Division 2 malocclusion
2. To compare the values obtained with those of Andrew's and other studies and observe the variance or similarity, if any
3. To evaluate the tooth size discrepancies in Angle's Class II Division 2 patients.

Materials and Methods

Study setting

Thirty patients were selected from the outpatient department who were diagnosed as having Angle's Class II Division 2 malocclusion [Figure 1]. Patients were selected from the sample that was initially screened through purposive sampling technique. The screened patients who fulfilled the selection criteria were selected for the study.

Selection criteria

Inclusion criteria

1. Patients in the age group of 14–30 years
2. Patients having Angle's Class II Division 2 malocclusion
3. Patients with no history of orthodontic treatment.

Exclusion criteria

1. Patients with Angle's Class I, Angle's Class II Division 1, and Angle's Class III malocclusion
2. Patients with craniofacial anomalies.

Method of collection of data

Alginate impressions of all the thirty patients, who satisfied the selection criteria, were made for both maxillary and mandibular arches, poured with Orthokal and the study models prepared. Armamentarium was used to measure tip, torque, and tooth size discrepancies: [Figure 2]:

- Models of maxillary and mandibular arches
- Protractor device with adjustable readout arm
- Boley gauge with sharpened points
- 0.5 mm pencil.

Method of measurements

The measurements were carried out by protractor with adjustable readout arm [Figure 3]. The facial axis of clinical crown (FACC) and its midpoint, the facial axis point, were marked on each crown of both the maxillary and mandibular arches. The FACC was considered the reference line from which crown angulations and inclination were measured [Figures 4 and 5].

Crown angulation/tip

The base of the protractor was placed on the occlusion plane parallel to a line that would connect the contact points of the crowns being measured. The protractor readout arm was adjusted parallel to the crown's FACC. The angulation of the crown was read from where the line of the readout arm fell on the protractor's scale [Figure 6].

Crown inclination/torque

The protractor was positioned at right angle to the line that would connect the contact points of the crowns being measured. The protractor's readout arm was adjusted parallel and tangent to the FACC at the facial axis point, and the inclination of the crown was read on the protractor's scale [Figure 7].

Tooth size discrepancies

Bolton's analysis was used to determine disproportion in size between maxillary and mandibular teeth. First, the individual mesiodistal measurements of all teeth from the first molars mesially were recorded. Tooth size measurements were taken with a sharp pointed Boley

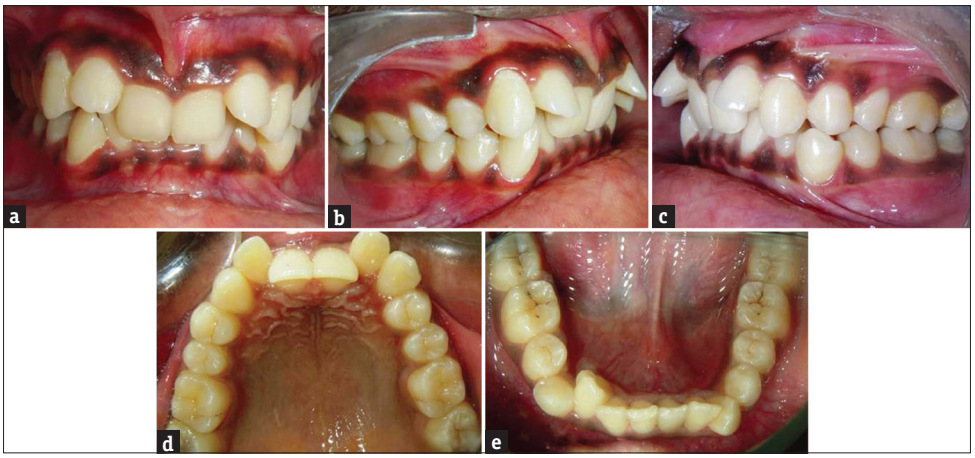


Figure 1: (a) Representation of occlusion of Class II Division 2 patients - frontal view, (b) representation of occlusion of Class II Division 2 patients - right lateral view, (c) representation of occlusion of Class II Division 2 patients - left lateral view, (d) representation of occlusion of Class II Division 2 patients - palatal view, (e) representation of occlusion of Class II Division 2 patients - lingual view

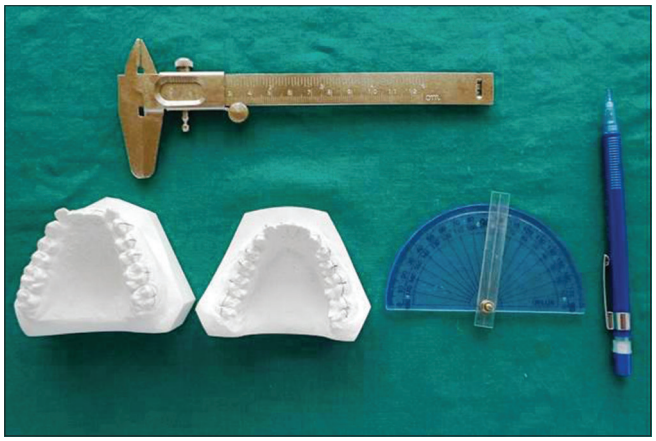


Figure 2: Armamentarium used to measure tip, torque, and tooth size discrepancies

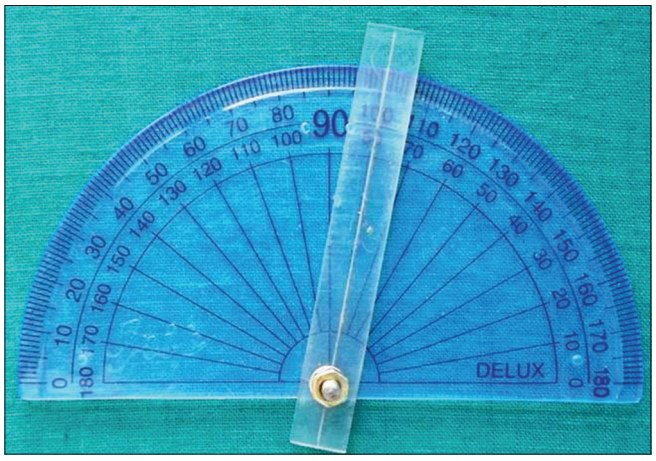


Figure 3: Protractor with adjustable readout arm

gauge [Figure 8], measuring the widest mesiodistal dimension of each tooth as described by Bolton. Next, the determination of tooth size discrepancy was made according to the method outlined by Bolton [Figure 9]. The overall ratio was calculated from the greatest mesiodistal measurement of the teeth in each arch from first molar to first molar. The anterior ratio was calculated from the greatest mesiodistal measurement of the six anterior teeth in each arch. Both are as follows:

$$\text{Overall ratio} = \frac{\text{Sum mandibular "12"}}{\text{Sum maxillary "12"}} \times 100$$

$$\text{Anterior ratio} = \frac{\text{Sum mandibular "6"}}{\text{Sum maxillary "6"}} \times 100$$

The mean, median, range, and standard deviation (SD) were calculated for both overall (12) ratio and anterior (6) ratio.

Statistical analysis

The measurements were presented as mean ± SD and range values. 95% confidence limits were found for each tooth separately and were presented along with mean and SD.

Results

The aim of the present study was to assess the tip/torque and tooth size discrepancies of Angle's Class II Division 2 malocclusion patients. From the sample of thirty casts, tip and torque measurements were carried out as described by Andrew's study. Anterior and posterior tooth size ratios were determined as described by Bolton.

Angulations/tip values:

Maxillary arch

- Maxillary central incisors: The mean tip values were found to be 1.48° with a SD of 5.31 and a range of −11°–13°
- Maxillary lateral incisors: The mean tip values were found to be 7.4° with a SD of 5.85 and a range of −17°–24°

Figure 4: Frontal view with the facial axis of clinical crown and facial axis of midpoint marked on each crown

Figure 5: Lateral view with the facial axis of clinical crown and facial axis of midpoint marked on each crown

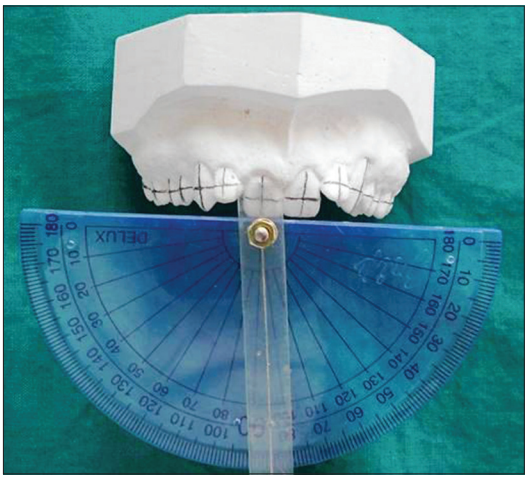


Figure 6: Protractor positioned on the trimmed cast to measure crown tip

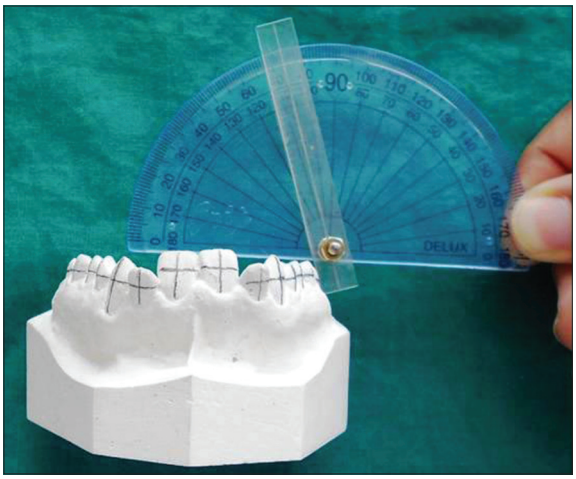


Figure 7: Protractor positioned on the trimmed cast to measure crown torque

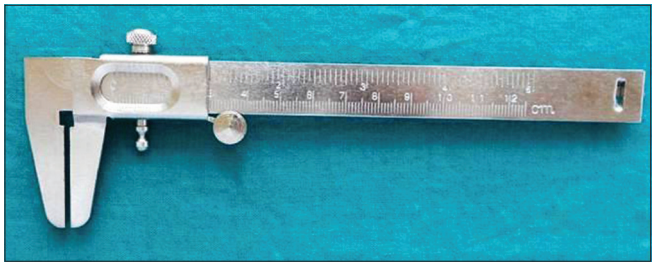
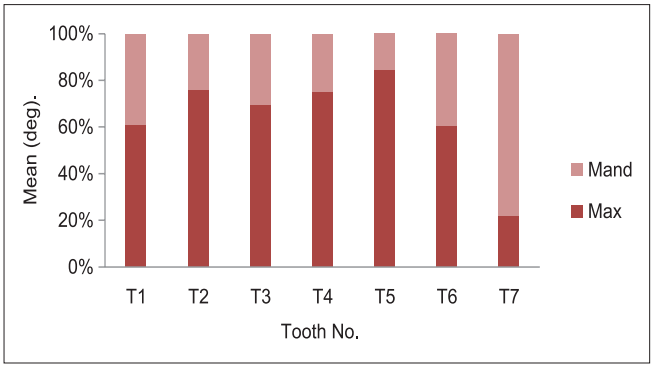


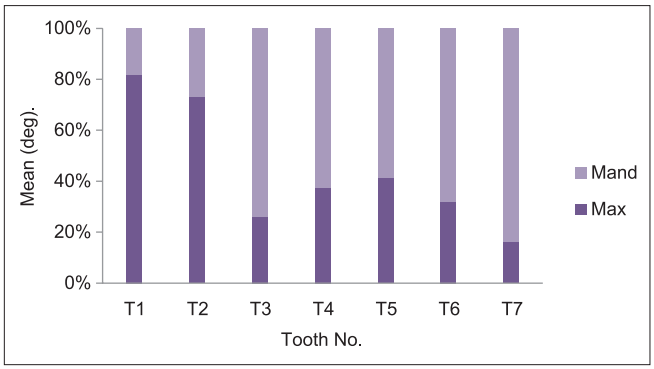
Figure 8: Boley gauge

- Maxillary canines: The mean tip values were found to be 6.45° with a SD of 8.83 and a range of −11°–35°
- Maxillary first premolars: The mean tip values were found to be 5.18° with a SD of 4.97 and a range of −5°–14°
- Maxillary second premolars: The mean tip values were found to be 5.05° with a SD of 6.23 and a range of −10°–20°
- Maxillary first molars: The mean tip values were found to be 4.78° with a SD of 5.04 and a range of −7°–13°

Figure 9: Measuring mesiodistal diameter of each tooth with the help of Boley gauge



Graph 1: Angulation/tip values



Graph 2: Inclination/torque values

- Maxillary second molars: The mean tip values were found to be −1.89° with a SD of 7.42 and a range of −15°–12°.

Mandibular arch

- Mandibular central incisors: The mean tip values were found to be −0.94° with a SD of 3.97 and a range of −10°–6°
- Mandibular lateral incisors: The mean tip values were found to be −2.33° with a SD of 4.71 and a range of −15°–9°
- Mandibular canines: The mean tip values were found to be −2.8° with a SD of 4.98 and a range of −21°–9°
- Mandibular first premolars: The mean tip values were found to be −1.7° with a SD of 3.59 and a range of −10°–5°
- Mandibular second premolars: The mean tip values were found to be 0.93° with a SD of 3.61 and a range of −7°–8°
- Mandibular first molars: The mean tip values were found to be 3.13° with a SD of 3.41 and a range of −15°–10°
- Mandibular second molars: The mean tip values were found to be 6.64° with a SD of 5.49 and a range of −13°–20° [Graph 1].

Inclinations/torque values:

Maxillary arch

- Maxillary central incisors: The mean torque values were found to be −10° with a SD of 6.98 and a range of −25°–8°
- Maxillary lateral incisors: The mean torque values were found to be 5.4° with a SD of 8.35 and a range of −14°–20°
- Maxillary canines: The mean torque values were found to be −1.57° with a SD of 6.28 and a range of −13°–10°
- Maxillary first premolars: The mean torque values were found to be −4.1° with a SD 4.59 and a range of −6-9° and a range of −13 to 4°
- Maxillary second premolars: The mean torque values were found to be −6.06° with a SD of 4.24 and a range of −15°–4°
- Maxillary first molars: The mean torque values were found to be −6.65° with a SD of 3.39 and a range of −20°–4°
- Maxillary second molars: The mean torque values were found to be −3.6° with a SD of 6.65 and a range of −18°–10°.

Mandibular arch

- Mandibular central incisors: The mean torque values were found to be −2.26° with a SD of 6.08 and a range of −17–10°
- Mandibular lateral incisors: The mean torque values were found to be −1.98° with a SD of 5.33 and a range of −15°–10°
- Mandibular canines: The mean torque values were found to be −4.48° with a SD of 5.41 and a range of −15°–7°
- Mandibular first premolars: The mean torque values were found to be −6.68° with a SD of 5.41 and a range of −19°–10°
- Mandibular second premolars: The mean torque values were found to be −8.68° with a SD of 4.56 and a range of −20°–0°
- Mandibular first molars: The mean torque values were found to be −14.23° with a SD of 5.53 and a range of −30°–4°
- Mandibular second molars: The mean torque values were found to be −18.59° with a SD of 8.4 and a range of −30°–31° [Graph 2].

Maxillary-to-mandibular tooth size relationship/discrepancies were calculated using Bolton's analysis, and the mean anterior ratio was found to be 76.82% with a SD of 4.11 while the overall ratio was found to be 90.93% with a SD of 3.63 [Table 1].

Discussion

Normal occlusion is dependent on a proper distal crown tip, especially for upper anterior teeth since they have the longest crowns. The degree of incisor tip determines

Table 1: Maxillary-to-mandibular tooth size relationship/ discrepancies as calculated using Bolton's analysis with mean anterior and overall ratios

	Anterior ratio	Overall ratio
Mean±SD	76.82±4.11	90.93±3.63

SD: Standard deviation

the amount of mesiodistal space they consume and therefore has a considerable impact on posterior occlusion as well as anterior esthetics.[2] Upper and lower crown inclinations are intricately complimentary and significantly affect overbite and posterior occlusion. Properly inclined anterior crowns contribute to normal overbite and posterior occlusion; when too straight up and/or down, they lose their functional harmony resulting in overeruption which is seen normally in Angle's Class II Division 2 malocclusion patients. When the crowns of upper anterior teeth are insufficiently inclined, the crowns of upper posterior teeth are forwardly tilted from their normal positions, while when they are properly inclined, the upper posterior teeth are seen in their normal positions. The contact points move distally in concert with the increase in positive anterior crown inclinations.[2] Even when the upper posterior teeth are in proper occlusion with the lower posterior teeth, undesirable spaces result somewhere between the anterior and posterior teeth if the inclinations of the crowns of upper anterior teeth are not proper. This space, in treated cases, is often incorrectly blamed on discrepancies seen.[2] Specific dimensional relationships must exist between the maxillary and mandibular teeth to ensure normal overjet and overbite. Achieving a good functional occlusion with proper overjet and overbite requires the maxillary and mandibular teeth to be proportional in size. Inter-arch tooth size discrepancies hinder achieving an ideal occlusion. A proper relationship of the total mesiodistal width of the maxillary dentition to the mandibular dentition favors an optimal post-treatment occlusion.[6] While the related fields of growth and development, cephalometrics, visualized treatment planning, and directional and magnitudinal force requirements have been the subject of much research, the individual unit of dentition, the tooth, has not received the attention it deserves. Indeed, all the fields are extremely important to the contemporary orthodontic practice, but the anatomy of the teeth and the position of each individual tooth within the oral complex, deserve equal consideration.[7] Andrew studied angulations and inclinations of untreated ideal occlusions and a large sample of orthodontically treated occlusions and found six keys or qualities in the arrangement and occlusion of teeth. He defined the terms "angulations" as mesiodistal tip of the crowns and "inclinations" as labiolingual or buccolingual inclination of the crowns. Andrew's definition of torque is an angle between the tangent to the midpoint of the clinical crown and a perpendicular line dropped to the occlusal plane. Andrew stated that the proper mesiodistal inclination (tip) and labiolingual or buccolingual inclination (torque) are required for ideally positioned teeth. Proper axial inclination is necessary for distributing occlusal forces through the tight interproximal contacts and it is an important factor in maintaining a treatment result.[8] The present straight wire appliance therapy assumes that there is a certain fixed inclination of the labial or buccal surfaces of all the teeth. The theory, also, assumes that the labiolingual or buccolingual steps are constant from tooth to tooth. Under ideal circumstances, base of the bracket would fit infinitely well to the labial or buccal surface of the teeth. The bracket would act as an interface of compensating values composed of a fixed scheme of numbers which would reflect itself as a co-planar receptacle for an unbent (untorqued) rectangular arch wire. The same interface would adjust itself by a series of fixed values to eliminate the placing of labiolingual or buccolingual steps and/or axial inclination corrections.[9] The present study was conducted with an aim to assess the tip, torque, and Bolton's tooth size discrepancies in patients exhibiting Angle's Class II Division 2 malocclusion. The sample consisted of thirty patients within the age group of 14–30 years. The study models were prepared for the selected patients. A customized protractor with adjustable readout arm was used to measure the tip and torque values. Bolton's tooth size discrepancies were also measured for each patient. This study has not taken into consideration the established bracket prescription for comparison. The findings of the present study were compared with that of the original values of the Andrew's study.[5] Positive tip values were obtained for all the maxillary teeth except the maxillary second molar which is similar to the values obtained in the Andrew's study and Currim and Wadkar's study based on Indian population except that they had obtained positive values for all the maxillary teeth.[3,5] The maxillary arch readings for crown angulations in the present study were 1.48° ± 5.31° for the central incisors, 7.4° ± 8.85° for lateral incisors, 6.45° ± 8.83° for canines, 5.18° ± 4.97° for first premolars, 5.05° ± 6.23° for second premolars, 4.78° ± 5.04° for first molars, and −1.89° ± 7.42° for second molars while Andrew's original findings had confirmed an angulation of 5° for central incisors, 9° for lateral incisors, 11° for canines, 2° for first and second premolars, and 5° for the first and second molars. The findings of the present study were found to be lower than those of Andrew's values for central as well as lateral incisors, canines, and first and second molars.

The study by Currim and Wadkar[3] indicated lower values for lateral incisors, canines, first premolar, and first molar (4.22°, 2.66°, 2.6°, and 4.53°, respectively) than our values (7.4°, 6.45°, 5.18°, and 4.78°, respectively).[3] They also found higher values for central incisors, second premolars, and second molars (3.30°, 5.07°, and 3°, respectively) than seen in the present study. Positive angulation/tip values were obtained for mandibular second premolar, first and second molars while negative angulation/tip values were obtained for central and lateral incisors, canines, and first premolars which were comparable to the values obtained by Currim and Wadkar's study whereas Andrew's study found positive angulation/tip values for all the mandibular teeth.[3,5] Andrew's original findings had confirmed angulations of 2° for mandibular central and lateral incisors, 5° for canines, 2° for first and second premolars and first and second molars.[5] In the present study, angulations of −0.94° ± 3.97° for central incisors, −2.33° ± 4.71° for lateral incisors, −2.8° ± 4.98° for canines, −1.7° ± 3.59° for first premolars, 0.93° ± 3.61° for second premolars, 3.13° ± 3.41° for first molar, and 6.64° ± 5.49° for second molar were found. The values obtained in the present study were lower than that of Andrew's study for incisors, canines, and premolars while the values for molars were found to be higher.[5] The study by Currim and Wadkar indicated negative angulation values of −0.23° for central incisors, −0.43° for lateral incisors, −1.17° for canines, and −0.32° for first premolars which were quite similar to the present study. Positive angulation values of 1.54° for second premolars, 1.67° for first molars, and 2.12° for second molars.[3] The findings of crown inclinations of the present study were compared with Andrew's,[5] Currim and Wadkar's,[3] Vardimon and Lambertz's, and Morrow's original values.[3,5,10] The present study showed positive crown inclinations for maxillary lateral incisors while negative crown inclinations for maxillary central incisors, canines, premolars, and molars. Andrew's original findings suggest an inclination of 7° for central incisors, 3° for lateral incisors, −7° for canines, first and second premolars, and −9° for first and second molars.[5] In the present study, an inclination of −10° ± 6.98° for central incisors, 5.4° ± 8.35° for lateral incisors, −1.57° ± 6.28° for canines, −4.1° ± 4.59° for first premolars, −6.06° ± 4.24° for second premolars, −6.65° ± 3.39° for first molars, and −3.6° ± 6.65° for second molars were obtained. The study by Currim and Wadkar[3] confirmed an inclination of 5.80° ± 3.44° for maxillary central incisors, 4.44° ± 4.16° for lateral incisors, −5.99° ± 5.82° for canines, −8.40° ± 5.24° for first premolars, −9.88° ± 6.10° for second premolars, −11.27° ± 7.17° for first molars, and −9.95° ± 6.87° for second molars.[3] In the study by Vardimon and Lambertz, an inclination of 0.74° ± 4.45° for central incisors, −0.96° ± 5.16° for lateral incisors, and negative values of −8.39° for canines, −8.44° for premolars, −10.50° for first molars, and −9.28° for second molars of the upper posterior segment were seen.[10] The results of the present study indicated higher negative values of inclination for maxillary central incisors, −10° ± 6.98°, than were seen in Andrew's (7°), Currim and Wadkar's (5.80°), Vardimon and Lambertz's (0.74°) and Morrow's (3.76°) studies.[3,5,10] The maxillary incisor inclination was reduced in patients exhibiting Angle's Class II Division 2 malocclusion. The inclination values for canines in the present study were found to be higher than those of Andrew's and Currim and Wadkar's studies.[3,5] However, similar values were obtained for premolars in the present study as compared to Andrew's study although Currim and Wadkar found higher negative values than the present study. The present study also found reduced negative torque values for the molars compared to that of Andrew's and Currim and Wadkar's studies.[3,5] The study by Vardimon and Lambertz showed higher values of crown inclination for central incisors while lower values for lateral incisors when compared to the present study.[10] Central incisors were upright, and laterals showed negative torque. They also obtained negative torque from canines to second molars; however, the present study showed less negative torque values. Morrow's study showed very low inclination values for maxillary central and lateral incisors (3.76° and 1.16°) while the premolars values were found to be closure to the values obtained in the present study (−6.53° and −6.83°). The values for the first molars were more negative although less negative for the second molars than the present study (−6.86° and −2.22°).[10] The inclination values of the present study for the mandibular arch were central incisors, −2.26° ± 6.08°, lateral incisors, −1.98° ± 5.33°, canines, −4.48° ± 5.41°, first premolars, −6.68° ± 5.41°, second premolars, −8.68° ± 4.56°, first molars, −14.23° ± 5.53°, and second molars, −18.59° ± 8.4°. Andrew's values were −1° for incisors, −11° for canines, −17° for first premolar, −22° for second premolar, −30° for first molars while −35° for second molars, suggesting higher values found for incisors in Andrew's study.[5] Both studies showed negative torque values from canines to second molars which were also progressively increasing. The torque values obtained in Andrew's study were higher than the present study.[5] Positive crown inclination of mandibular incisors was found in the study by Currim and Wadkar (1.36° and 0.88°) which is in contrast to the present study wherein negative crown inclination for incisors was seen. Higher negative values for canines (−8.20°),

first premolar (−14.6°), second premolar (−18.5°), first molar (−27.4°), and second molar (−33.6°) were found in the study conducted by Currim and Wadkar.[3] The results of the present study differed from the studies by Andrew and Currim and Wadkar. The values obtained by Vardimon and Lambertz were lower; central incisors, 2.24°, lateral incisors, −0.90°, canines, −9.69°, first premolar, −16.40°, second premolar, −22.53°, first molar, −26.89°, and second molar, −36.41°.[10] The present study showed positive torque values for lower central incisors (2.24°) which was similar to the findings of Currim and Wadkar's study but contrasts with the present study which found increased negative inclination for both mandibular incisors. The inclination values from lateral incisor to second molar were found to be negative in both the studies; however, the values were much lower from canine to second molar in the present study. Morrow's inclination values for central incisors (0.15° ± 7.03°) also showed a positive trend which was in contrast with the present study. At −2.54° ± 5.84°, the lateral incisors showed higher negative torque than the present study. Morrow's values from canine to second molar were −10.85° for canines, −15.49° for first premolar, −18.81° for second premolar, −25.73° for first molar, and −30.60° for second molar, showing considerably higher negative torque values than the present study. The lower incisors and second molars were found to be more upright in the present study. The upper incisor torque obtained in the present study was considerably lower than all the other studies compared with the difference between central and lateral incisor torque being more than double (16.68° and 8.93°). The upper incisors were found to be more retroinclined in the present study. The torque value for the second mandibular molar (−18.59°) obtained in the present study also differed from all the previous studies in being much higher and followed a progressively increasing negative inclination seen in all the other studies from canine to second molar. The lower incisors in the present study were found to be more upright than all the other studies compared with a higher negative torque (−2.26° and −1.98°). The other studies either showed positive torque for central incisors or a mild negative torque for both the lower incisors. The lower incisors and second molars were found to be more upright in the present study.

Maxillary-to-mandibular tooth size relationship was calculated using Bolton's analysis. The overall ratio was calculated from the greatest mesiodistal measurements of the teeth in each arch from the first molar on one side to the first molar on the other side. The anterior ratio was calculated from the greatest mesiodistal measurements of the six anterior teeth in each arch. The present study found nearly identical values to Bolton's study for anterior ratio and overall ratio. Smith *et al*. evaluated Bolton's interarch ratios in three populations, Blacks, Hispanics and Whites and evaluated the variation in genders. They found significantly different relationships between the lower and upper teeth. In addition, significant gender differences were observed for the overall and posterior ratios but not for the anterior ratio.[11] The anterior ratio (76.82%) evaluated in the present study was lower than that found by Smith *et al*. for the three populations. The overall ratio (90.93%) was also found to be lower in the present study. Similarly, Lavelle showed that there was sexual dimorphism in tooth dimensions and in the ratio of upper and lower arch tooth size. Lavelle found that Blacks have larger overall and anterior ratios than the Whites and Asians although the actual differences were not tested and the arch segments responsible for the differences were not evaluated. He also showed that the overall and anterior ratios were consistently larger in males than in females regardless of the race.[12] The tooth size data reported by Moorrees *et al*. implied gender differences in the overall ratio.[11] Stifter replicated Bolton's study in Angle's Class I dentitions and reported similar results.[13]

Conclusion

The results of the present study showed some similarities with the Andrew's and other studies in the overall pattern of tip and torque values, for example, the positive tip of all maxillary teeth except second molars. The torque values showed a pattern of positive torque for maxillary lateral incisors while negative torque for all the other teeth. However, the values for individual teeth showed many variations. The upper incisor torque obtained in the present study was considerably lower than all the other studies compared with the difference between central and lateral incisor torque being more than double (16.68° and 8.93°). The torque value of the second mandibular molar (−18.59°) obtained in the present study differed from all the previous studies in being much higher and following the progressively increasing negative inclination seen in all the other studies from canine to second molar. The lower incisors in the present study were found to be more upright than all the other studies with a higher negative torque (−6.65° and −6.48°). The other studies either showed positive torque for central incisors or mild negative torque for both lower incisors. All these findings indicated the possible racial and ethnic factors contributing to a difference in readings. Furthermore, Bolton's analysis did show minor tooth size discrepancies.

Limitations of the present study

The major limitations of the present study included a relatively small sample size and the device used for measurement of the values wherein accurately calibrated digital devices might have been used.

Acknowledgment

The authors would like to thank all the researchers and patients who contributed toward the research without whom this review would not have been feasible.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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