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Correlation between difference of mesiodistal width of upper and lower lateral incisors and anterior bolton

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Abstract

Introduction: Good occlusion necessarily requires good dimensional relationship between maxillary and mandibular dentition. Hence the aim of this study was to assess quantitative correlation between mesiodistal difference between upper and lower lateral incisors and Anterior Bolton.

Material and Methods: A retrospective study was conducted at the orthodontic department of Margalla Institute of Health Sciences, Rawalpindi, Pakistan by using patient's dental casts. Mesiodistal tooth dimensions were measured from right canine to left canine in both arches using digital Vernier Callipers. Anterior Bolton was calculated and sample was divided into two groups on the basis of presence of mandibular and maxillary excess. Difference of upper and lower lateral incisors were then correlated with their respective Anterior Bolton.

Results: Upper lower lateral incisor difference showed a negative moderate correlation (r = -0.4) with dentition showing Anterior Bolton with mandibular excess which was statistically significant. With dentition showing anterior Bolton with maxillary excess, upper lower lateral incisor difference showed a negative weak correlation (r = 0.01) which was statistically insignificant.

Conclusions: It can be concluded from this study that for quick initial assessment of anterior tooth size discrepancy, eyeballing is not reliable.

Keywords: Anterior Bolton; bolton analysis; tooth size discrepancy

Introduction

Good occlusion, normal overjet and overbite are vital aims of comprehensive orthodontic treatment. To attain these objectives a good dimensional relationship must exist between maxillary and mandibular dentition.[1]

Following Black's research who proposed tables of mesiodistal widths of teeth based on average widths measured from numerous casts, several authors have studied tooth widths relative to occlusion.[2] Neff established a proportion called the "anterior coefficient" in which he stated that for achievement of optimal overbite, the ratio obtained after dividing sum of maxillary mesiodistal width by mandibular mesiodistal width should be 1.20 to 1.22.[3] Lundstrom analysed the association between anterior sum of maxillary and mandibular dentition and called it "anterior index". The optimal ratio they calculated was from 73% to 85% and the mean was 79% for an ideal overbite.[4] Ballard ML compared the mesiodistal diameters of each tooth on one side of the dental arch with the opposite side. A right to left discrepancy amounting to 0.25 mm was observed in more than ninety percent of the sample.[5]

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In 1958, the best-known study of tooth size discrepancy in regards to treatment of malocclusion was defined by W. Bolton. Bolton presented two ratios for estimation of tooth size discrepancy by measuring the sum of mesio-distal widths of the mandibular and maxillary teeth; anterior and overall ratio. From these ratios, the presence of excess mandibular or maxillary tooth material is specified (Figure 1).[6] Smith et al stated that specific dimension relationships must exist between the maxillary and mandibular teeth to ensure proper interdigitation, overbite and overjet. [7]

Special attention should be given to the presence of tooth size discrepancy because about 60% of orthodontic patients present an anterior Bolton discrepancy.[8] For assessment of anterior tooth size discrepancy, Proffit recommended a quick check method. This can be done by simple eyeballing method in which size of upper and lower lateral incisors can be compared. He anticipated that a discrepancy will almost surely exists unless the upper lateral incisors are larger.[9]

The main basis of this visual check or eyeballing is the greatest amount of variation exists in the size of maxillary lateral incisors after third molars. This can be in the form of peg laterals and other developmental anomalies.[10] However visual check being subjective, there is no quantitative data present representing a correlation between upper lower lateral incisor difference with tooth size discrepancy. Therefore, the aim of this study was to assess the level of correlation between upper and lower lateral incisor mesiodistal difference with Anterior Bolton to ascertain if evaluation of lateral incisors will result in precise appraisal of tooth size discrepancy.

Material and Methods

A cross-sectional study using pre-treatment dental casts of patients was conducted in the Department of Orthodontics at Margalla Institute of Health Sciences, Rawalpindi, Pakistan. The study was approved by the Ethical Review Board of the hospital. Patients or guardians were informed about the purpose of this study and informed consent was obtained from them.

Non-probability Consecutive sampling technique was employed and all records from March 2010 to March 2017 were assessed from the archives. Included samples consisted of dental casts from both male and female patients with no previous history of orthodontic treatment. Permanent teeth from right canine to left canine were present in both arches with age range of 11-26 years. Casts without caries or extensive restorations and presence of significant tooth size discrepancy (mandibular / maxillary excess) were included in the sample. Presence of supernumerary and congenitally missing tooth or teeth were excluded from the sample. For data collection, patient's history performa (for clinical examination) and dental casts were used.

After screening all the records, 67 patients from both genders (28 males, 39 females) fulfilled the inclusion criteria. Mesiodistal tooth dimensions were measured from right to left canine in both arches on a dental cast using digital Vernier calliper to the nearest 0.1mm (Figure 2). The mesiodistal crown diameter was measured from anatomical contact of one tooth to another from frontal side perpendicular to the long axis of the teeth at its greatest interproximal distance. Anterior Bolton was calculated by using Bolton formula[6] and the sample was divided into two groups on the basis of presence of mandibular or maxillary excess. Sample with no tooth size discrepancy was disregarded. Anterior Bolton of significance was highlighted at 1.5mm. Mean mesiodistal width of upper and lower incisors and their difference was calculated for both groups. Difference of upper and lower laterals were then correlated with their respective Anterior Bolton by using Pearson correlation. p value was set at ≤ 0.05. Statistical analyses were done using SPSS version 23 (IBM SPSS Version 21, Armonk, NY).

Results

After the anterior Bolton assessment of 67 patients, 45 patients had significant mandibular excess and 22 patients had significant maxillary excess. In mandibular excess group, mean mesiodistal width of upper and lower incisors were 6.8 ± 0.7mm and 6.3 ± 0.4mm respectively. Mean difference of upper and lower lateral incisors was calculated to be 0.5 ± 2.8mm. In maxillary excess group, mean mesiodistal width of upper and lower incisors were 7.2 ± 0.5mm and 5.7 ± 0.4mm respectively. Mean difference of upper lower lateral incisors in maxillary excess group was 1.5 ± 0.3mm.

Pearson correlation of sample showing mandibular excess according to anterior Bolton with their respective upper and lower lateral incisors difference showed negative moderate correlation (r = -0.4) which was statistically significant (p = 0.01).

Pearson correlation of sample showing maxillary excess according to anterior Bolton with their respective upper and lower lateral incisors difference showed positive weak correlation (r = 0.01) which was statistically insignificant (p = 0.9) table I and fig 3 & 4.

$$\text{Anterior ratio} = \frac{\text{Sum of mesiodistal widths of mandibular 12 teeth}}{\text{Sum of mesiodistal widths of maxillary12 teeth}} \text{ X100}$$

$$\text{Anterior ratio} = \frac{\text{Sum of mesiodistal widths of mandibular 6 teeth}}{\text{Sum of mesiodistal widths of maxillary 6 teeth}} \text{ X100}$$

Figure 1: Bolton formula for calculation of anterior and overall ratios

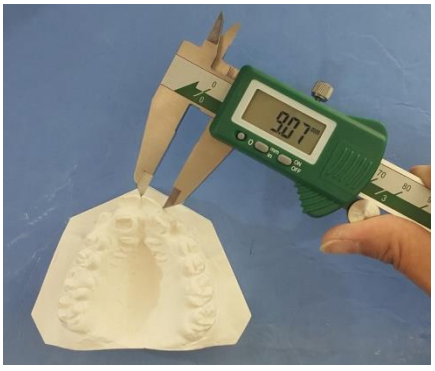

Figure 2: Digital Caliper showing recording of mesiodistal dimension of teeth on the cast

Table I: Correlation between Mandibular excess & Maxillary excess group of Anterior Bolton with upper and lower lateral incisor difference

	Mandibular excess N=45	
Lateral Incisor Difference	Pearson Correlation	-0.46
	Sig. (1-tailed)	0.00
	Maxillary excess N=22	
Lateral Incisor Difference	Pearson Correlation	0.9
	Sig. (1-tailed)	0.01

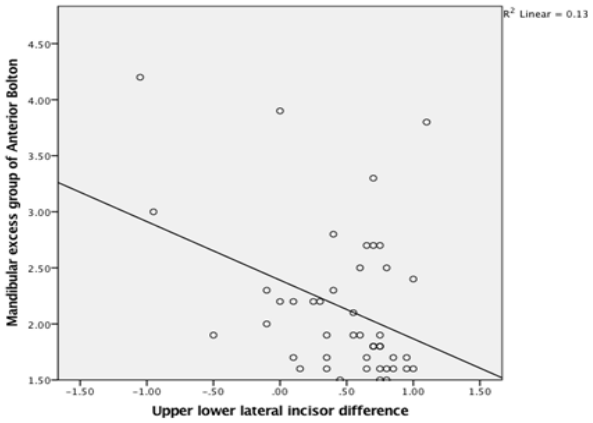

Figure 3: Scatter diagram showing a negative moderate correlation (r = -0.4) with dentition showing Anterior Bolton with mandibular excess

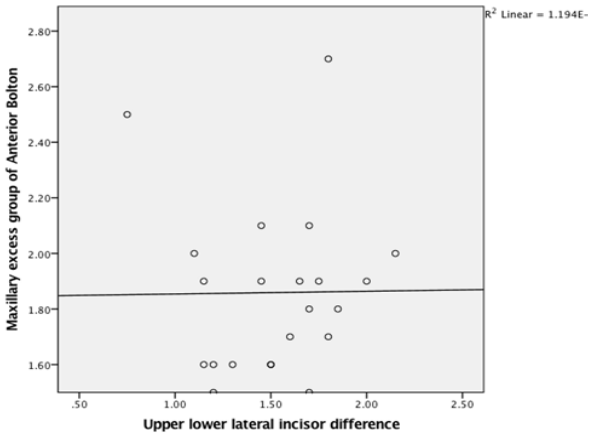

Figure 4: Scatter diagram showing a negative weak correlation (r = 0.01) with dentition showing anterior Bolton with maxillary excess

Discussion

Bolton analysis is the most prominent method used for in depth assessment of tooth size discrepancy. For swift assessment, visual evaluation of mesiodistal width of upper and lower lateral incisor difference (Profitt quick check method)[9] is gaining influence. It is clearly documented that in terms of morphology, maxillary lateral incisors show the most variations than any other tooth with exception of third molars.[11] Developmental variations are most commonly associated with maxillary lateral incisors. They occur unilaterally or bilaterally. Examples include; microdontia, hypodontia, dens invaginatus and dens evaginatus (talon cusp).[12-13] These variations can result in tooth size discrepancy in the anterior region which gives logical credence for assessing maxillary lateral incisors for discrepancy as stated by Profitt.[9] An average difference of upper and lower lateral incisors ranges from 1-1.75mm.[12-14] However, as stated before, no data exist expressing any quantitative association between upper and lower lateral incisor difference (Profitt quick check method) and Anterior Bolton.

In our study mean mesiodistal widths of upper lateral incisors in both mandibular and maxillary excess groups (6.8 ± 0.7mm, 7.2 ± 0.5mm) were in range to the norms of mesiodistal widths of upper lateral incisors (7.1 ± 0.65mm) as documented by Hussain et al[16] from outpatient Department, at Karachi Medical Dental College, Pakistan. Same comparison was seen in mesiodistal norms documented by Gorjizadeh et al[17] for Iranian sample (7.1 ± 0.51mm) and Otuyemi & Noar[18] for Nigerian population (7.25 ± 0.36mm). In contrast, the mesiodistal widths of upper lateral incisors in this study were higher than prescribed by Wheelers (6.5mm). [12]

With regards to mesiodistal widths of lower lateral incisors, mesiodistal widths of both mandibular and maxillary excess groups (6.3 ± 0.4mm, 5.7 ± 0.4mm) were in range to the norms of maxillary and mandibular mesiodistal widths of lateral incisors (5.9 ± 0.47mm) as documented by Hussain et al[16], Gorjizadeh et al[17] (6.2 ± 0.3mm) and Otuyemi & Noar[18] (6.19 ± 0.40) but contrasted with norms documented by Wheelers (5.5mm).[12]

There was a negative correlation (r = -0.4) between mandibular excess group of Anterior Bolton and upper lower lateral incisor difference which rationalises that anterior tooth size discrepancy due to mandibular excess increases as difference between upper and lower lateral incisors decreases. In terms of Anterior Bolton showing maxillary excess, their correlation with upper and lower lateral incisors difference showed positive weak correlation (r = 0.01) which proves that tooth discrepancy due to maxillary excess is very weakly, directly proportional to upper lower lateral incisors difference. The reasoning for these moderate and low correlations can be due to the fact that Bolton Ratios were calculated by using Caucasian female sample and it measures mesiodistal width of six anterior teeth of both arches for Anterior Bolton. Therefore, quantitative assessment of upper and lower lateral incisors difference in our study states that eyeballing is not a reliable tool and in depth analysis like Bolton ratios is recommended for assessment of tooth size discrepancy.

Conclusions

For quick initial assessment of anterior tooth size discrepancy, eyeballing is not reliable according to this study. However, the author will recommend future assessment of normal Anterior Bolton with upper and lower lateral incisors difference on a larger sample size.

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