

**Original Research Article****Bolton Ratios in Crowded and Non-Crowded Dentition among Solapur Population: An In-vitro Study**

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Abstract**Introduction:** *It has been seen that specific dimensional relationship must exist between the maxillary and mandibular teeth to ensure proper inter digitation, overbite and overjet. The purpose of this study is to compare bolton ratios in crowded and non-crowded dentition.***Materials and Methods:** *Out of the 60 cases, 30 were non-crowded cases and the rest 30 were crowded cases. Carey's Arch perimeter analysis was done on the patient casts. The arch length anterior to the first permanent molar was measured using a soft brass wire. The mesiodistal width of the teeth anterior to the first molars (second premolar to second premolar) was measured and summed up. The discrepancy referred to the difference between arch length and tooth material. Presence of difference (AL-TTM) greater than 2mm in both arches was considered as a non-crowded case and difference (AL-TTM) less than 2mm was considered as a crowded case. Mesiodistal width of each tooth was measured using digital Vernier caliper. Tooth width ratios were calculated in the two groups using formulas proposed by Bolton.***Results:** *No significant difference was found in the anterior and overall ratio between crowded and non-crowded dentitions between both males and females.***Conclusion:** *This study concluded that not much differences was found between Bolton's ratio and the ratios for the Solapur population. Crowded or non-crowded dentition did not show any difference in the ratio while the crowded dentition showed larger teeth in the mesio-distal dimension. When males & females were compared, the ratio did not vary considerably.***Keywords:** *Bolton Ratios, Bolton discrepancy.*

Introduction

It has been seen that specific dimensional relationship must exist between the maxillary and mandibular teeth to ensure proper interdigitation, overbite and overjet. It is important to determine the amount and location of a tooth size discrepancy before starting treatment because, patients with interarch tooth size discrepancies require either removal or addition of tooth structure to open or close spaces in the opposing arches¹.

Mesiodistal tooth width is considered a primordial etiologic factor in space anomalies, which together with tooth width discrepancy may cause malocclusion³⁻⁵. Differences between mesiodistal tooth width in crowded and no crowded dentitions have been reported in several studies⁶⁻¹². Because dental crowding should be associated to larger tooth width to a certain degree, it is probable that disproportions in the interarch tooth width relationship in the posterior arch area may also influence the presence of dental crowding². Discrepancies in tooth width could affect the excellence in the finishing of orthodontic cases¹³. Therefore, this study was designed to evaluate tooth width ratios in crowded and non-crowded dentitions and discuss the clinical implications of the possible differences.

Materials and Methods

The data for this study was obtained from the records of the patients from the outpatient department of Orthodontics, Pandit Deendayal Upadhyay Dental College, Solapur.

Method of collection of data

Sixty upper and lower dental casts were analyzed in the study.

The cases included in the study were:

- Patients all from Solapur city, with age from 12 year to 26 year were selected for the study.
- Cases with Class I or Class II skeletal bases, evaluated by the ANB angle and Wits appraisal together, using standard natural head position for the lateral cephalogram

were selected. ANB angle of 1 or more but less than or equal to 2 degrees was considered as Class I and ANB of more than 2 degrees was considered as Class II skeletal base. When considering the Wits, perpendiculars (AO and BO) were drawn on the functional occlusal plane from cephalometric landmark points A & B. BO was ahead of AO in males by 1mm and AO & BO coincided for females with Class I skeletal base. For Class II skeletal base, AO was well ahead of BO.

- The casts of both crowded and non-crowded dentition were used for the model analysis.

The cases excluded in the study were the following:

- Patients with caries, restoration or attrition in proximal surfaces.
- Anomalies in tooth number, size or shape.
- The subjects with a history of orthodontic treatment.

The materials used were as follows

- Lateral cephalogram.
- Brass wire.
- Digital Vernier calliper.
- Patient casts.



Figures 1: Arch perimeter measurement on a crowded cast



Figure 2: Measurement of mesiodistal width of a tooth using Vernier Caliper

Study Design

- a) Out of the 60 cases, 30 were non-crowded cases and the rest 30 were crowded cases.
- b) Carey’s Arch perimeter analysis was done on the patient casts. The arch length anterior to the first permanent molar was measured using a soft brass wire. The wire was passed from the mesial of the first molar, around the arch occlusally in the buccal contact point region bisecting the lingual inclined planes of the buccal cusps of the premolars over the incisal edges of the incisors to the opposite side, mesial to the first permanent molar. In case of proclined anteriors the wire was passed along the cingulum of the anterior teeth and if the teeth were retroclined, the brass wire in the

anterior segment passed labial to the teeth. The mesiodistal width of the teeth anterior to the first molars (second premolar to second premolar) was measured and summed up. The discrepancy referred to the difference between arch length and tooth material. Presence of difference (AL-TTM) greater than 2mm in both arches was considered as a non-crowded case and difference (AL-TTM) less than 2mm was considered as a crowded case.

- c) Mesiodistal width of each tooth was measured using digital Vernier calliper. Tooth width ratios were calculated in the two groups using formulas proposed by Bolton.

Results

No significant difference was found in the anterior and overall ratio between crowded and non-crowded dentitions between both males and females (table 1 and 2).

When comparison of tooth size discrepancy were made according to standard deviation from Bolton’s proposed mean values in crowded and non-crowded dentitions, it was found that generally anterior/ overall ratio difference did not bear any significance.(table1 & 2).

Table 1: Difference in Anterior ratio and overall ratio between Males and Females in Crowded group using Independent T-test

| Time | Gender | Mean | Standard Deviation | Mean Difference | 95% Confidence Interval for difference | | T | p |
|----------|--------|---------|--------------------|-----------------|--|---------|-------|------|
| | | | | | Lower | Upper | | |
| Anterior | Male | 78.5092 | 3.41762 | -.53750 | -3.27022 | 2.19522 | -.403 | .690 |
| | Female | 79.0467 | 3.68075 | | | | | |
| Overall | Male | 90.8283 | 2.60118 | 1.90389 | -2.24951 | 6.05728 | .939 | .356 |
| | Female | 88.9244 | 6.66157 | | | | | |

Table 2: Difference in Anterior ratio and overall ratio between Males and Females in Non-Crowded group using Independent T-test

| Time | Gender | Mean | Standard Deviation | Mean Difference | 95% Confidence Interval for difference | | T | p |
|----------|--------|---------|--------------------|-----------------|--|---------|------|------|
| | | | | | Lower | Upper | | |
| Anterior | Male | 80.2358 | 7.95779 | 2.16028 | -2.57059 | 6.89114 | .935 | .358 |
| | Female | 78.0756 | 4.72000 | | | | | |
| Overall | Male | 91.8800 | 4.90749 | 1.38889 | -1.66615 | 4.44393 | .931 | .360 |
| | Female | 90.4911 | 3.28553 | | | | | |

Table 3: Difference in Anterior ratio and overall ratio between crowded and non-crowded among males using Independent T-test

| Bolton ratio | Type | Mean | Standard Deviation | Mean Difference | 95% Confidence Interval for difference | | T | p |
|--------------|-------------|---------|--------------------|-----------------|--|---------|-------|------|
| | | | | | Lower | Upper | | |
| Anterior | Crowded | 78.5092 | 3.41762 | -1.72667 | -6.91158 | 3.45824 | -.691 | .497 |
| | Non-crowded | 80.2358 | 7.95779 | | | | | |
| Overall | Crowded | 90.8283 | 2.60118 | -1.05167 | -4.37686 | 2.27352 | -.656 | .519 |
| | Non-crowded | 91.8800 | 4.90749 | | | | | |

Table 4: Difference in Anterior ratio and overall ratio between crowded and non-crowded among females using Independent T-test

| Bolton ratio | Type | Mean | Standard Deviation | Mean Difference | 95% Confidence Interval for difference | | T | p |
|--------------|-------------|---------|--------------------|-----------------|--|---------|-------|------|
| | | | | | Lower | Upper | | |
| Anterior | Crowded | 79.0467 | 3.68075 | .97111 | -1.89598 | 3.83820 | .688 | .496 |
| | Non-crowded | 78.0756 | 4.72000 | | | | | |
| Overall | Crowded | 88.9244 | 6.66157 | -1.56667 | -5.12458 | 1.99125 | -.895 | .377 |
| | Non-crowded | 90.4911 | 3.28553 | | | | | |

No difference of statistical importance was found between males and females in the anterior ratio and overall ratio (table3 and 4)

The mean anterior and overall ratio for the crowded dentition among males in the Solapur population was 78.5092% and 90.8283% respectively. The same for the non-crowded dentition was 80.2358% & 91.8800% respectively. (Table 3)

The mean anterior and overall ratio for the crowded dentition among females in the Solapur population was 79.0467% and 88.9244% respectively. The same for the non-crowded dentition was 78.0756% & 90.4911% respectively. (Table 4)

Out of the 30 crowded cases, 36% had maxillary anterior excess, 64% had mandibular anterior excess, 36% had mandibular overall excess and 64% had maxillary overall excess.

In the non-crowded 30 cases, 64% had maxillary anterior excess, 36% had mandibular anterior excess, 55% had maxillary overall excess, and 45% had mandibular overall excess.

Discussion

In order to achieve excellence in orthodontic finishing, clinician should be familiar with the

discrepancies in tooth size at the initial stages of diagnosis and treatment planning. Tooth size discrepancies are considered an important factor for an ideal finishing. If the patient has significant tooth size discrepancy, orthodontic alignment into optimal occlusion with proper overjet and overbite may not be possible².

Several studies have reported differences between mesiodistal tooth width in crowded and non-crowded dentitions by considering tooth width of the individual tooth rather than considering whole arch². Previously Bolton⁴, Crosby and Alexander¹⁴ did a study on tooth size discrepancies but in their studies they did not consider gender and racial differences while analysing these tooth- size discrepancies. Therefore this study was designed to evaluate and compare tooth width ratios in crowded and non- crowded dentitions along with gender variation and to discuss the clinical significance of the same. This study compared tooth width ratios in 60 subjects with simultaneously crowded or spaced arches selected from records in the Department of Orthodontics and Dentofacial Orthopedics at Pandit Deendayal Upadhyay Dental College, Solapur.

The present study showed that there was no statistically significant difference found in

mesiodistal tooth width ratios between the gender (male and female) and dentition type (crowded and non-crowded). Eduardo Bernabe et al¹³ in his study on Peruvian adolescents concluded that there was no significant difference between the anterior and total tooth width ratios according to sex. Also Al-Tamimi T et al¹⁵ in their study on Saudi population found that there were no statistically significant differences between the mean values of the anterior ratio and the overall ratio between genders and the mean values reported by Bolton.

Adams⁹ made a comparison of the sum of tooth widths for each arch according to sex but also considered second molars. He found that the differences were significant for male individuals in both arches and for female individuals in the upper arch. He considered the second permanent molars for each arch sum, and he also used a sample of subjects with class I posterior relationships. No mean crowding was quantified for the crowded sample. Dental arches with and without crowding present significant statistical differences in tooth width ratios, these differences are too small to be considered of clinical significance (less than one mm).¹³ Proffit and Fields¹⁶ stated that tooth width discrepancies less than 1.5mm is rarely significant.

Conclusion

- As Bolton's ratio is now considered the seventh key of occlusion, it would seem prudent for clinicians to routinely include this analysis in their initial case workup, which would prove beneficial in both treatment planning and final expectations of both the clinicians and the patients
- This study concluded that not much differences was found between Bolton's ratio and the ratios for the Solapur population. Crowded or non-crowded dentition did not show any difference in the ratio while the crowded dentition showed larger teeth in the mesio-distal dimension.

When males & females were compared, the ratio did not vary considerably.

- The mean anterior and overall ratio for the crowded dentition in the Solapur population was 78.77% and 89.87% respectively.
- The same for the non-crowded dentition was 79.15% & 91.18% respectively. Bolton's ratio could be thus applied to the Sholapur population.

References

1. Sanjay Naduwinmani, Jyosna Preetham Naduwinmani, U.S.Krishna Nayak. Evaluation Of Bolton's Tooth Width Ratios In Crowded And Non-Crowded Dentitions Among The South Indian Population: An In-vitro Study, IJCD DECEMBER 2010 ;1(3):99-106.
2. Dr Karan Purohit et al. Clinical Significance of Bolton's Ratio in Crowded and Non-crowded Dentition With Gender Variations. JANUARY 2016 ;6(1): 560-563.
3. Lundstrom A. Intermaxillary tooth width ratio and tooth alignment and occlusion. Acta Odontol Scand. 1955; 12:265-292.
4. Bolton WA. Disharmony In tooth size and its relation to the analysis and treatment of malocclusion. Angle Orthod 1958; 28:113- 130.
5. Bolton WA. The clinical application of tooth-size analysis. Am J Orthod 1962; 48:504-529.
6. Fastlicht J. Crowding of mandibular incisors. Am J Orthod 1970; 58:156-163.
7. Norderval K, Wisth PJ, BoeOE. Mandibular anterior crowding in relation to tooth size and craniofacial morphology. Scand J Dent Res 1975; 83:267-273.
8. Doris JM, Bernard BW, Kuflinec MM, Stom D. A biometric study of tooth size and dental crowding. Am J Orthod 1981; 79:326- 336.
9. Adams CP. A comparison of 15 year old children with excellent occlusion and with

- crowding of the teeth, Angle Class I malocclusion, in respect of face size and shape and tooth size. *Swed Dent J Suppl* 1982; 15:11–26.
10. Dr Smith RJ, Davidson WM, Gipe DP. Incisor shape and incisor crowding: a re-evaluation of the Peck and Peck ratio. *Am J Orthod* 1982; 82:231–235.
 11. Chang HF, Shiau YY, Chen KC. The relationship of dental crowding to tooth size, dental arch width, and arch depth. *Proc Natl Sci Counc Repub China B* 1986; 10:229–235.
 12. Yoshihara T, Matsumoto Y, Suzuki J, Sato N, Oguchi H. Effect of serial extraction alone on crowding: relationships between tooth width, arch length, and crowding. *Am J Orthod* 1999; 116:691–696.
 13. Eduardo Bernabe', Karla M. Villanueva, Carlos Flores-Mir. Tooth Width Ratios in Crowded and Noncrowded Dentitions, *Angle Orthod* 2004;74:765–768.
 14. Crosby Dr, Alexander CG. The occurrence of tooth size discrepancies among different malocclusion groups. *Am J Orthod* 1989; 95:457-61.
 15. Al-Tamimi T, Hayder A. Hashim. Bolton tooth size ratio revisited. *World J Orthod* 2005; 6:289-295
 16. Profit WR. *Contemporary orthodontics*, 3rd Edn. St Louis: Mosby, 2000; 170.