Scientia Ricerca

# Boltons Ratio among South Indian Population

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## Abstract

**Background:** Indian being a diverse country, different ethnic populations have different types of occlusions. This has an impact on factors influencing the treatment planning in orthodontics and outcome. The objective of this study is to assess and compare the boltons ratio in all angles class of malocclusions of south Indian population.

**Material and Methods:** A total of 300 casts were included from the Department of Craniofacial Orthodontics in Dental College of South India. The inclusion and exclusion criterion was determined. The casts were categorised into Class I (N = 135), Class II division 1 (N = 74) and 2 (N = 3), Class III (N = 6) angles of malocclusion. The overall and anterior tooth ratio was determined using Boltons method. A statistical test was done by determining the mean, SD, chi square test, Fishers exact test and Kruskall wallis.

**Results:** The overall bolton ratio was found to be 91.13 per cent. The anterior Bolton ratio was 78.82 per cent. There was no statistical significant association found between the different classes of malocclusions.

**Conclusion:** The overall ratio was found to be within the boltons ratio but the anterior ratio was found to be increased in different class of malocclusions.

*Key Words: Angles class of malocclusions; Boltons ratio; South Indian population; Class I; Class II; and Class III*

## Introduction

Boltons ratio was first introduced by W. A. Bolton in 1958 [1]. It is the analysis of space discrepancy in the tooth of maxilla and mandible. It helps to determine the optimum inter-arch relationship by quantifying the mesio-distal widths of the anterior teeth. In Boltons ratio anterior ratio and overall ratio is used. The patients are more concerned about the aesthetics in the anterior region. The crowding and spacing are more pronounced in the anterior region. Hence, anterior teeth ratio becomes significant in clinical decision making in orthodontics. The anterior segment ratio is 77.2 ± 0.22%. Overall ratio is obtained by adding the widths of the 12 mandibular teeth divided by the sum of the widths of the 12 maxillary teeth and the ratio is 91.3 ± 0.26 % [2]. A recent study highlighted the boltons ratio for different ethnic groups. The anterior tooth ratio like between 77.2% and 80.62%. Similarly, the overall ratio lies in the 89.8% and 93.39% [1, 3].

The prevalence of anterior tooth ratio among orthodontic patients is between 17% and 31% and 20.5% in non-orthodontic patients [4,5]. The significance of boltons ratio as previously mentioned has an impact on clinical outcome [2]. It has been validated through many studies on different ethnic populations including India [3]. A study by Shastri D (2015) tried to look at the boltons ratio in north Indian populations with different malocclusions and he found that Angle's Class II patients showed a tendency toward wider mesio-distal widths of teeth in the mandibular anterior region or smaller tooth sizes in the maxillary anterior region [1].

Basaran., *et al*. (2006) studied casts of 300 patients and divided the casts into Class I, Class II division 1, Class II division 2, and Class III angles of malocclusion. The author concluded that, there was no statistically significant difference among different groups of malocclusions [6]. Other studies have found differences among different class of angles of malocclusion [7-10].

Wedrychowska-Szulc., *et al*. (2010) used 600 casts with different class of angles malocclusion. He found that, the overall ratio among all groups and anterior tooth size ratio between Class I and Class III groups was statistically significant [11]. Araujo and Souki (2003) tried to determine the association between tooth size discrepancy in the anterior region and Class I, II, and III angles malocclusions of 300 Brazilian patients. The author found that, there was higher prevalence of tooth size discrepancies in the anterior region of class I and class III. The anterior tooth ratio was found to be higher for the patients with Class III malocclusion than in those with Class I and Class II malocclusions [12].

The Boltons ratio for South Indian population is poorly reported. Hence, the objective of our study is to determine the overall ratio and anterior teeth ratio for South Indian population applying for orthodontic treatment and later comparing with the Bolton's standards.

## Materials and Methods

The study was done at Department of Oral Biology and Genomic Studies and Craniofacial Orthodontics at A.B. Shetty Memorial Institute of Dental Sciences, Mangalore Deralakate Nitte University, Karnataka India. The data was gathered using the study casts selected from 300 patients that previously came to the Department for Craniofacial Orthodontics for treatment during the period of 2013-16 from Southern part of India. Each patient had a cephalometric radiograph. The models were classified according to the Angles malocclusion i.e. Class I (N = 135), Class II division 1 (N = 74) and 2 (N = 3), Class III (N = 6) angles of malocclusion using molar and canine relationship. All measurements were done on the study models.

**The inclusion criteria were:**

1. Between the age of 12 to 35 years
2. Fully erupted permanent teeth in both maxillary and mandibular arches
3. Records, Study cats, panoramic views, lateral cephalograms
4. Clinical Diagnosis of Class I, II and III malocclusions
5. Molar to molar teeth present

The overall ratio and anterior tooth ratio was determined by the following standard formula;

**Overall ratio**

**Sum of Mandibular 12:** The sum of mesio-distal width of all the teeth mesial to the mandibular second permanent molars = ……………….. mm

**Sum of Maxillary 12:** The sum of mesio-distal width of all the teeth mesial to the maxillary second permanent molars = ………………. mm

$$\text{Determination of Overall Ratio} = \frac{\text{Sum of Mandibular 12}}{\text{Sum of maxillary 12}} \text{ x } 100$$

**Anterior tooth Ratio**

Sum of mandibular 6 = the sum of mesio-distal width of all the teeth from mandibular canine to canine = …………………. Mm

Sum of Maxillary 6 = the sum of mesio-distal width of all the teeth from maxillary canine to canine = …………… mm

**Determination of Anterior Ratio**

Anterior ratio = Sum of mandibular 6 x 100/Sum of maxillary 6

**Statistical Analysis**

The collected data was analysed by frequency, percentage, mean and standard deviation, chi square test, Fishers exact test and Kruskall wallis test was used to derive the significance.

## Results

| Malocclusion group | Gender | | Total N (%) |
|---|---|---|---|
| | Male N (%) | Female N (%) | |
| Class I | 58 61.1% | 77 62.6% | 135 61.9% |
| Class II division 1 | 32 33.7% | 42 34.1% | 74 33.9% |
| Class II division 2 | 0 .0% | 3 2.4% | 3 1.4% |
| Class III | 5 5.3% | 1 .8% | 6 2.8% |
| Total | 95 100.0% | 123 100.0% | 218 100.0% |

***Table 1:*** *Gender distribution between the groups investigated.*

| Class of malocclusion | Sample size (N) | Mean | Std. Division | Kruskal wallis test value | P < 0.05 |
|---|---|---|---|---|---|
| Class I | 135 (62.21%) | 19.23 | 5.596 | | |
| Class II division 1 | 74 (34.10%) | 18.09 | 4.018 | | |
| Class II division 2 | 3 (1.38%) | 17.67 | 2.082 | 2.398 | 0.494 |
| Class III | 6 (2.76%) | 19.80 | 2.950 | | |
| Total | 217 | 18.83 | 5.041 | | |

***Table 2:*** *Age distribution between the groups investigated.*

| Gender | Class of Malocclusion | N | Minimum | Maximum | Mean | Std. Deviation | Median | C.V (%) | Kruskal wallis test value | p |
|--------|----------------------|---|---------|---------|------|----------------|--------|---------|---------------------------|---|
| Male | Class I | 58 | 83.000 | 97.900 | 92.033 | 2.861 | 92.035 | 3.11 | 4.812 | 0.090 |
| | Class II Division 1 | 32 | 77.700 | 97.100 | 89.951 | 4.443 | 90.210 | 4.94 | | |
| | Class III | 5 | 88.700 | 94.230 | 91.978 | 2.421 | 92.900 | 2.63 | | |
| | Total | 95 | 77.700 | 97.900 | 91.329 | 3.563 | 91.790 | 3.90 | | |
| Female | Class I | 77 | 62.200 | 100.000 | 91.070 | 4.827 | 91.300 | 5.30 | 0.444 | 0.931 |
| | Class II Division 1 | 42 | 77.400 | 97.700 | 90.703 | 4.255 | 91.650 | 4.69 | | |
| | Class II Division 2 | 3 | 90.900 | 95.000 | 92.467 | 2.214 | 91.500 | 2.39 | | |
| | Class III | 1 | 91.300 | 91.300 | 91.300 | . | 91.300 | | | |
| | Total | 123 | 62.200 | 100.000 | 90.980 | 4.557 | 91.500 | 5.01 | | |

***Table 3:*** *Overall ratio.*

| Gender | Class of Malocclusion | N | Minimum | Maximum | Mean | Std. Deviation | Median | C.V (%) | Kruskal wallis test value | p |
|--------|----------------------|---|---------|---------|------|----------------|--------|---------|---------------------------|---|
| Male | Class I | 58 | 72.200 | 94.600 | 79.205 | 4.237 | 78.780 | 5.35 | 0.171 | 0.918 |
| | Class II Division 1 | 32 | 58.800 | 89.000 | 78.203 | 5.508 | 78.050 | 7.04 | | |
| | Class III | 5 | 76.000 | 82.600 | 78.954 | 2.442 | 78.800 | 3.09 | | |
| | Total | 95 | 58.800 | 94.600 | 78.854 | 4.622 | 78.720 | 5.86 | | |
| Female | Class I | 77 | 70.000 | 90.600 | 78.848 | 3.885 | 78.260 | 4.93 | 0.150 | 0.985 |
| | Class II Division 1 | 42 | 64.100 | 91.900 | 78.789 | 4.954 | 78.970 | 6.29 | | |
| | Class II Division 2 | 3 | 74.500 | 80.400 | 78.133 | 3.179 | 79.500 | 4.07 | | |
| | Class III | 1 | 77.630 | 77.630 | 77.630 | . | 77.630 | | | |
| | Total | 123 | 64.100 | 91.900 | 78.801 | 4.224 | 78.500 | 5.36 | | |

***Table 4:*** *Anterior tooth Ratio.*

| | Class of Malocclusion | N | Minimum | Maximum | Mean | Std. Deviation | Median | Co-efficient of variation (%) | Kruskal wallis test value | p |
|--|----------------------|---|---------|---------|------|----------------|--------|-------------------------------|---------------------------|---|
| Ratio (%) | Class I | 135 | 62.200 | 100.000 | 91.484 | 4.114 | 91.500 | 4.500 | 2.382 | .497 NS |
| | Class II Division 1 | 74 | 77.400 | 97.700 | 90.378 | 4.323 | 91.300 | 4.780 | | |
| | Class II Division 2 | 3 | 90.900 | 95.000 | 92.467 | 2.214 | 91.500 | 2.390 | | |
| | Class III | 6 | 88.700 | 94.230 | 91.865 | 2.183 | 92.100 | 2.380 | | |
| | Total | 218 | 62.200 | 100.000 | 91.132 | 4.148 | 91.500 | 4.550 | | |
| Maxi (mm) | Class I | 54 | .050 | 7.000 | 2.431 | 1.787 | 2.000 | 73.510 | 2.317 | .509 NS |
| | Class II Division 1 | 35 | .100 | 13.200 | 3.243 | 3.116 | 2.600 | 96.070 | | |
| | Class II Division 2 | 1 | .400 | .400 | .400 | . | .400 | | | |
| | Class III | 2 | 1.230 | 3.200 | 2.215 | 1.393 | 2.215 | 62.890 | | |
| | Total | 92 | .050 | 13.200 | 2.713 | 2.393 | 2.000 | 88.210 | | |

| | Class of Malocclusion | N | Minimum | Maximum | Mean | Std. Deviation | Median | Coefficient of variation (%) | Kruskal wallis test value | p |
|---|---|---|---|---|---|---|---|---|---|---|
| Mand (mm) | Class I | 81 | .174 | 8.040 | 2.577 | 2.072 | 2.090 | 80.380 | 1.182 | .757 NS |
| | Class II Division 1 | 39 | .172 | 6.100 | 2.084 | 1.543 | 1.900 | 74.030 | | |
| | Class II Division 2 | 2 | .300 | 3.500 | 1.900 | 2.263 | 1.900 | 119.090 | | |
| | Class III | 4 | .200 | 3.040 | 1.725 | 1.309 | 1.830 | 75.900 | | |
| | Total | 126 | .172 | 8.040 | 2.387 | 1.903 | 2.020 | 79.740 | | |

*NS = Not Significant

*Table 5: Total Overall Ratio.*

| | Class of Malocclusion | N | Minimum | Maximum | Mean | Std. Deviation | Median | Coefficient of variation (%) | Kruskal wallis test value | p |
|---|---|---|---|---|---|---|---|---|---|---|
| Ratio (%) | Class I | 135 | 70.000 | 94.600 | 79.001 | 4.029 | 78.300 | 5.100 | .031 | .999 NS |
| | Class II Division 1 | 74 | 58.800 | 91.900 | 78.536 | 5.172 | 78.650 | 6.590 | | |
| | Class II Division 2 | 3 | 74.500 | 80.400 | 78.133 | 3.179 | 79.500 | 4.070 | | |
| | Class III | 6 | 76.000 | 82.600 | 78.733 | 2.250 | 78.285 | 2.860 | | |
| | Total | 218 | 58.800 | 94.600 | 78.824 | 4.392 | 78.535 | 5.570 | | |
| Maxi (mm) | Class I | 45 | .070 | 9.600 | 1.609 | 1.671 | 1.000 | 103.850 | .179 | .915 NS |
| | Class II Division 1 | 25 | .020 | 6.850 | 1.614 | 1.602 | .960 | 99.220 | | |
| | Class III | 1 | .770 | .770 | .770 | . | .770 | | | |
| | Total | 71 | .020 | 9.600 | 1.599 | 1.626 | .960 | 101.690 | | |
| Mand (mm) | Class I | 90 | .000 | 5.810 | 1.751 | 1.451 | 1.400 | 82.890 | 4.116 | .249 NS |
| | Class II Division 1 | 49 | .090 | 12.100 | 2.415 | 2.321 | 1.800 | 96.130 | | |
| | Class II Division 2 | 3 | 1.170 | 1.800 | 1.490 | .315 | 1.500 | 21.150 | | |
| | Class III | 5 | .240 | 2.480 | 1.006 | .912 | .800 | 90.610 | | |
| | Total | 147 | .000 | 12.100 | 1.941 | 1.792 | 1.480 | 92.300 | | |

*NS = Not Significant

*Table 6: Total anterior tooth ratio.*

| Gender | Class of malocclusion | Sample size (N) | Frequency of overall ratio discrepancy | | | Frequency to anterior ratio discrepancy | | |
|---|---|---|---|---|---|---|---|---|
| | | | Total (%) | Relative maxillary excess (%) | Relative mandibular excess (%) | Relative Maxillary Excess (%) | Relative Mandibular Excess (%) | |
| Male | Class I | 58 | 26.60% | 34.5% | 65.5% | 34.5% | 65.5% | |
| | Class II division 1 | 32 | 14.67% | 53.1% | 46.9% | 31.3% | 68.8% | |
| | Class III | 5 | 2.29% | 40.0% | 60.0% | 20.0% | 80.0% | |
| | Total | 95 | 43.57% | 41.1% | 58.9% | 32.6% | 67.4% | |
| Female | Class I | 77 | 35.32% | 44.2% | 55.8% | 32.5% | 67.5% | |
| | Class II division 1 | 42 | 19.26% | 42.9% | 57.1% | 37.7% | 64.3% | |
| | Class II division 2 | 3 | 1.37% | 33.3% | 66.7% | .0% | 100.0% | |
| | Class III | 1 | 0.458% | .0% | 100.0% | .0% | 100.0% | |
| | Total | 218 | 56.42% | 43.1% | 56.9% | 32.5% | 67.5% | |

*Table 7: The frequency of Bolton tooth size discrepancies exceeding 2 SD.*

## Discussion

Our study results found that, the mean overall Bolton ratio was 91.13 per cent which is within the boltons standard. The overall boltons ratio for males was 91.32 per cent and for females was 90.98 per cent. The boltans ratio for females was found to be slightly less compared to males in overall boltons standard. The overall ratio was higher for class II division 2 and Class III malocclusion (Table 5). We found that the mean overall ratio for class I patients was 91.48 ± 4.11, which is within the normal boltons limits. Other malocclusions like, class II division 1 was 90.37 ± 4.32, class II division 2 was 92.46 ± 2.21 and class III was 91.86±86. The sample sizes for the class II division 1 and 2 and class III were less and it is difficult to justify that the results found are higher compared to boltons ratio. No statistical difference was found between mean overall ratio and angles class of malocclusions (Table 3). The results were similar to the previous studies [16,18,21,22]. But other studies showed statistical differences in overall ratio and angles class of malocclusion [9-11]. The possible explanation for this may be due to the differences in the racial groups, in the dimensions and proportions of the teeth [12].

The total mean anterior bolton ratio was 78.82 per cent. The anterior tooth ratio is higher compared to bolton's standard for all angles malocclusion groups and for both genders (Table 4,6). The anterior tooth ratio for males was 78.85 percent and for females was 78.80 percent. There was no significant difference in anterior tooth ratio between gender and type of malocclusion (Table 4). Our results co-relate with the previous reports [7-11]. The anterior tooth size (maxillary teeth) particularly lateral incisor differs within the populations. The anterior tooth size discrepancy is observed in greater percentage of patients compared to the discrepancies in overall ratio. The possible explanation to this finding is that, the size of the anterior teeth has mathematically, less effect on overall ratio [6]. The mean anterior ratio calculated was 79.00 ± 4.02 for class I malocclusion. The anterior tooth ratio was higher for all angles classes of malocclusions (Table 6) [20].

A study on North Indian populations (2015) found that, the overall ratio was 91.36% ± 2.13 and the anterior tooth ratio was 78.14% ± 4.09. The overall ratio is within the boltons standard but anterior tooth ratio was higher than the boltons standard. This indicates greater mesio-distal widths in the mandibular anterior segment in north Indian population [1]. The results of anterior tooth ratio of this study were similar to our study.

A study by Cancodo RH (2015) compared the overall and anterior ratios of tooth size discrepancies in all types of angles malocclusion groups using a sample size of 711 pre-orthodontic study casts from Brazil. The average mean age was 17.42 years. The sample was consisting of Class I (n = 321), Class II (n = 324) and Class III (n = 66). The authors found that, with respect to the overall and anterior ratios among the malocclusion groups, no statistically significant differences were found [12]. No significant difference was found between any of the angles malocclusion patients. No correlation was found between Angle's classification of malocclusion and Bolton discrepancy as shown by Crosby and Alexander.

A study on Polish population by Bielawska (1994) used 51 orthodontic patients with different malocclusions, also did not find any statistically significant differences in different class of malocclusions [12]. The possible reason for the results of our study and polish study is that, it is unlikely that sample size will affect the Bolton's results. Previous reports have found opposite to our findings. The reason might also be due to the geographical location.

The frequency of Bolton tooth size discrepancies exceeding 2SD for overall ratio was 48.76%. Similarly, the frequency of Bolton tooth size discrepancies exceeding 2SD for anterior tooth ratio was 67.5% (Table 7). According to Crosby and Alexander, any figure outside two standard deviations from Bolton's mean represent 2 to 3 mm tooth size discrepancy which must be considered clinically significant. In the current study, it was found that 67.5% had increased anterior tooth size ratios and has increased mandibular tooth size excess. According to Batool., et al. skeletal class II patients showed a tendency toward higher mesio-distal widths of teeth in the mandibular anterior region. Our study found the similar results [20].

The limitations of our study were the lesser number of sample size for the class II division 2 and Class III. We found less number of cases who found to be fit into the criteria for the study and lower number of cases coming to the hospital from southern part of India.

## Conclusion

The total anterior tooth ratio was greater than the Bolton's tooth ratio for all angles malocclusions among South Indian populations. However, there was no statistical significance in overall and anterior tooth ratio among all angles class of malocclusions. The results show that, there is increased mandibular excess.

### Key Message

It is clinically significant to consider Bolton's ratios during orthodontic treatment planning among south Indian population.

### Conflict of Interest

No conflict of interest.

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