***Original Research Article***

**Establishment Of Norms Of Bolton Analysis For The Central India Population.**

Running Title- Establishment of norms of Bolton analysis for the central India population.

**Abstract**

Objective: To establish the norms for the Bolton analysis in Central India (male and female) population. Materials and methods: 125 study casts (62 males and 63 females) from 15 to 30 years were selected from the Department of Orthodontics. The mesio-distal dimension from right to left permanent molar of maxillary and mandibular teeth was measured with a digital calliper, to calculate, analyse and compare the Bolton ratio. Paired and unpaired T-test, z-value was used for the statistical analysis. Results: The overall mean ratio for males and females was 88.42±6.01 and 88.85±4.03 and the anterior mean ratio for males and females was 77.83±6.42 and 78.88±5.13 respectively. There was a non-statistical difference in the anterior and overall mean within males and females. A statistically significant difference was found when Central Indian females were compared with Caucasian participants. In a comparison of the present study with other Indian populations, significant data was found with anterior and overall ratio but non-significant data was found for anterior ratio for the Telangana population. Conclusion: It is suggested the population-specific norms are needed to plan treatment for orthodontics taking into consideration retention and stability.

**Introduction:**

The number, size, and shape of tooth and jaws when normal, the equilibrium is maintained. But if variation occurs in any one of them, then there will be “malocclusion” [1]. To rectify their malocclusion, 90 percent of grown orthodontic cases require extractions. Many of them fall into the category of borderline circumstances that demand camouflage treatment. In borderline instances, the major dilemma in orthodontic treatment planning is whether to extract or not to extract.

It is essential to keep track of the case's diagnosis in order to arrange a successful orthodontic treatment. The use of diagnostic model analysis [1] is one of the most significant diagnostic tools. The objective of studying the diagnostic models during formulating a treatment protocol is an estimation of tooth material, to plan for extraction or non-extraction. Researchers, in a quest to evaluate the mesio-distal width, gave numerous analyses for example Peck and Peck [2] (1975), but this analysis was only for the lower anterior.

Wayne A Bolton et al [3] (1958) proposed "Bolton's analysis" to examine the tooth size disparity. He examined dental casts and developed two ratios for assessing tooth size disparity, comparing the mesio-distal widths of mandibular and maxillary anterior six teeth (anterior ratio) and permanent molar to molar twelve teeth (overall ratio) on Caucasians of all ethnicities and genders. Even though it is widely acknowledged, its applicability in different populations is being questioned.

Lundstrom et al[4] (1955) conducted a review of the European literature on tooth disharmonies and concluded that there was a strong hereditary predisposition in the mesiodistal width of tooth size, and so no single analysis could be applied to all populations. Jaw and tooth size varies from population to population. Because tooth growth is influenced by both inherited and environmental factors, the question of whether or not to treat other populations according to Caucasian standards arises.

The literature review by Lavelle et al[5] (1972) indicated that tooth size ratios have an ethnic, racial, and sexual variation. Few authors have also proposed an intermaxillary ratio analysis designed to localize discrepancies in tooth size for the Indian population of Maratha [6], Jaipur [7], Telangana [8], and Chattisgarh population [9].

Likewise, there arose a need to evaluate the mesio-distal dimension to treat the Central India population with orthodontic treatment. The following study was thus planned with an objective to;

1) To evaluate and compare the mesio-distal dimension (anterior ratio, overall ratio) in males and females.

2) To compare mesio-distal dimension (anterior ratio, overall ratio) in female patients with norms given by Bolton’s for female patients.

**Materials and methods:**

The Department of Orthodontics provided dental research casts of 162 adult patients (62 male and 63 female) with all second molars erupted (15-30 years). The sample size was calculated based on the mean and standard deviation values from Bolton's study [3]. The individuals were selected at random from the department's retrospective data. Pre-orthodontic treatment casts were chosen based on the following criteria: all permanent teeth in both arches, no mesio-distal or occlusal abrasions, caries, restorations, dental prosthesis, tooth anomalies, and patients whose case histories revealed that they were born in Central India and that their parents had lived here for many years. This study were approved by ethical committee and the IRB(Institutional Review Board) number for this study is DMIMS(DU)/IEC/2019/7985 .

The mesio-distal widths of the teeth (nearest 0.01 mm) on the study models (figure-1) were calculated using a digital calliper, and the anterior and overall ratios were calculated using Bolton's formulas [3]. The dental casts were re-evaluated by the same investigator two months later to confirm measurement accuracy, and a reliability test was conducted to the first and second values. The standard deviations were used to calculate random error.



**Figure 1- Use of digital caliper to evaluate the mesio-distal dimension.**

The range, standard deviation, and mean of the generated data were statistically examined. To discriminate between the results of the following investigation and the results of Bolton's study, an unpaired t-test was used. A paired t-test was performed to compare male and female results, and a z value was utilised to compare the results to Bolton's norms [3].

**Results:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | Minimum | Maximum | Mean | Std. Deviation |
| Sum of mandibular 6 | 62 | 29.00 | 46.00 | **36.86** | 3.69 |
| Sum of maxillary 6 | 62 | 41.00 | 55.00 | **47.44** | 3.85 |
| Anterior Ratio | 62 | 64.52 | 90.69 | **77.83** | 6.42 |
| Sum of mandibular 12 | 62 | 72.00 | 96.00 | **81.60** | 5.83 |
| Sum of maxillary 12 | 62 | 82.00 | 102.00 | **92.45** | 6.10 |
| Overall Ratio | 62 | 78.41 | 105.45 | **88.42** | 6.01 |

In males, the mean anterior ratio for males was 77.83±6.42, while the overall ratio was 88.42±6.01 (Table 1).

**Table 1: Mesio-distal tooth dimension (anterior and overall ratio) in male patients.**

In females; the mean anterior ratio was 78.88±5.13, while the overall ratio was 88.85±4.03 as shown in table 2.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | N | Minimum | Maximum | Mean | Std. Deviation |
| Sum of mandibular 6 | 63 | 28.20 | 42.00 | **34.28** | 2.56 |
| Sum of maxillary 6 | 63 | 38.80 | 49.60 | **43.66** | 2.34 |
| Anterior Ratio | 63 | 67.78 | 87.50 | **78.88** | 5.13 |
| Sum of mandibular 12 | 63 | 71.20 | 96.00 | **78.00** | 4.71 |
| Sum of maxillary 12 | 63 | 82.00 | 99.00 | **87.80** | 3.59 |
| Overall Ratio | 63 | 80.90 | 96.96 | **88.85** | 4.03 |

**Table 2: Mesio-distal tooth dimension (anterior and overall ratio) in female patients.**

Table 3 shows Statistically, a significant difference was found when mean of anterior ratio, the overall ratio for female was compared with norms given in Bolton's analysis; using z value which was 2.74 and 2.28 respectively.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | N | Minimum | Maximum | Mean | Std. Deviation | z-value |
| Sum of mandibular 6 | 63 | 28.20 | 42.00 | **34.28** | 2.56 |  |
| Sum of maxillary 6 | 63 | 38.80 | 49.60 | **43.66** | 2.34 |  |
| Anterior Ratio | 63 | 67.78 | 87.50 | **78.88** | 5.13 | **2.74, S** |
| Sum of mandibular 12 | 63 | 71.20 | 96.00 | **78.00** | 4.71 |  |
| Sum of maxillary 12 | 63 | 82.00 | 99.00 | **87.80** | 3.59 |  |
| Overall Ratio | 63 | 80.90 | 96.96 | **88.85** | 4.03 | **2.28,S** |

**Table 3: of Anterior ratio and overall ratio comparison in female patients with norms given by Bolton for female patients.**

As shown in table 4 by using Student’s unpaired t-test statistically significant difference was found in the mean sum of mandibular six and among gender (t=3.20, p-value=0.002) mean sum of maxillary six and among gender (t=4.70, p-value=0.0001). The mean sum of mandibular twelve and the mean sum of maxillary twelve for male patients was 81.60±5.83 and92.45 ±6.10, for female patients it was78.00 ±4.71 and 87.80±3.59.

By using Student’s unpaired t-test statistically significant difference was found in the mean sum of mandibular twelve and among gender (t=2.64, p-value=0.011) mean sum of maxillary twelve and among gender (t=3.70, p-value=0.00001). Mean sum of anterior ratio and overall ratio for male patient was 77.83±6.42 and 88.42±6.01 and for female patients was 78.88±5.13 and 88.85±4.03.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Bolton Analysis | Male | | Female | | t-value | p-value |
| Mean | Std.  Deviation | Mean | Std.  Deviation |
| Sum of mandibular 6 | 36.86 | 3.69 | 34.28 | 2.56 | 3.20 | 0.002, S |
| Sum of maxillary 6 | 47.44 | 3.85 | 43.66 | 2.34 | 4.70 | 0.0001, S |
| Anterior Ratio | 77.83 | 6.42 | 78.88 | 5.13 | 0.70 | **0.48, NS** |
| Sum of mandibular 12 | 81.60 | 5.83 | 78.00 | 4.71 | 2.64 | 0.011, S |
| Sum of maxillary 12 | 92.45 | 6.10 | 87.80 | 3.59 | 3.70 | 0.00001, S |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Overall Ratio | 88.42 | 6.01 | 88.85 | 4.03 | 0.33 | **0.73, NS** |

**Table 4: Comparison of the mesio-distal dimension (anterior ratio and overall ratio) between male and female patients.**

By using Student’s unpaired t-test statistically non-significant difference was found in the mean sum of anterior ratio and among gender (t=0.70, p-value=0.48). By using Student's unpaired t-test statistically non-significant difference was found in the mean sum of overall ratio and among gender (t=0.33, p-value=0.73).

**Discussion:**

Negroids exhibited consistently larger total and anterior ratios in males than Caucasoids and Mongoloids, according to Lavelle et al [5]. An inter-maxillary ratio study has been proposed by authors [6-9] to investigate tooth size disparities in the Indian population. In their investigation, Lavelle [5] and Smith [10] found a difference in the mesio-distal dimension of teeth in male and female patients. Smith [10] analysed three populations and questioned about the applicability of Bolton [4] for all populations.

The anterior and overall ratios for males were 77.83±6.42 and 88.42±6.01 respectively, while females were 78.88±5.13 and 88.85±4.03 respectively in the following study.

Furthermore, Bolton [3] did not take into account the gender distribution in the sampled population. Males had a much higher overall ratio, according to Smith et al [10].

When male and female patients were compared in the next study, there was no significant difference detected. Males and females had significantly different means for the sum of maxillary and mandibular, six and twelve teeth, indicating a wide range in mesio-distal dimension in teeth.

Another flaw in Bolton's [3] study was that only Caucasian ladies with good occlusion were assessed. 44 of the 55 instances had orthodontic treatment, whereas 11 had non-orthodontic treatment. While Bolton's [3] ratio was only used for white females and not for white males, blacks, or Hispanics, the overall ratio was consistently greater in females.

When the female sample was compared to Bolton [3] norms in the following analysis, a significant disparity in the anterior and overall ratio was discovered. The use of Bolton's [3] standards for harmonious dentition in general is currently being debated, and they may not be appropriate to other groups.

Several studies [6-9] have documented differences in mesio-distal tooth width in crowded and aligned arches around the world based on malocclusion, demographic, and gender. Bolton [3] only created two ratios: maxillary and mandibular anterior and total. As a result, more research is needed to develop norms for mesio-distal tooth width for a variety of dental and skeletal malocclusions.

**Conclusion:**

Bolton's [3] norms for the Caucasian female population were significantly different from the values reported for the Central India group. Significant values for anterior and overall ratios were found when the population of Central India was compared to that of other Indian populations [7-10]. As a result, certain guidelines are necessary for proper treatment planning as well as long-term stability and retention. As a result, the current statistics for the Central India population should be considered before considering any orthodontic treatment.

**References:**

1. JC, McLaughlin RP. Orthodontic Treatment Mechanics and the Pre adjusted Appliance. London: Wolfe Medical Publishing; 1993.
2. Peck S, Peck H. Crown dimension and mandibular incisor alignment. Angle Orthod.42:148-153,1975.
3. Bolton WA. Disharmony in tooth size and its relation to the analysis and treatment of malocclusion. Angle Orthod 1958;28:113-130.
4. Lundstrom A. Intermaxillarey tooth width ratio and tooth alignment and occlusion. Acta odontol scand 1955; 12:265-92.
5. Lavelle CL. Maxillary and mandibular tooth size in different racial groups and in different occlusal categories.Am J Orthod 1972;61:29 37.
6. Saritha T, Sunitha C, Kumar P K, Naveen R. Applicability of bolton's analysis to a South Telangana population. Indian J Dent Sci 2017;9:225-32.
7. Jindal R, Bunger E. Bolton's intermaxillary tooth size ratios among school going children in Punjab population. Indian J Oral Sci 2013;4:110-3.
8. Shastri D, Singh A, and Tandon P, Bolton ratio in a North Indian population with different malocclusion. J Orthod Sci. 2015 Jul-Sep; 4(3): 83–85.
9. Patel YV, Nair VS, Jamenis SC. Bolton analysis of the maratha population in Pune. J Dent Allied Sci 2017;6:8-11.
10. Smith SS, Buschang PH, Watanbe E. Interarch tooth size relationship of 3populations: “dose Bolton’s analysis apply?” .Am J Ortho Dento Facial Orthop 2000;117:169-74.