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TOOTH SIZE DISCREPANCY IN ORTHODONTIC PATIENTS AMONG DIFFERENT MALOCCLUSION GROUPS IN COIMBATORE (INDIAN)POPULATION- AN OBSERVATIONAL STUDY

Dr. J. Preethi[1]*, Dr. R. Chandrasekar[2] Dr. A S Apros Kanna[3]

[1]*Postgraduate student, Sri Ramakrishna Dental College and Hospital, Peelamedu, Coimbatore
[2]Professor & HOD, Sri Ramakrishna Dental College and Hospital, Peelamedu, Coimbatore
[3]M.D.S, Reader, Sri Ramakrishna Dental College and Hospital, Peelamedu , Coimbatore

***Corresponding Author:** Dr. J. Preethi
*Postgraduate student, Sri Ramakrishna Dental College and Hospital, Peelamedu, Coimbatore

ABSTRACT:

BACKGROUND:

Tooth size discrepancies and their absence is considered as the seventh key of an ideal occlusion. The effects of these discrepancies on the occlusion can be determined by measuring the mesio-distal widths of the upper and lower teeth. Bolton's method calculates the amount of tooth size discrepancies based on sum of the mesiodistal widths of the maxillary and mandibular teeth and substitutes those values in a mathematical formula. Since, the Bolton's method was initially developed based on the normal occlusion of the Caucasian population, their applicability in different malocclusions and populations needs to be studied further.

AIM: The aim of this present study is to assess tooth size discrepancies among individuals with Class I, Class II, and Class III malocclusions in the Coimbatore population using Bolton's analysis.

MATERIALS AND METHOD: This observational study was carried out in 150 pretreatment study casts of individuals, aged in the range 13-24 years with no history of previous orthodontic treatment. Included patients were divided into four Angle's malocclusion groups; Class I; Class II division 1; Class II Division 2; and Class III. Anterior, posterior and overall ratios were calculated and the values obtained were tabulated and then statistically analysed. Percentage of mean values of measured ratios that falls within the 2 Standard Deviation of Bolton's ratio was also noted. The level of significance was set at 95 % confidence interval ($p < 0.05$)

RESULTS: The mean value of overall ratios were 91.14 ± 3.52, 90.94 ± 4.82, 89.62 ± 3.10, and 90.51± 3.89 for Angle's Class I, Class II Division 1, Class II Division 2, and Class III malocclusions, respectively. Similarly, Anterior ratios were 77.47 ± 6.58, 76.97 ± 6.27, 76.17 ± 8.93, 75.32 ± 6.01, for Angle's Class I, Class II Division 1, Class II Division 2, and Class III malocclusions, respectively. Posterior ratios for the were 104.29 ± 6.46, 105.82 ± 6.45, 102.85 ± 9.13, and 106.2 ± 15.01 for Angle's Class I, Class II Division 1, Class II Division 2, and Class III malocclusions, respectively. The amount of TSD that was outside the Bolton's ratio was described in percentages as 68% for ± 1 SD, 31 % for ± 2 SD, and 1% for > 2 SD.

CONCLUSION: The results of this study suggests that the mean values for anterior, posterior, and overall ratios were similar to that of established Bolton's ratio, thereby stating the applicability of the ratios with modified values specific to Coimbatore population. It is necessary for the clinicians to use Bolton's ratio in their practice as it would aid in providing better treatment outcome and meet the treatment expectation by both the orthodontist and the patient. Although variations exist among different population, future studies should be directed towards assessing the variability of these ratios and formulating values specific to a population.

KEY WORDS: Tooth size discrepancy, Malocclusion, Bolton's ratio, Digital Vernier Calliper,

Diagnosis, and Treatment planning.

INTRODUTION:

Orthodontics deals with the growth and development of the face, jaw, and dentition, as well as the prevention and repair of occlusal abnormalities or anomalies. It has been demonstrated that maintaining good dental alignment is crucial for maintaining oral health and for restoring an individual's appearance and functionality. Teeth that are malpositioned or misaligned can result in a number of undesirable outcomes, such as poor oral cleanliness, which increases the risk of dental caries and periodontal disease, abnormalities in function, psychological issues like aesthetic concerns, and temporomandibular joint problems. [1].

Malocclusion can have a strong impact on psychological aspect due to its aesthetic value on smile as well as face [2]. Social contacts are made by humans through face and smile, and perceptions of these can potentially impact the self-esteem of an individual negatively [3]. Orthodontic treatment is commonly undertaken by the patients for improvement in esthetics thereby subsequently enhancing their overall psycho-social well-being, although this concept remains debatable [4].

Success of an excellent orthodontic treatment is in obtaining ideal intercuspation with optimal occlusion [5]. It is necessary that the maxillary and mandibular teeth should exist in a specific relationship with each other to ensure proper occlusion with ideal overjet and overbite [6]. Bonwill [7] suggested a nature theory based on measurements on 6000 skulls and 4000 living persons. It states that "nature itself brings proposition and the proposition of the upper teeth to lower teeth are exact as any". Edward Angle utilized this nature theory in early orthodontics where non-extraction method was widely practiced.

In order to achieve a normal occlusion, various skeletal, dental, and soft tissue factors are involved. This was studied by Andrews who stated that there are six significant characteristics exists for achieving ideal occlusion [7]. Later a seventh character, named equitable tooth size proportion was added by Bennett and Mclaughlin [8]. Difference between the tooth size in upper and lower arch was not expressed until 1949 after which *anterior coefficient* by Neff was developed [9]. He compared the widths of the anterior teeth in upper and lower arch and derived a coefficient based on the overbite level noted at the incisor level. Mandibular incisor crown height of 20% overlapped when an ideal coefficient of 1.20 to 1.22 was noted [9].

Tooth size was described initially as mesiodistal width of the tooth. Any relative excess of tooth structure in an arch related to other arch or degree of disproportion among the size of individual teeth is termed as tooth size discrepancy (TSD) [10-11]. Emphasis of TSD is being considered by orthodontists as a significant diagnostic element in relating maxillary and mandibular arches [12]. Proper occlusion cannot be achieved in the presence of single or multiple TSD in the arch leading to spacing, crowding, abnormal overjet or overbite, and poor contacts of teeth [13].

Determining TSD before initiation of orthodontic therapy is useful for orthodontist in preparing a treatment plan that takes TSD into account during the treatment rather than trying to manage it later. Mesiodistal widths of the teeth were primarily investigated by GV Black [14]. He set up a table of mean dimensions based on measurement on large number of teeth that is still being used as reference today. Later, Young et al., [15] assessed the intermaxillary teeth width ratio in occlusion followed by Gilpatric et al., [16] who concluded that the width of maxillary arch was 8-12 mm wider than that of lower arch. Later many other methods had been suggested by authors to account the proportion of the tooth its inter-arch relationship [17-20].

Bolton's method [19] is the commonly employed method to assess the TSD which was based on his investigation on 55 individuals with excellent occlusion out of which 44 were orthodontically treated and remaining 11 who were left untreated. He gave an overall index (OI) which is the percentage of aggregated widths of 12 mandibular teeth divided by the aggregated widths of 12 maxillary teeth. Similarly, another index was derived named anterior index (AI), which is the percentage of

aggregated widths of 6 mandibular anterior teeth divided by the aggregated widths of 6 mandibular anterior teeth. An overall ratio of 91.3% for OI and 77.2% for AI is required for an ideal intercuspation between maxillary and mandibular teeth [19]. TSD can be classified into two types; Anterior TSD that involves six anterior teeth; and Overall TSD that involves all teeth except second and third permanent molars. It was found that anterior TSD were noted in the range of 4-11% [13, 21-23] and overall TSD being in the range of 17-38% [12-13, 21, 24-25] in patients undergoing orthodontic therapy. TSD can also vary among different ethnicities and gender which was studied by some of the researchers [6, 14, 21, 26-28]. Hence, application of a standard value cannot be applied for other population as differences exist in dentition of individual.

Assessment of TSD can be either carried out manually by measuring the mesio-distal widths of teeth using vernier caliper [14] or digitally by utilizing computer software packages that calculates the tooth size ratios automatically [29]. Digital study models are proven to be more appropriate alternative to conventional plaster models for measuring TSDs [30].

Obtaining an ideal occlusion is one of the main treatment outcomes in formulating a treatment plan in Orthodontics. A literature review was carried out by Jabri et al.,[31] to assess the relationship between various malocclusion group and TSD. A total of 66 article were selected for review and it was concluded that many investigators found no significant differences between TSD and angles malocclusion group (Class I, II, and III). They also found an inadequacy of data on relating TSD to subgroups of Angles' classes of malocclusion [31].

Hence, the present study was proposed in order to assess the population specific tooth size discrepancy measured as anterior, posterior and overall ratios according to Bolton's analysis and to correlate them with Angles class I, II, and III malocclusion to determine any relations exist between TSD and malocclusion types.

INCLUSION CRITERIA:

Patients included in this study were based on the following criteria

1. Study models of patients belonging to Coimbatore belonging to 13-24 years.
2. Pre treatment models of good quality
3. Presence of dentition from second molar to second molar on both the arches
4. Absence of any tooth deformities or alterations in size of teeth
5. Absence of mesiodistal and occlusal abrasions, caries, class II restorations, or crowns in teeth from first molar to first molar.
6. No history of previous orthodontic treatment.

EXCLUSION CRITERIA:

The exclusion criteria for this study are

1. Presence of gross restorations, restorative build-ups, inlays, onlays, class II restorations (amalgam or composite) that affects the mesio-distal dimensions of the tooth.
2. Congenital deformities that alter the size of the teeth.
3. Congenitally missing or missing tooth due to extraction or exfoliation from second molar to second molar in ether arches.
4. Occlusal or interproximal wear of the tooth due to attrition
5. Presence of crowns or prosthesis.

MATERIALS AND METHODS:

1. Tropicalgin Alginate impression material
2. Upper and lower dentulous impression trays
3. Orthodontic stone class III
4. Base former for models
5. Dental plaster class III

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6. Digital Vernier caliper

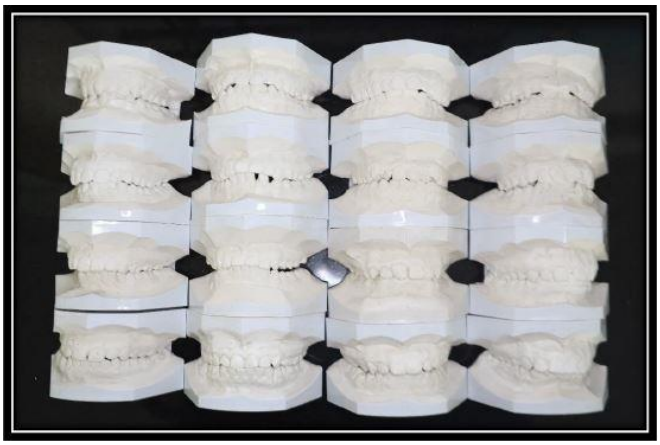


Figure 1: Sample models of various Malocclusion patients

Figure 2: Digital Vernier caliper for measuring mesiodistal dimensions

150 clinically diagnosed cases of malocclusion according to Angle (Class I, Class II division 1, Class II division 2, and Class III) were selected after meeting the inclusion and exclusion criteria. Alginate impressions were taken and then dental cast models were made by pouring orthodontic stone. Base former was used to create a base for dental cast model with help of dental plaster (Figure 1). Digital Vernier caliper (Figure 2) was used to measure the size of the tooth from second molar to second molar on both the arches after calibrating it to nearest 0.01 mm.

BOLTON'S ANALSYIS:

Mesiodistal width (MD) of each tooth was measured at the greatest interproximal dimension from mesial contact point to the distal contact point was performed by a single observer as described by **Moorees et al., (1957)** (Figure 3). Based on the measurements obtained, Bolton's anterior, posterior and overall ratio were calculated by substituting the values in the formulas mentioned below.

$$\text{Anterior ratio:} \quad \frac{\text{MD values from 33-43}}{\text{MD values from 13-23}} * 100$$

$$\text{Posterior ratio:} \quad \frac{\text{MD values from 36-34 + 46-44}}{\text{MD values from 16-24 + 26-24}}$$

$$\text{Overall ratio:} \quad \frac{\text{MD values from 36-46}}{\text{MD values from 16-26}} * 100$$

Tooth size discrepancies obtained were compared between males and females in Angle's Class I,

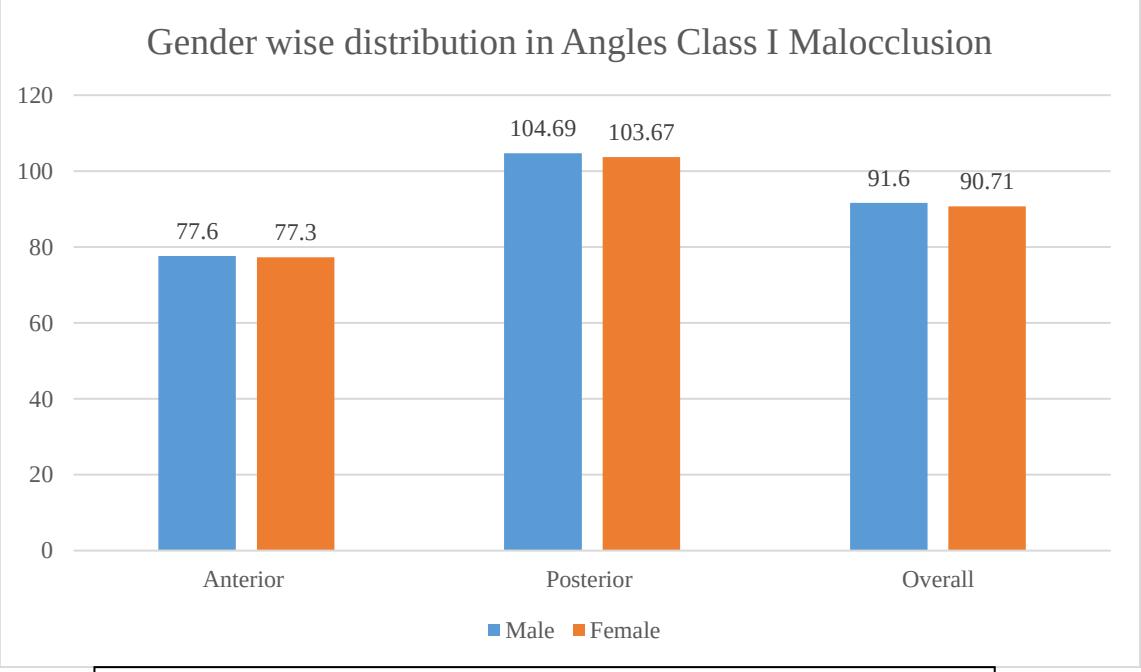
Class II division 1, Class II division 2, and Class III malocclusion cases. The incidence of significant discrepancies outside 2 SD of Bolton's mean was assessed for each malocclusion group. Hence, a significant discrepancy for the assessed samples was as follows

1. Anterior ratio : Ratio below 73.9 and above 80.5
2. Overall ratio : Ratio below 87.5 and above 95.1

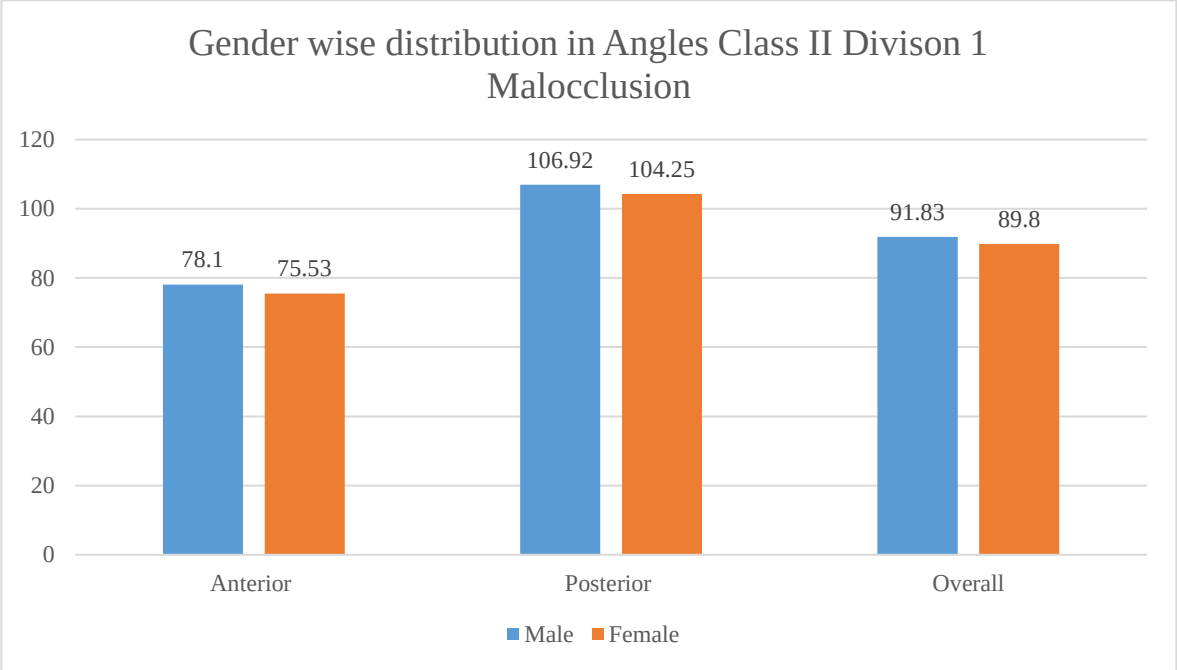
STATISTICAL ANALYSIS:

The data were entered in Microsoft Excel and analysed statistically using the SPSS software, version 21; SPSS Inc., (Chicago, IL, USA). The normality of the data was assessed prior to analysis using the Shapiro-Wilk's test/Kolmogorov-Smirnov test. Parametric test was chosen as the data were normally distributed. Descriptive statistics were used to calculate mean and standard deviation values of TSD for anterior, posterior, and overall ratio. Frequencies, and percentages were used to assess the deviation from 2 SD of Bolton's mean. Independent *t* test was performed to determine the mean differences in the overall, anterior, and posterior ratio for males and females with respect of maxillary and mandibular arches. Repeated measures ANOVA followed by Scheffe's post hoc test were carried out compare the mean differences between the groups. All statistical tests were performed at a significance level of 5% ($p < 0.05$)

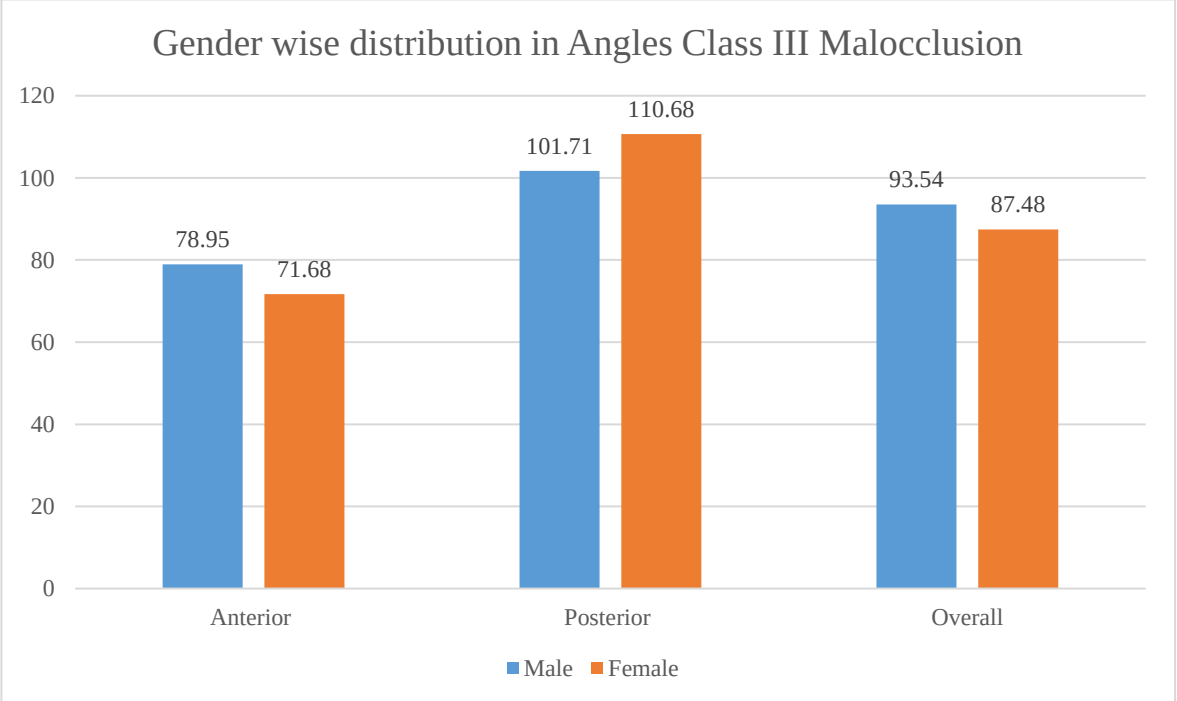
Data regarding the malocclusion groups and the ratios obtained from Bolton's analysis were entered in Microsoft Excel and analysed statistically using the SPSS software, version 21; SPSS Inc., (Chicago, IL, USA). The normality of the data was assessed prior to analysis using the Shapiro-Wilk's test/Kolmogorov-Smirnov test. Data were found to be normally distributed. Thus, parametric test was chosen. Descriptive statistics were used to calculate frequencies, percentages, and mean values. Student *t* test was performed to assess the tooth size discrepancies among males and females of the included samples belonging to various malocclusion groups. One-way ANOVA followed by Scheffé's post-hoc test was carried out to compare the tooth size discrepancies among various groups. Also, amount of discrepancy outside the 2-standard deviation (2 SD) of the anterior, posterior, and overall ratio were calculated for the included samples. All statistical tests were performed at a significance level of 5% ($p < 0.05$).



Graph 1: Mean Values of Tooth size discrepancies in males and females of Class I Malocclusion group.



Graph 2: Mean Values of Tooth size discrepancies in males and females of Class II Division 1 Malocclusion group.



Graph 3: Mean Values of Tooth size discrepancies in males and females of Class III Malocclusion group.

The mean values for males and females are plotted in the bar diagram with their mean values for overall, anterior, and posterior ratios. It is noted that mean values of overall, anterior, and posterior ratio were comparable higher in males compared to females in Class I, Class II division 1, Class II division 2, and Class III malocclusion which is depicted in the Graph 1,2 and 3 respectively.

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Comparison of mean and standard deviation for anterior, posterior and overall tooth discrepancy ratios for various malocclusion groups were assessed using one-way ANOVA test. No statistically significant difference was noted for overall samples with p value being greater than 0.9 for most of the included samples. Minimum and maximum value for anterior, posterior and overall ratio along with mean and standard ratio for Class I, Class II division 1, Class II division 2, and Class III malocclusion is described in Table 1

Table 1: Mean and Standard deviation for anterior, posterior and overall tooth discrepancy for overall sample among different group of malocclusions.

Malocclusion	Parameter	n	Descriptive measurement				p Value
			Mean	S.D	Minimum	Maximum	
Class I	Overall Ratio	78	91.14	3.52	80.2	102	0.99
	Ant Ratio		77.47	6.58	39.29	89.70	0.97
	Post Ratio		104.29	6.46	80.81	126.74	0.68
Class II Div 1	Overall Ratio	59	90.94	4.82	70.82	100	0.97
	Ant Ratio		76.97	6.27	61.50	88.30	0.97
	Post Ratio		105.82	6.45	90.73	127.11	0.68
Class II Div 2	Overall Ratio	3	89.62	3.10	87.41	93.16	0.94
	Ant Ratio		76.17	8.93	66.6	84.3	0.99
	Post Ratio		102.85	9.13	92.31	108.25	1.0
Class III	Overall Ratio	10	90.51	3.89	83.60	96.45	0.97
	Ant Ratio		75.32	6.01	61.5	81	0.81
	Post Ratio		106.2	15.01	79.07	140.56	0.90

Mean values of females were found to be lesser than that of males in all malocclusion groups and ratios except for posterior ratio in Class III malocclusion with no statistically significant differences. Mean values of overall, anterior and posterior ratio in various malocclusion groups for males and females is described in Table 2.

Table 2: Mean and Standard deviation for anterior, posterior and overall tooth discrepancy for Males and Females among different group of malocclusions.

Malocclusion	Parameter	Descriptive measurement				p Value
		Male		Female		
		Mean	S. D	Mean	S. D	
Class I	Overall Ratio	91.6	3.07	90.71	3.89	0.26
	Ant Ratio	77.6	7.6	77.3	5.55	0.87
	Post Ratio	104.69	4.68	103.67	7.83	0.60
Class II Div 1	Overall Ratio	91.83	5.25	89.80	3.30	0.11
	Ant Ratio	78.1	5.69	75.53	6.80	0.13
	Post Ratio	106.92	6.83	104.25	5.39	0.13
Class II Div 2	Overall Ratio	93.16	-	87.86	0.63	0.09
	Ant Ratio	77.63	-	75.45	12.52	0.91
	Post Ratio	108	-	100.3	11.27	0.68
Class III	Overall Ratio	93.54	1.75	87.48	2.82	0.00*
	Ant Ratio	78.95	1.83	71.68	6.71	0.04*
	Post Ratio	101.71	12.82	110.68	17.08	0.37
Malocclusion	**Parameter**	**Descriptive measurement**				**p Value**
		Male		**Female**		
		Mean	**S. D**	**Mean**	**S. D**	
Class I	Overall Ratio	91.6	3.07	90.71	3.89	0.26
	Ant Ratio	77.6	7.6	77.3	5.55	0.87
	Post Ratio	104.69	4.68	103.67	7.83	0.60
Class II Div 1	Overall Ratio	91.83	5.25	89.80	3.30	0.11

	Ant Ratio	78.1	5.69	75.53	6.80	0.13
	Post Ratio	106.92	6.83	104.25	5.39	0.13
Class II Div 2	Overall Ratio	93.16	-	87.86	0.63	0.09
	Ant Ratio	77.63	-	75.45	12.52	0.91
	Post Ratio	108	-	100.3	11.27	0.68
Class III	Overall Ratio	93.54	1.75	87.48	2.82	0.00*
	Ant Ratio	78.95	1.83	71.68	6.71	0.04*
	Post Ratio	101.71	12.82	110.68	17.08	0.37

Table 3 – Oneway ANOVA – Anterior, posterior and overall ratio for malocclusion groups.

Group	Malocclusion	N	Anterior ratio			Posterior ratio			Overall ratio		
			Mean	S.D	p Value	Mean	S.D	p Value	Mean	S. D	p Value
Group A	Class I	78	77.47	6.58	0.97	104.29	6.46	0.69	91.14	3.51	0.99
Group B	Class II Div I	59	76.97	6.27	0.98	105.82	6.45	0.69	90.94	4.82	0.99
Group C	Class II Div II	3	76.17	8.94	0.99	102.85	9.13	0.99	89.62	3.09	0.94
Group D	Class III	10	75.31	6.01	0.81	106.20	15	0.90	90.51	3.89	0.98

Discrepancies outside the 1 and 2 standard deviations of Bolton's analysis was assessed specific to population assessed. For anterior discrepancies, mean value of 77.1 was obtained as the mean value. Discrepancies outside this mean value for ± 1 S.D were in the range of 70.67 - 77.0 and 77.1 - 83.53.

Similarly, the value range of ± 2 S.D were 64.24 – 70.66 and 83.54-89.96. Frequency of patients within ± 1 S.D were 68% and within ± 2 S.D were 31%. The remaining 1% of the assessed samples were either <64.24 or >89.96. The values of anterior discrepancy outside the standard deviation are described in Table 3.

Table 4 percentage distribution of anterior discrepancies outside 1 or 2 standard deviations (SD).

Group	Class	Outside 2 S.D%	2 S.D (%)	1 S.D (%)	Mean	1 S.D (%)	2 S.D (%)	Outside 2 S.D (%)
		<64.24	64.24 – 70.66	70.67- 77.0	77.1	77.1-83.53	83.54-89.96	>89.96
A	Class I	0.5	15.5	34	77.47	34	15.5	0.5
B	Class II Div I	0.5	15.5	34	76.96	34	15.5	0.5
C	Class II Div II	0.5	15.5	34	76.18	34	15.5	0.5
D	Class III	0.5	15.5	34	75.32	34	15.5	0.5

Similarly, discrepancies for posterior ratio was assessed. Mean value of 105.27 was obtained and any deviations from this were considered as discrepancy. Discrepancies outside this mean value for ± 1 S.D were in the range of 103.28 - 105.26 and 105.27 - 107.26. The value range of ± 2 S.D were 101.29 – 103.27 and 107.27 - 109.25. Frequency of patients within ± 1 S.D were 68% and within ± 2 S.D were 31%. The remaining 1% of the assessed samples were either < 101.28 and >109.25. The values of anterior discrepancy outside the standard deviation are described in Table 4.

Also, discrepancies for overall ratio was assessed. Mean value of 91.30 was obtained and any deviations from this were considered as discrepancy. Discrepancies outside this mean value for ± 1 S.D were in the range of 89.93 - 91.29 and 91.31 - 93.21. The value range of ± 2 S.D were 87.48 – 89.92 and 93.22 - 95.12. Frequency of patients within ± 1 S.D were 68% and within ± 2 S.D were 31%. The remaining 1% of the assessed samples were either < 87.47 and > 95.13. The values of overall discrepancy outside the standard deviation are described in Table 5.

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Table 5 percentage distribution of posterior discrepancies outside 1 or 2 standard deviations (SD).

Group	Class	Outside 2 S.D%	2 S.D (%)	1 S.D (%)	Mean	1 S.D (%)	2 S.D (%)	Outside 2 S.D (%)
		< 101.28	101.29 – 103.27	103.28- 105.26	105.27	105.27-107.26	107.27-109.25	>109.25
A	Class I	0.5	15.5	34	104.29	34	15.5	0.5
B	Class II Div I	0.5	15.5	34	105.82	34	15.5	0.5
C	Class II Div II	0.5	15.5	34	102.86	34	15.5	0.5
D	Class III	0.5	15.5	34	106.20	34	15.5	0.5

Table 6 percentage distribution of total discrepancies outside 1 or 2 standard deviations (SD).

Group	Class	Outside 2 S.D%	2 S.D (%)	1 S.D (%)	Mean	1 S.D (%)	2 S.D (%)	Outside 2 S.D (%)
		<87.47	87.48 – 89.92	89.93- 91.29	91.30	91.31-93.21	93.22-95.12	>95.13
A	Class I	0.5	15.5	34	91.14	34	15.5	0.5
B	Class II Div I	0.5	15.5	34	90.94	34	15.5	0.5
C	Class II Div II	0.5	15.5	34	89.62	34	15.5	0.5
D	Class III	0.5	15.5	34	90.52	34	15.5	0.5

DISCUSSION:

Success of orthodontic treatment depends upon comprehensive diagnosis and treatment planning. There are certain factors like condition of spacing, tooth size, arch form and its dimensions, crowding etc. that should be considered in diagnosis before initiating orthodontic treatment.(32).

Proportionality of tooth size is essential to develop a good and proper occlusion. Maxillary and mandibular teeth should exist in specific dimensional relationship to have proper interdigitation, overjet as well as overbite.(6) Any relative excess of tooth structure in an arch in relation to other arch, is described as tooth size discrepancy (TSD) (10,11). TSD is one of the causative factors that causes inadequate relationship between maxillary and mandibular teeth.

An important variable in the anterior segment is TSD. It was stated by Proffit et al., [10] that, the commonest cause of tooth discrepancies is due to the size of the lateral incisors, although it could be due to variations of other teeth. Lavelle et al., [28] proposed that, the orthodontists paid least attention to tooth size and proportion which plays a vital role in malocclusion. It was also noted that about 5% of the people have TSD.

Although various methods exist to measure the TSD, Bolton's method [19] that uses a versatile mathematical calculation is applicable to all circumstances where the proportion of maxillary and mandibular tooth material is assessed. Bolton's ratio is an essential tool in diagnosis as well as planning of orthodontic treatment to obtain esthetic and functional outcome following orthodontic treatment.

Bolton's analysis is often overlooked by clinicians during clinical examinations owing to the nature that it requires calculations and use of tables that may or may not be available at the time of patient care. When questioned about the use of Bolton's analysis in their daily practice by a study [33], results revealed only less than half of the participants (47%) used it. This states the need of application of Bolton's ratio in generating the treatment plan and management according to it.

Gender differences is noted in teeth similar to other human attributes. Also, Bolton's ratio differs among different geographical locations. Both these were in disagreement in relation to the TSD. In a sample of 65 Saudi subjects, Tamimi and Hashim et al., [34] found no sexual dimorphism regarding the tooth size.

This was in concordance to this study, where there were no statistically significant differences noted for males and females for anterior, posterior, and overall ratio in Angle's Class I, Class II Division 1, Class II Division 2, and Class III malocclusion patients. Results revealed that the males had higher mean values for all the ratios except for posterior ratio in Class III malocclusion group.

Anterior, posterior, and overall ratios were assessed for various malocclusion groups and mean ratio value for which malocclusion group is more were compared. A tendency for increased Bolton's ratio was noted for Class III malocclusion in many studies that have reported in the past [12, 13, 23, 35,36, 37,38]. Contrary to these findings, in this study the overall and anterior ratio were higher in Class I malocclusion patients, and the posterior ratio was higher in Class III malocclusion patients, especially in females with no statistically significant differences ($p = 0.37$).

Studies reporting the evaluation of anterior, posterior, and overall ratios of Bolton's analysis are very minimal. In a study by Strujić et al.,[23] the three ratios were compared among Angle's Class I, Class II, and Class III malocclusion patients.

In order to determine the clinical significance of TSD, the frequency of TSD outside 2 SD from obtained Bolton's mean values specific to Coimbatore population was assessed for anterior, posterior, and overall ratios. It was noted that 31% of the included samples fell within the range of ± 2 SD irrespective of the sex, type of malocclusion, and the Bolton's ratio in the overall sample. This result was contrary to those reported in literature where overall ratios were 9.5% [39], 11% [21], 13.4% [25], and 15.3% [40] respectively. that was reported in various populations. Posterior ratio outside 2 SD was reported only in two studies where the values of 7% [41], and 8% [5] respectively is way less than reported percentage in this study.

Application of these ratios in clinical practice signifies the importance of TSD which clinicians seldom pay attention to. Present study revealed that the tendency of TSD is equal for all the included samples of various malocclusions. Studies conducted among various diverse population is essential to draw a conclusion about ideal Bolton's ratio for a specific sample to aid in diagnosis, treatment planning as well as predicting the prognosis of the orthodontic treatment.

CONCLUSION:

From this study it can be concluded that

- There were no statistically significant differences between males and females in respect to anterior, posterior, and overall ratios for Class I, Class II Division 1, Class II Division 2, and Class III malocclusion patients proving that sexual dimorphism does not exist.
- The mean values for overall, anterior, and posterior ratios were higher in Class II division 1 patients with no statistically significant differences comparing various malocclusion groups.
- It was found that the TSD within ± 2 SD for anterior, posterior and overall ratios were equal (31%) and the values greater than 2 SD (1%) were also same for all the ratios.
- The mean values for anterior, posterior, and overall ratios were similar to that of established Bolton's ratio, thereby stating the applicability of the ratios with modified values specific to Coimbatore population.

Being the Seventh key of occlusion, as mentioned by McLaughlin, Bolton's analysis is recommended for the clinicians to use it routinely in their practice that would aid in providing better treatment outcome and meet the treatment expectation by both the orthodontist and the patient. Future studies should be carried out in different populations to assess the diversity of the Bolton's ratio and to formulate a population specific database that aids in delivering utmost and appropriate orthodontic care to the patients.

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