EAS Journal of Dentistry and Oral Medicine
Abbreviated Key Title: EAS J Dent Oral Med
ISSN: 2663-1849 (Print) & ISSN: 2663-7324 (Online)
Published By East African Scholars Publisher, Kenya

OPEN ACCESS

Volume-5 | Issue-5 | Sep-Oct-2023 | DOI:10.36349/easjdom.2023.v05i05.002

Original Research Article

Association between Bolton Analysis and Dentoskeletal Parameters of Patients with Malocclusion

Carlos Alberto López-Contreras (DDS)[1*], Guillermo Pérez-Cortez (DDS, MSC)[2], Tely Adriana Soto-Castro (DDS, MSC)[3], Maikel Hermida-Rojas (DDS, MSC, PhD)[4], Fernanda Itatí Ramírez-Ruíz (DDS)[1]

[1]Dentist, Resident of the Orthodontics Program, Mexicali Dental School, Universidad Autónoma de Baja California, Mexico
[2]Professor, Dean of the Dental School of Mexicali, Universidad Autónoma de Baja California, Mexico
[3]Professor, Coordinator of University Extension and Liaison, Dental School of Mexicali, Universidad Autónoma de Baja California, Mexico
[4]Professor, Research and Postgraduate Coordinator, Dental School of Mexicali, Universidad Autónoma de Baja California, Mexico

Article History
Received: 19.08.2023
Accepted: 30.09.2023
Published: 03.10.2023

Journal homepage:
https://www.easpublisher.com

Quick Response Code

Abstract: The mesiodistal diameter of the teeth must be considered during orthodontic diagnosis; the implementation of measurement tools has made it possible to classify each patient into parameters that determine their treatment needs. The aim of this study is to analyze the association between the Bolton Index and dentoskeletal parameters in patients who come to receive orthodontic treatment at the University Polyclinic of the Mexicali Faculty of Dentistry of the Autonomous University of Baja California. A cross-sectional analytical observational study was carried out. The sample consisted of 45 initial plaster models that met the inclusion criteria. The models were measured to obtain the Bolton Index. Lateral skull radiographs were plotted to determine skeletal class according to Steiner's cephalometric analysis. The data were collected and tabulated in Microsoft Excel 365. A two-factor analysis of variance was performed with several samples per group to determine the association between the Bolton Index with dentoskeletal parameters and sex. To compare the mesiodistal measurements of the teeth, a test was performed. hypothesis for a two-tailed mean difference where the normal distribution was used in both with a significance level of α=0.05. No statistically significant results were found between the values of the analysis of variance and the normal distribution value with a confidence interval of α=0.05. In conclusion no statistically significant difference was found between the results of the dentoskeletal parameters between men and women that determine an association with Bolton index discrepancies.

Keywords: Bolton Index, Molar Class, Skeletal Class.

INTRODUCTION

According to the World Health Organization (WHO) (1969), malocclusions are third in prevalence among oral health problems, after dental caries and periodontal disease [1].

The first classification of malocclusion was presented by Edward Angle in 1899 where he first described the variation of the molar relationship [2].

The orthodontic diagnosis must be obtained through a rigorous clinical examination which must be complemented with the use of diagnostic tools such as photographs, x-rays and the analysis of plaster models [3, 4].

Bolton's analysis was developed by Dr. Wayne Bolton in 1958. During his research on tooth size, said author made measurements of the mesiodistal width of each of the teeth in the permanent dentition, both maxillary and mandibular, starting from the first right molar to its contralateral counterpart, leaving out second and third molars, he established two indices, one which he named the anterior or partial Bolton index or anterior ratio, and the posterior or Total Bolton index or overall ratio, with average values of 77.2% and 91.3%. respectively [5].

***Corresponding Author:** Carlos Alberto López-Contreras
Dentist, Resident of the Orthodontics Program, Mexicali Dental School, Universidad Autónoma de Baja California, Mexico

Al-Gunaid and Yamaki [6] in their study, aimed to determine the average width of the mesiodistal size of the teeth and the anterior and total Bolton indices, find possible differences between sexes, study the frequency of discrepancies in the size of the teeth among the Yemeni population and establish if there were differences in the size of the teeth between the right and left sides.

The results showed that males had significantly larger teeth than females. The prevalence rates of clinically significant discrepancy greater than 2 SD were 29.53% and 14.20% in the anterior and total indices, respectively. Furthermore, the results revealed that there were no significant differences in tooth size width between the right and left sides.

Mollabashi and Soltani [7] conducted a study to determine and compare the Bolton ratio in normal occlusion and in different malocclusion groups of the Iranian population.

In their results, they obtained that the average mesiodistal size of all the teeth in the malocclusion group was significantly greater than in the normal occlusion group. Although there was no relationship between the anterior index and gender or malocclusion groups, a significant relationship was observed between the total index in Class II division 1 and normal occlusion. Furthermore, a significant difference was found between the anterior and total indices of this study and the original Bolton values.

They concluded that, in the normal occlusion group, the anterior and total indices were greater than those in Bolton's original study. Furthermore, “class II division 1" showed the lowest Bolton index values among the other normal occlusion and malocclusion groups. Therefore, the original Bolton values should be used conservatively in the Iranian population.

The development of this research is of great importance for the identification of the prevalence with which alterations occur in the size of the teeth in the Orthodontic Clinic of the Faculty of Dentistry Mexicali since, according to Pizzol (2011) 60% of orthodontic patients present alterations in the mesiodistal diameter of the teeth [8].

These alterations have been associated with multiple difficulties in the completion phases of orthodontic treatment, like crowding, unwanted overjet or overbite, among others, that may be present due to failures in the orthodontic technique or due to a discrepancy of tooth size [9, 10].

Therefore, it is essential in the diagnosis to detect discrepancies in tooth size through the use of the Bolton Index; this will allow the clinician to adapt a treatment plan that considers several alternatives for said discrepancies [9].

The purpose of this article was to determine the association between the Bolton index and dentoskeletal parameters in patients who come to receive orthodontic treatment for the first time at the University Polyclinic of the Mexicali Faculty of Dentistry of the Autonomous University of Baja California in the period from August 2020 to December 2022.

The hypothesis is that there is an association of the Bolton index with dentoskeletal parameters and sex.

MATERIAL AND METHODS

An observational, cross-sectional analytical study was carried out where a non-probabilistic convenience sampling was applied until obtaining a sample of 45 patients who met the inclusion criteria of a universe composed of 233 patients. For the inclusion criteria, the following points were considered:

1. Study plaster models without imperfections such as fractures or alterations in size and shape.
2. Completely erupted permanent dentition from right first molar to left first molar in maxillary and mandibular arches.
3. Patients who have a lateral skull teleradiography.
4. Patients without previous orthodontic and/or maxillary orthopedic treatment.
5. Initial plaster models of patients who entered the clinic of the Postgraduate Program in Orthodontics of the Autonomous University of Baja California of the Mexicali Faculty of Dentistry in the period 2020-2 to 2022-2.
6. Lateral skull teleradiographs of patients who entered the clinic of the University's Postgraduate Program in Orthodontics from 2020-2 to 2022-2.

The exclusion criteria were the following:

1. Plaster models with missing teeth due to agenesis, extraction or premature loss.
2. Plaster models of patients with any craniofacial syndrome.
3. Plaster models with extensive restorations on any of the teeth.
4. Plaster models that present severe abrasion at the occlusal and mesiodistal level.
5. Plaster models with the presence of mixed dentition.
6. Plaster models with partially erupted teeth.
7. Plaster models that present dental anomalies of shape, structure or development, such as: fusion, germination, mesiodens, supernumerary teeth. (Only anomalies such as macrodontia and microdontia are included in the sample).

Measurement data were collected manually using:

- Stationery supplies (pen *Techniclick Pentel PD105T* 0.5 mm fine, 0.5 mm gauge graphite tips, ruler and square).
- Initial plaster study models.
- NEIKO Brand Digital Vernier Caliper, with a resolution of tenths of millimeters of 0.01 mm of appreciation (Figure 26).

The mesiodistal width of each tooth was measured at the greatest distance between the contact points of the proximal surfaces. This measurement was obtained with the help of a digital caliper and the data were recorded on a measurement record sheet.

The molar class was determined following Angle's classification and Steiner's cephalometric analysis to obtain the skeletal class through the ANB angle.

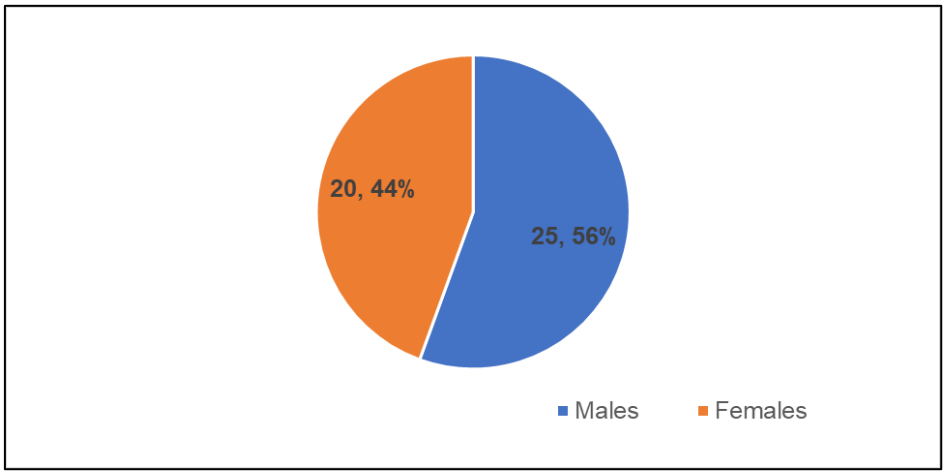
The data required for the study were collected from the clinical records, the plaster models of each patient and the lateral skull radiographs, which were tabulated in a spreadsheet of the Microsoft Excel 365 program 2023.

To compare the mesiodistal measurements of the teeth of each hemiarch, a hypothesis test was carried out for a difference in means. It was a two-tailed test where the normal distribution was used with a significance level of α=0.05.

To determine the association between the Bolton Index with the dentoskeletal parameters and gender in the sample, a two-factor statistical analysis of variance was performed where the normal distribution was used based on the confidence interval of α=0.05.

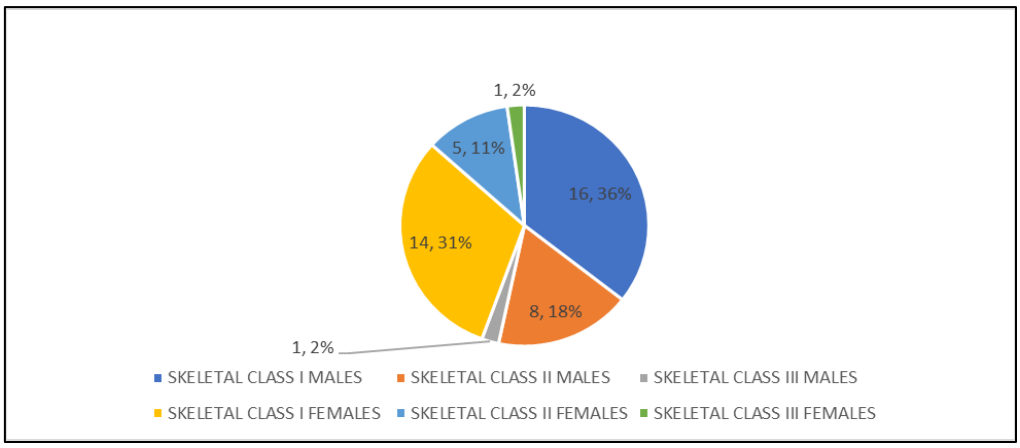
RESULTS

The sample of the present study was constituted by a total of 45 plaster models and lateral radiographs of the skull of patients who attended the orthodontic postgraduate clinic of the Autonomous University of Baja California of the Mexicali Faculty of Dentistry, of which 25 are male and 20 are female, which corresponds to 56% and 44% of the sample respectively (Graph 1). The average age of the patients in general was 22.9 years, being 23.6 for men and 22.1 for women.



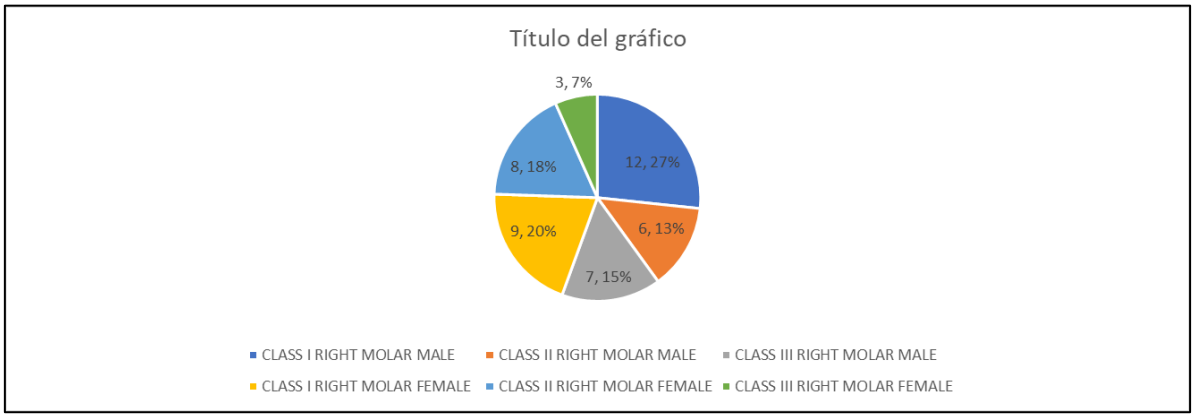
Graph 1: Proportion of patients in the sample by sex. The number of men and women in number and percentage that were part of the sample in the study is described
Source: Author

Based on the Steiner cephalometric analysis carried out on lateral skull radiographs, a total of 30 patients were classified as skeletal class I, with 16 being the representative figure for the male group while the female group presented a total of 14 patients. The skeletal class II patients were a total of 13 patients, 8 men and 5 women. Finally, a total of 2 patients presented skeletal class III, 1 from the male group and 1 from the female group (See Graph 2).



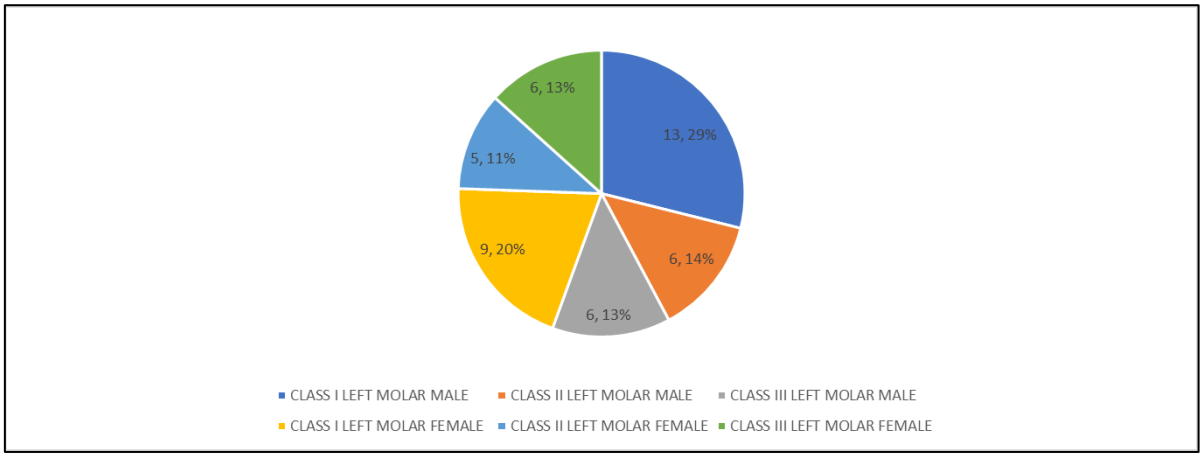
Graph 2: Proportion of patients by sex and skeletal class
Source: Author

The molar class was determined based on Angle's classification, where a total of 21 patients with right molar class I were obtained, of which there were 12 men and 9 women respectively. The total obtained for the right molar class II was 14, with 6 in the male group and 8 in the female group. The right molar class III presented a total of 10, 7 within the male group and 3 within the female group (See Graph 3).



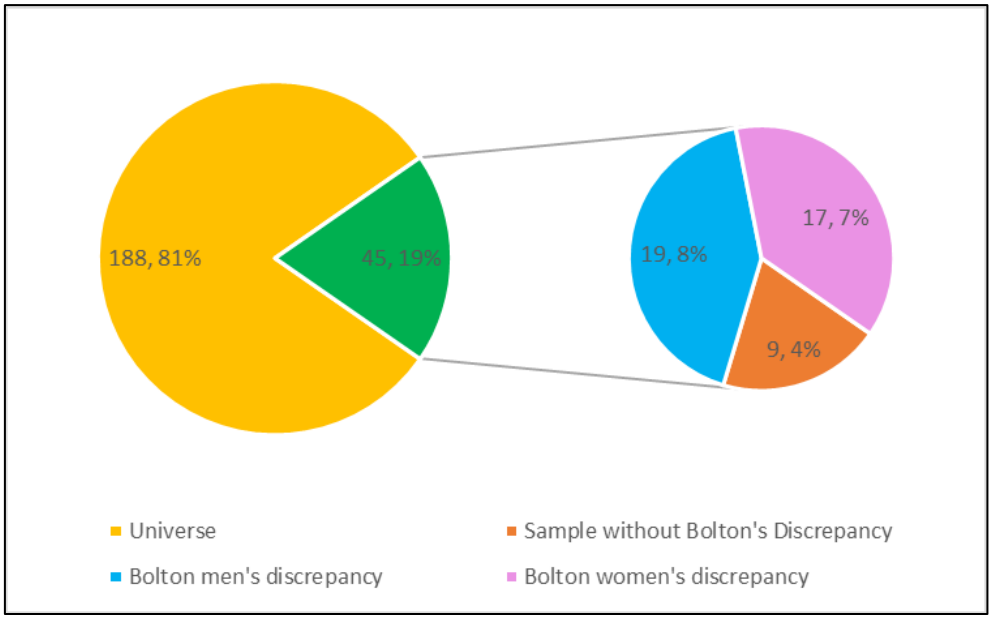
Graph 3: Proportion of patients by sex and right molar class
Source: Author

The left molar class had the following distribution: For class I the total was 22, 13 from the male group and 9 from the female group. In class II a total of 11 were obtained, 6 in the group of men and 5 in the group of women. Finally, the left molar class III showed a total of 12, with 6 within each male and female group respectively (See Graph 4).

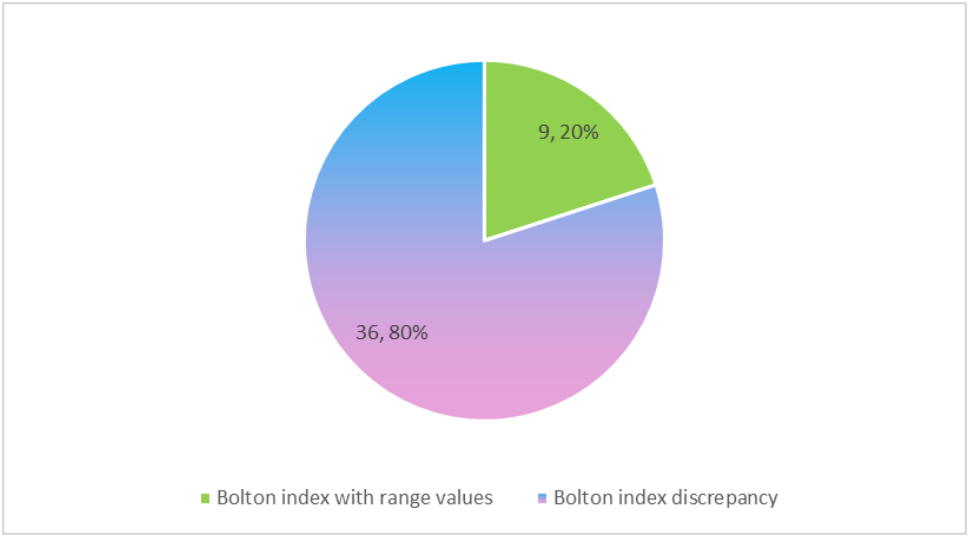


Graph 4: Proportion of patients by sex and left molar class

A probability study was carried out to determine the percentage of the sample that presented discrepancies in the Bolton Index (See Graph 5 and 6).



Graph 5: Proportion of Bolton Index discrepancy prevalence by sex
Source: Author



Graph 6: Percentage of the Bolton Index discrepancy of the sample
Source: Author

The mesiodistal width of the dental organs of the right and left maxillary and mandibular hemiarches was measured to identify if there is a significant difference in the average sizes between the contralateral teeth, of which no statistically significant difference was found. For this case, a hypothesis test was carried out for a difference in means, it was a two-tailed test because the alternative hypothesis is that $\mu 1 - \mu 2 \neq 0$. The normal distribution was used with a significance level of $\alpha=0.05$. The following formula was respected to determine the selection of the null or research hypothesis:

$m_1 - m_2 = 0$ (Null hypothesis)
$m_1 - m_2 \neq 0$ (Alternative hypothesis)

Comparison of the measurements of teeth 11 and 21: Since the value of $Zc = -0.0155$ is negative and greater than $Z_{0.025} = -1.96$ is not in the rejection region, so the null hypothesis is not rejected, that is, there is no significant difference between the average measurement of teeth 11 and 21 of the sample of 45 patients from the Autonomous University of Baja California (See Table 1).

Table 1: The values of the mean mesiodistal width of the upper right central incisor and upper left central incisor teeth of the sample of 45 patients are described in addition to the Zc values that indicate the value of the sample to determine the selection of the hypothesis

Table 1	Tooth 11	Tooth 21
Media	9.02159091	9.02659091
Standard deviation	1.51743088	1.52855309
Mean difference	-0.005	
Standard deviation of the difference of means	0.32107704	
Significance level	0.05	
$WITH_{0.025}$	-1.96	1.96
Null hypothesis rejection region	Zc <-1.96 Zc > 1.96	
Zc	-0.0155725	

Comparison of the measurements of teeth 12 and 22: Since the value of Zc= 0.32154929 is positive and less than $Z_{0.025}$= 1.96 is not in the rejection region, so the null hypothesis is not rejected, that is, there is no significant difference between the average measurement of teeth 12 and 22 of the sample of 45 patients from the UABC (See Table 2).

Table 2: The values of the mean mesiodistal width of the upper right lateral incisor and upper left lateral incisor teeth of the sample of 45 patients are described in addition to the Zc values that indicate the value of the sample to determine the selection of the hypothesis

Table 2	Tooth 12	Tooth 22
Media	7.21977273	7.12931818
Standard deviation	1.34951911	1.31903343
Mean difference	0.09045455	
Standard deviation of the difference of means	0.28130849	
Significance level	0.05	
$WITH_{0.025}$	-1.96	1.96
Null hypothesis rejection region	Zc <-1.96 Zc > 1.96	
Zc	0.32154929	

Comparison of the measurements of teeth 13 and 23: Since the value of Zc= -0.4186063 is negative and greater than $Z_{0.025}$= -1.96 is not in the rejection region, so the null hypothesis is not rejected, that is, there is no significant difference between the average measurement of teeth 13 and 23 of the sample of 45 patients from the UABC (See Table 3).

Table 3: The values of the mean mesiodistal width of the upper right canine and upper left canine teeth of the sample of 45 patients are described in addition to the Zc values that indicate the value of the sample to determine the selection of the hypothesis

Table 3	Tooth 13	Tooth 23
Media	8.07954545	8.19954545
Standard deviation	1.35282869	1.36668378
Mean difference	-0.12	
Standard deviation of the difference of means	0.2866655	
Significance level	0.05	
$WITH_{0.025}$	-1.96	1.96
Null hypothesis rejection region	Zc <-1.96 Zc > 1.96	
Zc	-0.4186063	

Comparison of the measurements of teeth 14 and 24: Since the value of Zc= -1.0657564 is negative and greater than $Z_{0.025}$= -1.96 is not in the rejection region, so the null hypothesis is not rejected, that is, there is no significant difference between the average measurement of teeth 14 and 24 of the sample of 45 patients from the UABC (See Table 4).

Table 4: The values of the mean mesiodistal width of the first upper right premolar and first upper left premolar teeth of the sample of 45 patients are described in addition to the Zc values that indicate the value of the sample to determine the selection of the hypothesis

Table 4	Tooth 14	Tooth 24
Media	7.30577778	7.45622222
Standard deviation	0.68491701	0.65390536
Mean difference	-0.1504444	

Table 4	Tooth 14	Tooth 24
Standard deviation of the difference of means	0.14116212	
Significance level	0.05	
$WITH_{0.025}$	-1.96	1.96
Null hypothesis rejection region	Zc <-1.96 Zc > 1.96	
Zc	-1.0657564	

Comparison of the measurements of teeth 15 and 25: Since the value of Zc= -1.3618644 is negative and greater than $Z_{0.025}$= -1.96 is not in the rejection region, so the null hypothesis is not rejected, that is, there is no significant difference between the average measurement of teeth 15 and 25 of the sample of 45 patients from the UABC (See Table 5).

Table 5: The values of the mean mesiodistal width of the upper right second premolar and upper left second premolar teeth of the sample of 45 patients are described in addition to the Zc values that indicate the value of the sample to determine the selection of the hypothesis

Table 5	Tooth 15	Tooth 25
Media	6.96755556	7.15688889
Standard deviation	0.67395426	0.64462753
Mean difference	-0.1893333	
Standard deviation of the difference of means	0.1390251	
Significance level	0.05	
$WITH_{0.025}$	-1.96	1.96
Null hypothesis rejection region	Zc <-1.96 Zc > 1.96	
Zc	-1.3618644	

Comparison of the measurements of teeth 16 and 26: Since the value of Zc= 0.06525383 is positive and less than Z0.025= 1.96, it is not in the rejection region, then the null hypothesis is not rejected, that is, there is no significant difference. Between the average measurement of teeth 16 and 26 of the sample of 45 patients from the UABC (See Table 6).

Table 6: The values of the mean mesiodistal width of the first upper right molar and first upper left molar teeth of the sample of 45 patients are described in addition to the Zc values that indicate the value of the sample to determine the selection of the hypothesis

Table 6	Tooth 16	Tooth 26
Media	10.6793333	10.6618182
Standard deviation	0.63789569	1.68380605
Mean difference	0.01751515	
Standard deviation of the difference of means	0.26841567	
Significance level	0.05	
$WITH_{0.025}$	-1.96	1.96
Null hypothesis rejection region	Zc <-1.96 Zc > 1.96	
Zc	0.06525383	

Comparison of the measurements of teeth 31 and 41: Since the value of Zc= -0.3462121 is negative and greater than Z0.025= -1.96, it is not in the rejection region, then the null hypothesis is not rejected, that is, it does not exist. significant difference between the average measurement of teeth 31 and 41 of the sample of 45 patients from the UABC (See Table 7).

Table 7: The values of the mean mesiodistal width of the lower right central incisor and lower left central incisor teeth of the sample of 45 patients are described in addition to the Zc values that indicate the value of the sample to determine the selection of the hypothesis

Table 7	Tooth 31	Tooth 41
Media	5.58477273	5.65545455
Standard deviation	0.97586186	0.96088853
Mean difference	-0.0706818	
Standard deviation of the difference of means	0.20415752	
Significance level	0.05	
$WITH_{0.025}$	-1.96	1.96
Null hypothesis rejection region	Zc <-1.96 Zc > 1.96	
Zc	-0.3462121	

Comparison of the measurements of teeth 32 and 42: Since the value of Zc= -0.2136608 is negative and greater than Z0.025= -1.96, it is not in the rejection region, then the null hypothesis is not rejected, that is, it does not exist. significant difference between the average measurement of teeth 32 and 42 of the sample of 45 patients from the UABC (See Table 8).

Table 8: The values of the mean mesiodistal width of the right lower lateral incisor and left lower lateral incisor teeth of the sample of 45 patients are described in addition to the Zc values that indicate the value of the sample to determine the selection of the hypothesis

Table 8	Tooth 32	Tooth 42
Media	6.38272727	6.4325
Standard deviation	1.09853171	1.1114077
Mean difference	-0.0497727	
Standard deviation of the difference of means	0.23295202	
Significance level	0.05	
$WITH_{0.025}$	-1.96	1.96
Null hypothesis rejection region	Zc <-1.96 Zc > 1.96	
Zc	-0.2136608	

Comparison of the measurements of teeth 33 and 43: Since the value of Zc= -0.0421105 is negative and greater than Z0.025= -1.96, it is not in the rejection region, then the null hypothesis is not rejected, that is, it does not exist. significant difference between the average measurement of teeth 33 and 43 of the sample of 45 patients from the UABC (See Table 9).

Table 9: The values of the mean mesiodistal width of the lower right canine and lower left canine teeth of the sample of 45 patients are described in addition to the Zc values that indicate the value of the sample to determine the selection of the hypothesis

Table 9	Tooth 33	Tooth 43
Media	7.44613636	7.45466667
Standard deviation	1.23589938	0.56488374
Mean difference	-0.0085303	
Standard deviation of the difference of means	0.20256911	
Significance level	0.05	
$WITH_{0.025}$	-1.96	1.96
Null hypothesis rejection region	Zc <-1.96 Zc > 1.96	
Zc	-0.0421105	

Comparison of the measurements of teeth 34 and 44: Since the value of Zc= 0.66379012 is positive and less than Z0.025= 1.96, it is not in the rejection region, then the null hypothesis is not rejected, that is, there is no significant difference. Between the average measurement of teeth 34 and 44 of the sample of 45 UABC patients (See Table 10).

Table 10: The values of the mean mesiodistal width of the first lower right premolar and first lower left premolar teeth of the sample of 45 patients are described in addition to the Zc values that indicate the value of the sample to determine the selection of the hypothesis

Table 10	Tooth 34	Tooth 44
Media	7.48159091	7.30454545
Standard deviation	1.27057002	1.2597256
Mean difference	0.17704545	
Standard deviation of the difference of means	0.26671903	
Significance level	0.05	
$WITH_{0.025}$	-1.96	1.96
Null hypothesis rejection region	Zc <-1.96 Zc > 1.96	
Zc	0.66379012	

Comparison of the measurements of teeth 35 and 45: Since the value of Zc= 0.06132667 is positive and less than Z0.025= 1.96 is not in the rejection region, then the null hypothesis is not rejected, that is, there is no significant difference between the average measurement of teeth 35 and 45 of the sample of 45 patients from the UABC (See Table 11).

Table 11: The values of the mean mesiodistal width of the right lower second premolar and left lower second premolar teeth of the sample of 45 patients are described in addition to the Zc values that indicate the value of the sample to determine the selection of the hypothesis

Table 11	Tooth 35	Tooth 45
Media	7.40181818	7.38545455
Standard deviation	1.26246404	1.26887495
Mean difference	0.01636364	
Standard deviation of the difference of means	0.26682741	
Significance level	0.05	
$WITH_{0.025}$	-1.96	1.96
Null hypothesis rejection region	Zc <-1.96 Zc > 1.96	
Zc	0.06132667	

Comparison of the measurements of teeth 36 and 46: Since the value of Zc= 0.79987958 is positive and less than Z0.025= 1.96, it is not in the rejection region, then the null hypothesis is not rejected, that is, there is no significant difference between the average measurement of teeth 36 and 46 of the sample of 45 UABC patients (See Table 12).

Table 12: The values of the mean mesiodistal width of the first lower right molar and first lower left molar teeth of the sample of 45 patients are described in addition to the Zc values that indicate the value of the sample to determine the selection of the hypothesis

Table 12	Tooth 36	Tooth 46
Media	11.3717778	11.2473333
Standard deviation	0.71513918	0.76012678
Mean difference	0.12444444	
Standard deviation of the difference of means	0.15557897	
Significance level	0.05	
$WITH_{0.025}$	-1.96	1.96
Null hypothesis rejection region	Zc <-1.96 Zc > 1.96	
Zc	0.79987958	

With the tabulation in a spreadsheet in the Excel Microsoft 365 program of the data on the mesiodistal widths of the upper and lower teeth, the analysis of the Bolton Index was carried out on the 45 patients in the sample and the results were associated with dentoskeletal parameters such as skeletal class I, II and III and right and left molar class I, II and III in men and women.

To determine the association between the Bolton Index with skeletal class I, II and III in the group of men, a two-factor analysis of variance was carried out which showed statistically non-significant results since a value of α=0.099131816 was obtained., which is compared with the confidence interval of α=0.05, as the value is greater than the confidence interval, the null hypothesis is not rejected (See Table 13).

Table 13: The two-factor statistical analysis of variance is shown to determine the association of skeletal classes I, II and III with the Bolton index in male patients

Two- factor analysis of variance with several sample per group

SUMMARY	Anterior decreased	Anterior increased	Total decreased	Total increased	Total	
CLASE I						
Total	2	2	2	2	8	
Sum	17	33	18	25	93	
Average	8.5	16.5	9	12.5	11.625	
Variance	112.50	0.5	98	24.5	45.41071429	
CLASE II						
Total	2	2	2	2	8	
Sum	9	25	10	17	61	
Average	4.5	12.5	5	8.5	7.625	
Variance	24.5	40.5	18	0.5	23.69642857	
CLASE III						
Total	2	2	2	2	8	
Sum	2	18	3	10	33	
Average	1	9	1.5	5	4.125	
Variance	0	128	0.5	32	34.69642857	
Total						
Total	6	6	6	6		
Sum	28	76	31	52		
Average	4.666666667	12.66666667	5.166666667	8.666666667		
Variance	38.66666667	45.06666667	34.56666667	22.66666667		

ANALYSIS OF VARIANCE

Sum of squares	*Degrees of freedom*	*Mean squares*	*F*	*Probability*	*Critical value for F*	*Valor crítico para F*
Sample	225.3333333	2	112.6666667	2.819603754	0.099131816	3.885293835
Columns	247.125	3	82.375	2.061522419	0.158961786	3.490294819
Interaction	1.13687E-13	6	1.89478E-14	4.74189E-16	1	2.996120378
Within the group	479.5	12	39.95833333			
Total	951.9583333	23				

Source: Author

For the group of women, a two-factor analysis of variance was carried out to associate the Bolton Index with skeletal class I, II and III. This analysis resulted in a value of α=0.135022583, which, being greater than the interval confidence level of α=0.05, indicates that the null hypothesis is not rejected (See Table 14).

Table 14: The two-way statistical analysis of variance is shown to determine the association of skeletal classes I, II and III with the Bolton index in female patients

Two- factor analysis of variance with several sample per group						
SUMMARY	Anterior decreased	Anterior increased	Total decreased	Total increased	Total	
CLASE I						
Total	2	2	2	2	8	
Sum	18	27	18	19	82	
Average	9	13.5	9	9.5	10.25	
Variance	50	0.5	50	40.5	24.21428571	
CLASE II						
Total	2	2	2	2	8	
Sum	6	22	7	14	49	
Average	3	11	3.5	7	6.125	
Variance	8	72	4.5	8	24.98214286	
CLASE III						
Total	2	2	2	2	8	
Sum	2	18	3	10	33	
Average	1	9	1.5	5	4.125	
Variance	0	128	0.5	32	34.69642857	
Total						
Total	6	6	6	6		
Sum	26	67	28	43		
Average	4.333333333	11.16666667	4.666666667	7.166666667		
Variance	25.46666667	44.16666667	23.06666667	20.16666667		
ANALYSIS OF VARIANCE						
Origin of variations	*Sum of squares*	*Degrees of freedom*	*Mean squares*	*F*	*Probability*	*Critical value for F*
Sample	156.0833333	2	78.04166667	2.376903553	0.135022583	3.885293835
Columns	179	3	59.66666667	1.817258883	0.197649168	3.490294819
Interaction	14.25	6	2.375	0.072335025	0.997913297	2.996120378
Within the group	394	12	32.83333333			
Total	743.3333333	23				

Source: Author

The two-factor analysis of variance was carried out in the same way to associate the Bolton index with the right molar class I, II and III in the group of men where the results showed a value of α = 0.455884191, which is greater than the confidence interval of α=0.05, so the null hypothesis is not rejected (See table 15).

Table 15: The statistical analysis of variance of two factors is shown to determine the association of right molar class I, II and III with the Bolton index in male patients

Two- factor analysis of variance with several sample per group						
SUMMARY	Anterior decreased	Anterior increased	Total decreased	Total increased	Total	
RIGHT MOLAR I						
Total	2	2	2	2	8	
Sum	13	29	14	21	77	
Average	6.5	14.5	7	10.5	9.625	
Variance	60.5	12.5	50	4.5	29.98214286	
RIGHT MOLAR II						
Total	2	2	2	2	8	
Sum	7	23	8	15	53	
Average	3.5	11.5	4	7.5	6.625	
Variance	12.5	60.5	8	4.5	23.98214286	
RIGHT MOLAR III						
Total	2	2	2	2	8	
Sum	8	24	9	16	57	
Average	4	12	4.5	8	7.125	
Variance	18	50	12.5	2	23.55357143	
Total						
Total	6	6	6	6		
Sum	28	76	31	52		
Average	4.666666667	12.66666667	5.166666667	8.666666667		
Variance	20.26666667	26.66666667	16.16666667	4.266666667		
ANALYSIS OF VARIANCE						
Origin of variations	*Sum of squares*	*Degrees of freedom*	*Mean squares*	*F*	*Probability*	*Critical value for F*
Sample	41.33333333	2	20.66666667	0.839255499	0.455884191	3.885293835
Columns	247.125	3	82.375	3.345177665	0.055749629	3.490294819
Interaction	5.68434E-14	6	9.4739E-15	3.84727E-16	1	2.996120378
Within the group	295.5	12	24.625			
Total	583.9583333	23				

Source: Author

To associate the Bolton Index with the right molar class I, II and III in the group of women, a two-factor analysis of variance was carried out in which a result was obtained with a value of α=0.27050221, a value that, being higher, at the confidence interval of α=0.05, determines that the null hypothesis is not rejected (See Table 16).

Table 16: The two-factor statistical analysis of variance is shown to determine the association of right molar class I, II and III with the Bolton index in female patients

Two- factor analysis of variance with several sample per group						
SUMMARY	Anterior decreased	Anterior increased	Total decreased	Total increased	Total	
RIGHT MOLAR I						
Total	2	2	2	2	8	
Sum	13	22	13	14	62	
Average	6.5	11	6.5	7	7.75	
Variance	12.5	8	12.5	8	9.928571429	
RIGHT MOLAR II						
Total	2	2	2	2	8	
Sum	12	21	12	13	58	
Average	6	10.5	6	6.5	7.25	
Variance	8	12.5	8	4.5	8.785714286	
RIGHT MOLAR III						
Total	2	2	2	2	8	
Sum	8	17	8	9	42	
Average	4	8.5	4	4.5	5.25	
Variance	0	40.5	0	0.5	9.928571429	
Total						
Total	6	6	6	6		
Sum	33	60	33	36		
Average	5.5	10	5.5	6		
Variance	5.5	13.6	5.5	4		
ANALYSIS OF VARIANCE						
Origin of variations	*Sum of squares*	*Degrees of freedom*	*Mean squares*	*F*	*Probability*	*Critical value for F*
Sample	28	2	14	1.460869565	0.27050221	3.885293835
Columns	85.5	3	28.5	2.973913043	0.074277838	3.490294819
Interaction	0	6	0	0	1	2.996120378
Within the group	115	12	9.583333333			
Total	228.5	23				

Source: Author

Similarly, the two-factor analysis of variance was carried out to associate the Bolton index with the left molar class I, II and III in the group of men in which a value of α=0.402509117 was obtained, being a value greater than confidence interval of α=0.05, the null hypothesis is not rejected (See Table 17).

Table 17: The statistical analysis of variance of two factors is shown to determine the association of left molar class I, II and III with the Bolton index in male patients

Two- factor analysis of variance with several sample per group						
SUMMARY	Anterior decreased	Anterior increased	Total decreased	Total increased	Total	
LEFT MOLAR I						
Total	2	2	2	2	8	
Sum	14	30	15	22	81	
Average	7	15	7.5	11	10.125	
Variance	72	8	60.5	8	32.98214286	
LEFT MOLAR II						
Total	2	2	2	2	8	
Sum	7	23	8	15	53	
Average	3.5	11.5	4	7.5	6.625	
Variance	12.5	60.5	8	4.5	23.98214286	
LEFT MOLAR III						
Total	2	2	2	2	8	
Sum	9	25	10	17	61	
Average	4.5	12.5	5	8.5	7.625	
Variance	24.5	40.5	18	0.5	23.69642857	
Total	*Anterior Dis*	*Anterior Aum*	*Total Dis*	*Total Aum*		
Total	6	6	6	6		
Sum	30	78	33	54		
Average	5	13	5.5	9		
Variance	24.4	24.4	19.9	5.2		
ANALYSIS OF VARIANCE						
Origin of variations	*Sum of squares*	*Degrees of freedom*	*Mean squares*	*F*	*Probability*	*Critical value for F*
Sample	52	2	26	0.982677165	0.402509117	3.885293835
Columns	247.125	3	82.375	3.113385827	0.066590251	3.490294819
Interaction	0	6	0	0	1	2.996120378
Within the group	317.5	12	26.45833333			
Total	616.625	23				

Source: Author

For the association of left molar class with the Bolton Index in the group of women, a two-factor analysis of variance was carried out in which the result gave a value of α=0.420476356, this being greater than the confidence interval used equal to α= 0.05, thus determining that the null hypothesis is not rejected (See Table 18).

Table 18: The statistical analysis of variance of two factors is shown to determine the association of left molar class I, II and III with the Bolton index in female patients

Two- factor analysis of variance with several sample per group						
SUMMARY	Anterior decreased	Anterior increased	Total decreased	Total increased	Total	
LEFT MOLAR I						
Total	2	2	2	2	8	
Sum	13	22	13	14	62	
Average	6.5	11	6.5	7	7.75	
Variance	12.5	8	12.5	8	9.928571429	
LEFT MOLAR II						
Total	2	2	2	2	8	
Sum	9	18	9	10	46	
Average	4.5	9	4.5	5	5.75	
Variance	0.5	32	0.5	0	8.785714286	
LEFT MOLAR III						
Total	2	2	2	2	8	
Sum	11	20	11	12	54	
Average	5.5	10	5.5	6	6.75	
Variance	4.5	18	4.5	2	8.214285714	
Total						
Total	6	6	6	6		
Sum	33	60	33	36		
Average	5.5	10	5.5	6		
Variance	4.3	12.4	4.3	2.8		
ANALYSIS OF VARIANCE						
Origin of variations	*Sum of squares*	*Degrees of freedom*	*Mean squares*	*F*	*Probability*	*Critical value for F*
Sample	16	2	8	0.932038835	0.420476356	3.885293835
Columns	85.5	3	28.5	3.32038835	0.056806271	3.490294819
Interaction	0	6	0	0	1	2.996120378
Within the group	103	12	8.583333333			
Total	204.5	23				

Source: Author

DISCUSSION

Bolton analysis is a method that was developed by Dr. Wayne Bolton in 1958, during his research on dental size, with the objective of locating and determining intermaxillary size discrepancies of the teeth [11].

This author establishes that approximately 5% of the population has a discrepancy in the size of their teeth, similarly to Pizzol *et al.*, [8] In his research work carried out at the State University of São Paulo he determined that 60% of orthodontic patients had anterior Bolton discrepancy, likewise the plaster models examined by Ñacato [12] in their research carried out at the Central University of Ecuador, they presented a discrepancy from the previous Bolton Index of 95.6% and 92.2% for the total Bolton Index respectively.

In this investigation, the discrepancy percentages were 77.78% of plaster models examined, which presented anterior Bolton discrepancy and 46.67% of the models revealed total Bolton discrepancy.

Regarding the relationship between the alterations of the Bolton Index with the different types of dental malocclusion, the conclusions are contradictory, since there are authors who do not find a relationship, while others affirm the opposite [13].

Some research has been carried out with the purpose of determining the incidence of the Bolton discrepancy and its relationship with the different groups of Angle malocclusion [14], among them the research carried out by Nie and Lin in 1999 stands out, where they compared the measurements of the intermaxillary teeth, dividing the universe into two groups, 60 subjects with normal occlusions and 300 patients divided into five groups of malocclusion in the Chinese population, where they did find statistically significant differences in the Bolton Index in Angle Class I, II and III malocclusion [15]. This contrasts with our results for both the male and female groups in Angle I, II and III molar classes.

Our results, despite being a small sample, agree with the research carried out by Uysal in 2005, who compared the discrepancies in interarch dental size in 150 patients with normal occlusion and 560 patients from four different groups of malocclusion, where there were no statistically significant differences between the groups of malocclusion and anterior and total Bolton ratio.

In general, the molar classes (I, II and III) have similar percentages in the various total and anterior

Bolton discrepancies. Which indicates that there is no significant difference between the malocclusion groups and the Bolton anterior and total relationship, also coinciding with studies such as that of Al Jatib and Abu Alhaija in 2006, Oktay 2009 [16], where they also did not find differences between discrepancies of the Bolton analysis among the different malocclusions.

In the present study, no statistically significant differences were found in the widths of the mesiodistal size of the teeth between the right and left sides. This agrees with the results obtained by Al-Gunaid (2012) in his study, suggesting that measurements could be taken from the right or left side to represent the size of the teeth of that population. Similar results were obtained in Hattab's *et al.*, [17] studies, carried out in the population of Jordan and Hashim and Al-Ghamdi [18], in Saudi population with the same ethnic origin.

Regarding the relationship between the discrepancies of the Bolton Index with the skeletal classes, no statistically significant difference was found.

CONCLUSIONS

1. According to the results obtained in the present investigation, a high incidence of dental size discrepancies was found. 77.78% of plaster models examined showed anterior Bolton discrepancy and 46.67% of the models showed total Bolton discrepancy.
2. Regarding the discrepancy of the mesiodistal widths of the contralateral teeth of the right and left hemiarches, no average values with statistically significant differences were found.
3. The values obtained in the statistical analyses showed that in our sample there is no relationship between the molar classes, the skeletal class and the male sex to determine a trend in the discrepancies of the Bolton Index.
4. The values obtained in the statistical analyses showed that in our sample there is no relationship between the molar classes, the skeletal class and the female sex to determine a trend in the discrepancies of the Bolton Index.

REFERENCES

1. WHO Expert Committee on Dental Health Education, & World Health Organization. (1970). *Educación sanitaria e higiene dental : informe de un Comité de Expertos de la OMS [se reunió en Ginebra del 2 al 8 de diciembre de 1969]*. Recuperado de https://apps.who.int/iris/handle/10665/38295
2. Okeson, J. (2013). Tratamiento de Oclusión y Afecciones Temporomandibulares. (7 ed). Elsevier
3. Canut, J. A. (2000). Ortodoncia clínica. Barcelona, España: Ed. Masson-Salvat Odontología.
4. Rodríguez, E., & Contemporánea, O. (s. f.). *Ortodoncia contemporánea: diagnóstico y tratamiento*.
5. Endo, T., Abe, R., Kuroki, H., Oka, K., & Shimooka, S. (2008). Tooth size discrepancies among different malocclusions in a Japanese orthodontic population. *The Angle Orthodontist*, *78*(6), 994-999. doi: 10.2319/101007-486.1
6. Al-Gunaid, T., Yamaki, M., & Saito, I. (2012). Mesiodistal tooth width and tooth size discrepancies of Yemeni Arabians: A pilot study. *Journal of Orthodontic Science*, *1*(2), 40-45. doi: 10.4103/2278-0203.99760
7. Mollabashi, V., Soltani, M. K., Moslemian, N., Akhlaghian, M., Akbarzadeh, M., Samavat, H., & Abolvardi, M. (2019). Comparison of Bolton ratio in normal occlusion and different malocclusion groups in Iranian population. *International Orthodontics*, *17*(1), 143-150. doi: 10.1016/j.ortho.2019.01.005
8. Pizzol, K. E. D. C., Gonçalves, J. R., Santos-Pinto, A. dos, & Peixoto, A. P. (2011). Análise de Bolton: uma proposta alternativa para a simplificação de seu uso. *Dental press journal of orthodontics*, *16*(6), 69-77. doi:10.1590/s2176-94512011000600012
9. Educar en Ortodoncia. (2008). *Ortodoncia*. Recuperado de Available from: www.educarenortodoncia.com/revista/definit/2-monogrfia1.pdf
10. Araujo, E., & Souki, M. (2003). Bolton anterior tooth size discrepancies among different malocclusion groups. *The Angle Orthodontist*, *73*(3), 307-313. doi:10.1043/0003-3219(2003)073<0307:BATSDA>2.0.CO;2
11. *Disharmony in Tooth Size and Its Relation to the Analysis and Treatment of Malocclusion*. (1958).
12. Marcillo, Ñ., & Gabriela, K. (2017). *Discrepancia del índice de Bolton calculado mediante Software y su relación con maloclusiones de Angle en modelos de pacientes de la*.
13. Crosby, D. R., & Alexander, C. G. (1989). The occurrence of tooth size discrepancies among different malocclusion groups. *American Journal of Orthodontics and Dentofacial Orthopedics: Official Publication of the American Association of Orthodontists, Its Constituent Societies, and the American Board of Orthodontics*, *95*(6), 457-461. doi:10.1016/0889-5406(89)90408-3
14. Ricci, I. D., Scanavini, M. A., Kaieda, A. K., Rosário, H. D., & Paranhos, L. R. (2013). Bolton ratio in subjects with normal occlusion and malocclusion. *Brazilian journal of oral sciences*, *12*(4), 357-361. doi:10.1590/s1677-32252013000400015
15. Uysal, T., Sari, Z., Faruk, A., & Memili, B. (2005). Intermaxilary tooth size discrepancy and Maloclusion. *The Angle Orthodontist*, *75*.
16. Oktay, H., & Ulukaya, E. (2010). Intermaxillary tooth size discrepancies among different malocclusion groups. *European Journal of Orthodontics*, *32*(3), 307-312. doi: 10.1093/ejo/cjp079
17. Hattab, F. N., Al-Khateeb, S., & Sultan, I. (1996). Mesiodistal crown diameters of permanent teeth in jordanians. *Archives of Oral Biology*, *41*(7), 641-645. doi:10.1016/s0003-9969(96)00066-0

18. Hashim, H. A., & Al-Ghamdi, S. (2005). Tooth width and arch dimensions in normal and malocclusion samples: an odontometric study. *The Journal of Contemporary Dental Practice*, *6*(2), 36-51. doi:10.5005/jcdp-6-2-36

Cite This Article: Carlos Alberto López-Contreras, Guillermo Pérez-Cortez, Tely Adriana Soto-Castro, Maikel Hermida-Rojas, Fernanda Itatí Ramírez-Ruíz (2023). Association between Bolton Analysis and Dentoskeletal Parameters of Patients with Malocclusion. *EAS J Dent Oral Med*, *5*(5), 126-139.