BOLTON ANALYSIS FOR DIFFERENT SAGITAL PROBLEMS & ITS CORELTION WITH DENTAL PARAMETERS

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ABSTRACT

The clinician should be familiar with discrepancies in tooth size at the initial diagnosis and treatment planning stages if excellence in orthodontic finishing is to be achieved. Bolton's method of diagnosing tooth size discrepancies by analyzing the mesiodistal tooth size ratio between the maxillary and mandibular teeth has been widely used in scientific studies since its publication. Aim of my study was to calculate Bolton Ratio & Anterior Bolton Ratio[1,2] for Different Skeletal Malocclusions i.e. Skeletal Class I , II & III. The study was also aimed at establishing correlation between Bolton's anterior and overall ratios and dental parameters i.e. upper & lower incisor inclinations & Arch length Discrepancy. The study was conducted on 60 subjects with mean age 18.43±4.21. Study models & lateral Cephalogram were taken for each subject. Patients were categorized into Skeletal Class I , II & III. Bolton Analyses, Anterior Bolton Analyses, Arch length discrepancy for maxilla & mandible, UI-SN & IMPA were calculated and analyzed using SPSS version 13.It was concluded from the results that 1.Bolton Ratio though slightly different but was statistically insignificantly different in Skeletal Class I, II & II patients 2. Anterior Bolton Ratio though slightly different but was statistically insignificantly different in Skeletal Class I, II & II patients 3. Incidence of Anterior Bolton Ratio was more in Skeletal Class III cases than in Skeletal Class I & II 4.Statistically significant correlations between Arch Length Discrepancy in Maxilla and intermaxillary tooth size discrepancies were determined. Therefore, an orthodontist should be aware of such discrepancies and their probable effects on occlusion and dental relations when solving the malocclusion jigsaw.

Key words: *Bolton Analyses, Anterior Bolton Analyses, Skeletal Malocclusions, IMPA*

INTRODUCTION

The clinician should be familiar with discrepancies in tooth size at the initial diagnosis and treatment planning stages if excellence in orthodontic finishing is to be achieved. Orthodontic treatment comprises different phases, and each segment presents unique characteristics and challenges. The orthodontic "finishing" phase is recognized for the multitude of details necessary to achieve an excellent result. Finishing – phase is associated with many difficulties & a high percentage of these finishing-phase difficulties arise because of tooth size imbalances. An excellent orthodontic treatment result with optimal occlusion and ideal intercuspation, overjet, and overbite is often jeopardized by tooth size discrepancies or problematical tooth anatomy.

Thus a proper balance should exist between the mesiodistal tooth size of the maxillary and mandibular arches to ensure proper occlusion at the completion of orthodontic treatment. Bolton's method of diagnosing tooth size discrepancies by analyzing the mesiodistal tooth size ratio between the maxillary and mandibular teeth has been widely used in scientific studies since its publication[1,2].

Bolton CalculatedTooth Size Discrepancy as:[1]

Overall ratio

= [(Sum of mesiodistalwidth of mandibular 12 teeth

¸ (Sum of mesiodistal width of maxillary 12 teeth)] X100%

Overall Ratio (X) = 91.3%

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Anterior ratio

= [(Sum of mesiodistalwidth of mandibular six anterior teeth

, (Sum of mesiodistal width of maxillary six anterior teeth)] X100%

Anterior Ratio (Y) = 77.2%

Values greater or lesser than the norms has been associated with difficulty in achieving Andrew's Six Keys of occlusion at the end of treatment.

Genetic influences have been considered important in the determination of tooth dimensions. Studies on twins, however, helped in understanding the genetic contribution of tooth size in that a greater tooth size correlation was found in monozygotic twins.[3,4] Other investigators de-emphasized the genetic contribution and described the determination of tooth size as multifactorial, with the environment playing an important role.[5]

As in many other human attributes, teeth vary in size between males and females. There is lack of agreement regarding gender differences in relation to the tooth size proportion between upper and lower teeth. Although Lavelle[6] described a difference, Richardson and Malhotra[7] reported no differences in upper and lower anterior tooth size proportions. More recently, other studies have reported significant differences in tooth size between males and females but no evidence of a significant difference in upper to lower anterior tooth size proportions.[8,9]

Tooth size differences exist among various ethnic groups.[6,7,8,10]

Different studies have compared the Bolton Ratio & Anterior Bolton Ratio in different Skeletal Problems. Sperry et al,[11] concluded that the frequency of mandibular tooth size excess (overall ratio) was greater in cases of mandibular prognathism than in Angle Class I and Class II cases.

Lavelle,[6] studied anterior tooth size stated that the teeth in the lower arch are larger in Class III cases than in Class I and II cases, with the inference that a Bolton discrepancy is greater in Class III cases than in the other malocclusion groups.

Araujo and Souki[12] reported that the mean anterior tooth size discrepancy for Angle Class III subjects was significantly greater than that for Class I and Class II subjects. Nie and Lin[13] demonstrated that a significant difference was found for intermaxillary tooth size ratios among different malocclusion groups, with the ratios showing that Class III > Class I > Class II. Furthermore, they added that intermaxillary tooth size discrepancy might be one of the important factors in the cause of malocclusions.

Alkofide and Hashim,[14] however, determined no significant difference in the incidence of tooth size discrepancies existed for the overall ratio and anterior ratio between the different malocclusion groups, except for the anterior ratio in Class III malocclusion. Crosby and Alexander,[15] also reported no difference in the incidence of tooth size discrepancies from one malocclusion group to another, but they did not include Class III subjects in their sample.

In more recent articles, other variables such as incisor inclinations,[16,17] upper-incisor thickness,[18,19] and arch form[18,20] have been described as important to consider in achieving optimal occlusion relationships. Efforts have been made to adapt the Bolton analysis to these variations. Several authors[18,20] proposed new methods to study tooth size discrepancies. However, these proposals need to be tested in clinical studies and, for now, the Bolton analysis prevails as an efficacious clinical tool for appraising various relationships of upper to lower dentitions.

Aim of this study was to calculate Bolton Ratio & Anterior Bolton Ratio for Different Skeletal Maloccusions i.e. Skeletal Class I , II & III. The study was also aimed at establishing correlation between Bolton's anterior and overall ratios and dental parameters i.e. upper & lower incisor inclinations & Arch length Dis-crepancy.

The objectives of this study are to:

- Establish Bolton Ratio and Anterior Bolton ratio for Skeletal class I, II & III cases
- Establish the co-relation between the Bolton Ratio, Anterior Bolton ratio and Dental parameters i.e. (Arch Length Discrepancy) ALD and Upper & lower incisor inclination.

MATERIALS AND METHODS

The study was conducted on 60 subjects (36 females, 24 males) who reported at de,Montmorency College of Dentistry & University college of Dentistry, University of Lahore. Subjects with age range of 12-30 years were selected.

Exclusion criteria includes:

Children with cranio-facial syndrome (clefts, Apert's syndrome, Cleido-cranial dysplasia, Pier Robbins syndrome e.t.c)

Children with facial asymmetry

Children with CO-CR shift

Children with supernumerary or congenitally missing teeth

Children who were already undergoing with orthodontic treatment

Children with functional mandibular shift

Sample was collected using the non-probability convenience sampling technique.

Study Casts were taken for each subject and Bolton Analysis was performed as

Bolton Ratio (X) =

$$\frac{\text{Sum of mesiodistal width of mandibular 12 teeth X100}}{\text{Sum of mesiodistal width of maxillary 12 teeth}} = 91.3\%$$

Anterior Bolton Ratio (Y) =

$$\frac{\text{Sum of mesiodistal width of mandibular 6 Anterior teeth X100}}{\text{Sum of mesiodistal width of maxillary 6 Anterior teeth}} = 77.2\%$$

Arch Length Discrepancy for maxillary & mandibular arch was calculated using the formula

Arch Length Discrepancy = Space Available-Space Required

Space Available =measurement of arch Length by using Brass wire following catenery curve in each arch from mesial of 1st molar to mesial of 1st molar of other side

Space Required = mesiodistal width of teeth from mesial of 1st molar to 1st molar in both arches

Lateral Cephalogram was taken in natural head position for each subject. Lateral Cephalogram was then traced and analyzed for each patient. ANB angle was calculated to establish skeletal discrepancy and UI-SN & IMPA were calculated to find out incisor inclinations.

STATISTICAL METHOD

SPSS 13.0 was used for statistical evaluation.

1. Mean, Standard Deviation, Variance, Minimum & Maximum value and Range were calculated for each variable for each subject.
2. Correlation coefficients between Bolton Ratio, Anterior Bolton Ratio & Sagital Skeletal Discrepancies were calculated using Pearson's correlation.
3. Correlation coefficients between the Bolton Ratio, Anterior Bolton Ratio and ALD & incisor inclinations were also calculated using Pearson's correlation.

RESULTS

The study was conducted on 60 subjects (36 females & 24 males) with mean age 18.43±4.21. Descriptive Statistics i.e. Mean, Standard Deviation, minimum & maximum value and range was calculated for each variable for each subject as shown in table I.

Patients were categorized on the basis of ANB angle. Lateral cephalogram was taken for each patient and ANB angle was calculated. Normal value of ANB angle is $0\text{-}4^0$ (Skeletal Class I). Value greater than 4^0 suggested Skeletal Class II & value less than 0^0 suggested Skeletal Class III. Sample selected thus consisted of 15 patients having Skeletal Class I, 35 patients having Skeletal Class II and 10 patients having Skeletal Class III malocclusion. Descriptive statistics for different malocclusions have been shown in tables 2, 3 & 4 respectively.

Overall Bolton Ratio (X) for Different Skeletal Malocclusions

Overall Bolton Ratio (X) for the sample was 92.25%±2.3, for Skeletal Class I patients was 92.05%±2.17, for Skeletal Class II patients was 92.42%±2.39 and for Skeletal Class III patients were 92.2%±2.4 & 78.02%± 3.47 respectively as shown in table 5. This shows that Bolton Ratio (X) for Skeletal Class II > Skeletal Class III > Skeletal Class I though statistically insignificant.

Anterior Bolton Ratio (Y) for Different Skeletal Malocclusions

Anterior Bolton Ratio (Y) for the sample was 78.6% ± 2.67, for Skeletal Class I patients was 77.5%± 1.61 for Skeletal Class II patients was 79.04%± 2.75 and for Skeletal Class III patients was 78.02%± 3.47. This shows that Anterior Bolton Ratio (Y) for Skeletal Class II > Skeletal Class III > Skeletal Class I though statistically insignificant as shown in table 6.

Correlation Between Bolton Ratio & Dental Parameters

Correlation Coefficient (r) between Bolton Ratio & the Dental Parameters was calculated for the overall data and for different skeletal malocclusions as shown in tables 7,8,9,10.

	Range	Minimum	Maximum	Mean	Std. deviation
AGE	18.00	12.00	30.00	18.4333	4.2080
ANB	21.00	-9.00	12.00	4.1917	4.3052
X	11.42	88.00	99.42	92.2538	2.3099
XMM	4.20	.00	4.20	1.5092	1.0121
Y	12.23	73.10	85.33	78.6007	2.6685
YMM	4.33	08	4.41	1.3015	.9698
ALD MAXILLA	13.00	-8.00	5.00	-1.2583	2.8796
ALD MANDIBLE	16.00	-10.00	6.00	-2.5250	3.0217
IMPA	36.00	82.00	118.00	97.5583	8.7416
UISN	925.00	88.00	1013.00	123.8083	117.0843
Valid N (listwise)					

N = 60 (ENTIRE DATA)

TABLE 1: DESCRIPTIVE STATISTICS

	Minimum	Maximum	Mean	Std. deviation
PTAGE	14.00	28.00	19.1875	4.1347
ANB	.50	6.00	3.2813	1.2645
X	88.50	94.98	92.0550	2.1734
XMM	.36	3.53	1.6131	1.0873
Y	75.00	81.00	77.9525	1.6078
YMM	.08	2.40	1.0469	.6992
IMPA	83.00	105.00	95.6563	5.9434
UISN	100.00	130.00	109.8438	8.1644
ALDM	-6.00	3.00	-1.6250	2.1871
ALDMAND	-7.00	4.00	-2.9688	2.9010
Valid N (listwise)				

N = 15 (SKELETAL CLASS I)

TABLE 2: DESCRIPTIVE STATISTICS

	Minimum	Maximum	Mean	Std. deviation
PTAGE	12.00	30.00	17.8571	4.1526
ANB	1.00	12.00	6.7429	2.5157
X	88.00	99.42	92.4243	2.3979
XMM	.00	4.20	1.5689	.09691
Y	74.10	85.20	79.0366	2.7495
YMM	.13	4.30	1.3477	.9692
IMPA	82.00	118.00	99.6286	9.5758
UISN	88.00	1013.00	133.9857	153.2942
ALDM	-5.00	.00	-1.1429	.7334
ALDMAND	-10.00	6.00	-2.6143	3.2789
Valid N (listwise)				

N = 35 (SKELETAL CLASS II)

TABLE 3: DESCRIPTIVE STATISTICS

	Minimum	Maximum	Mean	Std. deviation
PTAGE	12.00	26.00	19.2000	4.4171
ANB	-9.00	.00	-3.1000	3.0714
X	89.00	97.33	92.2000	2.3993
XMM	.14	3.60	1.1540	1.0139
Y	73.10	85.33	78.0220	3.4711
YMM	.13	4.41	1.5670	1.2669
IMPA	84.0	110.00	92.6000	7.1833
UISN	100.00	115.00	108.3500	4.5464
ALDM	-2.00	1.00	-5.00E-02	1.1168
ALDMAND	-4.00	2.00	-1.4500	1.8922
Valid N (listwise)				

N = 10 (SKELETAL CLASS III)

TABLE 4: DESCRIPTIVE STATISTICS

Bolton Ratio	Skeletal Class I N		Skeletal Class II N		Skeletal Class III n		Total n	
Normal	10	66.67%	25	71.4%	9	90%	44	73.33%
Discrepancy	5	33.34%	10	28.6%	1	10%	16	26.67%
Total	15		35		10		60	

TABLE 5: RESULTS OF CHI-SQUARE TESTING DEMONSTRATING NO SIGNIFICANT DIFFERENCES (P>0.05) IN THE PREVALENCE OF $\pm$1 SD BOLTON TOOTH SIZE DISCREPANCY AMONG ANGLE'S CLASSIFICATION GROUPS

Anterior Bolton Ratio	Skeletal Class I N		Skeletal Class II N		Skeletal Class III n		Total n	
Normal	9	60%	18	51.42%	5	50%	32	53%
Discrepancy	6	40%	17	48.57%	5	50%	28	47%
Total	15		35		10		60	

TABLE 6: RESULTS OF CHI-SQUARE TESTING DEMONSTRATING NO SIGNIFICANT DIFFERENCES (P>0.05) IN THE PREVALENCE OF $\pm$1 SD ANTERIOR BOLTON TOOTH SIZE DISCREPANCY AMONG ANGLE'S CLASSIFICATION GROUPS

Correlation Between Anterior Bolton Ratio & Dental Parameters

Correlation Coefficient (r) between Anterior Bolton Ratio & the Dental Parameters was calculated for the overall data and for different skeletal malocclusions as shown in table 7,8,9,10.

DISCUSSION

In this study, the Bolton Ratio & Anterior Bolton Ratio was compared in Skeletal Class I, Class II, and Class III Patients in selected Pakistani Sample. Moreover Bolton Ratio & Anterior Bolton Ratios were correlated with the dental parameters i.e. Arch Length Discrepancy in Maxilla & Mandible), Inclination of upper & lower incisors (UI-SN & IMPA).

Overall Bolton Ratio (X) in our sample was 92.25%$\pm$2.3, for Skeletal Class I patients was 92.05%$\pm$2.17, for Skeletal Class II patients was 92.42%$\pm$2.39 and for Skeletal Class III patients was 92.2%$\pm$2.4 respectively but the difference was statistically insignificant. Incidence of Bolton Discrepancy, however in Skeletal Class I patients (33.34%) is > in Skeletal Class II patients (28.67%) which is > in skeletal Class III cases (10%). Alkofide and Hashim,[14] in their study determined no significant difference in the incidence of tooth size discrepancies existed for the overall ratio. Crosby and Alexander,[15] also reported no difference in the incidence of tooth size discrepancies from one malocclusion group to another. However, Sperry et al,[11] concluded that the frequency of mandibular tooth size excess (overall ratio) was greater in cases of

TABLE 7: CORRELATION BETWEEN BOLTON RATIO, ANTERIOR BOLTON RATIO & DENTAL PARAMETERS

		X	Y	ANB	ALDM	ALDMAND	IMPA	UISN
X	Pearson Correlation		.0406**	.059	-1.124	-1.50	-.007	-.222
	Sig. (2-tailed)		.001	.653	.345	.252	.958	.088
Y	Pearson Correlation			.264*	-.259*	-.229	-.005	-.204
	Sig. (2 tailed)			.042	.046	.079	.970	.118
ANB	Pearson Correlation				-.039	-.056	-.336**	.075
	Sig. (2 tailed)				.767	.673	.009	.569
ALDM	Pearson Correlation					.819**	-.045	-.212
	Sig. (2 tailed)				.	.000	.731	.103
ALDMAND	Pearson Correlation						.071	.030
	Sig. (2 tailed)				.		.591	.820
							60	60
IMPA	Pearson Correlation						.	.276*
	Sig. (2 tailed)				.			.033
								60
UISN	Pearson Correlation							
	Sig. (2-tailed)							

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

TABLE 8: CORRELATION BETWEEN BOLTON RATIO & DENTAL PARAMETERS FOR SKELETAL CLASS I MALOCCLUSION

		X	Y	ANB	ALDM	ALDMAND	IMPA	UISN
X	Pearson Correlation	1.000	.642**	.582*	-.308	-.225	.421	.171
	Sig. (2-tailed)		.007	.018	.248	.403	.105	.526
Y	Pearson Correlation	.642**	1.000	.249	-.346	-.259	.291	.324
	Sig. (2 tailed)	.007		.352	.189	.333	.274	.222
ANB	Pearson Correlation	.582*	.249	1.000	-.270	-.189	.140	-.252
	Sig. (2 tailed)	.018	.352		.312	.484	.605	.346
ALDM	Pearson Correlation	-.308	-.346	-.270	1.000	.875**	-.454	.192
	Sig. (2 tailed)	.246	.189	.312		.000	.078	.476
ALDMAND	Pearson Correlation	-.225	-.259	-.189	.875**	1.000	-.308	.377
	Sig. (2 tailed)	.403	.333	.484	.000		.246	.150
							16	16
IMPA	Pearson Correlation	.421	.291	.140	-.454	-.308	1.000	.515*
	Sig. (2 tailed)	.105	.274	.605	.078	.246		.041
								16
UISN	Pearson Correlation	.171	.324	-.252	.192	.377	.515*	1.000
	Sig. (2-tailed)	.526	.222	.346	.476	.150	.041	

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

mandibular prognathism than in Angle Class I and Class II cases. Nie and Lin[13] demonstrated that a significant difference was found for intermaxillary tooth size ratios among different malocclusion groups, with the ratios showing that Class III > Class I > Class II.

Akyalçin S[21], et al in their study investigated the frequency and association of Bolton tooth size discrepancies with dental discrepancies. Forty-eight skeletal Class I, 60 Class II, and 44 Class III subjects with similar skeletal characteristics were included in this study. Analysis of variance was performed to compare the mean ratios of Bolton analysis as a function of the Angle classification and sex. To determine the prevalence of tooth size imbalances among the three groups of occlusions and the two sexes, chi-square tests were performed. No statistically significant differences were

		X	Y	ANB	ALDM	ALDMAND	IMPA	UISN
X	Pearson Correlation	1.000	.328	-.090	.040	-.123	-.188	-.297
	Sig. (2-tailed)		.055	.607	.821	.483	.280	.083
Y	Pearson Correlation	.328	1.000	.110	-.138	-.208	-.197	-.286
	Sig. (2 tailed)	.055		.528	.428	.229	.258	.095
ANB	Pearson Correlation	-.090	.110	1.000	-.132	.228	.102	.001
	Sig. (2 tailed)	.607	.528		.449	.188	.559	.996
ALDM	Pearson Correlation	.040	-.138	-.132	1.000	.121	.084	.047
	Sig. (2 tailed)	.821	.428	.449		.487	.630	.791
ALDMAND	Pearson Correlation	-.123	-.208	.228	.121	1.000	.198	.033
	Sig. (2 tailed)	.483	.229	.188	.487		.254	.849
IMPA	Pearson Correlation	-.188	-.197	.102	.084	.198	1.000	.291
	Sig. (2 tailed)	.280	.258	.559	.630	.254		.090
UISN	Pearson Correlation	-.297	-.286	.001	.047	.033	.291	1.000
	Sig. (2-tailed)	.083	.095	.996	.791	.849	.090	

TABLE 9: CORRELATION BETWEEN BOLTON RATIO & DENTAL PARAMETERS FOR SKELETAL CLASS II MALOCCLUSION

		X	Y	ANB	ALDM	ALDMAND	IMPA	UISN
X	Pearson Correlation	1.000	.448	.170	.374	-.170	.122	-.357
	Sig. (2-tailed)		.194	.639	.288	.639	.738	.311
Y	Pearson Correlation	.448	1.000	.554	-.232	-.411	.241	-.595
	Sig. (2 tailed)	.194		.096	.519	.238	.502	.070
ANB	Pearson Correlation	.170	.554	1.000	-.131	-.295	.295	-.144
	Sig. (2 tailed)	.639	.096		.718	.407	.408	.691
ALDM	Pearson Correlation	.374	-.232	-.131	1.000	.540	.080	.157
	Sig. (2 tailed)	.288	.519	.718		.107	.825	.665
ALDMAND	Pearson Correlation	-.170	-.411	-.295	.540	1.000	.169	.091
	Sig. (2 tailed)	.639	.238	.407	.107		.640	.802
IMPA	Pearson Correlation	.122	.241	.295	.080	.169	1.000	-.024
	Sig. (2 tailed)	.7.38	.502	.408	.825	.640		.947
UISN	Pearson Correlation	-.357	-.595	-.144	.157	.091	-.024	1.000
	Sig. (2-tailed)	.311	.070	.691	.665	.802	.947	

TABLE 10: CORRELATION BETWEEN BOLTON RATIO & DENTAL PARAMETERS FOR SKELETAL CLASS III MALOCCLUSION

determined for the prevalence of tooth size discrepancies and the mean values of Bolton's anterior and overall ratios among the occlusal groups.

Al-Khateeb SN, Abu Alhaija ES[22] also found no statistically significant difference in the Bolton & Anterior Bolton Ratios for different malocclusions.

Anterior Bolton Ratio (Y) for the sample was 78.6%± 2.67, for Skeletal Class I patients was 77.5%± 1.61 for Skeletal Class II patients was 79.04%± 2.75 and for Skeletal Class III patients was 78.02%± 3.47 but the difference was statistically insignificant. Incidence of Anterior Bolton Discrepancy, however in Skeletal Class III patients (50%) is > in Skeletal Class II patients (48.67%) which is > in skeletal Class I cases (40%). Lavelle[6] studied anterior tooth size in 160 subjects and stated that the teeth in the lower arch are larger in Class III cases than in Class I and II cases, with the inference that a Bolton discrepancy is greater in Class III cases than in the other malocclusion groups. Araujo and Souki[12] also reported that the mean anterior tooth size discrepancy for Angle Class III subjects was significantly greater than that for Class I and Class II subjects. The results of theses studies were in congruence with ours. Crosby and Alexander,[15] however reported no difference in the incidence of tooth size discrepancies from one malocclusion group to another, which is in accordance with our study.

Literature shows that if there is Anterior Bolton Discrepancy in a case it will either effect the inclination of incisors and thus will affect the Over jet or will lead

to Arch length Discrepancy. Akyalçin S[21], et al in their study found that Bolton's anterior ratio discrepancies had significant correlations with midline shifts ($P < .05$) in Angle Class I cases, with U1-SN angle ($P < .01$) in Angle Class II cases, and with L1-APog distance ($P < .05$) in Angle Class III cases. Bolton discrepancies related to overall ratio had significant correlations with overjet ($P < .05$) in Class I cases, with overbite ($P < .05$) and U1-SN angle ($P < .01$) in Class II cases, and with IMPA ($P < .01$) in Class III cases. In our study Correlation Coefficient (r) was calculated between the Bolton ratio, Anterior Bolton ratio & various dental parameters to find the validity of the concerns in literature. Thus Correlation Coefficient (r) was calculated between Bolton Ratio (X), Anterior Bolton ratio (Y) and Dental parameters i.e. ALD in maxilla, ALD in mandible, Upper Incisor Inclination (UI-SN) & Lower Incisor Inclination (IMPA). Table VII showed that Anterior Bolton ratio is statistically significantly related to ALD in Maxilla (r=0.259).

CONCLUSIONS

1. Bolton Ratio though slightly different but was statistically insignificantly different in Skeletal Class I, II & II patients
2. Anterior Bolton Ratio though slightly different but was statistically insignificantly different in Skeletal Class I, II & II patients
3. Incidence of Anterior Bolton Ratio was more in Skeletal Class III cases than in Skeletal Class I & II
4. Statistically significant correlations between Arch Length Discrepancy in Maxilla and intermaxillary tooth size discrepancies were determined. Therefore, an orthodontist should be aware of such discrepancies and their probable effects on occlusion and dental relations when solving the malocclusion jigsaw.

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