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The influence of Bolton's analysis and Peck & Peck index on the pre and post-treatment overjet: A retrospective study

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***Abstract*---**Background: To evaluate the relationship between the overjet with pre and post orthodontic treatmentBolton's analysis and with Peck & Peck index. Materials and Methods: Pre and post-treatment orthodontic study models (n=30) of patients in the age range of 18 to 35 years, who underwent orthodontic treatment were evaluated for overjet, Bolton's analysis (overall ratio & anterior ratio) and Peck & Peck index (in 31,32,41&42). A digital Vernier caliper was used for all the measurements. The collected data was analyzed in SPSS software using appropriate statistical tests based on normality to compare the pre- and post-treatment mean values and Pearson's correlation was done between the Bolton's analysis and Peck & Peck index with overjet. The p value <0.05 was considered as statistically significant. Results: The Pearson's correlation revealed an inverse correlation between Bolton's anterior ratio and overjet (pre:-0.226, post:-0.254). The pre-treatment overjet with Peck & Peck index

revealed an inverse correlation in PP 31 (-0.230) and positive correlation in other teeth. The correlation in the post-treatment overjet with Peck & Peck index was an inverse correlation in all teeth (-0.347; -0.184; -0.184 & -0.074 in PP31, PP32, PP41 & PP42 respectively). Conclusion: The pre- & post-treatment overjet had negative correlation with the Bolton's analysis, and both positive and negative correlation with Peck & Peck index. The findings conclude that the tooth dimensions influence and determine the overjet. Thus, achieving the ideal Bolton's ratio by matching maxilla-mandibular tooth material and considering facio-lingual crown diameter of incisors are essential to achieve the optimum overjet.

***Keywords*---**Bolton's analysis, Peck & Peck index, overjet, orthodontic study models.

Introduction

Anterior teeth dimensions and their morphology greatly influence the intra-arch and inter-arch relationships. Various study model analyses are used as clinical orthodontic diagnostic aids to anticipate the tooth-material arch-size discrepancy and assist us in selecting the best treatment plan for each case.1-3 Many authors had proposed indices to evaluate the relationship between the tooth dimensions with their corresponding arch dimensions, as well as the inter-arch relationships.[4-10]

Bolton's analysis and Peck & Peck index are two study model analyses that are used to determine inter-arch and intra-arch ratios of tooth dimensions.11-13 Bolton (1958) investigated the inter-arch effects of tooth size discrepancy to develop a method that measures the ratio of the total tooth material in mandibular arch versus maxillary arch and the ratio of anterior tooth material of mandibular arch against maxillary arch.11,12 The study of anterior ratio will help in determining the anterior horizontal relationship i.e., optimum overjet, and obtaining Class I canine relationship which are the essential treatment objectives to be achieved at the end of orthodontic treatment. Likewise, the overall ratio helps in achieving proper interdigitation of posteriors without any excess space or crowding in anteriors. The morphology of tooth and the dimensions vary greatly with respect to ethnicity and gender.[14-17]

Peck and Peck (1972) correlated the presence or absence of lower incisor crowding to the morphology of the lower anterior teeth. He found that people with a perfect incisal arrangement had a smaller mesiodistal width and a bigger labiolingual width than people with incisal crowding.13 This ratio not only influences the overlap within the arch, but the labio-lingual thickness of the incisors could also influence the horizontal overlap between anteriors. Although both of these analyses have been considered to correlate with the tooth dimensions of anterior teeth and influence the horizontal relationships of anterior i.e., overjet, the literature lacks adequate evidence and no one has studied on the same. Thus, the present research will look into the dimensions of teeth, both mesiodistally and

labiolingually in incisors, and their influence on the horizontal relationship of the anterior dentition.

Materials and Methods

The present study was conducted on the study models of 30 patients in the age range of 18-35 years who underwent orthodontic treatment in the Department of Orthodontics and Dentofacial Orthopaedics, Vinayaka Mission's Sankarachariyar Dental College (DU), Salem. The study approval was obtained from the institutional ethical committee (Protocol number: IRC/180719/S/18). The pre-treatment and post-treatment study models (n=30) of a total 60 pairs were collected as part of essential orthodontic treatment records during their treatment. The collected study models were analyzed for overjet, Bolton's analysis and Peck & Peck index. The following inclusion criteria were followed; Patients' pre-treatment study models with full complement of teeth (excluding third molars);Patients who didn't underwent any previous orthodontic treatment; Patients with no evidence of caries, teeth fractures, interproximal wear, congenital malformations in tooth size which may cause loss of mesiodistal tooth material.Patients,who had Angle's Class I and Class II division 1 malocclusion, were treated with first premolar extractions. Whereas, patients with Angle's Class II div. 2 and Class III malocclusion, patients with single tooth or many teeth anterior crossbite, patients' study models that are broken, eroded, damaged study models where accurate tooth dimensions cannot be measured, and patients who are treated with lower single incisor extractions were excluded.

The following parameters were measured:

- Overjet
- Anterior tooth material – maxilla and mandible
- Overall tooth material – maxilla and mandible
- Bolton's anterior ratio
- Bolton's overall ratio
- PP 31 (Peck & Peck index of 31)
- PP 32 (Peck & Peck index of 32)
- PP 41 (Peck & Peck index of 41)
- PP 42 (Peck & Peck index of 42).

The overjet was measured from labial surface of maxillary study model by using stainless-steel ruler in conventional method. The tooth material was measured as maximum mesiodistal crown diameter (mesio-distal width) of the maxillary and mandibular teeth from first molar to first molar by using a digital Vernier caliper. The caliper beaks were kept perpendicular to the long axis of tooth and positioned at the greatest tooth dimension. The anterior tooth material was calculated from canine to canine and overall tooth material was calculated from first molar to first molar.11,12 The facio-lingual crown diameter of mandibular incisors was measured by positioning the beaks of the digital Vernier caliper near the gingival border and parallel to the long axis of tooth.[13]

The Vernier caliper was calibrated with a digital micrometer and read to the nearest 0.1 mm. The caliper tips were custom designed to ensure the highest

accuracy level. Two investigators (AV and AR) measured the parameters manually and independently. According to Bishara et al, the investigators two measurements were compared, and the values were averaged if they differed by less than 0.2 mm. The teeth were measured after the interval of two weeks, when the measurements differed by more than 0.2 mm, and the closest three measurements were averaged.18 After all the samples had been measured, each set of models was subjected to Bolton's analysis.Ratio between the maxillary and mandibular anteriors was calculated using the similar procedure (canine to canine). The “anterior ratio,” or the percentage relationship of mandibular anterior width to maxillary anterior width, is the ratio between the two.11,12Whereas, Peck & Peckindex was calculated as percentage of the mesiodistal (MD) crown diameter to thefacio-lingual (FL) crown diameter.[13]

Statistical Analysis

A master chart was prepared from the collected data and analyzed by using SPSS software (IBM, Chicago, IL, version 25.0). All the data were tested for normality using Kolmogorov-Smirnov test and found that certain parameters were not normally distributed.The Paired t-test was used in normally distributed parameters and Wilcoxon signed rank test was used in not normally distributed parameters. The Pearson’s correlation coefficient was used to correlate the overjet with Bolton’s and Peck & Peck index. P-value of 0.05 was kept as statistically significant.

Results

Table 1 revealed that Pearson’s correlation between the pre- and post-treatment overjet with the Bolton’s anterior ratio had an inverse correlation (pre: -0.226, post: -0.254). Table 2 shows that when the Pearson’s correlation was done between the pretreatment overjet with Peck and Peck index, there was an inverse correlation between 31 with overjet (-0.230), and positive correlation with other teeth were found. Table 3 shows that when the correlation was done between the post treatment overjet with Peck and Peck index, there was an inverse correlation seen with PP31, PP32, PP41 & PP42 (-0.347; -0.184; -0.148 and -0.074 respectively).

Variables	Pre OJ	Post OJ	Pre BR	Post BR
Pre OJ	1	-	-.226	-
Post OJ	-	1	-	-.254
Pre BR	-.226	-	1	-
Post BR	-	-.254	-	1

Table 1: Pearson’s correlation relating the pre and post-treatment overjet with pre and post-treatment Bolton’s anterior ratio respectively

OJ- Overjet, BR- Bolton’s anterior ratio. * Correlation significant at p value <0.05 (sig. 2-tailed)

Variables	OJ	PP 31	PP 32	PP 41	PP 42
OJ	1	-.230	.104	.112	.214

PP 31	-.230	1	-	-	-
PP 32	.104	-	1	-	-
PP 41	.112	-	-	1	-
PP 42	.214	-	-	-	1

Table 2: Pearson's correlation relating the pretreatment overjet with PP index of 31, 32, 41 and 42

OJ- Overjet, PP- Peck & Peck index. * Correlation significant at p value <0.05 (sig. 2-tailed)

Variables	OJ	PP 31	PP 32	PP 41	PP 42
OJ	1	-.347*	-.184	-.148	-.074
PP 31	-.347*	1	-	-	-
PP 32	-.184	-	1	-	-
PP 41	-.184	-	-	1	-
PP 42	-.074	-	-	-	1

Table 3: Pearson's correlation relating the post treatment overjet with PP index of 31, 32, 41 and 42

OJ- Overjet, PP- Peck & Peck index. * Correlation significant at p value <0.05 (sig. 2-tailed)

Discussion

Tooth size discrepancies are one among the important factors in causing the malocclusion, particularly in anterior segment which in turn affecting the overjet. Although tooth dimensions and its proportion play a crucial role in malocclusion, orthodontists have paid a very little attention to study about the anterior tooth size measurements.19 For a balanced occlusion and good intercuspation, the mesiodistal width of upper and lower teeth should be matched (Bolton's overall ratio), whereas to achieve optimum overjetBolton's anterior ratio should be matched.16,20 Also, the PP index may influence the overjet as the change in facio-lingual diameter of incisors might change the horizontal overlapping of incisors i.e. overjet.

When relating the pre & post-treatment Bolton's anterior ratio with pre & post-treatment overjet, there was an inverse correlation found (-0.226 and -0.254 respectively) which reveals that increase in Bolton's ratio can cause reduction in overjet (Table.1). Although not statistically significant (p>0.05), increase in BR could be due to increase in mandibular anterior excess. The excess tooth material might compensate as proclination of mandibular anteriors which reduced the overjet. The findings are well supported by Alamir et al. who found statistically significant inverse associations between anterior ratio and with the variable's overjet, overbite and upper anterior tooth thickness.21Also, the increased anterior ratio could be due to maxillary anterior deficiency. A study done by Turtinenalso supported that negative overjet was related to the maxillary anterior deficiency.22

When correlating the pre-treatment overjet and PP index, the results showed an inverse correlation in 31 (-0.230) and a positive correlation in the other teeth (0.104 in 32, 0.112in41, 0.214 in 42) (Table 2) which indicates that in most of the cases differential overjet was found, whereas when the correlation was done between the post treatment overjet and PP index there was an inverse correlation seen in 31, 32, 41 and 42 (-0.347, -0.184, -0.184 and -0.074 respectively) (Table 3) which indicates that increase in PP index can cause reduction in overjet.This definitive relationship between thickness of incisors and overjet and overbite also found by Steadman SR. He concluded that the pre-treatment labio-lingual thickness of incisors influence the overjet and overbite and could be used as a predetermining factor for overjet and overbite.[23]

According to Sheldon Peck's study, mesio-distal dimension for mandibular central and lateral incisors were smaller in the perfect alignment sample, whereas facio-lingual crown diamesion for mandibular central and lateral incisors were greater in the perfect alignment sample than in the control population. The findings are consistent with our present study with respect to the PP index of teeth 31 and 41, 32 and 42.24 When comparing the pre-treatment and post-treatment overjet,the post-treatment overjet was found to be decreased. The anterior ratio of Bolton's analysis that measured mesiodistal width was inversely proportional to overjet. It indicates that excess tooth material in mandibular anteriors might reduce the overjet.

The following limitations were found in our study, inclination of anterior teethand facio-lingual diameter of upper anterior teeth were not considered in this study.This study included only the pre and post operative study models. Follow up study models to assess the retention of the treatment should have been considered.

Conclusion

The findings conclude that the tooth dimensions act as determinants for overjet. Thus, achieving the ideal Bolton's ratio by matching maxilla-mandibular tooth material and considering facio-lingual crown diameter of incisors are essential to achieve the optimum overjet.

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