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ORIGINAL RESEARCH

A Cephalometric Evaluation of Pretreatment and Post-treatment Outcome using Tetragon Analysis: A Retrospective Study

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ABSTRACT

Statement of problem: Few cephalometric analyses have been put forward to assess the treatment outcome after orthodontic treatment. However, these analyses are somewhat complicated and time consuming. The Tetragon analysis is introduced with measurement of treatment outcome as one of its objectives.

Purpose of study: The study was undertaken to evaluate the treatment outcome by checking the skeletal and dental changes using pretreatment and post-treatment radiographs and to evaluate the efficiency of treatment in the Department of Orthodontics, College of Dental Sciences, Davangere, using the Tetragon analysis.

Materials and methods: Records of 35 finished patients with fixed orthodontic therapy using preadjusted edgewise appliance were selected. The samples were analyzed separately for the skeletal parameters consisting of skeletal class I, II and III using Tetragon analysis.

Results: The post-treatment reduction of upper incisor palatal plane angle was found to be statistically significant in skeletal class I ($p < 0.01$) and skeletal class II patients ($p < 0.05$). The post-treatment increase in interincisal angle was found to be statistically significant in skeletal class I ($p < 0.01$) class II patients ($p < 0.05$).

Conclusion: Fixed appliance therapy reduced the proclination of upper incisors and increased the interincisal angle in skeletal class I and II cases but not in skeletal class III cases. The lower incisal angulation and the maxilla-mandibular plane angle did change significantly and so were the angles of the Trigon. The Tetragon analysis proved easy to measure the treatment outcome.

Keywords: Preadjusted edgewise appliance, Cephalogram, Tetragon analysis interincisal angle, Trigon.

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INTRODUCTION

Social, economic and political pressures are bringing about changes in all aspects of health care delivery. Changes are conditioned by a need to strive for evidence-based clinical practices. A prerequisite for evidence-based care is that it should be patient centered and that objective and measurable outcomes are specified. Evidence-based decision making has become a hallmark of 21st century health care and this trend has placed a premium on quantitative measures of treatment outcome.[1] Few cephalometric analyses have been put forward to assess the treatment outcome. However, these analyses are somewhat complicated, difficult and time consuming to be used in day-to-day practice. Recently, the Tetragon analysis was introduced with measurement of treatment outcome as one of its objectives.[2] This analysis appeared to be the least complicated among all the cephalometric analysis available to measure the treatment outcome. This study was undertaken to evaluate the outcome of treatment by checking the skeletal and dental changes using pre- and post-treatment radiographs and to evaluate the efficiency of treatment in the Department of Orthodontics and Dentofacial Orthopedics, College of Dental Sciences, Davangere, using the Tetragon analysis.

MATERIALS AND METHODS

Thirty-five finished cases were randomly selected from the departmental records of Department of Orthodontics and Dentofacial Orthopedics, College of Dental Sciences, Davangere.

Inclusion Criteria

1. Patients with standardized pre- and post-treatment lateral cephalogram and case records.

2. Patients who received fixed orthodontic therapy with preadjusted edgewise appliance.
3. Native patients of Davangere.

Exclusion Criteria

1. Patients were rejected if standardized pre- and post-treatment lateral cephalograms and case records were lacking.
2. Patients with craniofacial deformities.
3. Patients who have received functional or orthopedic appliance therapy and those in which orthognathic surgery was undertaken.

Method of Collecting Data

Patient records which included a detailed case history and pre- and post-treatment cephalogram were screened by a single operator and the final study sample was chosen satisfying the above-listed criteria.

The study sample consisted of 35 patient records which included 25 females and 10 males. The pre- and post-treatment lateral cephalograms were traced on acetate tracing sheets.

The whole sample of 35 cases was analyzed separately for the skeletal parameters consisting of skeletal class I, II and III using ANB angle as the criterion to distinguish between the skeletal malocclusions.

The skeletal malocclusion parameter consisted of:

15 – Class I cases having ANB angle of 0° to 4°

10 – Class II cases having ANB angle greater than 4°

10 – Class III cases having ANB angle less than 0°

The Tetragon analysis was applied to pretreatment and post-treatment lateral cephalograms to evaluate the skeletal parameters and the degree of improvement in each parameter.

TETRAGON (FIG. 1)

U1-PP: Intersection of the palatal plane (PP) and the long axis of the maxillary central incisor.
U1-L1: Intersection of maxillary and the mandibular central incisor planes.
L1-MP: Intersection of the mandibular incisor long axis and the mandibular plane.
MP-PP: Intersection of the mandibular plane and the PP.

The Tetragon has four sides, forming four angles and always adds to 360°. If any angle is modified, either by growth or by orthodontic treatment, the angles of the Tetragon will change, but their sum will still be 360°. If that is not the case, it means either that the tracing is inaccurate or that one or more angles have been calculated incorrectly.

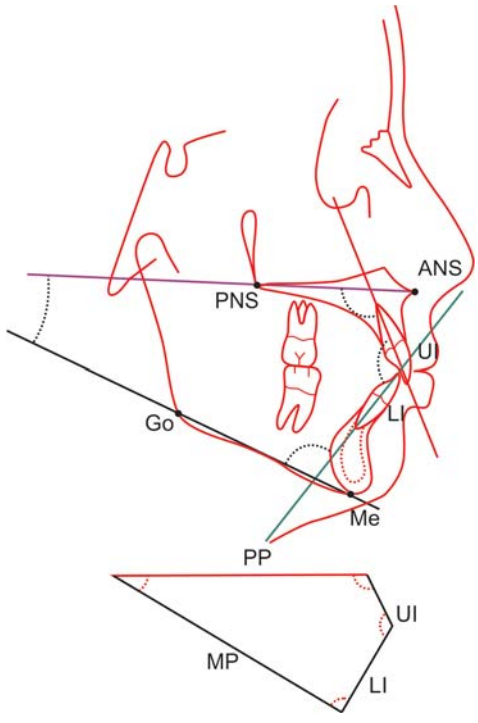

Fig. 1: Tetragon

TRIGON (FIG. 2)

Pt.-Or/Pt-PNS: Intersection of Pt-Or plane and Pt-PNS plane called 'Upper Pt'.
Pt.-PNS/PP: Intersection of the Pt-PNS and the PP called 'Lower Pt'.
Pt.-Or/PP: Intersection of the Pt.-Or plane and the PP.

The Trigon has three sides, forming three angles that always add up to 180°. In any patient, the three angles should always total 180°. If the PP and the Pt-Or plane are parallel, their angulation will be neutral or 0°, but the sum of the two remaining angles will still be 180°.

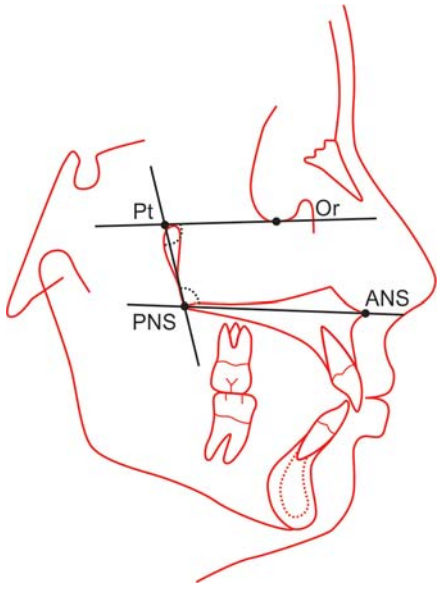

Fig. 2: Trigon

Results are presented as mean and standard deviation for scores and as percentages for categorical data. Post-treatment changes are compared by paired t-test. Intergroup comparisons were made by Mann-Whitney U test which is a nonparametric test. A p-value of less than 0.05 was considered for statistical significance. All the analyses were done on PCXT with Minitab Software (Version 6, USA). The descriptive data are presented as mean, standard deviation and percentage of improvement. The significance of improvement in each group has been assessed using paired t-test and Mann-Whitney test. The whole sample of 35 cases was analyzed separately for the skeletal parameters on the basis of the Tetragon and the Trigon.

RESULTS

Tetragon

1. U1-PP Angle (Fig. 3)

The pretreatment mean value of the upper incisor PP angle was the highest in skeletal class I patients with a mean of 123.8° ± 6.4°, closely followed by skeletal class II patients having a mean of 117.0° ± 8.4° with the skeletal class III patients showing the least value for this angle (122.0° ± 9.0°). The angle was higher than the norm for all classes.

The post-treatment difference for the upper incisor PP angle was highest in skeletal class I patients with a mean reduction of 8.0° ± 10.1° in the angle, showing a statistical significance of $p < 0.01$. Skeletal class II and skeletal class III patients showed a post-treatment reduction of 6.3° ± 9.8° and 3.0° ± 9.7° respectively, but the values were not statistically significant.

The reduction of the angle, as a result of treatment, in relation to the norm, was found to be statistically significant in skeletal class I ($p < 0.01$) and skeletal class II patients ($p < 0.05$). Skeletal class III subjects did not show any significant change ($p = 0.68$).

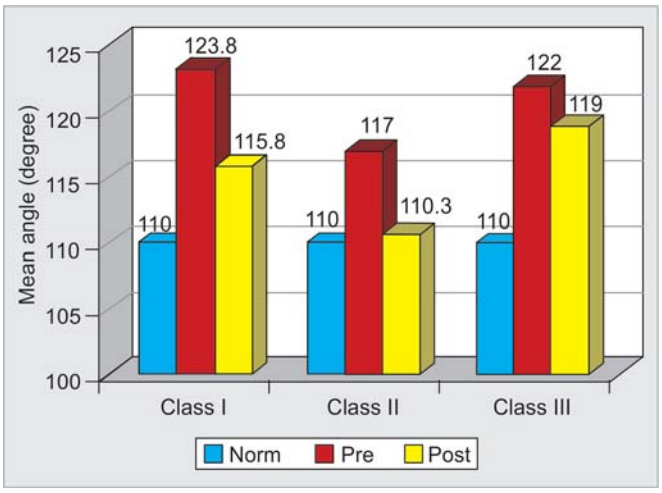

Fig. 3: U1-PP angle

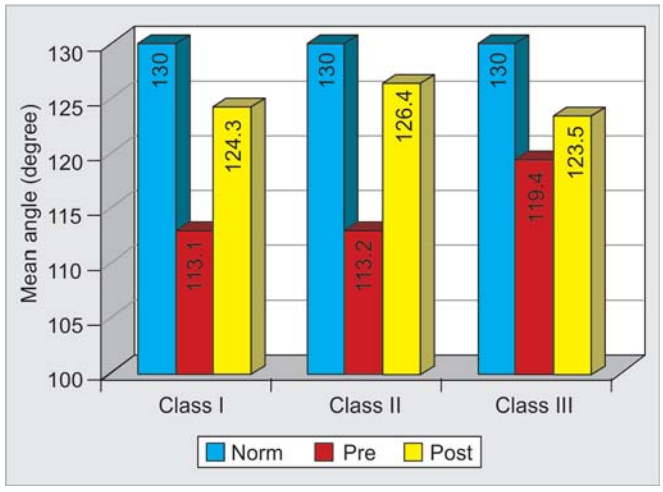

Fig. 4: U1-L1 angle

2. U1-L1 Angle (Fig. 4)

The interincisal angle showed a maximum pretreatment value of 119.4° ± 17.3° for skeletal class III cases with the skeletal class I and skeletal class II patients showing a similar mean value (113.1° ± 12.5° and 113.2° ± 11.4° respectively) for this angle. The angle was lower than the norm for all classes.

All the skeletal classes showed a mean increase in the interincisal angle during treatment. The greatest post-treatment increase in the interincisal angle was 13.2° ± 17.7° seen in skeletal class II cases followed closely by skeletal class I cases showing an increase of 11.1° ± 12.8°. The increase in angle was statistically significant for both classes with $p < 0.05$ for skeletal class II and $p < 0.01$ for skeletal class I patients. Skeletal class III subjects showed an increase of 4.1° ± 13.2° which was not statistically significant ($p = 0.35$).

The increase in the angle, as a result of treatment, in relation to the norm, was found to be statistically significant in skeletal class I ($p < 0.01$) and skeletal class II patients ($p < 0.05$). Skeletal class III subjects did not show any significant change ($p = 0.22$).

3. L1-MP (Fig. 5)

The pretreatment mean value of the lower incisor mandibular plane angle was similar in skeletal class I and II patients showing a mean of 101.0° ± 7.0° and 101.7° ± 5.6° respectively, while the skeletal class III patients showed a mean of 94.7° ± 7.6°, which was the least value for this angle. The angle was higher than the normal for all classes.

The post-treatment difference for the lower incisor mandibular plane angle was highest in skeletal class II patients with a mean reduction of 7.1° ± 11.5° in the angle. However, the value was not statistically significant ($p = 0.08$). Skeletal class I patients showed a post-treatment reduction

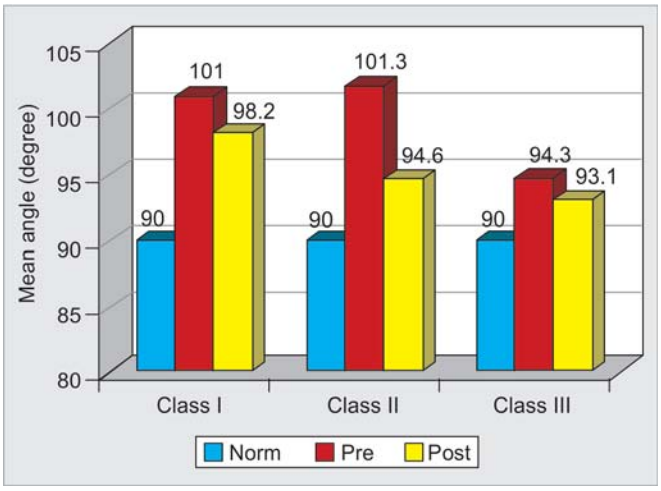

Fig. 5: L1-MP angle

of 2.8° ± 6.1°, but the value was not statistically significant (p = 0.09). Similarly, skeletal class III patients showed a post-treatment reduction of 1.6° ± 7.7°, but the value was not statistically significant (p = 0.53).

The reduction in the angle, as a result of treatment, in relation to the norm, was not statistically significant for all classes.

4. MP-PP (Fig. 6)

The maxillomandibular plane angle showed a maximum pretreatment value of 28.1 ± 6.0° for skeletal class II cases with the skeletal class I and skeletal class III patients showing a mean of 22.1° ± 5.1° and 23.9° ± 4.9° respectively, for this angle. The angle was lower than the norm for all classes.

The post-treatment difference as well as the change in the angle, as a result of treatment, in relation to the norm, was not statistically significant for all classes.

Trigon

There was no significant post-treatment difference seen for the three angles of the Trigon. The change in the three angles, as a result of treatment, in relation to the norm, was also not statistically significant for all classes.

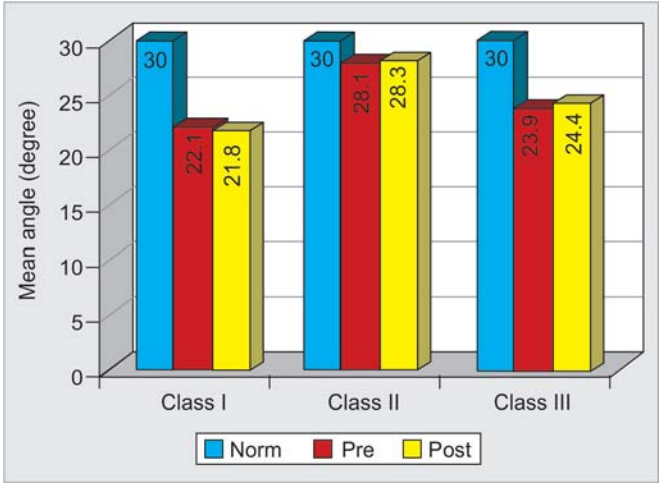

Fig. 6: MP-PP angle

DISCUSSION

The Tetragon

1. U1-PP

The pretreatment maxillary incisor proclination was highest in skeletal class I patients and was closely followed by skeletal class III patients. The skeletal class II had the least value for this angle. This can be explained by the fact that dentoalveolar compensations take place for variation in sagittal jaw relationships, which has also been confirmed by other authors.[3]

However, John and Valiathan (1991), in a study on subjects from Kerala, noted that proclination of maxillary incisors was maximum for class II patients. This difference might have occurred because; in the present study dental class II division 1 and class II division 2 malocclusion were included under the skeletal class II malocclusion category. So the mean proclination of maxillary incisors would have been reduced.[4]

The post-treatment difference for the upper incisor PP angle was highest in skeletal class I patients, followed by class II and least for class III patients. The objective of treatment in all these cases was to obtain a dental camouflage. Hence, in most of the skeletal class II cases, upper incisors were moved bodily, but in many cases, the upper incisors tipped lingually more than they were bodily retracted. In skeletal class III cases, the upper incisors were proclined in 60% of the cases whereas the incisors were retracted in others. This can be the reason for insignificant findings of maxillary incisor angulation in skeletal class III cases.

In the present study, the maxillary incisor proclination was reduced significantly in skeletal class I and II cases but not in skeletal class III cases because in some class III cases the maxillary incisors were proclined whereas in some they were retroclined.

The post-treatment value of U1-PP angle for skeletal class I and III were above the norm. This can be explained by the fact that the norms of Fastlicht's Tetragon (are based on Caucasian population and the incisors in Indian population are more proclined than the Caucasian population [John and Valiathan (1991), Valiathan (1974)].[4,6]

2. U1-L1

The interincisal angle showed a maximum pretreatment value for skeletal class III cases with skeletal class I and II patients showing the same value for the angle.

John and Valiathan (1991) noted the least interincisal angle for class II cases. This difference in finding can be due to the reason that the present study considered skeletal malocclusion as the grouping criteria whereas John and Valiathan (1991) considered dental malocclusion as the grouping criteria. Also, the skeletal class II group in the present study consisted of dental class II division 1 and 2 cases which might explain the difference in the results.

All the skeletal classes showed increase in the interincisal angle during treatment and the post-treatment value for all skeletal classes was similar.

Skeletal class II subjects showed the maximum increase in interincisal angle and was closely followed by skeletal class I cases. This increase in interincisal angle was mostly due to retraction of upper incisor rather than the retraction of lower incisor. These results were similar to those obtained by Basciftci and Usumez (2003), who did a study to compare class I and II malocclusions.[5]

The change in interincisal angle in skeletal class III cases was not significant because in some cases the upper incisors were proclined and in others the incisors were retroclined. So the net effect diminished the statistical significance.

The increase in the angle, as a result of treatment, in relation to the norm, was found to be statistically significant in skeletal class I and II patients. However, due to variation in post-treatment upper incisor angulation in the skeletal class III group, the results were not statistically significant. The change in interincisal angle ranged from –21° to +21° in the skeletal class II group depending on the customized treatment provided for each patient. Hence, in this group, the treatment was efficient enough to change the interincisal angle individually for each patient in spite of low significance shown by the statistical data. The post-treatment value for the interincisal angle was lower than the norms for all classes and these results were similar to those of the previous studies.[4,6]

3. L1-MP

The pretreatment mean value of the lower incisor mandibular plane angle was found to be similar for skeletal class I and II patients. The skeletal class III patients showed the lowest value for lower incisor angulation. The reduced lower incisor angulation in skeletal class III cases was due to dentoalveolar compensation for the skeletal malocclusion.[4]

The post-treatment difference for lower incisor angulation was highest for skeletal class II subjects. But the reduction in angulation was not statistically significant. Similarly, the reduction in the angle was not significant for skeletal class I and III cases also. Basciftci and Usumez (2003) compared class I and II cases and showed similar results. Also, 50% of cases in the skeletal class III group showed an increase in lower incisor angulation whereas 30% showed a decrease, in the present study. Hence, the statistical significance of the change in this angle was reduced.

The treatment efficiency for change in the angle in relation to the norm was not found to be significant for all classes. This was because of high individual variations which diminished the statistical significance.

The post-treatment value for lower incisor mandibular plane angle was higher than the norm for all skeletal classes which has also been shown by Valiathan (1974) and Kharbanda et al (1989).[6,7]

4. MP-PP

The maxillomandibular plane angle indicates the relationship of the jaws to each other. This angle was lower than the norm for all the skeletal malocclusions. This could be in part due to lower mandibular plane angle found in the Indian population as compared to the Caucasians as shown by John and Valiathan (1991) Kharbanda (1989).[6,7] There was no significant post-treatment change in this angle as all the patients were treated with fixed appliances without any surgical or functional therapeutic intervention.

Earlier study has been done using Tetragon analysis evaluating the dentoskeletal characteristics of to establish cephalometric norms using the cephalometric values for class II and III malocclusion groups. The results of this study indicate that the norms established should be used to evaluate the dentoskeletal relationship of our local population, for Tetragon analysis, because certain differences have been noted between the original and current study. Thus, by using the local norms one will get more accurate picture of the dentoskeletal relationship for the local population.[8]

Trigon

On analysis of the Trigon, this study has shown that the PP was tipped caudally (i.e. clockwise). This was indicated by an increase in the Pt.-PNS/PP angle and decrease in Pt-Or/PP angle. Fastlicht (2000) stated in the Tetragon analysis that 'the angle formed by the intersection of Pt-Or plane which represents the cranial base and the PP, which represents the base of the maxilla, indicates the overall inclination of the Tetragon'. In other words, he meant that if the PP is tipped cranially, the entire Tetragon would be tipped in the same direction. However, this may not be totally correct. To understand this better, let us consider a situation where the posterior aspect of the maxilla is up and the anterior aspect down; i.e. the maxilla would be rotated

clockwise. In this situation, there is a greater chance that, due to overclosure, the mandible will rotate upward and forwards, i.e. 'counterclockwise. Thus, in this situation, the PP is rotated in a 'clockwise' fashion, but the entire Tetragon is not. Here, it should be remembered that rotation of the mandible does not depend only on the inclination of the PP. It also depends the amount of compensation (that is vertical and sagittal growth) occurring in ramus.

The aforementioned argument may explain the reason for convergent rotation of the jaw bases in the current study. Here, the PP was tipped caudally, i.e. clockwise on account of which the mandible may have rotated counterclockwise.

There was no post-treatment difference in any of the angles of Trigon. This was because all the cases were treated with fixed appliance therapy without any surgical or functional intervention. Since most of the subjects considered in the study were adolescents and adults, minimum growth changes were expected in the angles of Trigon. It can be inferred that Trigon and specifically the Pt-Or plane appears to be a stable reference line and provides for accurate superimposition for the Tetragon, which has also been shown by Fastlicht.[2]

The Trigon and Tetragon plus cephalometric analysis is a condensed version of the most important measurements needed to diagnose the patient's skeletal pattern.[9] Various studies have been done to develop cephalometric norm for more better diagnosis for different group of population using Tetragon analysis.[10,11]

CONCLUSION

From the present study it was concluded that the upper incisor proclination was reduced and the interincisal angle was increased in skeletal class I and II subjects as a result of fixed appliance therapy. The changes in upper incisor angulation and interincisal angle were not significant for skeletal class III cases due to individual variation within the sample. The lower incisor mandibular plane angle and maxillomandibular plane angle did not change appreciably in the sample.

Upper and lower jaw bases tend to be more convergent and the upper jaw is caudally tipped in the Davangere population. The upper and lower incisors tend to be more proclined on their respective jaw bases when compared to Caucasian group. The Trigon appeared to be stable with fixed appliance therapy and Pt-Or plane proved to be a useful reference line for superimposition. The treatment provided in department was efficient in reducing the proclination of upper incisors and increasing the interincisal angle.

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