Frontal Facial Morphological Changes related to Twin Block Appliance using Posteroanterior Cephalogram - A Prospective Comparative Study

Aakanksha Kashyap[1], Roopa Jatti[2]

ABSTRACT

Introduction: The class II malocclusion is one of the most common orthodontic problems and is seen in nearly 1/3rd of the population. Study was done to assess the treatment induced dentoskeletal cephalometric changes in the frontal facial aspect using the frontal cephalogram.

Material and methods: A total of 10 patients of either sex with skeletal class II malocclusion and requiring therapy using twin block myofunctional appliance were included in the study.Standardized digital frontal and lateral cephalograms were taken both pre and post-treatment and Pre-functional and post -functional evaluation of skeletal landmarks and dental landmarks were carried out. The results thus obtained were tabulated and subjected to statistical analysis. A p value of less than 0.05 was considered statistically significant.

Results: Statistically significant correlation ($p \leq 0.05$) was found in the following parameters ie ICA (Inter condylar angle), AFH (Anterior facial height), PFH (Posterior facial height), Z-Co, Total facial area, AG-Me-AG when the pre and post treatment variables were compared on the PA cephalograms. Similarly, statistically significant correlation ($p \leq 0.05$) was found in the Co-Go (Ramal length), Co-Gn (Effective mandibular length), AFH (Anterior facial height), PFH (Posterior facial height), MPA (Mandibular plane angle) and N perp PG when the pre and post treatment variables were compared on the lateral cephalograms. For the rest of the parameters on either cephalograms, the comparison revealed no data of statistical significance.

Conclusion: In conclusion, we believe that the overall cephalometric readings shows minimal change in width but other parameters corresponding to antero-posterior positioning and vertical height shows increment which is contributing to the balanced facial proportions.

Keywords: Frontal Facial Morphological, Twin Block Appliance, Posteroanterior Cephalogram

INTRODUCTION

Amongst a wide range of functional appliances that encompasses both removable and fixed appliances available for correction of class II skeletal and occlusal disharmonies, the twin block appliance has gained widespread acceptance over the last decade or so.[1] The therapy is based on the dentofacial orthopaedic principle that aims to create a physiologic balance between the skeleton, muscles and teeth of the entire stomatognathic system.

In orthodontics, the cephalometric radiography has been a valuable contribution to studying the growth changes since its inception. Although most growth studies have utilised lateral cephalograms in analysing the anterior posterior and vertical dimensions of the face, nevertheless, such modality provides inappropriate detail about the horizontal or transverse dimensions of the face. Bilateral facial asymmetries and development of the oronasal area can be best assessed from a transverse analysis of postero-anterior cephalometric radiographs. No study as of now has actually reported changes in transverse dimensions that occur following the twin block appliance therapy using PA cephalograms.[2-4]

This study was therefore intended to investigate the facial changes in transverse dimensions that occur following the twin block appliance therapy as studied on the PA cephalograms in addition to studying changes in the anteroposterior direction using the lateral cephalograms.

MATERIAL AND METHODS

A total of 10 patients of either sex requiring therapy using twin block myofunctional appliance and satisfying the inclusion criteria of age range between 10-15 years, having skeletal class II malocclusion with ANB angle $\geq$ 4 degrees and having a positive VTO were included in the study. Those who had previously undergone orthodontic treatment, those with craniofacial deformity or gross facial asymmetries were excluded. An informed written consent was procured from all the participants of the study.

The Twin block appliance was constructed to a protrusive bite and the purpose was to promote protrusive mandibular function for correction of the skeletal class II malocclusion.[1] Twin block appliance was designed to be worn for 24 hours per day to take full advantage of all functional force applied to the dentition, including the forces of mastication. Construction bite was made with modeling wax with 6-7mm of advancement and 2-3mm of vertical opening (rule of 10) as most of the subjects were of horizontal to average growth pattern[2] and with SMI stage 4-5.

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Facial index {facial height (N to Gn)/ bizygomatic width X 100}^{2} (calculated using vernier caliper) was evaluated before and after the treatment.

Standardized digital frontal and lateral cephalograms were taken of all the individuals who were participating in the study. Frontal cephalograms were taken on Kodak 8000C digital panoramic and cephalometric system, where the distance between the subject and X-ray source was fixed at 5 feet and exposure parameters at 76Kvp and 12mA, with exposure time of 1.25sec.

Tracings were made by the same person at different intervals of time to avoid inter-examiner bias, using a 0.3mm mechanical lead pencil on acetate paper over an illuminated light box. Cephalometric points and contours were marked.

Magnification error was calculated for the posterior-anterior cephalogram by placing 2 Steel ball bearings of 6mm in diameter[3] at a distance of 7mm near the malar prominence and another method was used by measuring the bi-mastoid width of each patient clinically.[4]

Pre-functional and post -functional evaluation of skeletal landmarks and dental landmarks were done on frontal and lateral cephalograms of the patients. Overall, cephalometric analysis in the present study covers 15 parameters in frontal cephalogram and 9 parameters in lateral cephalogram. The cephalometric parameters studied on PA cephalogram include

1. **Frontal facial taper angle: (ZA to AG POINT)** – Angle formed by lines passing through the zygomatic arch and antegonial notch on left and right side.
2. **Intercondylar angle (Co-Me-Co) -** Angle formed by the condyles.
3. **Z perpendicular (reference plane) -** Perpendicular drawn from Z point.
4. **Posterior face height: (Z-Ag) -** Line drawn from Z point to Ag point.
5. **Anterior face height: (Cg-Me) -** Line drawn from crista galli to menton.
6. **Vertical Condylar distance: (Z-Co) -** Line drawn from Z to condylion.
7. **Ag-Ag -** Width of the mandible.
8. **Z-Z plane –** Horizontal line passing through point Z bilaterally.
9. **Antegonial notch to Z perpendicular -** Distance of Ag point to $Z_{\perp}$.
10. **Center of ramus to Z perpendicular -** Distance of CR point to $Z_{\perp}$.
11. **Total Facial Area (Z-Co-AG-Me-AG-Co-Z) -** Calculated by dividing it into trapezium and right angled triangles and then using the mathematical formula for each.
    a. Trapezium: A= a+b/2*h
    b. Triangle: A= ab/2
12. **Total Mandibular ratio:** B1-Me/Cg-Me
13. **Maxillo-mandibular ratio:** ANS-A1/B1-Me

Dental parameters

1. **Intermolar width** - Line passing through the buccal surface of 1st molar on right and left side
2. **Intercanine width -** Line passing through the buccal surface of canine on right and left side

The cephalometric parameters studied on lateral cephalogram include:

1. **Co-Go -** Line passing the condylion and gonion point.
2. **Co –Gn -** Line passing the condylion and gnathion point.
3. **AFH -** A line passing through nasion to menton point.
4. **PFH -** A line passing through sella to gonion point.
5. **Ar-Go-Me: gonial angle -** Angle formed by articulare, gonion and menton.
6. **Go-Gn -** A line passing through gonion to gnathion.
7. **$N_{\perp}$Pg -** A perpendicular drawn from Frankfurt horizontal plane at point nasion.
8. **N-ANS -** A line passing through nasion to anterior nasal spine.
9. **MPA:** A tangent drawn along the lower border of the mandible.

RESULTS

Comparison of pre and post treatment scores of different measurements of PA and lateral Cephalogram was done using paired t test.When the pre and post treatment variables for both the lateral and PA cephalograms were compared, the following information was discerned. Statistically significant

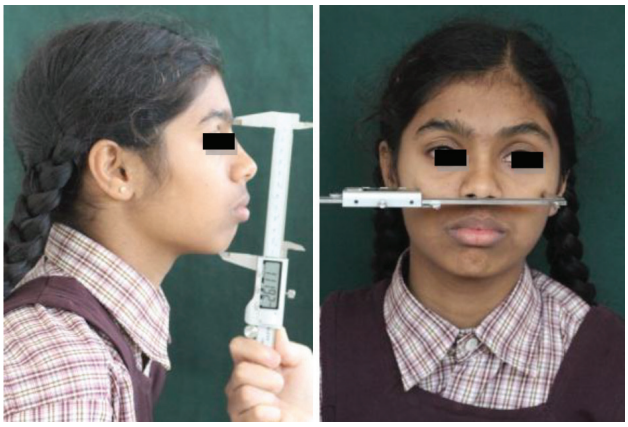

Figure-1: Measurement for facial index.

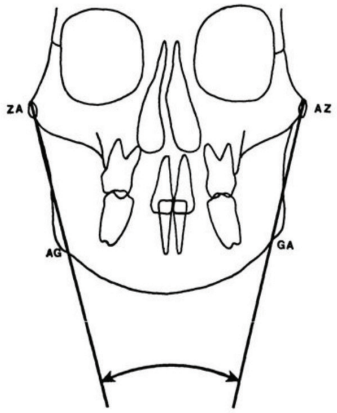

Figure-2: Frontal facial angle

Variables	Treatment	Mean	SD	Mean Diff.	SD Diff.	Paired t	p-value
FFTA	Pre treatment	9.20	3.155	.300	1.767	.537	.604
	Post treatment	8.90	3.107				
ICA	Pre treatment	69.20	5.653	-2.300	1.636	-4.445	.002*
	Post treatment	71.50	5.339				
TMR	Pre treatment	.300	.0000	-.02400	.04195	-1.809	.104
	Post treatment	.3240	.04195				
MMR	Pre treatment	.850000	.2013841	-.0700000	.1159502	-1.909	.089
	Post treatment	.920	.1989				
AFH	Pre treatment	95.540	4.7197	-4.3600	2.0304.	-6.790	.000*
	Post treatment	99.90	5.547				
PFH	Pre treatment	73.950	7.2359		3.11212	-3.985	.003*
	Post treatment	77.8720	6.49149	-3.92200			
Z-CO	Pre treatment	23.50	5.720	-2.0400	2.0370	-3.167	.011*
	Post treatment	25.540	4.6553				
AGAG	Pre treatment	73.90	3.573	-0.200	.816	-0.422	
	Post treatment	74.10	3.542				.168
Z-Z	Pre treatment	85.810000	6.3249857	-.3400000	.8630695	-1.246	.244
	Post treatment	86.150	5.7545				
Z PERP AG	Pre treatment	3.420000	2.9415793	.2200000	4541170	1.532	.160
	Post treatment	3.200	2.7508				
Z PERP CR	Pre treatment	3.330000	2.0992327	.1400000	.9935347	.446	.666
	Post treatment	3.190	1.3844				
IM	Pre treatment	53.060	3.9317		1.6128	-1.941	.084
	Post treatment	54.050	3.8184	-.9900			
IC	Pre treatment	30.050	3.3867	-.5800	1.0528	-1.742	.115
	Post treatment	30.630	3.5296				
Total facial area	Pre treatment	1066.10	177.006	-56.100	20.388	-8.702	.000*
	Post treatment	1122.20	182.082				
AG-ME-AG	Pre treatment	128.20	9.004	-7.000	4.967	-4.457	.002*
	Post treatment	135.20	8.817				
*Statistically significant p value <0.05							

Table-1: Comparison of pre and post treatment scores of different measurements byPA Cephalogram using paired t test

Variables	Treatment	Mean	SD	Mean Diff.	SD Diff.	Paired t	p-value
Co-Go	Pre treatment	44.234000	5.5922569	-2.8060000	2.8156554	-3.151	.012*
	Post treatment	47.040	5.1998				
Co-Gn	Pre treatment	88.8420	7.86739	-2.86800	2.74121	-3.309	.009*
	Post treatment	91.710	7.6637				
Go-Gn	Pre treatment	59.80	7.021	-0.300	.483	-1.964	.081
	Post treatment	60.10	7.141				
AFH	Pre treatment	92.990	6.3180	-3.4900	1.8835	-5.859	.000*
	Post treatment	96.480	5.7967				
PFH	Pre treatment	61.984000	7.6754663	-1.9360000	1.4756031	-4.149	.002*
	Post treatment	63.920	7.1746				
Ar-Go-Me	Pre treatment	123.70	5.964	-1.000	3.162	-1.000	.343
	Post treatment	124.70	4.809				
MPA	Pre treatment	23.380	5.1833	-2.3200	1.0119	-7.250	.000*
	Post treatment	25.70	5.034				
N PERP PG	Pre treatment	-7.00	4.472	-4.300	.949	-14.333	.000*
	Post treatment	-2.70	4.296				
N-ANS	Pre treatment	44.20	4.131	-.3000	.5375	-1.765	.111
	Post treatment	44.500	3.8873				
*Statistically significant p value <0.05							

Table-2: Comparison of pre treatment and post treatment scores of different measurements by Lateral Cephalogram using paired t test

correlation ($p \leq 0.05$) was found in the following parameters ie ICA (Inter condylar angle), AFH (Anterior facial height), PFH (Posterior facial height), Z-Co, Total facial area, AG-Me-AG when the pre and post treatment variables were compared on the PA cephalograms (Table 1). Similarly, statistically significant correlation ($p \leq 0.05$) was found in

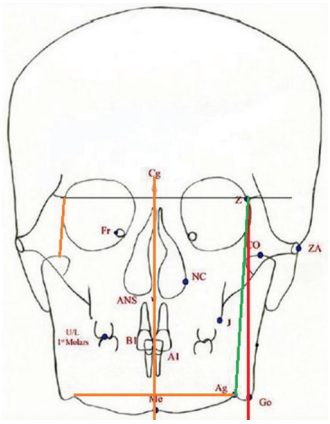

Figure-3: Linear Parameters (PA cephalogram)

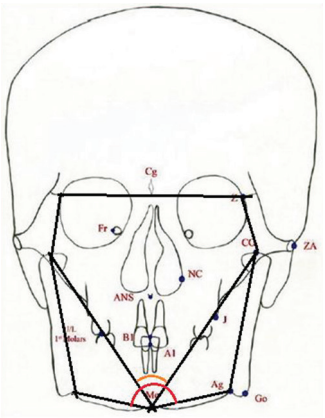

Figure-4: Angular Parameters (PA cephalogram)

the Co-Go (Ramal length), Co-Gn (Effective mandibular length), AFH (Anterior facial height), PFH (Posterior facial height), MPA (Mandibular plane angle) and N perp PG when the pre and post treatment variables were compared on the lateral cephalograms.(Table 2). For the rest of the parameters on either cephalograms, the comparison revealed no data of statistical significance. (Table 1 and 2)

DISCUSSION

The most consistent diagnostic finding in Class II malocclusion is mandibular skeletal retrusion which causes facial disharmony and considering that facial esthetics in the society is judged in the frontal view unlike trained orthodontists who are accustomed to visualize the face in profile view. To harmonise this esthetic imbalance the use of various functional appliances are recommended and the twin block is commonly used appliance. The introduction of twin block appliance in the year 1977 by Dr.WilliamClark, has been a major breakthrough in treatment of non-compliant Class II malocclusion patients. It is a two part appliance resembling a Schwartz double plate and a split activator. In comparison with other appliances there are a number of advantages for using separate upper and lower appliances with occlusal bite blocks. Occlusal inclined planes give greater movement in anterior and lateral excursion causing less interference with normal function.[5]

Following functional jaw orthopedics, the correction of jaw relationship is achieved in all 3 planes of space (sagittal, transverse and vertical). However, since the time cephalometry has been introduced in orthodontics; orthodontists are solely relying on lateral cephalogram for evaluating skeletal and dentoalveolar parameters. However, for proper diagnosis and treatment planning, the frontal cephalogram also contains valuable information.Most growth studies have used lateral cephalometric radiographs to analyze changes in the vertical and sagittal dimensions of the face. However, evaluation of the transverse structure of the face is needed for a comprehensive dentofacial analysis which is made possible using the PA cephalogram.

In present study we decided to use the twin block appliance as recent survey showed that it is the most popular functional appliance because of various advantages like ease of fabrication, less acrylic component, patient compliance to treatment, lateral movement etc. Anatomic relationships and treatment changes in the sagittal dimension have been studied extensively using the lateral cephalogram but limited literature is available on transverse dimension changes after functional appliance therapy; therefore transverse cephalometric changes after twin block appliance therapy were also studied usingthe frontal cephalogram in addition to anteroposterior changes using the lateral cephalogram.

The study had null hypothesis that there will be no change in the morphology of dentofacial skeleton after the functional appliance therapy.

A total of 10 patients showing a positive VTO were treated with conventional twin block appliance. The overjet of these patients was ranging from 8-11mm, with an average of 10mm. The age group of these patients was ranging from 10-15 yrs.

The positive aspect of early treatment is that it can intercept a developing malocclusion at a time when the maxillary incisors are more vulnerable to fracture and loss. Protecting these teeth with functional appliances eliminates functional aberrations, trains the perioral musculature to assist in optimal dentofacial development and helps the mandible, through spatial posturing achieved with a properly taken construction bite, to attain the most favourable growth increments and direction.[5]

The treatment duration was 6 to 8 months on an average. Once the ideal objectives of molar, canine and incisor relationships were achieved clinically and also the mandibular centric relation confirmed that the forward movement of mandible is not by the habitual forward positioning, as advocated by Ricketts then the post treatment radiographs were taken.

Pre-treatment and post-treatment changes were assessed individually by frontal and lateral cephalograms. A total of 15 parameters in frontal cephalogram and 9 parameters in lateral cephalogram along with facial index (facial height(N to Gn)/ bizygomatic width X 100)[2] (calculated using vernier caliper) were evaluated. Construction bite was made with 6-7mm of advancement and 2-3mm of vertical opening as most of the subjects were of horizontal to average growth pattern.[2]

The changes brought by twin block appliance have never been evaluated using a frontal cephalogram before and so

very limited literature is available regarding the same making this study one of its kind.

In the present study, significant changes were seen in vertical and sagittal plane in both frontal and lateral cephalogram. anterior facial height, posterior facial height, mandibular plane angle, N perpPg, Z-Co, Co-Go, Co-Gn due to downward and forward movement of mandible. Studies by various authors support this explaination.[6-11]

There was no true opening of the gonial angle contributing to the increase in mandibular plane. Baccetti et al[12] in a systemic review annualized elongation in 23 of 33 samples for total mandibular length (Co-Gn), in 12 of 17 samples for mandibular ramus height (Co-Go). Baccettiet al (1997)[13] have mentioned that the TMJ position was more posterior in skeletal Class II when compared with skeletal Class III and was more caudal in low angle subjects when compared with subjects with normal or high angle vertical relationships it may be one of the contributing factors ultimately leading to increase in face height.

A study was done by Ingervellet al[14] showed a marked inclination of the condylar path and marked height of the articular tubercle of the TMJ were found to be associated with rectangular form of the face

1. The significant change in intercondylar angle (ICA) is seen due to the change in the position of condyle after functional appliance therapy. According to Enlow's V principle- horizontal expansion, there is widening of the posterior part of mandible and coronoid process moves in backward direction[15], another reason could be the remodeling changes seen in the bone due to the muscular forces acting upon it.

Probable widening of ICA has lead to opening of Ag-Me-Ag angle giving a more flattening appearance of base of mandible. Thus, making the face look more proportionate.

Another findings seen in our study with 6.5% increase in total area of face and an increase in Ag-Me-Ag angle leading to a more proportionate face. The hypothesis implied for this finding could be the path of movement of the condyle during protrusion appears to be lateral considering the osteological structure of glenoid fossa i.e the articular eminence being wider towards the zygomatic end than the sphenoid end.

Frontal facial taper angle and Ag-Ag showed not significant result as stated by Owen[16] the angle decreases at 0.2 degree per year and the mandibular width (Ag-Ag) increases between 0.66mm and 1.50mm per year.

In the present study a change in transverse dimension was expected after functional appliance therapy as seen in class II cases but it has been confirmed with cephalometric findings that there is no actual change in the width of face but only in height leading to a well proportioned face with negligible amount of growth in transverse dimension. To verify this, facial index[5] of each subject was calculated clinically, giving an inference of mesoproscopic facial form in post treated individuals which is considered ideal facial form type.

Therefore, it can be said that other than the physical results attained by orthodontic movements, a part of the treatment's success also lies in the visual perception of the treatment results no matter how small. This factor, if properly assessed by clinician, can help attain good results with minimal efforts and expenditure.

CONCLUSION

1. Cephalometric analysis revealed a statistically significant increase in anterior facial height, posterior facial height on both the frontal and lateral cephalograms when the pre and the post treatment radiographs were compared, giving an inference of overall increase in facial height.
2. Cephalometric analysis also revealed a statistically significant increase in inter-condylar angle, Z-Co, area and Ag-Me-Ag angle on pre and post treatment frontal cephalograms which points towards the change in condylar path.
3. Furthermore, a statistically significant increase in mandibular ramal length, effective mandibular length, mandibular plane angle and N $\perp$ Pg on comparison of the pre and post treatment lateral cephalograms was observed. These findings conclude that he mandible has undergone forward and downward movement.

Based on the results of this study, we can conclude that although the overall cephalometric findings show a minimal change in width, yet there is a statistically significant increment in other cephalometric parameters corresponding to antero-posterior positioning and vertical height that contributes to balanced facial proportions. The increase in total facial area as observed in the present study contributes in making the face more proportional thereby achieving the favorable facial form (mesoproscopic).

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