CONDYLAR CHANGES ASSOCIATED WITH FUNCTIONAL ORTHOPEDIC APPLIANCES, IN SKELETAL CLASS II PATIENTS

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ABSTRACT

Objective: This study compared the positional changes in mandibular condyle before and after treatment with functional appliances.

Study Design: Comparative, cross sectional study.

Place and Duration of Study: Armed Forces Institute of Dentistry, Rawalpindi, from Dec 2016 to Dec 2018.

Methodology: In this study patients opting for orthodontic treatment in Armed Forces Institute of Dentistry (AFID) and falling on our inclusion criteria were selected and were compared for pre and post treatment positional changes of condyle associated with twin block/bionator therapy, by comparing lateral cephalometric changes.

Results: Age range was 11 years to 15 years, with mean of 12.02 ± 1.05. Changes in condyle position with respect to midface were found to be significant with a mean of 2.20 ± 2.97, $p<0.001$ between pre and post treatment values. Changes in condyle position with respect to anterior cranial base were also significant reported by a mean pre and post treatment difference of 2.09 ± 1.23, $p<0.001$. Orientation of long axis of condyle with posterior cranial base was also significantly changed with a mean difference of 5.11 ± 4.19, $p<0.001$.

Conclusion: Condyle was displaced posteriorly with respect to anterior cranial base as well as midface. Vis-à-vis the orientation of long axis of mandibular condyle, it attains a more upright position post treatment, with respect to cranial base.

Keywords: Condylar changes, Functional appliances, Temporomandibular joint.

INTRODUCTION

Prevalence of skeletal class II malocclusion is quite common. In Pakistani population according to Abida *et al*[1] class II malocclusion is reported to be 41%. Prominence of teeth is the most mocked feature of childhood, Shaw *et al*[2] in a study found that 7% children reported that they were repeatedly teased because of their teeth. However dental esthetics is a significant factor in child's social life as teasing is often directed at the dental appearance, and it may have a marked upsetting effect on child's well-being[3]. In a study carried out at Agha Khan University Hospital, 70.5% of subjects reporting to orthodontics department were having class II malocclusion[4] hence major concern behind seeking orthodontic treatment is prominence of teeth that appears as a relative feature in presence of retrognathic mandible.

Orthodontics and dentofacial orthopedics have evolved a great deal in management of skeletal discrepancies to date but of all the modalities; functional jaw orthopedics not only prove to be an attractive and simple but also an efficient mode of treatment. Majority of subjects having class II malocclusions if presented in growing phase, are treated by one or other functional appliance. There is a concept of catchup of mandibular growth and it is supposed to occur as a subject reaches the pubertal spurt of growth and this concept is quite prevalent is that, the growth occurs naturally and in all individuals. Though misleading asifmandibular growth always catches up, there would be no skeletal class II mandibular retrusion in adults[5]. Contrary to this fact, we believe that much of the work done in orthodontics is due to the observation of

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clinicians, that timely diagnosis and interception leads to skeletal correction of retrognathism giving the patient a pleasant, harmonious and above all a stable facial profile.

Condylar cartilage is nature's synchronizer that matches maxillomandibular sagittal relationship[5]. Functional appliances tend to target temporomandibular joint, induce resorptive and adaptive changes in temporal fossa as well as condylar head. The orthopedic treatment by Herbst appliance effect was visible as a change in length and morphology of the condyle in a distocranial direction[6]. Twin-block appliance makes the condyles move in a forward direction[7]. Multiple authors have highlighted the mechanism of action and there exists wide variability of thoughts, that indicate positional changes as well as increase in mandibular lengths by treatment with functional appliances. In conclusiveness of available literature about positional changes or true increment in mandibular lengths secondary to functional appliance therapy has led towards a need to investigate the changes that these appliances produce[7-10]. Objective of this study was to compare the positional changes in mandibular condyle before and after treatment with functional appliances.

METHODOLOGY

The study was approved by ethical review committee (Ref letter no: 905/Trg-ABP1K2) of Armed Forces Institute of Dentistry (AFID). It was a comparative, cross sectional study where patients opting for orthodontic treatment in AFID and falling on our inclusion criteria were selected bynon-probability consecutive sampling. Data was collected from December 2016 to December 2018. Digital cephalograms were taken for all the subjects included in the research sample and evaluated for SNA, SNB and ANB (points, planes and angles used are defined in table-I) in order to confirm if they comply with our inclusion criteria. All these pretreatment cephalograms were preserved for future references.

Inclusion criteria was subjects with age between 11 years to 15 years, Class II (retrognathic mandible) sagittal skeletal relationship having ANB angle of 4.5 degrees or more, having a normal SNA (indication that increased overjet is mainly due to mandibular retrognathism), and a skeletal maturity corresponding to cervical vertebral maturity (CVM) stage 3, non-syndromic subjects, no clefting disorders and otherwise healthy subjects found eligible for functional appliance therapy were included. Whereas subjects with class I and class III (prognathic mandible) sagittal skeletal relationship, CVM index passed stage 4 or less than stage 2, having previous orthodontic, orthopedic treatment and/or orthognathic surgery, known syndromal conditions like Treacher Collins syndrome, hemifacial macrosomia, endocrine abnormalities including growth hormone deficiency, dwarfism were excluded.

After fulfilling the requisites for indications of functional jaw orthopedics these subjects were provided with functional appliances, twin block or bionator. Subjects were reviewed on 4 weekly basis, till the time occlusion of class I molars was obtained. Approximately after a period of 6 to 8 months post functional appliance treatment (the time needed for the correction of class II molar relationship to a class I relationship, i.e. the active phase of functional appliance therapy), cephalograms were taken. All cephalograms were traced by single observer. Static reference points for anterior cranial base and midface were selected so as to minimize the chances of anatomic variations and associated errors. For anterior cranial base sella perpendicular to Frankfort horizontal was selected whereas for midface pterygoid vertical was selected as static reference points. Reference points and planes are described in detail in table-I. Following three variables were compared for pre and post treatment changes.

Position of condyle with respect to cranial base was assessed by taking the pretreatment distance of condylion point to Sella perpendicular and comparing with post treatment value.

Position of condyle with respect to midface was assessed by comparing pre and post

treatment distance of condylion point to pterygoid vertical.

Angle of mandibular condyle's long axis was taken with Frankfort horizontal plane and compared for pre and post treatment values.

Sample size was calculated using G-power 3.1.9.2 software. For paired sample t-test, keeping the value of Effect size as 0.8, Alpha error as 0.05, Beta error as 0.2, Probability and power 0.8, a sample size of 50 was calculated. Informed consent was obtained from subject's guardians for inclusion of their radiographic records in our research. Patients with class II malocclusions that were to be treated with removable functional appliances (Twin block, Bionator) were incorporated into research. 53 subjects, fulfilling the inclusion criteria, were given functional appliances and followed up. Three subjects reported with multiple appliance breakages and loss of appliance. Six subjects dropped out because of lack of compliance. At the end of functional appliance therapy phase, 44 subjects remained in the study. Post treatment lateral cephalograms were obtained after completion of functional appliance phase. Pre and post treatment radiographs were traced and compared for the three variables. The statistical analysis was carried out using statistical software (version 23; SPSS).

Frequencies and percentages were calculated for age and gender. Since the data showed normality of distribution, paired sample t test was applied for testing the statistical significance between mean scores ofpre and post functional appliance treatment values for the three variables, condylion to Sella perpendicular, condylion to pterygoid vertical and long axis angle of condyle between the pretreatment and post treatment groups. The confidence interval was set at 95%. Alpha value was kept at 0.05 (i.e. *p*-value ≤0.05 was considered to be significant).

Table-I: Reference points, planes and angles.

Landmark	Abbreviation	Definition
Points		
Sella	S	The center of sella turcica, the upper limit of which is defined as the line joining the tuberculum and the dorsum sella
Nasion	N	The most anterior point of the fronto-nasal suture
A point	A	The most posterior point on the anterior contour of the maxillary alveolar arch
B point	B	The most posterior point on the anterior contour of the mandibular alveolar arch
Porion		The highest point on upper margin of the opening of each external auditory canal
Orbitale		The low point on the lower margin of the left orbit
Condylion	Co	Most posterior/superior point on the condyle of mandible
PT point	PTM	Junction of Pterygomaxillary fissure and the foramen rotundum
Planes		
Sella-Nasion	Sn	Linejoining Sella and Nasion points
Frankfort Horizontal	FH	Plane that extends from porion to orbitale
Pterygoid Vertical	Pt Vert	Line from PTM point that is perpendicular to FH plane
Long axis of Condyle	Co LA	Line passing through long axis of condylar neck and head
Angles		
Sella-Nasion-Point A	SNA	Angle formed by joining S, N with point A
Sella-Nasion-Point-B	SNB	Angle formed by joining S, N with point B
Point A- N- Point-B	ANB	Angle formed by joining point A, N and point B

RESULTS

Out of total sample (44), 16 (36%) comprised of males and 28 (64%) were females. Subjects fell in an age range of 11 years to 15 years, with mean

of 12.02 ± 1.05. Results are summarized in table-II.

Changes in condyle position with respect to midface were found to be significant, as there was reported an increase in post treatment distance of condylion point to pterygoid vertical as compared to pretreatment one by a mean of 2.20mm ± 2.97, $p<0.001$.

Likewise changes in condyle position with respect to anterior cranial base were found to be significant, as there was an increased post treatment distance of condylion point to pterygoid vertical by a mean of 2.09mm ± 1.23, $p<0.001$.

Orientation of long axis of condyle with posterior cranial base was also significantly changed as there was observed an increase in post treatment angle of long axis of condyle with Frankfort horizontal by a mean of 5.11° ± 4.19, $p<0.001$.

Table-II: Mean, standard deviations and significance levels of variables.

	Co-Cranial Base		Co-Midface		Co-LA	
	Pre Treatment (mm)	Post Treatment (mm)	Pre Treatment (mm)	Post Treatment (mm)	Pre Treatment (Degrees)	Post Treatment (Degrees)
	12.68 ± 2.32	14.88 ± 2.83	24.60 ± 3.03	14.89 ± 2.83	76.50 ± 7.78	81.61 ± 7.57
p-value	*p*<0.001		*p*<0.001		*p*<0.001	

DISCUSSION

Multiple authors have studied the effects of functional appliances on mandible, condyle, temporomandibular (TMJ) joint and associated facial structures. There is still controversial data regarding the mode of action of functional appliances if they produce actual increment in growth, increase in mandibular length[8], produces positional changes in condyle or resorption / apposition changes in TMJ or mere dentoalveolar effects[12]. Some reviews have found no statistically or clinically significant differences between groups treated with functional appliances and controls[9] while other authors have observed these differences to be statistically significant[10]. Studies have found other results for the treatment with functional appliances, such as secondary statistically significant mandibular elongation[11] and changes in the facial profile, due to incisal inclination[12]. In our study we tried to establish that does position of condyle changes in antero-posterior plane with respect to cranial base and midface, anticipating it to be a cause of class II correction. In conclusiveness of available data[12-16] and repeatedly stated facts that cases treated with or without functional appliances may appear to be similar after the growth is completed leads to confused opinions regarding the effectiveness of such appliances. Functional appliances not only are therapeutic devices effective in bringing about skeletal and dental correction[17] of skeletal class II patients but also they are myofunctional exercise devices that can produce effective neuro-muscular changes improving muscle adaptation and activating various brain regions.

For relation with anterior cranial base we found that post treatment distance of condyle with sella perpendicular was statistically higher than that of pretreatment ones. This can be interpreted as the condyle adapts to a more posterior position as the mandible is advanced by functional appliance. Similarly, a statistically significant increase in post treatment distance of condyle with respect to midface was observed. This positional change of condyle is expected to result in an adaptive response in temporal portion of TMJ that is supposed to shift in a posterior direction. Our findings were consistent with a Magnetic Resonance Imaging (MRI) study conducted by Chavan *et al* that demonstrated translation of the mandibular condyle by functional appliances. It stated that after 6 months of treatment the mandibular condyle had apparently moved back into the glenoid fossa[18]. An advancement seen in occlusion from class II to class I with accompanied posterior positioning of condyle TMJ complex, with respect to both

anterior cranial base as well as midface indicates that an increment in total mandibular bone might be present as it elongates from condyle to symphysis on one side and similarly on the other. This is found to be consistent with the findings of a systematic review conducted by Santamaría-Villegaset, alstated that functional appliance treatment results in a longer mandible[8].

Since it is a cephalometric measurement a two dimensional observation may prove to be erroneous in describing the three dimensional objects. Three dimensional cone beam computed tomography (CBCT) would be more precise in effectively describing that if these post treatment increment in distance is mere a repositioning phenomenon or it actually results in a larger mandible.

Condyle is the pivot around which the effects of mandibular anterior repositioning are produced. As we hypothesized that condyle changes its position with respect to cranial base and midface, we took into consideration the long axis changes of the condyle also. According to our findings the angle that long axis of condyle made with the FH was increased, statistically. We can say that condyle adapts a straighter orientation to cranial base after functional appliance therapy as compared to a more inclined pre-treatment value. If common sense prevails it is logical to say that as the mandible is advanced forward condyles shift backward so its angle with the FH would decrease and become more acute, that is contrary to our findings. Condyle acquires a more upright position after treatment that indicates the presence of some remodeling changes at condyle neck and ramus as well. For the condyle to achieve an upright orientation to FH there must be ramal lengthening occurring besides the enlargement of the corpus. Vertical lengthening of ramus might be a feature that is responsible for maintaining/increasing the angle of long axis of condyle with cranial base.

Since we have taken the post treatment radiographs after the correction to class I was achieved, bony remodeling might have occurred by that time. A logical initial decrease in long axis angle might be observed if cephalograms are taken after a short time, as that would depict a true postural change not coupled with bony remodeling. Chaven *et al* have found an anterior condylar positional shift compared to the pre-treatment position[18] as could be seen in MRI with wax bite in place. MRI taken at wax bite stage depicts merely a positional change that is similar to the situation during early phase of functional jaw orthopedics. More research is needed to confirm these findings.

Limitation for such a conclusion to be drawn is that cephalometric radiograph is a two dimensional representation of a three dimensional object and we cannot predict the volumetric increments. CBCT studies or volumetric studies may prove to be beneficial in confirming these findings.

CONCLUSION

Condyle was displaced posteriorly with respect to anterior cranial base as well as midface. Vis-à-vis the orientation of long axis of mandibular condyle, it attains a more upright position post treatment, with respect to cranial base.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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