

Skeletal and Dentoalveolar Changes Using Removable and Fixed Functional Appliances in Class II Malocclusion

Sukanya Arya¹, Pradeep Raghav², Amit Kumar Khera³, Sajal Gupta⁴, Ushmita Mehta⁵

^{1,2,3,4,5}Swami Vivekanad Subharti University, Department of Orthodontics and Dentofacial Orthopedics, Meerut, Uttar Pradesh

¹sukanya.arya01@gmail.com

²drpradeepraghav@gmail.com

³amitkhera@rediffmail.com

⁴sajalgupta0004@gmail.com

⁵ushmitamehta97@gmail.com



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Abstract—The prevalence of Class II malocclusion is common in orthodontic practice. Functional appliance therapy has become a generally accepted method to treat severe and moderate discrepancies of sagittal jaw relations in children. A variety of different functional appliances are available but their selection is of prime importance. The efficacy of functional appliances and changes produced by their application are still the subject of controversy. Functional appliances encompass a range of removable and fixed devices that are designed to create three-dimensional changes in the dentition and development of the jaws. This literature review attempts to summarize the skeletal and dentoalveolar changes produced by different functional appliances in Class II malocclusion with the help of recent databases (2000-2021).

Keywords —Class II malocclusion, functional appliances, fixed functional appliances, removable functional appliances, dentoalveolar effects.

I. Introduction

The prevalence of Class II malocclusion is common in orthodontic practice. Mc Namara¹ reported mandibular retrusion as the most common characteristic of class II malocclusion. Class II division 1 malocclusions with mandibular deficiency have been treated with different type of functional appliances

Functional appliances have been used for over a century in the management of Class II malocclusion being proven to produce a combination of skeletal and dental effects during the treatment phase to effectively reduce overjet in growing patients.

A variety of functional appliances are available that can be broadly categorized into removable functional and fixed functional appliances. An important discriminating factor between the fixed functional and removable functional appliance is the need for patient compliance. However, the degree of skeletal versus dentoalveolar change that underlies these treatment effects is a source of debate. Despite their long history, functional appliances continue to be controversial in their use, effectiveness and mode of action. Some researchers have proposed that the Class II correction observed with functional appliances was caused by headgear effect by restraining maxillary growth.^{2,3} While many of the researchers observed that there is stimulation of mandibular growth caused by forward positioning of mandible.^[4,5] Anterior glenoid fossa remodeling and spontaneous anterior mandibular displacement that occurs after elimination of a functional retrusion also have been cited as contributors to Class II correction.^{6,7} So, this review describes the current evidence based on various fixed functional appliances and removable functional appliances and its effects on dentoalveolar and skeletal pattern in Class II malocclusion.

II. Removable Functional Appliances

A. Activator

It is a monoblock appliance which is given in actively growing individual with favourable (horizontal) growth pattern.⁸ Ruf⁹ showed that there was increase in vertical effective condylar growth and decrease in sagittal effective condylar growth and increase in the vertical development of chin by activator therapy. Basciftci et al¹ showed that ANB angle was decreased and the bite was opened with reduction in overjet. Ramus height, corpus length, anterior and posterior face height all increased significantly. The activator appliance caused maxillary incisor lingual tipping and mandibular incisor labial tipping. The overjet was decreased as a result of the increased forward growth of the mandible and dentoalveolar changes.

B. Bionator

It is an activator derived appliance which enhances normal development. Almeida et al¹¹^[12] evaluated that there was no restriction to maxillary growth along with significant increase in mandibular length (Co-Gn) by with reduction in ANB angle. No significant change was observed in Lower Anterior Facial Height (LAFH) while posterior face height (S-Go) was increased. Mandibular plane orientation (SN.GoMe) was unaffected while the palatal plane rotated

significantly more clockwise. In dentoalveolar structures changes observed were, retroclination of maxillary incisors with proclination of mandibular incisors. The lower molars were extruded significantly more while no effect on maxillary molars was seen. It mainly produces dentoalveolar effect with a smaller skeletal effect.[13]

C. Twin Block

Ehsani et al [14] reported that maxilla showed a very minor restriction in growth while the mandible was projected slightly forward with the increase in mandibular and the anterior facial dimensions. “Headgear effect” was seen with twin block appliance as shown by Khan et al [5] this appliance therapy restricts maxillary growth with maxillary molar distalization. Mills and McCulloch [16] and Baccetti et al [17] attributed most of the overjet reduction to the mandibular skeletal changes. 73 percent of overjet correction was due to dentoalveolar changes in which molar correction contributed 59 percent. There was increase in mandibular growth with increased proclination of lower incisors, reduction of overjet and correction of molar relation.[18] At the dental level, significant changes were identified with reduction in upper incisor proclination and increase in the lower incisor inclination.

D. Frankel Appliance

There was an improvement of the anteroposterior relationship between the maxilla and the mandible with no restriction to the growth of maxilla while redirecting mandibular growth.[11,19,20] Janson et al [21] suggested that increase in effective mandibular incisors, without any forward movement of the maxillary first molars but mesial movement and extrusion of the mandibular first molars were observed in addition to the skeletal effects of Frankel appliance.[19,20,22]

E. Sander Bite Jumping Appliance

Martina et al [23] reported that BJA did not appear to cause significant maxillary restraint. It produced significant increase in the mandibular length with 51% of the molar relationship correction. It did not have a significant effect on the divergence of the jaws which aids in maximum advancement. Also, the correction of the overjet was due to the increase in mandibular length, to the slight pro-inclination of the lower incisors and the mild retro-inclination of the upper incisors.[24]

III. Comparison Among Removable Functional Appliance

Toth and McNamara[25] reported that Twin Block, as compared to Frankel appliance, produced greater changes in regard to SNB and ANB angles and posterior tipping of the upper incisors. Furthermore, in comparison to Bionator, Twin Block was more effective in the treatment of Class II malocclusion.[18] Most of the studies reported that the Sander Bite Jumping appliance to be the most effective appliance aiming to improve the mandibular length, followed by the Twin Block.[26,27,28] Saima Nizar Hirji et al[29] reported a significant increase in the mandibular length with RFA therapy with an increase in the vertical dimension in a short time using Twin-Block appliance therapy, followed by Bionator appliance therapy. In addition, Frankel appliance treatment effects are more skeletal in nature, with better control in the vertical dimension. However, it takes a more extended treatment duration to produce similar effects.

IV. Fixed Functional Appliances

A. Herbst Appliance

Most of the studies reported that significant amount of Class II correction was achieved by distal bodily movement and tipping of the maxillary first molars combined with bodily forward movement of the mandibular first molars.[30,31,32] Fan et al[33] evaluated that the principal skeletal effect of Herbst appliance treatment was due to additional gain at the condyles, which contributes to increase in the sagittal dimension that aids in Class II correction.

B. Mandibular Protraction Appliance

Jena et al[34] reported that 38.50% of the molar correction was contributed by skeletal change due to MPA appliance therapy. Thus, the dentoalveolar changes have major contribution in Class II correction. Siqueira et al[35] reported that increased palatal movement of the upper incisors with increased proclination of lower incisors.

C. Mandibular Anterior Repositioning Appliance(MARA)

Kulbersh et al [36] reported that this appliance restricted the maxillary growth while no significant contribution to mandibular growth for Class II correction. However, Ardeshtna et al[37] reported that maxilla had no significant headgear effect while the maxillary incisor position remained unchanged, whereas the distalization of molar was observed with increase in anterior lower facial height. Thikriat S. Al-Jewair [38] reported that the total mandibular

dimensional change was more due to vertical development of mandible rather than the horizontal growth.

D. Functional Mandibular Advancer (FMA)

In a study, it was found that using the FMA in phase 1 therapy that did not incorporate the incisors into the treatment mechanics caused dentoalveolar changes to a lesser extent; thus, the treatment of Class II malocclusion resulted in more pronounced mandibular skeletal changes.[39] The occlusion's improvement in the sagittal dimension was due to overjet reduction while molar relationship improvement was achieved by a combination of dental effects (distalization of upper teeth, mesialization of lower teeth) and skeletal effects (mandibular growth stimulation).40,41

E. Jasper Jumper

It effectively corrected Class II malocclusion, but the changes were 80% dentoalveolar. The appliance therapy had restrictive effect on the maxilla along with clockwise rotation of the occlusal plane.42,43 Both the maxillary incisors and molars displayed controlled posterior tipping around their apices. There was significant intrusion of mandibular incisors that occurred with JJ therapy. There was mild increase in lower anterior facial height with limitation on the vertical development of the maxillary molars; labial tipping and intrusion of the mandibular incisors along with extrusion of mandibular molars.43

F. Forsus Nitinol

Flat Spring Karacay et al44 reported that 66% of the sagittal correction was accounted by dental effects. It was observed that mandibular length was increased to a lesser extent with significant posterior rotation in the occlusal plane. The maxillary and mandibular arches were expanded at the front and rear during treatment. It can be activated more on one side than on the other, so it excels at correcting midline deviations. The sagittal occlusal relations were improved by approximately 3/4 of a cusp width to the mesial on both the right and left side as a result of distal movement of the upper molars and mesial movement of the lower molars. Overjet reduction was found due to retrusion of the upper and protrusion of the lower incisors while intrusion and protrusion of incisors reduced the overbite. 45,46

G. Eureka Spring

Stromeyer et al⁴⁷ reported that 10% of overjet correction was contributed by skeletal changes while 90% of correction occurred by dental compensation. There was neither an increase in the mandibular plane angle nor in anterior face height is notable. Molar movement was greater in the mandible (60%) than in the maxilla (40%). Change in the occlusal plane was observed as a result of maxillary molar and mandibular incisor intrusion with angular changes in the maxillary and mandibular incisors.

H. Powerscope

There was lengthening of the mandible with no restraining effect on maxilla.⁴⁸ Although there were significant skeletal changes but dentoalveolar changes contributed mostly to correction of Class II relation. Kalra et al⁴⁹ reported significant changes in skeletal parameters such as forward positioning of the mandible leading to improved Class II jaw base relationship. Also, significant changes were reported in dental parameters such as forward positioning of mandibular incisors, maxillary molar distalization and intrusion with reduction in overbite and overjet respectively.

I. Advansync

It had a continued restraining effect on maxillary growth “headgear effect”. Also, this appliance had short-term orthopedic effect on the maxilla and the mandible. It affects the skeletal and dentoalveolar craniofacial complex and are effective in normalizing the Class II malocclusion to Class I in patients treated during the skeletal growth spurt.⁵⁰ Al-Jewair et al⁵¹ reported that treatment modalities resulted in reduction in the ANB angle and the angle of convexity and an increase in the anterior and posterior facial height. A significant clockwise rotation of the functional occlusal plane due to proclination of the mandibular incisors while mandibular molars erupted and drifted forward with nonsignificant eruption and distalization of maxillary molars was reported.

V. Comparison Among Fixed Functional

Appliances Rigid fixed functional appliances provide better skeletal results than flexible and hybrid ones.⁵² Flexible and hybrid appliances produce greater tooth movement during treatment, in comparison to rigid ones as they are not moving the condyle from the mandibular fossa.^{53,54} Cozza et al⁵⁵ showed that mandibular changes produced by Herbst appliance showed the highest coefficient of efficiency. In a survey study it was evaluated that 51.5%

orthodontists used rigid fixed functional appliances, among them the most preferred was the Herbst appliance with 72% response followed by Mandibular Anterior Repositioning Appliance (24%) and AdvanSync (4%).⁵⁶

VI. Fixed versus Removable Functional Appliances

The Herbst appliance had the highest coefficient of efficiency (0.28 mm per month) followed by the Twin-block (0.23 mm per month). Both the bionator and the activator had intermediate scores of mandibular growth efficiency (0.17 and 0.12 mm per month, respectively). The Frankel appliance had the least efficiency (0.09 mm per month).⁵⁵ Long term studies, i.e. 5–10 years follow-up, showed that the mandible growth appears to return to its earlier pattern after treatment and the reason for relapse was the changes in tooth position.⁵⁷

In accordance to SN Hirzi et al⁵⁸, skeletal corrections achieved with removable or fixed functional appliances seem to be overall stable in the long term while the dentoalveolar relapse is more frequent. Skeletal corrections, including mandibular elongation, may be achieved if treatment is performed during the pubertal growth phase.

There is little evidence available, concerning the relative effectiveness of fixed and removable functional appliances or in relation to patient experiences and perceptions of these treatment modalities.^{59,60}

VII. - Summary and Conclusion

Among the removable functional appliance Sanders Bite Jumping appliance was most effective for improving the mandibular length followed by Twin Block and Bionator. They are mostly associated with excessive vertical bite opening and produce interference with normal functions and mandibular movement, precluding their full-time use.

Among the fixed functional appliances, rigid fixed functional appliances provide better skeletal results than flexible and hybrid ones. The most preferred rigid fixed functional appliances are Herbst appliance followed by MARA and AdvanSync.

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