

FIXED FUNCTIONAL APPLIANCES- A REVIEW

Amandeep kainth¹, Avkash Sakolia², Disha Singh³, Himani Chopra⁴¹Registered Dental hygienist, Canada.^{2,3}Post Graduate student 2nd Year, Department of Orthodontics & Dentofacial Orthopaedics,
Desh Bhagat Dental College& Hospital, Mandi Gobindgarh, Punjab.⁴Dental Surgeon, Maxcare dental Home, Jalandhar.**Corresponding author:**

Amandeep kainth, Registered Dental hygienist, Canada.

Email id: kainthaman2@yahoo.com, Contact No.-+2049990549

Abstract

Class II malocclusion is one of the most common malocclusion in orthodontic patients seeking orthodontic treatment and it occurs in about one third of population. In growing patients skeletal discrepancy can be corrected by using removable and fixed functional appliances. These appliances are capable of altering direction and amount of growth of individual. Use of removable appliances needs patient compliance for their effectiveness. So to make these appliances non dependent on patients, fixed functional appliances were introduced. This review will discuss the history, classification, indications and skeletal/dental effects of fixed appliances.

Keywords: Functional appliance, Mandible, malocclusion, camouflage.

Introduction

Class II malocclusion is one of the most common malocclusion in orthodontic patients seeking orthodontic treatment and it occurs in about one third of population. Class II malocclusion may be due to skeletal or dental factors. Skeletal class II malocclusion may be due mandibular retrusion, maxillary protrusion or combination of both. But most common component in class II patients is found to be mandibular retrusion.¹

In order to treat the full spectrum of malocclusions effectively, a clinician must recognize and assess such developing skeletal pattern at an early age. If conservative orthodontic therapy cannot be provided at appropriate time, then such skeletal malocclusions become worse and may have to be treated with surgical treatment or camouflage orthodontic treatment.²

Class II patients with retrognathic mandible, the ideal treatment is aimed to alter the amount or direction of growth of mandible for correcting malocclusion. This can be achieved with Functional appliances including removable and fixed devices that are capable to change the position of the mandible, both sagittal and vertical direction and also can do supplementary lengthening of the mandible.¹

The functional appliances are “those removable or fixed appliance that alters the posture of mandible and transmits the force created by the resulting stretch of the muscle and soft tissue and change of neuromuscular environment to the dental and skeletal tissues to produce movement of the teeth and modification of growth”³.

Initial removable appliances were bulkier and inconvenient and patient compliance was poor with these appliances. It was difficult for patients to carry out normal functions like speaking and mastication after wearing these appliances. Furthermore, intermittent wear does not elicit continuous muscle activity, which is very much needed for promoting the skeletal change⁴

Failure to adhere to prescribed schedule by patient, usually seen with removal appliances resulted in slow treatment response or some time no response at all. Therefore successful orthodontic treatment with removable functional appliances was dependent on patient cooperation in wearing of the appliance. Also

the treatment time with the removable functional appliance was around one and one-half years, which was long enough to promote non – compliance and burnout.

To avoid these problems of removable functional appliances, fixed appliances were introduced. Fixed functional appliances are those functional appliances that are fixed to the upper or lower jaws and which cannot be removed by the patient.

Origin of fixed functional appliance was started with Emil Herbst's introduction of his appliance for the temperomandibular joint patient in 1905.³ This appliance was reintroduced by Hans Pancherz of Malmo, Sweden in 1979, which actually showed the potential of this appliance in stimulating the mandibular growth.³

Development of such appliances was aimed in eliminating the need for patient compliance and placing treatment outcome under the control of clinician. With fixed functional appliances, the treatment duration was reduced to around 6 months. Beside this faster result, it became possible to use the advantage of growth modification treatment in those unfortunate patients who were near the completion of growth and were unable to take treatment during early mixed dentition period .

History of appliances

The first ever fixed functional appliance was introduced by German professor **Emil Herbst**³, at the international dental congress in Berlin in 1905. Infact the appliance was originally recommended for disorders of temperomandibular joint.

Herbst (1934)³ presented a series of article in the “**Zahnartzliche Rundschau**” based on his experiences with the appliance. After that, however very little literature was published on the subject and the treatment method was more or less forgotten.

Baume LJ, Derichsweiler H (1960)⁵ using fixed inclined planes in young monkeys observed condylar head assuming a prolonged bilobed shape and increased cartilage proliferation resulting in increase of length of mandible.

The honour of reintroducing Herbst appliance goes to **Hans Pancherz (1979)**³ of Malmo, Sweden. He called attention of the orthodontic society to the possibility of stimulating mandibular

growth by “jumping the bite” with the help of Herbst appliance. Using Herbst appliance, **Hans Pancherz** showed that Class II correction could be treated successfully in 6 months, without patient cooperation. Sagittal mandibular growth was increased by treatment and contraction of muscles change towards normalcy.

Langford NM Jr (1981)⁶ wrote about the modification in Herbst appliance to reduce pushing forward of lower anteriors. He used the full lingual arch which prevents the pushing of the lower anteriors forward, which was a problem mentioned by Dr. Pancherz. He also observed for expansion of the upper first premolars, if a full upper lingual arch is not used. This is due to the rotation of the molar during treatment, which causes premolar expansion via the sectional lingual bars. Upper anterior brackets and an archwire from premolar to premolar can be used to control this expansion.

Raymond P. Howe (1982)⁷ introduced the bonded Herbst appliance to overcome some of the problem encountered with earlier designs. The principle difference between the original and proposed appliance design is that the paired telescoping elements, which had been attached to the lower bicuspid bands, are now attached to the entire lower dental arch by an acrylic bite splint.

Coelho Filho (1995)⁸ introduced the mandibular protraction appliance (MPA) for class II treatment. Initially he introduced MPA 1 and MPA 2.

Calvez X (1998)⁹ presented the universal bite jumper. It can be used in mixed or permanent dentition. It can be used in class III patients by mounting it in a reverse configuration.

D.D. Guner et al (2003)¹⁰ evaluated the effect MARS on temporomandibular joint using single photon emission computerized tomography.

Meanwhile, **James J Jasper (1987)**¹¹ developed a new and more flexible fixed functional appliance that allow lateral movements, the Jasper Jumper (JJ).

West R.P (1995)¹² had devised the Adjustable Bite Corrector. It is stretchable closed coil spring. The push force is generated by a nickel titanium wire in the center of lumen of the spring. Its advantage is that it can be used on either side left or right.

Devincenzo J (1997)¹³ introduced a new interarch force delivery system, the Eureka spring. Better patient cooperation and enhanced esthetic because of reduced size are the major advantages claimed besides reducing cost and inventory.

Klapper Lewis (1999)¹⁴ introduced the super spring II in non compliant class II patients.

Thus the fixed functional appliance has undergone various modifications by the hands of talented clinicians, they have tried to use the concept in a way suitable to their existing practising system of orthodontics.

Classification of Fixed Functional Appliances

Ritto's classification^{15,16}

I) Flexible Fixed Functional Appliances (FFFA)

- 1) Jasper Jumper
- 2) Amoric Torsion Coils
- 3) Adjustable Bite Corrector
- 4) Scandee Tubular Jumper
- 5) Klapper Super Spring
- 6) Bite Fixer
- 7) Churro Jumper

II) Rigid Fixed functional appliances (RFFA)

- 1) Herbst Appliance
- 2) Cantilevered Bite Jumper

- 3) MALU Herbst Appliance
- 4) Flip-Lock Herbst Appliance
- 5) Ventral Telescope
- 6) Magnetic Telescopic Device
- 7) Mandibular Protraction Appliance
- 8) Universal Bite Jumper
- 9) BioPedic Appliance
- 10) Mandibular Anterior Repositioning Appliance
- 11) IST – Appliance
- 12) Ritto Appliance

III) Hybrid Appliances

- 1) Calibrated Force Module
- 2) Eureka Spring
- 3) Twin Force Bite Corrector
- 4) Forsus – Fatigue Resistant Device
- 5) Alpern Class II Closers

Moschos A. Papadopoulos's classification¹⁷

Appliance Author

(A) Rigid intermaxillary appliances (RIMA)

- 1) Herbst appliance
 - Banded Herbst design Pancherz (1979)
 - Cap Splint Herbst design Pancherz (1997)
 - Stainless Steel Crown Langford (1982),
Herbst design Dischinger (1989)
 - Acrylic Splint Herbst design
(cemented or bonded) Howe (1982)
(removable) Howe (1987)
(upper bonded and lower
removable) McNamara (2001)
 - Goodman's modified Goodman and
Herbst McKenna (1985)
 - Upper Stainless Steel crown Valant (1989)
And lower acrylic
 - Flip- Lock Herbst design Miller (1996)
 - Hanks Telescoping Hanks (2003)
Herbst design
 - Open bite intrusion Dischinger (2001)
Herbst design
- 2) Mandibular Advancing
Repositioning Splint (MARS) Clement and
Jacobson (1982)
- 3) Cantilever bite jumper (CBJ) Mayes (1996)
- 4) Molar moving Bite
Jumper (MMBJ) Mayes (1998)
- 5) Mandibular Corrector
Appliance (MCA) Jones (1985)
- 6) Mandibular Protraction Appliance (MPA)
 - Type I Coelho Filho (1995)
 - Type II Coelho Filho (1997)
 - Type III Coelho Filho (1998)
 - Type IV Coelho Filho (2001)
- 7) Mandibular Anterior
Repositioning Appliance (MAR) Eckhart (1998)
- 8) Ritto Appliance Ritto Orthod
Cyber-J Archives
- 9) Functional Mandibular
Advancer (FMA) Kinzinger (2002)

(B) Flexible intermaxillary appliances (FIMA)

- 1) Jasper Jumper Jasper (1987)
- 2) Scandee Tubular Jumper
- 3) Flex Developer (FD) Winsauer (2002)
- 4) Amoric Torsion Coils Amoric (1994)
- 5) Adjustable Bite Corrector West (1995)
- 6) Bite Fixer Awbrey (1999)
- 7) Gentle Jumper
- 8) KlapperSuperspring II Klapper (1999)
- 9) Churro Jumper Castanon (1998)
- 10) Forsus Nitinol Heinig&Goz (2001)
- Flat Spring
- 11) Ribbon Jumper

(C) Hybrid appliances (combination of RIMA and FIMA)

- 1) Eureka Spring DeVincenzo (1997)
- 2) Sabbagh Universal - Spring (SUS)
- 3) Forsus Fatigue Resistance Device -
- 4) Twin Force Corbett and Bite Corrector Molina (2001)

Indications of fixed functional appliances:¹⁸

- The correction of skeletal abnormality in young growing individuals including skeletal class II with retrognathic mandible and skeletal class III with maxillary retrusion.
- To use of the residual growth left in neglected post adolescent patients who have already passed the maximal pubertal growth.
- In adult patients, these appliances can be used for:
- Distalization of the maxillary molars to correct dental class II molar relationship.
- Enhancing anchorage.
- As a mandibular anterior repositioning splint in patients having temporomandibular joint disorders.
- Conditioning of muscles in presurgical stage in patients with class II malocclusion.
- Post surgical stabilization of class II / class III malocclusion

Skeletal and dental effects of appliances

Functional Jaw Orthopaedic treatment responds well in actively growing individuals. In 1979, Pancherz performed a cephalometric evaluation of class II patients treated with Herbst appliance by jumping the bite. Treatment duration was 6 months and findings were¹⁹:

- Achievement of normal occlusion in all patients;
- Slight reduction in SNA indicating maxillary growth restriction or redirection;
- Increased SNB showing greater than average mandibular growth;
- Increased mandibular length supportive of condylar growth stimulation;
- Reduction in hard and soft tissue convexity¹⁹

Pancherz H and Anehus-Pancherz M.²⁰ investigated the effect of continuous bite jumping on masticatory muscle activity using EMG records, in Class II division 1 malocclusion treated with the Herbst appliance. It was reported that EMG activity before treatment for masseter muscle was less than the temporalis muscle. With Herbst appliance, the mandible was jumped forwardly to an incisor edge to edge position with no occlusal contact in

posterior area. Increase in EMG activity was observed, increase seen greater in masseter and than temporalis muscle due to change in sagittal jaw base/ dental relationship after six month of treatment with this appliance.

Wieslander L²¹ did intensive treatment of severe Class II malocclusion in early mixed dentition using a special headgear-herbst appliance. The treatment duration was for 5 months. Results of treatment revealed:

Change in sagittal relation of 7.5mm. The posteriorly directed impact on the maxilla was seen about 3.1 mm which is due combined effect of distal movement of the dentoalveolar arch and of distal translation of maxilla. The anteriorly directed effect upon the mandible of 4.4 mm was mainly due to anterior movement of the basal part of that bone, with a small part resulting from labial movement of the lower incisors.

It was reported that the displacement resulting from fixed functional appliances was mainly dentoalveolar in nature. There is forward and downward displacement of lower incisors which is the most pronounced dentoalveolar effect of these appliances followed by mandibular molar displacement. The mandible is rotated in the forward and downward direction, but maxillary dentition showed posterior and superior displacement.²²

The Jasper Jumper and the Herbst appliances are effective in maxillary anterior displacement restriction. In addition to this, the Jasper Jumper was also found to be more effective in restricting the increased effective length of maxilla.²³

Jasper Jumper, Herbst and MPA appliances were used to stimulate and/or redirect mandibular growth, but no significant difference was observed between the experimental and control individuals in relation to the mandibular length. Therefore, these appliances do not seem to significantly influence mandibular growth.^{24,25}

The MPA produced significantly greater palatal inclination in relation to the control group.²³ This could be actually consequent to the appliance effect and/or also to the non-significantly greater labial inclination and protrusion of the maxillary incisors in this group. This result is commonly seen during the use of fixed functional appliances.²⁶⁻²⁸ But, the Herbst appliance produced significantly greater protrusion of the maxillary incisors than the control group.

Jasper Jumper and Forsus appliance, both are effective in correction of class II malocclusion. These appliances produce restriction of maxillary growth, improve maxillomandibular relationship, overjet, overbite and molar relationship. They also induce clockwise rotation of occlusal plane, restrict vertical maxillary molar development, intrusion of mandibular molars and retrusion of upper lip.²⁹

Woodside DG, Metaxas A, Altuna G³⁰ found significant changes in the glenoid fossa following Herbst therapy in growing monkeys. He observed the formation of large volume of new bone in anterior border of post glenoid spine and resorption along the posterior border of spine. He observed thickening of articular disc which stabilizes the anterior condylar displacement.

Conclusion

Fixed functional appliances are effective in the management of Class II malocclusion.

These appliances are the only successful bite-jumping treatment for noncompliant, postpubertal patients that does not require orthognathic surgery at a later stage. Fixed functional appliances

are reported to correct Class II skeletal problems by encouraging mandibular growth and by inducing dentoalveolar effects. The changes in the condyle caused by these appliances are assumed to be a result of mechanical stimulus of the fibrocartilage layer of the condyle, such as for long bones with similar structure. Thus the stress from fixed functional appliances should be studied to further explore the association with morphologic changes of the dentoalveolar complex. So that maximum benefit of these appliances can be provided to patients for correcting their malocclusions.

References

1. Kaur S, Soni S, Prashar A, Bansal N, Brar JS. Functional appliances. *Indian J Dent Sci* 2017; 9:276-81.
2. Frankel R. A functional approach to orofacial orthopaedic. *Br. J. Orthod* 1980; 7: 41-51
3. Pancherz H. The herbst appliances – its biological effect and clinical use. *Am J Orthod* 1985 ;87(1):1-20
4. Woodside DG, A.Metaxas, Altuna G. The influence of functional appliance therapy on glenoid fossa remodelling. *Am. J. Orthod dentofacial Orthop* 1987 ; 92 : 181-98
5. Baume LJ, Derichswiler H. Is the condylar growth center responsive to orthodontic therapy? An experimental study in *Macaca mulatta*. *Oral Surg Oral Med Oral Pathol* 1961; 14:347-62.
6. Langford NM Jr. The Herbst appliance. *J. clinical orthod.* 1981; 15: 549-568.
7. Raymond P. Howe. The bonded Herbst appliance. *J. Clin. Orthod* 1982; 16 :663-667
8. Coelho Filho CM. Mandibular protraction appliance for class II treatment. *J. Clin. Orthod.* 1995; 29: 319-336
9. Calvez X. The universal bite jumper *J. clin. Orthod.* 1998; 32 : 493-500
10. D.D.Guner et al. Evaluation of effect of functional orthopaedic treatment on temporomandibular joint with single photon emission computerized tomography. *Eur. Jr. Orthod.* 2003;25:9-12
11. Jasper JJ. The Jasper Jumper—A Fixed Functional Appliance. *Sheboygan, Wis: American Orthodontics*; 1987:5–27.
12. Jasper JJ, Mc namara J Jr. Correction of Interarch malocclusion using a fixed Force module. *Am. J. Orthod Dentofacial Orthop* 1995;108 : 641-50
13. Devincenzo J. The Eureka spring: A new interarch force delivery system. *J. clin. Orthod.* 1997 ; 31 : 454-467
14. 14. Klapper L. The super spring II: A new appliance for non compliant class II patients. *J. clin. Orthod.* 1999 ; 33: 50-54
15. Ritto AK. Fixed functional appliance Trends for the Next century. *The funct. Orthod.* Apr/may/june 1999; 22-39
16. Ritto AK. Fixed functional appliances – A classification (updated). *Cyber journal.* June 2001
17. Papadopoulos M A. Orthodontic treatment of the Class II Non-compliant patient current principle and techniques. *Mosby Elsevier*; 2006.
18. Prateek, Jain S. Fixed functional appliances. *International Journal of Current Research.* 2017; 9, (03):47407-47414.
19. Pancherz H. Treatment of Class II malocclusions by jumping the bite with the Herbst appliance: a cephalometric investigation. *Am J Orthod.* 1979; 76: 423-442.
20. Pancherz H. Pancherz MA. Muscle activity in class II Div.I malocclusion treated by bite jumping appliance. An electromyographic study. *Am. J. Orthod* 1980 ; 78(3): 321-29
21. Weislander L. Intensive treatment of severe class II malocclusion with headgear Herbst appliances in early mixed dentition. *Am. J. Orthod* 1984; 86 :1-13
22. Panigrahi P, Vineeth V. Biomechanical effects of fixed functional appliance on craniofacial structure. *Angle Orthod.* 2009; 79(4):668-675.
23. De Araujo DB et al. Effects of class II division 1 malocclusion treatment with three types of fixed functional appliances. *Dental Press J Orthod.* 2019; 24(5):30-39.
24. D'apostantò V, Bucci R, Franchi L, Rongo R, Michelotti A, Martina R. Class II functional orthopaedic treatment: a systematic review of systematic reviews. *J Oral Rehabil.* 2015; 42(8):624-42.
25. 25. McNamara JA, Bookstein FL, Shaughnessy TG. Skeletal and dental changes following functional regulator therapy on Class II patients. *Am J Orthod.* 1985 June; 88(2):91-110.
26. Nalbantgil D, Arun T, Sayinsu K, Isik F. Skeletal, dental and soft-tissue changes induced by the Jasper Jumper appliance in late adolescence. *Angle Orthod.* 2005; 75(3):426-36.
27. Herrera FS, Henriques JFC, Janson G, Francisconi MF, Freitas KMS. Cephalometric evaluation in different phases of Jasper jumper therapy. *Am J Orthod Dentofacial Orthop.* 2011; 140(2):e77-84.
28. Karacay S, Akin E, Olmez H, Gurton AU, Sagdic D. Forsus nitinol flat spring and Jasper Jumper corrections of Class II division 1 malocclusions. *Angle Orthod.* 2006 July; 76(4):666-72.
29. Cubas Pupulim D et al. Class II treatment effects with fixed functional appliances: jasper Jumper vs. Forsus fatigue resistant device. *Orthodontics & Craniofacial Research.* 2022; 25:134-141.
30. Woodside DG, Metaxas A, Altuna G. The influence of functional appliance therapy on glenoid fossa remodeling. *Am J Orthod Dentofacial Orthop* 1987; 92; 181-98.