INTRODUCTION

Altering patient’s facial profile has been a challenge for orthodontists over the years. Growth modification is the best way to correct a jaw discrepancy as it allows the patients to grow out of the skeletal disharmony. (Kragt and Herman S Duterloo, 1982) Functional appliances refer to a variety of appliances designed to alter the arrangement of various muscle groups that influence the function and position of the mandible in order to transmit forces to dentition and basal bone. (Kragt and Herman S Duterloo, 1982) Functional orthopedic treatment seeks to correct malocclusions and harmonize the shape of the dental arch and oro-facial functions. (Profitt and Fields, 2000) The ideal time for treatment with fixed functional appliance is permanent dentition (to ensure a stable intercuspsation of teeth post treatment) and after the pubertal growth spurt (to reduce retention period). (Issacson, 1990) Fixed functional appliances are normally described as “Non compliance class II correctors” giving a false idea about the co-operation necessary during treatment, in reality when we compare them to removable appliance, we can clearly recognize fixed appliances as non compliance devices. However, for treatment to be successful good co-operation is always necessary.

Historical perspective

A major reason for development of functional appliances was recognition that function had an effect on ultimate morphologic structure of dentofacial complex. A number of fixed functional appliances have gained popularity in recent years to achieve better results in non-compliant patient. The correction consists of advancing the mandible to a forced anterior position to stimulate growth and harmonize skeletal defects. Fixed Functional Appliance was introduced first in dentistry by Dr. Emil Herbst of Germany at the 5th International Dental Congress in Berlin in 1909. Herbst (1934) presented a series of article in the “ZAHNAZTLICHE RUNDSCHAU” on his experience with the appliance, which was later rediscovered by Pancherz in the late 1970s. Hans Pancherz et al. (1979) 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. James J. Jasper (1987) introduced a relatively new type of flexible, fixed tooth borne functional appliance that allowed lateral movements. Hans Pancherz (1981) showed that sagittal mandibular growth was accelerated by continuous bite jumping. During treatment mandibular length and the SNB angle increased. The influence of bite jumping on maxillary growth appeared to be reversible. SNA angle significantly reduced during treatment but during follow-up period maxillary growth caught-up and the SNA angle returned almost to pretreatment values. Clements and Jacobson (1982) introduced the MARS (Mandibular Advancing Repositioning Splint). It is a fixed functional device which is attached to the archwires of a multibanded orthodontic appliance. It forces the patient to maintain the mandible in a protruded position 24 hours a day and yet allows full and complete opening and closing as well as lateral excursive movement. Jasper and
McNamara Jr (1995) describes the use of a flexible force module (the Jasper Jumper) that can be incorporated into existing fixed appliances to correct various types of sagittal malocclusion. The flexible spring module provides greater freedom of mandibular movement than is possible with the more rigid mechanism of the Herbst appliance. Weiland and Bantleon (1995) gave a report of treatment of class II malocclusion with the Jasper Jumper. It concluded that correction was a result of skeletal (40%) and dental (60%) changes. Skeletal class II correction was predominantly restricted to mandible. Almeida et al. (2005) described the short term treatment effects produced by the Herbst appliance during treatment of mixed dentition patients with Class II division I malocclusion. The results indicated that the treatment effects produced were primarily dentoalveolar in nature. Ritto (1999) described a miniaturised telescopic device the Ritto appliance. Ashok and Ritu (2010) has shown the treatment effects of MPA-IV in the correction of class II malocclusion. They concluded that Twin-block and MPA-IV were effective in correcting the molar relationships and reducing the overjet in Class II division I malocclusion subjects. However, twin-block contributed more skeletal effects than MPA-IV for the correction of Class II malocclusion.

Indications of fixed functional appliances

It is a well known fact that for successful completion of functional appliance therapy patient’s compliance is of paramount importance. The fixed functional appliance, being fixed to the teeth is a most important weapon against non-compliance offered by the patient.

1) The correction of skeletal abnormality in young growing individuals.
   a) In skeletal class II patients with retrognathic mandible.
   b) In skeletal class III patients with retrusive maxilla.

2) Making use of the residual growth left in neglected post adolescent patients who have passed the maximal pubertal growth and are too old for removable functional appliances.

3) In adults patients
   a. Can be used to distalize the maxillary molars in correction of dental class II molar relationship.
   b. Can be used to enhance anchorage.
   c. Can be used as an mandibular anterior repositioning splint in patients having temporomandibular joint disorders.
   d. Presurgical muscle conditioning of patients with class II malocclusion.
   e. Post surgical stabilization of class II / class III malocclusion.

4. Correction of functional midline shifts by using the appliance unilaterally.

Classification of fixed functional appliances: By Ritto A. Korrodi (2001)

A) Rigid Fixed Functional Appliances (RFFA)

1. The Herbst Appliance and its modifications.

2. The Mandibular Protraction Appliance (MPA)

3. The Mandibular Anterior Repositioning Appliance (MARA)

4. The Ritto Appliance

5. The IST-Appliance

6. The Biopedic Appliance

B) Flexible Fixed Functional Appliances (FFFA)

1. The Jasper Jumper

2. The Adjustable Bite Corrector

3. The Churro Jumper.

4. The Amoric Torsion Coils.

5. The Scandee Tubular Jumper

6. The Klapper Super Spring

7. The Bite Fixer

C) Hybrid Fixed Functional Appliances (HFFA)

1. Eureka Spring

2. FORSUS- Fatigue Resistant Device

3. The Twin Force Bite Corrector.

4. Alpern Class II Closers

5. The Calibrated Force Module

Considerations for fixed functional appliances

1) Age factor: fixed functional appliances have an important advantage that they can be used in post adolescent patients in whom very less growth is remaining.

2) Growth considerations: The prognosis of the fixed functional therapy is poor in patients with hyperdivergent facial growth patterns i.e. in patients with alarge gonial angle and increased lower anterior facial height and also in patients having an open bite.

3) Esthetic considerations: Fixed functional appliances yield excellent results in patients with skeletal class II bases with retrognathic mandible who have a positive VTO (visual treatment objective). On the contrary fixed functional appliances are not recommended in patients with a negative VTO because of unsatisfactory results.

4) Compliance: Being fixed type of appliances they have an advantage that they do not demand patient compliance which is an important factor in the success of removable type of functional appliances.

Mode of action

The mechanism of mandibular adaptation to the forward posturing by fixed functional appliance is the same as that seen in removable functional appliance. The appliance is toothborne and exerts its effects via teeth to the underlying bone by transmitting the forces developed as a result of the continuous forward posturing of the lower jaw. (Graber et al., 1997) Inspite of the various differences in concept, the general mode of action is one or combination of the following.

- Mandibular growth induction
- Maxillary growth restriction
- Dentoalveolar changes
- Glenoid fossa relocation
- Changes in neuromuscular anatomy and function.
Typically, the results obtained by functional appliance in correction of class II malocclusion consists of combination of orthopedic (30-40%) and dentoalveolar (60-70%) effects. (Graber et al., 1997)

Flow chart : Showing mechanism of action of the fixed functional appliances

Biomechanical Effects of Fixed Functional Appliance on Craniofacial Structures

1) Fixed functional appliances move the entire mandible anteroinferiorly, with maximum displacement observed in the parasymphysial and midsymphysial regions. The anteroinferior displacement of the mandibular dentition was most pronounced in the incisor region, while the maxillary dentition was displaced posterosuperiorly.

2) The displacement was more pronounced in the dentoalveolar region as compared to the skeletal displacement.

3) All dentoalveolar structures experience tensile stresses, except for anterior nasal spine and the maxillary posterior teeth.

4) Maximum tensile stress and von Mises stresses occurred in the condylar neck and head. (Panigrahi and Vineeth, 2009)

Complications with use of fixed functional appliances

Sanden et al. (2004) described the complications during fixed functional appliance treatment. Three types of complications were most commonly seen,

### Rigid Fixed Functional Appliances

<table>
<thead>
<tr>
<th>S No.</th>
<th>Appliance name</th>
<th>Introducer</th>
<th>year</th>
<th>Description</th>
</tr>
</thead>
</table>
| 1     | THE HERBST APPLIANCE & its modifications (fig 1). | Introduced by Emil Herbst, Reinvented by Hans Pancerz | 1979 | - The Herbst appliance is an artificial joint between maxilla and mandible. A telescope mechanism on either side of the jaw, attached to orthodontic bands, keep the mandible continuously in an anterior jumped position during all mandibular functions.  
- The telescopic tube was attached to the maxillary permanent first molar band and the telescope plunger to the mandibular first premolar band.  
A) The principal difference between the original and the bonded appliance is that the paired telescoping elements, which has been attached to the lower bicuspid bands, are now attached to the entire lower dental arch by an acrylic bite splint.  
B) Maxillary and mandibular acrylic splints are placed. Maxillary acrylic splint is made with cusp tips perforating the acrylic. And mandibular with posterior cusp tips perforating and anterior occlusal coverage.  
C) It is an integration of the Herbst appliance with conventional upper and lower fixed appliances. A lower auxiliary archwire with the herbst pistons attached is used to distribute the force from the appliance to the main mandibular archwire, thus reducing the possibility of bracket loosening and wire breakage.  
D) It consists of two tubes, two plungers, two upper “Mohee” hinges with ball pins and two lower key hinges with brass pins.  
E) It is a horse-shoe ball joint Herbst appliance. Since the ball joint is smaller in size as compared to pervious appliances it give more patient comfort. |
| 2     | Mandibular advancing repositioning splint (MARS). | Clements & Jackson | 1982 | - It is a fixed functional device, attached to the archwires of a multibanded orthodontic appliance. The function of the MARS appliance is similar to that of the Herbst appliance in that the mandible is maintained in a continuous protruded position via compressive struts.  
- There are four types of MPA (I - IV).  
- The first type of MPA2 requires stainless steel edgewise appliance in both arches. It is used for the treatment of skeletal class II deformity. Sufficient overjet reduction has been seen in period as short as 4 months.  
- The result may be due to mandibular growth promotion and dentoalveolar changes. Dentoalveolar changes include distalization of maxillary molars, retraction of maxillary anterior, mesialization of mandibular molars without retraction of mandibular anterior.  
- This appliance was developed to overcome the costly laboratory procedures associated with the herbst appliance and the jasper jumper. |
<p>| 3     | Mandibular protraction appliance (fig 2). | Coelho Filho | 1995 | Continue .......... |</p>
<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Reference</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Functional orthopedic magnetic appliance (FOMA)</td>
<td>Vardimon et al.</td>
<td>1989</td>
</tr>
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<td></td>
<td>FOMA II - Correction of class II skeletal relations</td>
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<tr>
<td></td>
<td>FOMA III - Correction of class III skeletal relations</td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td>Ritto Appliance (fig 3)</td>
<td>Dr. A Koroddi Ritto</td>
<td>1999</td>
</tr>
<tr>
<td>5</td>
<td>Intraoral snoring therapy appliance (IST appliance)</td>
<td>Hinz</td>
<td></td>
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<tr>
<td>6</td>
<td>Biopedic appliance. (fig 5)</td>
<td>Designed Collins J. and marketed by GAC</td>
<td>1997</td>
</tr>
<tr>
<td>7</td>
<td>Universal bite jumper.</td>
<td>Xavier Calvez</td>
<td>1998</td>
</tr>
<tr>
<td>8</td>
<td>MARA (Mandibular repositioning appliance)</td>
<td>Douglas toll</td>
<td>1991</td>
</tr>
<tr>
<td>10</td>
<td>The ventral telescope</td>
<td>The Professional Positioners</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Magnetic telescopic device</td>
<td>A.K.Ritto</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Cantilevered bite jumper</td>
<td>mayes</td>
<td>Mid - 1980s</td>
</tr>
<tr>
<td>13</td>
<td>Fixed Magnetic Appliance</td>
<td>Varun kalra</td>
<td>1989</td>
</tr>
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</table>
### Flexible fixed functional appliances

<table>
<thead>
<tr>
<th>S No.</th>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jasper Jumper. ( fig 7).&lt;sup&gt;12&lt;/sup&gt;</td>
<td>Jasper &amp; McNamara</td>
<td>1995</td>
<td>• In an attempt to overcome the rigidity problem of the Herbst Appliance, James Jasper developed a new pushing device that is flexible. It is termed as Jasper Jumper. It can be attached between the maxillary and mandibular arches to produce both sagittal and intrusive forces which may be either &quot;head-gear like&quot;, “activator-like forces” or combination of both.</td>
</tr>
<tr>
<td>2</td>
<td>Adjustable bite corrector.&lt;sup&gt;24&lt;/sup&gt;</td>
<td>Dr. Richard west</td>
<td>1995</td>
<td>• The appliance is similar to Jasper Jumper but incorporates several useful features. It consists of a stretchable closed-coil spring with internally threaded endcaps at both ends. This allows additional range of opening with no risk of breaking the appliance or accidentally changing its length.</td>
</tr>
<tr>
<td>3</td>
<td>Churro Jumper. (fig 8).&lt;sup&gt;25&lt;/sup&gt;</td>
<td>Ricardo castanon et.al.</td>
<td>1998</td>
<td>• The name has been taken from a Mexican cinnamon twist. It functions more like the Jasper Jumper.</td>
</tr>
<tr>
<td>4</td>
<td>Amoric torsion coils</td>
<td>Amoric N.</td>
<td>1994</td>
<td>• Made up of two intermaxillary springs, one of which goes inside the other.</td>
</tr>
<tr>
<td>5</td>
<td>Scandee tubular jumper</td>
<td>Saga dental AS, Kongsvinger, Norway</td>
<td>2001</td>
<td>• It is marketed in one size only and are bilateral.</td>
</tr>
<tr>
<td>6</td>
<td>The Bite fixer</td>
<td>ormco</td>
<td></td>
<td>• It is a flexible fixed functional appliance.</td>
</tr>
<tr>
<td>7</td>
<td>Super Spring II. (fig 9).&lt;sup&gt;26&lt;/sup&gt;</td>
<td>Lewis Klapper</td>
<td>1999</td>
<td>• The super spring II is a flexible spring that attaches between the maxillary molar and mandibular canine. It is designed to rest in the vestibule, making it impervious to occlusal damage and allowing for good hygiene.</td>
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</table>

### Hybrid fixed functional appliances

<table>
<thead>
<tr>
<th>S No.</th>
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<th>year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Eureka spring. (fig 10).&lt;sup&gt;11&lt;/sup&gt;</td>
<td>John Devincenca</td>
<td>1997</td>
<td>• This is also a fixed intermaxillary force delivery system similar to fixed Herbst appliance, used in non compliant class II patients.</td>
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<td></td>
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<td></td>
<td></td>
<td>• Advantages of eureka spring are that Minimal patient co-operation is required.</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>• The Eureka spring because of its small size and lack of protuberances into the buccal vestibule is almost invisible. Hence its esthetic acceptability is high. And it is Resistant to breakage. And causes minimal tissue irritation.</td>
</tr>
<tr>
<td>2</td>
<td>Forsus (fatigue resistant device). ( fig 11).</td>
<td>William Vogt marketed by (3M Unitek Corporation)</td>
<td>2006</td>
<td>• The Forsus (also known as the Forsus Fatigue Resistant Device [FRD]) is a semirigid telescoping system incorporating a superelastic nickel-titanium coil spring that can be assembled chair-side, and it can be used in conjunction with complete fixed orthodontic appliances.</td>
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<td></td>
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<td></td>
<td>• The Forsus (FRD) can be used instead of Class II elastics in mild cases and instead of Herbst appliances in severe cases. Forsus springs work best in patients with convex profiles, but they are indicated in any Class II patients except those with normal mandibles and protrusive maxillae, or with prognathic or overly large mandibles relative to the other cranial structures.</td>
</tr>
<tr>
<td>3</td>
<td>Alpern Class II corrector</td>
<td>(GA C International Inc )</td>
<td></td>
<td>• This appliance was designed as a substitute for elastics. It consists of a small telescopic appliance with an inferior coilt spring and two books for fixing.</td>
</tr>
<tr>
<td>4</td>
<td>Calibrated force module</td>
<td>The Cor Mar Inc.</td>
<td>1988</td>
<td>• It was a fixed appliance designed to substitute Class II elastics.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• It is applied to the inferior arch close to the molars and fixed by a screw, mesial or distal to upper cuspids, and also fixed to the arch. Its coil spring produced a force between 150-200 gm.</td>
</tr>
<tr>
<td>5</td>
<td>Power scope. (fig 12).</td>
<td>Dr. Andy Hayes (Marketed by American orthodontics)</td>
<td></td>
<td>• Indicated for use in treating Class II Malocclusions during orthodontic treatment of both growing and non-growing patients with full permanent dentition. Use standard treatment protocols for Class II Correction when using appliance.</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>• PowerScope 2 Class II Corrector is contraindicated for use with patients who have a history of severe allergic reactions to nickel.</td>
</tr>
</tbody>
</table>
Fig. 1. The herbst appliance

Fig. 1B. Acrylic splint Herbst appliance

Fig. 1C. Integrated Herbst Appliance

Fig. 1D. Components of MALU Appliance

Fig. 1E. Flip locked Herbst appliance

Fig. 2. Mandibular protraction appliance (MPA)
1. Breakage of bands or splints.
2. Breakage of telescoping mechanisms.
3. Loosening of bands or splints.
4. Trauma to buccal mucosa

There were no significant differences in complications of treatment between male and female patients.

Conclusion

Removable functional appliances are effective but rely heavily at the mercy of patient cooperation for achieving predictable results in a reasonable time frame. Patient cooperation is variable and is not always forth coming, with appliances such as headgear or removable functional appliances.

REFERENCES


Profitt WR and HW Fields. Contemporary orthodontics. 3rd Ed. Mosby; 2000

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