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HYBRID APPLIANCE- PIVOTAL ROLE IN DENTOFACIAL ORTHOPEDICS

Dental Science

Richa Shree* MDS (Ortho), Senior Lecturer, Department of Orthodontics and Dentofacial Orthopedics, Buddha Institute of Dental Sciences & Hospital, Patna, Bihar.* Corresponding Author

Swapnil Nangare MDS(Ortho), Assiatant Professor, Dept. of Dentistry, Prakash Medical Sciences & Research Centre, Urun Islampur, Sangli, Maharashtra

Pooja Shanker. P MDS (Pedo), Private Practitioner, Guntur, Andhra Pradesh

ABSTRACT

Dentofacial Orthopedics appliances are used to change position of mandible by increasing the contractile activity of lateral pterygoid muscles. Which, thereby leads to chage in trabecular orientations. Subsequently bringing the change the length of mandible. This is done by using myofunctional appliances or via hybrid appliances. Hybrid appliance poses cumulative effects resulting from growth and adaptation in response to therapeutic biomechanical interference may be manipulated to result in clinically significant morphologic alterations in the growing child's dentition and craniofacial skeleton1. Hybrid functional appliances are specifically and individually designed to exploit the natural processes of growth and development. It determines the selection of the component and their assemblies, resulting in appliance design that matches the needs of individual patient.

KEYWORDS

INTRODUCTION

Orthodontic appliance on the basis of necessity is divided basically into two classes i.e., functional appliances (myofunctional, removal and fixed) and fixed orthodontic appliances. The net treatment effect of orthodontic or orthopedic therapy may be considered as the algebraic sum of all dentoalveolar, skeletal, and neuromuscular changes over time. Cumulative effects resulting from growth and adaptation in response to therapeutic biomechanical interference may be manipulated to result in clinically significant morphologic alterations in the growing child's dentition and craniofacial skeleton[1]. Functional appliances have been widely used in Europe for more than 100 years. Vast span of this appliance exist and still it seems to be germinate and develop. These appliance plays a pivotal role in the treatment of dentofacial orthopedics. Functional appliances are considered by most authorities to be primarily orthopedic tools to influence the facial skeleton of the growing child in the condylar and sutural areas[2].

METHOD OF OPERATION OF FUNCTIONAL APPLIANCES

The servosystem concepts account not only for biological organization but also for mechanism of action of appliances used in dentofacial orthopedics. According to experimental investigations functional appliances may be tentatively divided into two categories.

1. The postural hyperpropulsor activator, class II elastics, Frankel appliance, Clark twin block and Balters bionator all exert their effects mainly through the movements of the mandible. Indeed their stimulating effects on condylar cartilage growth are produced mainly during the wearing of the appliance.
2. The Herren and L.S.U activators and by inferences the Harvold and Hamilton activators and extraoral forward traction on the mandible seem to exert their effects mostly through saggital repositioning of the mandible.

Regardless of the differences in the mode of action of the various functional appliances, the following causal chain is involved:-

Functional appliance

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Increased contractile activity of the lateral pterygoid muscles

↓

Intensification of the repetitive activity of the retrodiscal pad (bilaminar zone)

↓

Increase in growth stimulating factors

- Enhancement of local mediators
- Reduction of local mediators(factors having negative feedback effect on cell multiplication rate)

↓

- Change in trabecular orientation
- Additional growth of condylar cartilage
- Additional subperiosteal ossification of the posterior border of the mandible

↓

Supplementary lengthening of mandible

TREATMENT PRINCIPLE

Applied forces may be comprehensive or tensile. Depending on the type applied, two treatment principles can be differentiated: - force application and force elimination.

1. **Force application: -** compressive stress and strain act on the structures involved, resulting in a primary alteration in form with a secondary adaptation in function. All active fixed or removal appliance work according to this principles.
2. **Force elimination:-** abnormal and restrictive environmental influences are eliminated ,allowing optimal development. The lip bumper and frankel buccal shields employ force elimination. Function is rehabilitation is rehabilitated and followed by a secondary adaptation in form. During the elimination of pressure a tensile strain can arise as a result of the viscoelastic displacement of periosteum and the bone forming response in the affected areas. Tension can be more effective than the pressure because most bony structures are designed to resist pressure but not tension.

VARIOUS HYBRID APPLIANCES AND ITS DESCRIPTION

Hybrid functional appliances are specifically and individually designed to exploit the natural processes of growth and development. It determines the selection of the component and their assemblies, resulting in appliance design that matches the needs of individual patient.

1. Bow activator
2. Wunderer's modification
3. Reduced activator of cybernator
4. Propulsor
5. Cutout or palate free activator
6. Karwetzky modification
7. Herren's shaye activator
8. Frankel hybrid appliance
9. The bass appliance system
10. Rick – a – nator appliance
11. Posterior bite plate with headgear
12. Activator headgear
13. Headgear – herbst appliance
14. Functional regulator with headgear
15. Flip lock herbst appliance

16. Modified edgewise herbst appliance
17. Mars appliance
18. Active vertical corrector
19. Magnetic twin block
20. The Concorde Facebow
21. Mandibular protraction appliance
22. Eureka appliance
23. Universal bite jumper
24. Jasper jumper
25. Churro jumper

1. The bow activator- A.M. Schwarz (1956)[3]

The bow activator is a horizontally split activator having a maxillary portion and a mandibular portion connected together by an elastic bow. This kind of modification allows stepwise sagittal advancement of the mandible by adjustment of the bow. In addition this design allows certain amount of transverse mobility of the mandible. The independent maxillary and the mandibular portions can have screw incorporated to allow arch expansions (fig1)

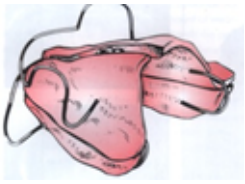

Fig 1:- The bow activator

2. Wunderer's modification (1971)[3]

This appliance is used in the treatment of Class III malocclusion. This type of activator is characterized by maxillary and mandibular portions connected by an anterior screw. By opening the screw the maxillary portion is moved anteriorly, with a reciprocal backward thrust on the mandibular portion (fig 2).

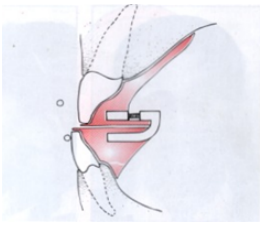

fig 2:- Wunderer's modification

3. Reduced activator of cybernator- Schmuth (1973)[3]

This appliance resembles to bionator with the acrylic portion of the activator reduced from the maxillary anterior area leaving a small flange of acrylic on the palatal slopes. The two halves may be connected by an omega shaped palatal wire similar to bionator (fig 3).

fig 3:- reduced activator of cybernator

4. Propulsor- Muhlemann (1980)[3]

This appliance can be said to be a hybrid appliance because it combines the features of both the monobloc and the oral screen. The propulsor is devoid of any wire components and consists of acrylic that covers the maxillary buccal portion like an oral screen (fig 4). This acrylic portion extends into the interocclusal area and also as a lingual flange that helps position the mandible forward.

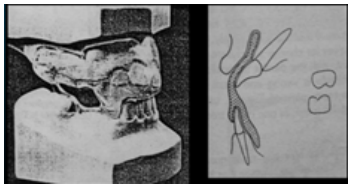

Fig 4:- Propulsor

5. Cutout or palate free activator – Klaws Metzelder(1968)[3]

This appliance combines the advantages of bionator and the Andersen's activator. The mandibular portion of the appliance resembles an activator while the maxillary portion has acrylic covering only the palatal aspect the buccal teeth and a small part of the adjoining gingiva. The palate thus remains free of acrylic thereby making the appliance more convenient for patients to wear the appliance for longer hours (fig 5). Dr Klaws Metzelder states that this appliance is excellent in mandibular positioning in TMJ dysfunction cases.

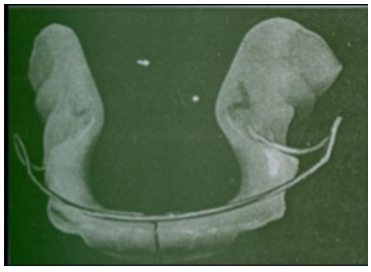

fig 5- Cutout or palate free activator

6. Karwetzky modification- Karwetzky (1964)

This appliance consists of maxillary and mandibular plates joined by a 'u' bow in the region of the first permanent molar. The maxillary and mandibular plates not only cover the lingual tissues and lingual aspects of teeth, it also extends over the occlusal aspect of all teeth. This type of activator allows stepwise advancement of the mandible by adjustment of the U loop. The U loop has a larger and a shorter arm. Based on their placement pattern we can have three types of Karwetzky activators.

Type I: used in the Class II division I patients.in this the larger lower leg is placed posteriorly. Therefore when the two arms of the U bow are squeezed the lower plate moves sagitally forwards (fig 6).

Type II: This is used for the treatment of Class III malocclusion. In this appliance the larger lower leg is placed anteriorly. Thus when the U bow is squeezed the mandibular plate moves distally (fig 6).

Type III: They are used in bringing about asymmetric advancement of the mandible. The U bow is attached anteriorly on one side and posteriorly on the other side to allow asymmetric sagital movement of the mandible (fig 6).

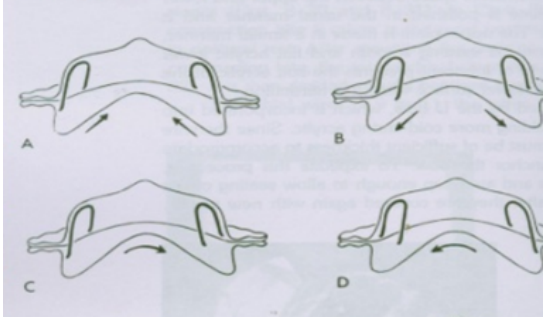

Fig 6:- A. used in class II malocclusion, B. used in class III malocclusion, C and D used in asymmetrical sagittal movement

7. Herren's shaye activator (1953)

Herren modified the activator in 2 ways:

a. By over compensating the ventral position of the mandible in the construction wax bite.
b. By seating the appliance firmly against the maxillary dental arch by means of clasps (arrowhead, triangular or Jackson's)

The construction bite is taken in a strong mandibular protrusion. This advanced position of the mandible causes the retractor muscles to try to bring the mandible back to original position. This causes a backwardly directed force on upper teeth and mesially directed force on lower teeth (fig 7). According to author with every 1 mm increase of forward position of the mandible, the sagittal force on the jaws will increase by 100 gm. The amount of forward positioning of the mandible is 3-4 mm beyond the neutral occlusion i.e., in case of Class II molar relation the mandible is brought forward to Class I molar plus an additional 3-4 mm forward. A vertical opening of 2-4 mm is recommended.

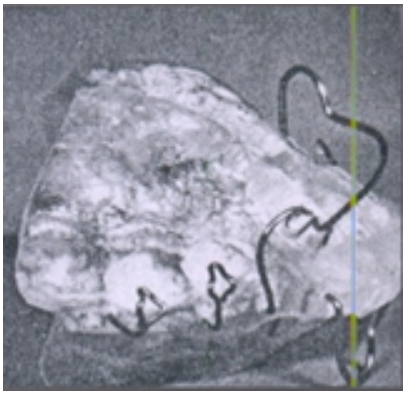

Fig 7:- Herren's activator

8. Frankel hybrid appliance- Vig (1986)

Appliance was designed for the treatment of patients with the following problems

- sagittal mandibular deficiency
- Increase overjet and overbite
- Bilateral cross bite of mandibular posterior teeth
- lack of space for eruption of second premolars

Components- mandibular component has the features of frankle 2 appliance (Lippads, Buccal shields, lingual pad with wire resting on the Cingulum. Maxillary portion has a bilateral posterior bite – block (fig 8).

Mode of action -The maxillary bite blocks prevents vertical emption and mesial and buccal movement of the upper posterior teeth. Lower buccal shields prevent processes from the buccal musculature hence the lower posterior teeth can erupt vertically and laterally under the influence of the tongue pressure. Wires contacting the upper and lower lingual prevents the further eruption of anterior teeth. The bite registration in taken with the mandible in a forward position to correct the molar relation. The functional phase of treatment lasted for 10 months, which led to differential skeletal growth and mandibular change that shortened the treatment time of the fully banded appliances considerably.

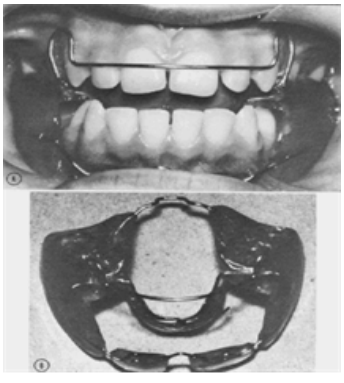

Fig 8:-frankel hybrid appliance

9. Bass appliance system- Neville Bass (1987)

Used in growing patients with skeletal Class II malocclusion to optimize facial appearence and to rapidly and effectively correct the class II dental relationship.

Mode of action

A well secured maxillary splint assures control of the upper arch. The anterior torquing spring prevents tipping and produces bodily movement of the incisors(fig :-9). The maxillary arch is expanded with a Jackscrew or spring to prevent cross bite and allow more space for dental alignment. The lingual pads helps to hold the mandibular incisors in a protrusive position, the pads are progressively reactivated every 6-8 weeks as the mandible develops forward. A rigid face bow connected to a high full headgear is used to retard maxillary growth and control vertical development of the maxillary dentition. Buccal screens are used to improve the soft tissue environment of the developing dentition.

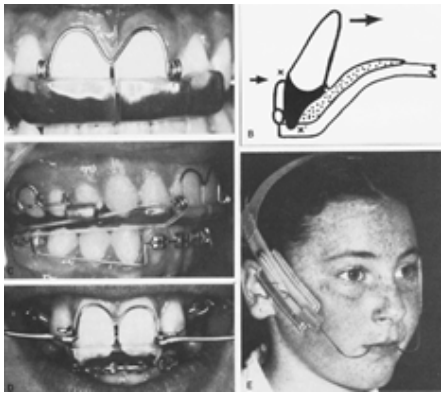

Fig 9:-A. Anterior torquing spring. B. Cross-section of torquing spring. Stippled area is relieved to avoid soft tissue swelling. Spring is lightly activated in palatal direction, forming force couple between points x and x'. Small acrylic ledge Is required at point x'. C. Class II elastics attached to torquing spring. D. J-hook headgear attached to torquing spring. E. Attaching extraoral traction anteriorly allows more vertical pull and greater premaxillary control.

10. Rick -a-nator appliance –Rondeau B.H (1992)

Used in for treatment of Class II malocclusion in the mixed dentition period.

Components

- Two molar bands with lingual attachments
- Connecting wire (0.040) from molar bands.
- Anterior bite plate.
- Incisal ramp

The Rick – a – Nator in a very simple appliance which consists for 2 molar bands, 1st molar bands attached to an anterior bite plate (fig 10). Initially to encourage patient compliance, the anterior bite plate is flat for one month, next month the anterior bite plate places the incisor forward by the addition of an incisal ramp.

The incisal ramp encourages the mandible to come forward which corrects the Class II molar relationship to class I and eliminates the overjet.

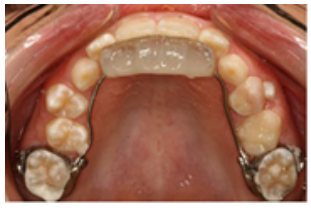

fig 10:- rick -a-nator appliance

11. Posterior bite plate with headgear- Orton

Posterior bite plate with headgear for the correction of Class II malocclusion with anterior open bite. The objective of this appliance is to intrude the upper posterior segment by at least 2 mm, so as to cause auto rotation of the mandible there by enabling, closure of the anterior open bite and 5-6mm of reduction in overjet. Here only the teeth in occlusion are overlaid with acrylic. The appliance is stabilized by Adam's clasp on the upper permanent first molars and on 1st premolars. The palate is relieved so that full intrusion from o c c l u s a l and headgear pressure is taken by the posterior teeth. Another advantage is total freedom from spontaneous vertical development of upper and lower buccal segments there by reducing the anterior open bite.

12. Activator headgear treatment4

Head gear and activator have both been used effectively for the treatment of Class II malocclusion. Hypothetically a simultaneous application of both appliances may result in number of desirable treatment effects greater than those induced by each appliance. It mainly works on the in restraining the maxillary growth, selective guidance of maxillary and mandibular dentoalveolar development, some influence on mandibular growth or position (fig 11). Among these the cervical headgear is claimed to be the most effective type of

headgear for initiating an orthopedic displacement of the maxilla.

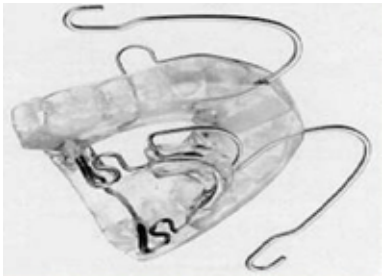

Fig 11:- Activator headgear

13. Headgear – herbst appliance- Lenant (1993)

The appliances is constructed with cast splint banded to the lower arch and with bands on the upper 1st molar. The bands were linked with a palatal bar and connected to the lower splint with Herbst Teclescopic arms, constantly keeping the mandible in a forward jump positioning (fig 12). Addition, a plate was constructed in the jaw as an anchorage for a Headgear to be worn 12-14 a day. Found that prolonged retention period of over several years of activator wear was required.

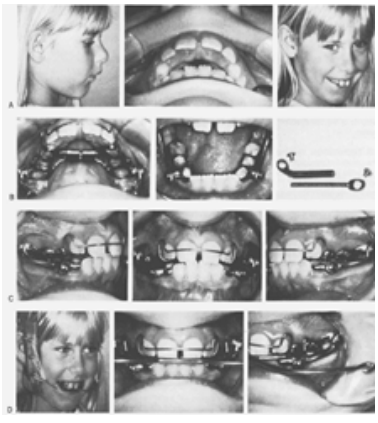

Fig 12:- A. Before treatment, B. Splints bonded to teeth.

C. Herbst telescoping arms for correction of intermaxillary relationship.Headgear worn at night.

14. Functional regulator with headgear- Albort oven 1985

This hybrid appliance is used for the treatment of vertical maxillary excess. The appliances consists of a regular headgear tubes to accept a face bow of a high pull headgear (fig 13). The construction bite was 3-4mm protrusive, with 3-4mm inter maxillary clearance in the molar area. The appliance was worn 20 hours/day and the headgear 12 hrs/day, lip seal exercises are important for proper lip seal, treatment usually lasted for19 months.

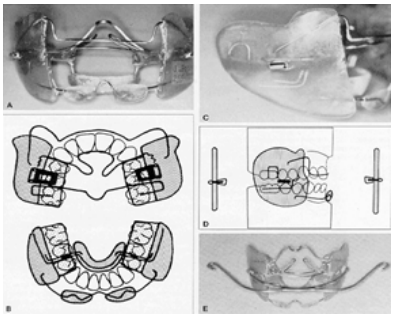

Fig 13 A. Modified function regulator. B. Occlusal view. C,D. Side views. E. With facebow attached

15. Flip lock herbst appliance- Robert Miller (1996)

It is easy to use and more comfortable for the patient than the conventional cantilever type herbst. Instead of a screw attachment, it has a ball joint connector and it needs no retaining springs. To place the appliance, the maxillary sleeve attachments are fastened in a lock and key manner, after the crowns are cemented. The rods must be long enough so that they do not come out of the sleeves on maximum opening. They have forked ends that are crimped into the mandibular balls (fig14). This appliance was designed to prevent accidental or intentional removal by the patient as often happens due to loose screws, but it can be removed at the chair with a loop forming plier.

It is reactivatd every six to eight weeks using 1-3 mm spilt bushing that are crimped on to the rods as needed. The molar tubes can be attached for fixed mehanotherapy.

The flip lock herbst can be combined with Jackscrew appliance.

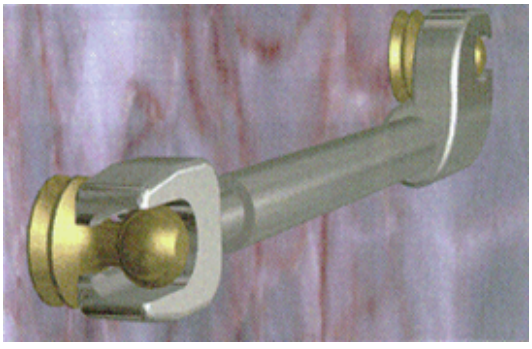

Fig 14:- Flip-Lock Herbst appliance's ball-joint connector

16. Modified edgewise herbst appliance

Mandibular Advancement Locking Unit (MALU)

The MALU consists of two tubes, two plungers, two upper "Mobee" hinges with brass pins, and two lower key hinges with brass pins. In the upper arch of the edgewise Herbst MALU appliance, only the Ist molars are banded, with 0.051" headgear tubes. A palatal arch can be used in cases of over expansion. In the lower arch, the Ist molars are banded and the anterior segment is bonded from cuspid to cuspid with 0.22" brackets (fig 15). The bicuspids may be left un – bracketed to help in settling the occlusion.

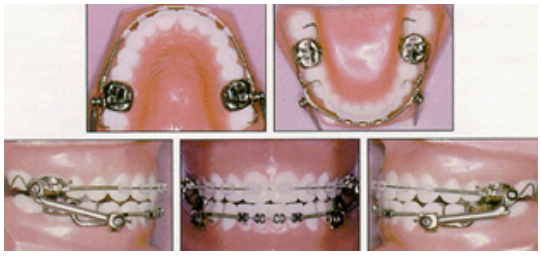

Fig 15:-Assembled Herbst with Malu attachments

17. Mars appliance - Ralph M. Clements and Alex Jacobson (1982)[5]

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. However there are several important differences between the two appliances.

Advantages

- Requires neither soldering nor extensive laboratory procedures.
- Has minimal incidence of breakage.
- Does not depress the canines, open spaces in the premolar area, or flare mandibular incisors (provided the mandibular rectangular archwire is tied back to the terminal molars).
- Is easily attached to or removed from the arch wire of a multi banded orthodontic appliance.

Appliance design

The MARS appliance is composed of a pair of telescope struts, the ends are attached to the upper and lower arch wires of a multibonded fixed appliance by means of locking device. Each strut is composed of two separate parts; a piston or a plunger and a cylindrical or hollow tube.

These two components telescope together, forming an individual strut. The free ends of the plunger and the hollow tube (strut) are attached to the upper and lower archwires by means of a slot and screw arrangement, which locks them securely in position on the arch wire (fig 16).

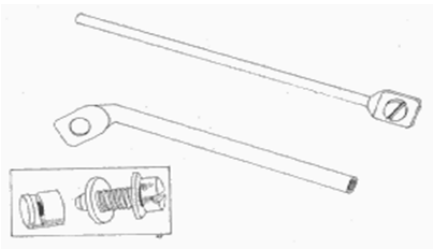

Fig 16:-Telescoping struts of MARS appliance. Locking screw is illustrated in box at lower left-hand corner of diagram.

18. Active vertical corrector[6]

The AVC consists of 2 posterior occlusal splints, one for the upper and one for the lower jaw. Samarium cobalt magnets are incorporated into the occlusal splints over the occlusal region of the teeth to be intruded. One magnet per distal quadrant is used. The magnets in the upper splints are incorporated in a mode to repel the magnets in the lower splints. Therefore the appliance is a combination of acrylic posterior bite blocks and repelling magnetic forces. To prevent unwanted cross bite development due to the shearing forces of repelling magnets ,angled buccal flanges are added to the lower occlusal splints to stablize the appliance during lateral jaw movements. A heavy gauge stainless steel wire connects the occlusal splint of each arch. The magnets are cylindrical in shape with a diameter of 10mm. The magnents along with bite blocks measures 12mm in height. Because SmCo is a highly reactive rare earth material they are best kept isolated from the oral environment. Hence, they are sealed in stainless steel capsules (fig 17). If the anterior open bite is of skeletal origin than dental origin, it is preferred. Hence, patients in the growing age and in the mixed dentition period are preferred to elicit maximum skeletal response. When the posteriors are intruded , auto rotation of the mandible take place and the mandible moves anteriorly to close the open bite. The AVC can be cemented or bonded. At end of 12 weeks the appliance can be removed and can be used as a removal appliance.

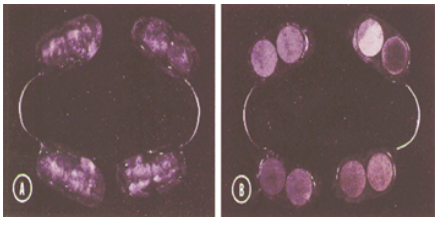

Fig 17:- Example of the A
ctive Vertical Corrector (AVC). Occlusal and tooth contact views of (A) mandibular appliance (B)maxillary appliance

19. Concorde Facebow

When the response to functional correction is poor, the addition of orthopedic traction force may be considered. The indications are confined to a minority of cases with growth patterns where maxillary retraction is the treatment of choice (fig 18)

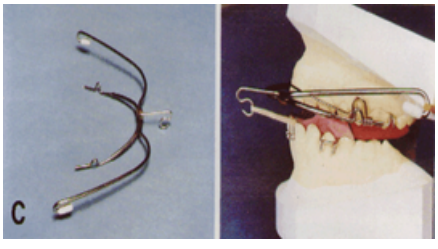

Fig 18 :-The Concorde Facebow

20. Magnetic Twin Block

Attracting magnets :- The increased activation can be built into the initial construction bite for the appliances. The attracting magnetic force pulls the appliance together and encourages the patient to occlude actively and consistently in a forward position.

Repelling Magnets:- It may be used with less mechanical built into the occlusal inclined planes. It is intended to apply additional stimulus to forward posture as the patient closes into occlusion.

Indicated in patients with weak musculature fails to respond to functional therapy. Used only where speed of treatment is an important considerations (fig 19).

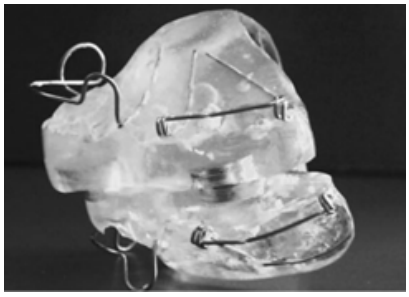

fig 19:- Magnetic Twin Block

21. Mandibular protraction appliance - Carlos M.C. Filho (1995)

Introduced the Mandibular protraction appliance for the treatment of Class II malocclusion. It is a cost efficient appliance in case of fabrication and rapid installation, with infrequent breakage. It is also comfortable to the patient.

22. Eureka spring - John Devincenzo (1997)7

The forerunner to this spring was a system devised by Northcutt (1974). The device incorporates significant changes to the Northcutt's design including triple telescoping action, flexible ball and socket attachment, a completely encased spring that remains intact even if the device becomes disengaged, and a shaft for guiding the spring. The main component of the spring is an open wound coil spring encased in a plunger assembly. The ram is made from a special work hardened SS wire that has been precision machined with three different radii. At the attachment end ,the Ram has either a closed or an open ring clamp that attaches directly to the arch wire. The plunger has a tolerance of 0.002 inch within the cylinder (fig 20). A triple telescoping action permits the mouth to open as wide as 60mm before the plunger becomes disengaged, even if it disengages it can be reassembled easily. The cylinder assembly is connected to a molar tube with 0.032 inch wire that has been annealed at the anterior end. A 0.036 inch solid ball at the posterior end acts as a universal joint permitting lateral and vertical movements of the cylinder.The spring is within 1.5mm of full compression. The force of the open wound spring is linear throughout the length of the Ram thrust and is 16.6 gm for every mm of Ram compression.

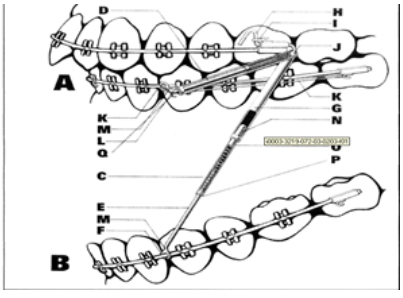

fig 20:- Eureka spring

21. Universal bite jumper

It can be used in all phases of treatment in the mixed or permanent dentition and with removable or fixed appliance. Like other mandibular protrusion appliances, the UBJ uses a telescopic mechanism, an active coil spring can be added if necessary. It can be used in Class II and III cases. the UBJ is attached to the maxillary Headgear tube with a ball pin. In the mandibular arch ,the sliding rods end in a 900 hook that is fixed to the each wire. Lower cantilever type of UBJ is also available when used with removable acrylic splints; two lateral UBJs link the maxillary molar areas and the mandibular 1st premolar areas. They are attached to 1.2-mm ball clasps, which are constructed on the working cast and then incorporated into the thermoformed splints (fig 21). The lower loop of the UBJ should be oriented in an anteroposterior direction. Re- activation is made every 6-8 weeks by crimping 2-4mm splint bushing on to the rods. UBJ with NiTi coil springs do not need to be activated. Adjusting one side or the other of the appliance can easily treat midline or asymmetrical problems.

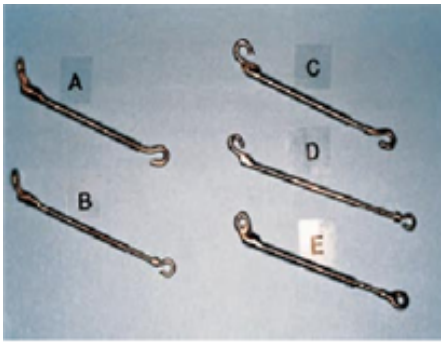

Fig 21:- A. The universal bite jumper B.UBJ for fixed appliance with nickel titanium coil spring C. lateral UBJ for removal splints(class II treatment) D. lateral UBJ with coil spring for removal splints(class III treatment) E. Median UBJ for removal splints (class II treatment)

24. Jasper jumper - Jasper JJ (1987)8

The disadvantages of the Herbst appliance are the rigidity of the Herbst bite jumping mechanism itself. Although every attempt is made to allow freedom of movement of enlarging the attachment holes of the tube and plunger to the axles, the bite jumping mechanism restricts lateral movements of the mandible. In an attempt to overcome these problems, Jasper developed a new pushing device that is flexible. This appliance produces both sagittal and intrusive forces, and affords the patient much freedom of mandibular movement. The jasper jumper can be attached to most of the commonly used fixed appliances. The system is composed of 2 parts –the force module and anchor units (fig 22)

Force module

The force module, analogous to the tube and plunger parts of the Herbst, is constructed by a stainless steel coil 0r spring that is attached at both ends to stainless steel end caps, in which holes have been drilled in the flanges to accommodate the anchoring unit. This module is surrounded by opaque polyurethane covering for hygiene and comfort. The modules are available in seven lengths, ranging from 26mm –38mm.]

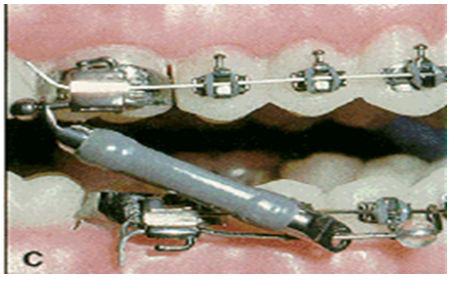

Fig 22:- jasper jumper

25. Churro jumper – Creekmore 1998[9]

The Churro Jumper is effective and inexpensive, alternative force system for the antero – posterior correction of class II and III malocclusions.

Although the Chrro Jumper was conceived as an improvement to the MPA, it functions more like the Jasper Jumper.

It is secured by bending the pin down on the mesial end of the tube (fig 23).

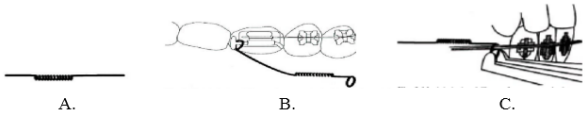

Fig 23:- A. Churro jumper without its terminal circle B. distal circle of churro jumper attached to headgear tube C. mesial circle of churro jumper attached to mandibular archwire by squeezing it shut.

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