Functional Appliance Philosophy

A Functional appliance can be defined as a removable or fixed appliance which:

- Changes the position of the mandible so as to transmit forces generated by the stretching of the muscles, fascia and or periosteum, through the acrylic and wirework to the dentition and underlying skeletal structures. (Mills 1991)
- Favourably changes the soft tissue environment. (Frankel 1974)

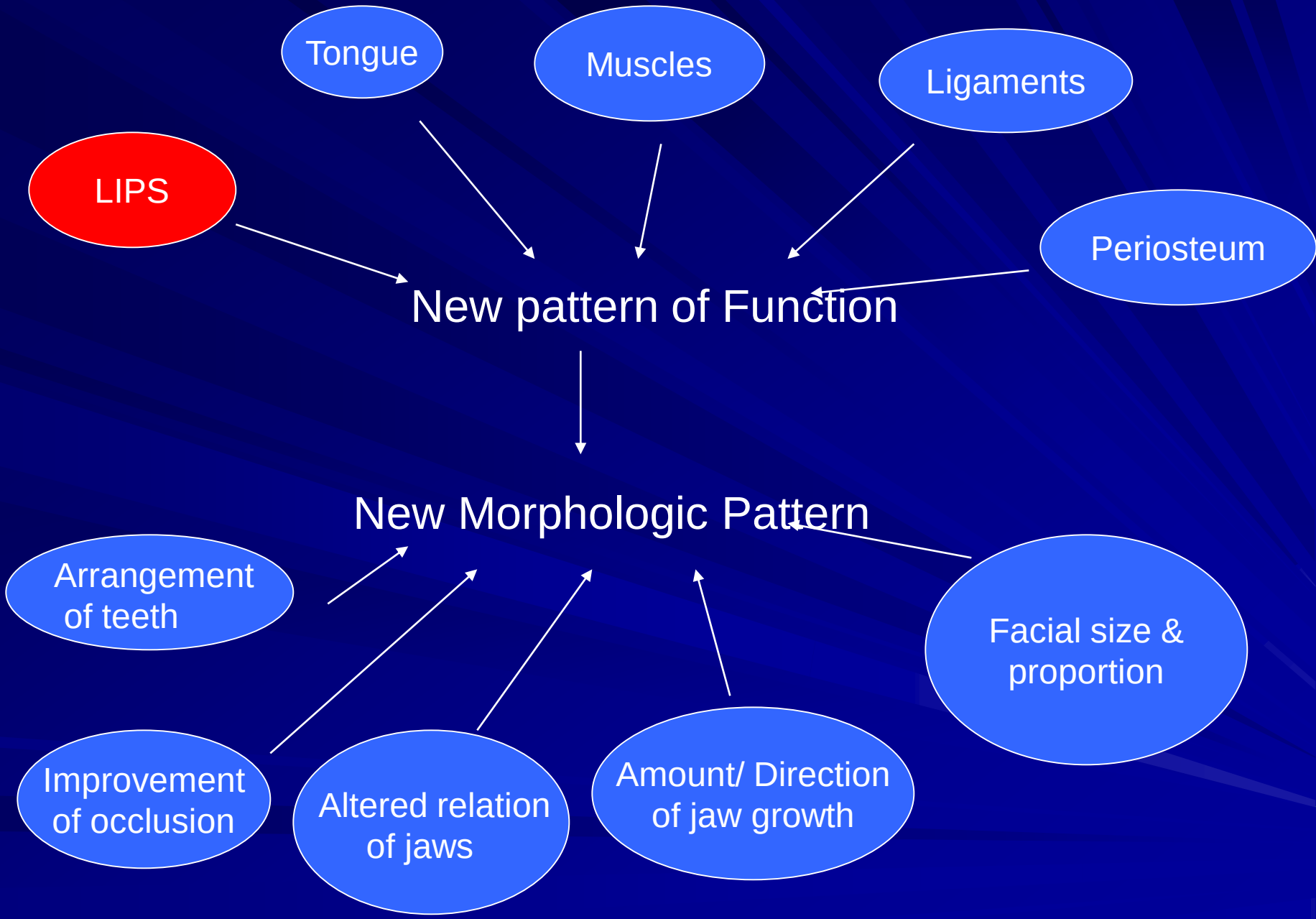
Functional appliances refer to a variety of appliances designed to alter the arrangement of various muscle groups that influence the function and position of the mandible in order to transmit forces to the dentition and basal bone.
(Bishara 1989)

Their uniqueness is their mode of force application. They do not act on the teeth like conventional appliances, using mechanical elements such as springs, elastics or ligatures, but rather transmit, eliminate or guide natural forces (eg muscle activity, growth or tooth eruption).

Aim Of Functional therapy :

1. To change the aberrant functional environment of the dentition and promote normal function. So the appliances are designed to control the forces applied to the dentition by the surrounding soft tissues and the muscles and establish a new functional behaviour pattern to support a new position of equilibrium.

2. It also aims to unlock the malocclusion and stimulate growth by applying favourable forces that enhance skeletal development.


Tongue
Muscles
Ligaments
LIPS
Periosteum
New pattern of Function
New Morphologic Pattern
Arrangement of teeth
Facial size & proportion
Improvement of occlusion
Altered relation of jaws
Amount/ Direction of jaw growth

Classification Of Functional Appliances:

Removable:

Tooth-borne passive eg: Activator
Bionator

Tooth- borne active eg:Clark twin block

Tissue-borne eg: Frankel functional regulator

Fixed:

Herbst Appliance

Based on the Clinical Use:

One stage treatment: Used in Patients treated with functional appliance alone. Patients usually have mild skeletal discrepancy, proclined upper incisors and no dental crowding.

Interceptive treatment: Early intervention with functional appliances

Two stage treatment: Functional appliances are an excellent means of improving the anteroposterior relationship at the beginning of fixed appliance treatment. It may reduce the need for later orthognathic surgery, with most cases progressing simply to fixed appliances with or without dental extractions.

Compromise treatment: Some patients who are unsuitable for fixed appliances(physically handicapped) may gain some benefit, both occlusally and facially, from functional appliance therapy.

DEVELOPMENT OF APPLIANCES : HISTORICAL PERSPECTIVE

Norman Kingsley → Credited with the development of the first appliance to position the mandible forward, as early as 1879. “jumping the bite”.

Pierre Robin → developed the earliest removable functional appliance, the monobloc, in France in 1902.

Only 3 years later, at the international dental congress in Berlin, Emil Herbst introduced a fixed pin and tube appliance to posture the mandible forward.

The ACTIVATOR was developed by Viggo Andersen in Denmark in 1908, and later modified in Norway by his colleague Karl Haupl.

FUNCTIONAL REGULATOR, was developed by Rolf Frankel in Germany & introduced in 1966.

TWIN BLOCK developed by Clark in 1977.

Genomic and functional paradigms

Genomic paradigm

Few workers are of the opinion that the genetic control is the main force behind the degree of growth that occurs in the cranio-facial structures (Brodie (1941), Bjork (1951) Ricketts (1952), Hiniker and Ramjford (1966)

Functional paradigm

Certain others believe that apart from the genetic control, the local factors at a certain point of time during growth can influence the degree of growth to a certain extent (functional matrix hypothesis was based on this philosophy)

Principles of growth modulation

- Growth modulation is possible in patients who are actively growing subjects (females 8-9yrs and males 10-11 yrs pre pubertal in both sexes) coinciding with the adolescent growth spurt.
- The growth pattern remains the same (i.e. the final size, and shape) but the expression of growth can be changed.

There are two types of growth stimulation

A) absolute or true stimulation

- treatment would attain a size larger than without treatement

B) Temporal stimulation

- the growth during a certain period will increase the growth at a particular period, but the final size attained would be the one that is expected even without treatment.

Treatment principles

Two cardinal pillars are anatomy (form) and physiology (function)

1. Force Application

↓

Compressive stress
and strain act on the structures involved.

↓

Primary alteration in form (alter anatomy)

↓

Secondary adaptation in function
(physiology)

2. Force elimination

↓

Abnormal and restrictive environmental influence are
eliminated (alter physiology)

↓

Secondary adaptation in form (anatomy)

FORCE CONSIDERATIONS

Duration: In most functional appliance, treatment is interrupted since the appliance is worn only for 12-16 hours/day.

Certain appliances are worn full day e.g. Herbst Appliance, Jasper Jumper.

- Direction: The direction of force (whether a stress or strain) for the movement of teeth should be consistent. Functional forces may stimulate tooth movement in one direction, but the forces of intercuspation and occlusion may drive the teeth in the opposite direction while the appliance is not being worn. Such “jiggling effects” should be eliminated if possible.

  Full-time wear, bonded appliances eliminate these see saw effects.

- Magnitude: The magnitude of force is small in function appliance therapy.

Mechanism Of Action

1) EFFECTS ON MAXILLARY GROWTH

The heavy extra oral forces applied by the head gear lead to

- Restrict development of maxilla
- Distal movement of maxillary complex

Headgear–activator combination produces an orthopedic effect restricting and redirecting growth of the maxilla.

Frankel appliance causes, on analysis of posteroanterior head plates and dental casts, extensive transverse effects. (Brieden; Angle Orthodontist. 1984).

2) EFFECTS ON MANDIBULAR GROWTH:

Few studies state that the Activators did not produce alterations in mandibular growth, since the changes that were observed would have occurred with out treatment.

Functional appliances lead to higher rate of mandibular growth in treated patients compared to untreated subjects.

How does mandibular growth occur when functional appliances are used?

A) CHANGE IN CONDYLAR POSITION
B) ROLE OF CONDYLAR CARTILAGE
C) RETRODISCAL PAD

CHANGE IN CONDYLAR POSITION

1) intermittent change in the condylar position

activators worn at night produce changes in the glenoid fossa when they are worn, but there is no increase in mandibular length, although there is proliferaton of the condylar cartilages

2) continuous change in condylar position

continuous functional therapy usually achieves an alteration in condylar–glenoid fossa relationship.

ROLE OF CONDYLAR CARTILAGE

Skeletoblast → Prechondroblast type II → Chondroblast type II

↓

Preosteoblast → Osteoblast → Osteocyte

STH-somatomedin complex comprises a direct and indirect effect on cell multiplication.

Prechondroblasts: are not surrounded by cartilaginous matrix and not isolated from influence of local factors. Thus local extrinsic factors may modulate growth rate of secondary cartilages. Therefore appropriate orthopedic devices can modulate growth amount.

RETRODISCAL PAD

Controls mandibular growth in 2 ways :

Vascular component : Controls the condylar cartilage growth rate and endochondral ossification rate; an increase in iterative activity of the retrodiscal pad produces an increase in condylar cartilage growth and endochondral ossification.

Biomechanic component : Governs bone apposition and condylar growth direction at the posterior border of the ramus.
Thus, condylar cartilage growth is integrated into an organized functional whole servosystem which is able to modulate the lengthening of the condyle

3) DENTOALVEOLAR CHANGES:

The various dentoalveolar changes reported include :

- Inhibition of mesial migration of maxillary teeth
- Inhibition of maxillary alveolar height increase
- Change in position of upper and lower incisors
- Intrusion of maxillary and mandibular incisors
- Mesial movement of mandibular teeth
- (Bjork 1969; Jacobsson 1967; Richardson 1982; Weislarder 1979).

These movements depend on :

design of appliance

extension of acrylic

With proper trimming, different movements can be performed and the eruption of teeth can be guided.

4) DEFELECTION OF RAMAL FORM:

The biomechanic effect of the retrodiscal pad is probably responsible for the posterior growth rotation and supplementary lengthening of the mandible(Paulson 1996), because of increased bone apposition at the posterior border of the ramus (stutzman, Petrovic 1990)

Functional appliances

↓

Increase of condylar cartilage growth rate and
More posterior growth direction of condyle correspond to

↓

Accentuation of concavity of ramus and posterior border

↓

Negative changes → Bone apposition

↓

Accentuation of ramus anterior convexity

Positive changes → Bone resorption

This causal chain may account for supplementary lengthening of the mandible produced by functional appliance.

5) HORIZONTAL EXPRESSION OF MANDIBULAR GROWTH

Use of posterior occlusal bite blocks and functional appliances to inhibit buccal segment eruption in both arches, produced horizontal mandibular growth directions in children with excess lower anterior facial height.

This horizontal expression of mandibular growth through relative mandibular rotation through buccal segment intrusion in growing children is a valuable tool for the correction of class II malocclusions associated with excess lower anterior facial height.

6) CHANGES IN NEUROMUSCULAR ANATOMY AND FUNCTION

Mechanism of neuromuscular adaptation to functional appliance therapy

Several adaptive processes suggested :

- Elongation of muscle fibres
- Elongation of tendons
- Migration of muscle attachments along bony surfaces
- Changes in muscle dimensions due to bone displacements and rotations.

LATERAL PTERYGOID MUSCLE HYPOTHESIS (LPM HYPOTHESIS)

* McNamara & Colleagues (1973) from their experiments in Macaca Mulatta primates → Anterior displacement of mandible was capable of inducing altered postural activity in the pterygoid muscle, which in turn induced additional condylar growth.

Petrovic, Charlier & Stutzman from their experiments on rats (AJO 1969) also claimed that the enhanced activity in the pterygoid muscle during mandibular hyper propulsion induced supplementary growth in the condylar cartilage.

The following causal chain is involved :

Functional Appliance

↓

Increased contractile activity of lateral pterygoid muscle

↓

Intensification of repetitive activity of retrodiscal pad (Bilaminar zone)

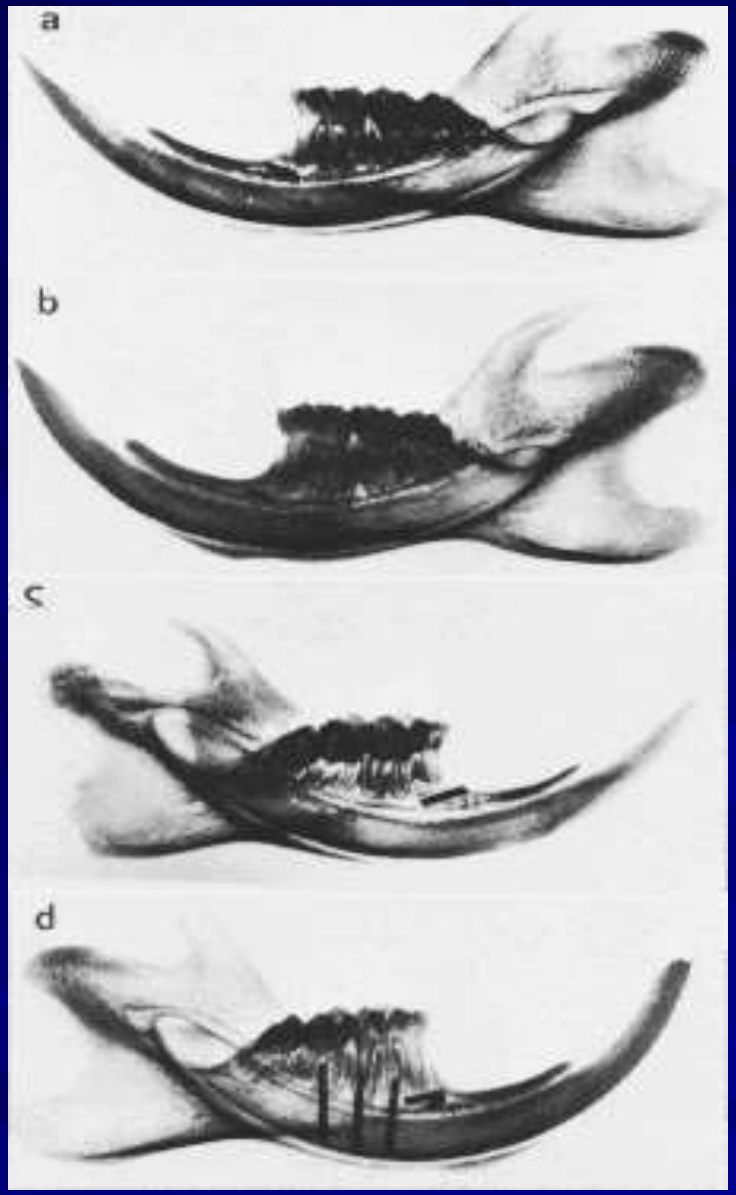
Increase in growth stimulating factors
Enhancement of local mediators
Reduction of local regulators (factors having negative feedback effects on cell multiplication rate)

↓

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

↓

SUPPLEMENTARY INCREASE OF THE MANDIBLE



Stutzman and Petrovic 1990

. Fig. 2. Radiograph of the mandible of a 48-day-old rat.

a, Control, sham-operated.

b, After treatment with postural hyperpropulsor, the condylar bone trabeculae became oriented more posteriorly.

c, After resection of LPM, the condylar bone trabeculae became also oriented more posteriorly.

d, After resection of TMF, the condylar bone trabeculae became oriented more vertically; this change is only statistically detectable.

DEMISE OF THE LATERAL PTERYGOID HYPERACTIVITY HYPOTHESIS

- By using lateral pterygoid myectomy in rats, Whetten & Johnston (AJO 1985) found little evidence that lateral pterygoid traction had any pronounced effect on condylar growth.
- * More recently (Sessle & Woodside AJO 1990), permanently implanted longitudinal muscle monitoring technique have found that the condylar growth is actually related to decreased postural and functional lateral pterygoid activity.
- This notion was also supported in human studies by :
- Pancherz & Anahus (AJO 1980)
- & Ingervall & Bitsaris (EJO 1986)

VISCOELASTIC HYPOTHESIS

- Selmer Olsen, Herren (1953), Harvold (1974) and Woodside (1973) do not accept the theory that myotactic reflex activity with isometric muscle contractions induces skeletal adaptation.

- According to their views : The viscoelastic properties of muscle and the stretching of soft tissues are decisive for activator action.
- During each application of force, secondary forces arise in the tissues, introducing a bioplastic process. Thus, not only the muscle contractions, but also the viscoelastic properties of the soft tissues are important in stimulating skeletal adaptation.
- The viscoelastic reaction can be divided into the following stages :
- Emptying of vessels
- Pressing out of interstitial fluid
- Stretching of fibers
- Elastic deformation of bone
- Bioplastic adaptation
- Voudaris & Kuftinec (AJO 2000) also postulate a non-muscular hypothesis to account for growth changes in Twin Block & Herbst treatment, as a result of radiating viscoelastic forces on the condyle and fossa.

7) TECHNIQUES IN GLENOID FOSSA LOCATION

- Woodside (1987) → Sample of juvenile monkeys → Mandibular advancement using Herbst appliance produced extensive remodeling and anterior relocation of glenoid fossa.
- Voudaris (1988) → Similar changes in mixed dentition animal
- Angelopoulos (1991) → These changes are stable

- The same authors in AJO 2003 → Herbst appl. in growing non human primate
- → Anterior & Inferior growth modification in glenoid fossa
- → Decreased postural electromyographic activity in lateral pterygoid muscle.
- Ruf & Pancherz (1999) AJO – Similar findings of temporomandibular joint remodeling analyzed by magnetic resonance imaging in adolescents and young adults treated with Herbst appliance.
- Rabie et al (AJO 2001, 2002) :Increase in vascular endothelial growth factor expression and bone formation in glenoid fossa in Sprague– Dawley rats with forward mandibular positioning

Orthopedic effect of functional appliances

There exists a wide variation in individual results (Woodside AJO 1998)

1. Patient compliance
2. Depending on the appliance wear,Night-time vs. Full time
3. Mandible grows in a wave like fashion, thus there could be a catch-up effect in mandibular growth during orthodontic treatment, followed by a period of diminished growth after the treatment.

   Multiple accelerations followed by quiescent periods. If treatment is applied during a quiescent period, orthopedic changes may not occur.
4. Improper diagnosis
5. The true nature of many malocclusions is camouflaged by downward and backward mandibular rotation or by upward and forward mandibular rotation into an over closed position. Eg. True prognathic Class III mandible may be rotated down and back into a moderate class II relation with excessive lower facial height.
6. 2 Stage orthodontic treatment → may be difficult to maintain growth control during the interval between phase A and phase B therapy.

Orthopedic effect of functional appliances

Validity of functional appliance studies is questionable because :

1. Cephalometric studies are used.
   - Small samples
   - SNA, SNB, ANB are Dependent on incisor position

2. Landmarks
   – Difficult to indentify (e.g.. condylion)
   - True mandibular length vs. Anterior mandibular displacement may be indistinguishable cephalometrically.
   - Anatomic landmarks are used for superimposition and are subject to considerable error.

3. It may be statistically significant but clinically,it may show an insignificant increase in mandibular length.

Orthopedic effect of functional appliances

4. Group averages may mask individual variability
5. Histologic studies – Problems

   a) Labeling methods eg. Tritiated thymidine

   Researchers may assume that :

   Increased cell activity → increased chondroblastic growth → increase in mandibular length

   In fact, this activity may only reflect increase metabolic activity

   b) Quantifying new bone formation :

   Plane of section may not be identical

   Thickness of section may not be identical

   There are anatomic and physiologic differences between animal models and human subject
6. Age variations in experimental models
7. Difficulty in obtaining untreated class II Div I control samples

DUAL BITE (Jayan Joseph & Ashima Valiathan KDJ Vol. 1)

- It is the habitual positioning of the mandible forward, from a more retruded centric relation into a habitual occlusion that appears to be correct when looking at the buccal occlusion but actually is a postural Maneuver initiated by the protracting muscular to achieve a full occlusion.
- This type of relationship is potentially damaging to the temporomandibular joint. It causes jiggling of the teeth as the mandible drops back during actual excursive function associated with mastication.
- Radiographic examinations of TMJ (Temporomandibular joints) → retruded contact position → (Harvold 1962) condyles in normal position in glenoid fossa.
- Habitual occlusion : Condyles downward and forward.
- Pattern of muscle activity during chewing indicate that retruded mandibular position is used during chewing.
- Therefore, it is functionally beneficial to create stable occlusion in the retruded position.

ANDRESEN ACTIVATOR

APPLIANCE DESIGN

The basic design is an acrylic plate which is so moulded so as to fit in the inter occlusive area of the molar teeth so as to cause a 4-6mm gap in between them

Wires are also incorporated into the plate but have a passive role in keeping the appliance in situ.

Woodside modification splints the teeth open upto 10-15 mm.

THE ACTIVATOR MECHANISM OF ACTION

There are 3 views as proposed by Andresen and Haupl, Woodside and lastly Eschler.

1st view: Andresen & Haupl(1955)

The activator is effective in exploiting the interrelationship between function and changes in internal bone structure. Petrovic (1984) and Mc Namara (1973) substantiate the Andresen – Haupl concept.

Application of activator

↓

Musculoskeletal adaptation

↓

Reeducating the orofacial musculature

↓

myotactic reflex activity

↓

isometric contractions in LPM

↓

upward and backward growth of the condylar cartilage

↓

new mandibular closing pattern

2nd view: Woodside (1973), Selmer(1973), Harvold (1974)

These workers opine that mandible normally drops open when the patient is asleep. As suggested by Andresen if there is only opened only 3 or 4 mm then

1. The appliance may fall out because the wider open sleep position does not permit it to advance the mandible.
2. The amount of actual muscle contraction possible when the patient is asleep is questionable, again making the appliance ineffective.

Woodside proposed that the appliance should be squeezed between the jaws in a splinting action, which activates the stretch reflex and inherent tissue elasticity is operative, and strain occurs without functional movement. The appliance works using potential energy. The viscoelastic hypothesis explains the mechanism of action of this apparatus. For this mode of action, an overcompensation of the construction bite in the vertical saggital plane is necessary.

Herren → Overextends in the sagittal plane moves the mandible anteriorly into an incisional cross bite relationship.

3rd view: transition between the first and second approach

Transitional type of activator action

↓

Alternately uses

1. Muscle contraction &
2. Viscoelastic properties of soft tissues

↓

Higher construction bite is used (4-6 mm)

↓

isometric and isotonic contractions (Eschler 1952).

Eschler defined techniques that open the vertical dimension beyond 4mm in the construction bite as the ‘muscle-stretching’ method. The force delivered is kinetic energy (isometric contractions) or potential energy (viscoelastic properties or a combination, depends on:

1. Nature of malocclusion
2. Interocclusal clearance and mouth opening
3. Head posture
4. State of mind and level of consciousness

SKELETAL & DENTOALVEOLAR EFFECTS OF ACTIVATOR

1) CONDYLAR RESPONSE:

Mandible is positioned anteriorly causes upward and backward growth of the condyle.

- Johnston (1976) attributes this response to “unloading the condyle”.

- According to Moss (1962), Petrovic, Woodside (1984), condylar growth is an expression of a locally base homeostasis for the establishment and maintenance of a functionally coordinated stomatognathic system.

According to Petrovic’s research, forward posturing of the condyle activates the superior head of the lateral pterygoid muscle. In young people this induces a cell proliferation in the condyle and a growth response.

2) HEADGEAR EFFECT:

The activator can, to a limited degree, control the upper growth vector, supplied by the spheno-occipital synchondrosis, which moves the maxillary base forward. If the mandible cannot be positioned anteriorly, maxillary growth can be inhibited and redirected.

(3) VERTICAL SKELETAL RELATIONSHIP:

If the activator is constructed with a vertical opening of the bite only, or with minimal sagittal change, both vertical maxillary growth and eruption of the teeth are restricted.

4) DENTOALVEOLAR EFFECTS:

The dentoalveolar effect of the activator is to control tooth eruption and alveolar bone apposition. For this reason the activator is most effective if used in the cases of mixed dentition.

1. Forward displacement of lower anterior teeth and alveolar bone. Bjork & Parkhouse (AJO 1951, 1969)
2. Bodily movement of lower incisors. Jacobsen (AJO 1967)
3. Labial tipping of lower incisors. Richardson (AJO 1982)
4. Lingual tipping of lower incisors. Moss (1962)

Several case reports show that maxillary anterior teeth can be retracted with activators. Although the primary action is lingual tipping, which is undesirable, it increases the overbite, restricting optimal forward positioning of the mandible.

Hagg & Rabie (AJO 2002) reported growth and treatment changes in 20 patients treated with a headgear–activator appliance. They found significant restraint of maxillary forward growth, restrained eruption of maxillary incisors and molars, forward growth of mandible and favourable dental change leading to improved overjet and molar relationship. These coincide with the finding of the earlier studies.

Cozza, Toffol, Colagrossi EJO (2004)

Activator effects on dental, skeletal and soft tissues in class II malocclusion

Results:

- Restriction of maxillary growth
- Advancement of the mandibular structures
- Correction of the overjet
- Improvement in the over bite
- Up righting of the maxillary incisors

Bionator

BIONATOR DESIGN

It is made of two components

1) An acrylic plate which fits on the lower arch

2) Wires which subserve
- cradling of the tongue to prevent thrusting
- relieves pressure of the perioral muscles (lateral extensions)
- screening effect provided by the labial bow

RATIONALE OF BIONATOR

Balters proposed that the Position of tongue is responsible for certain types of malocclusions.

E.g.

Class II malocclusion	→ Posterior displacement of tongue
Class III malocclusion	→ Low anterior displacement
Narrowing of arches / crowding	→ Diminished outward pressure during both postural rest and function, as opposed to forces from buccinator mechanics
Open bite	→Hyperactivity/forward posturing of the tongue.

Winders (1958), claimed that the tongue exerts 3 to 4 times as much force on the dentition as does the buccal and labial musculature.

This would support Balters Thesis if resting force and other factors like tissue rigidity, elastic index, atmospheric pressure and intercuspation are not considered

Balters designed his appliance to take advantage of tongue posture:

Forward positioning of mandible

(Incisors edge-to-edge)

↓

Enlarged oral space

↓

Dorsum of tongue in contact with soft palate

↓

Lip closure achieved

↓

Helps patients learn normal functional patterns.

Principles of Bionator

1. Not to activate the muscles but to ‘modulate’ muscle activity thereby enhancing normal development of the inherent growth pattern and eliminating abnormal and deforming environmental factors.
2. The Bite, should not be opened as the author believes it would encourage tongue thrusting.
3. Myotactic reflex activity with isotonic muscle contraction is stimulated, and the loose appliance works with kinetic energy.
4. The viscoelastic properties and stretch reflex response are not employed in the vertical dimension.

Araujo, Buschang, Melo , Ajo December 2004:(A Pilot Implant Study) reported that transverse skeletal base adaptation occurs as a result of bionator therapy.

-25 patients, 11 control, 14 treatment group
-Bionator was constructed approximately 2mm from the buccal dentition and observed for 12months.
- 4 bilateral maxillary and 2 bilateral mandibular implants were placed and observed cephalometrically.

Results:
Posterior maxillary implant width increased significantly compared to control.
The mandibular implants also showed greater increase in the treated group but it was not statistically significant.

Thus transverse skeletal base adaptation occurs as a result of bionator therapy.

Almeida,Henriques, Ursi Brazil, EJO 26(2004)

Evaluated the dentoalveolar and skeletal effects of the bionator on Class II div I malocclusion compared with untreated class II sample

Results:

- No changes in the forward growth of the maxilla compared to the control group
- Statistically significant increase in the mandibular protrusion and total mandibular and body length
- Labial tipping of the lower incisors and lingual inclination of upper incisisors and increase in mandibular posterior dentoalveolar height
- Dentoalveolar > skeletal changes

Pro and Cons

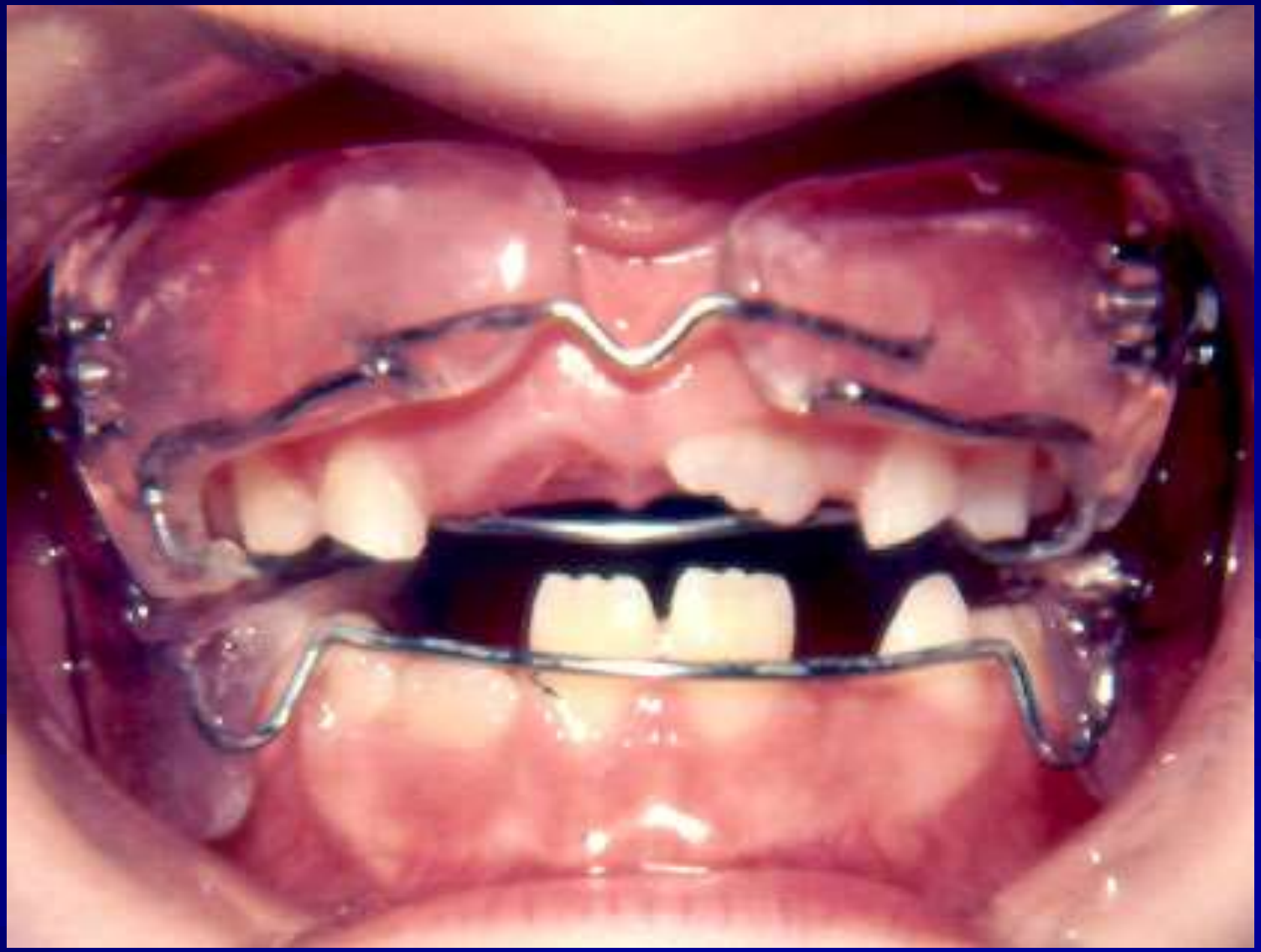
Pros:

1. It is small in size thus permiting full-time wear
2. Constant influence on tongue and perioral muscles because of screening effect of labial bow and lateral extensions, therefore restrictive effects prevented for a longer time, so the Bionators action is faster than that of the classic activator.
3. More rapid sagittal adjustment of the musculature to the forward mandibular posture because the mandible retracts only during eating.

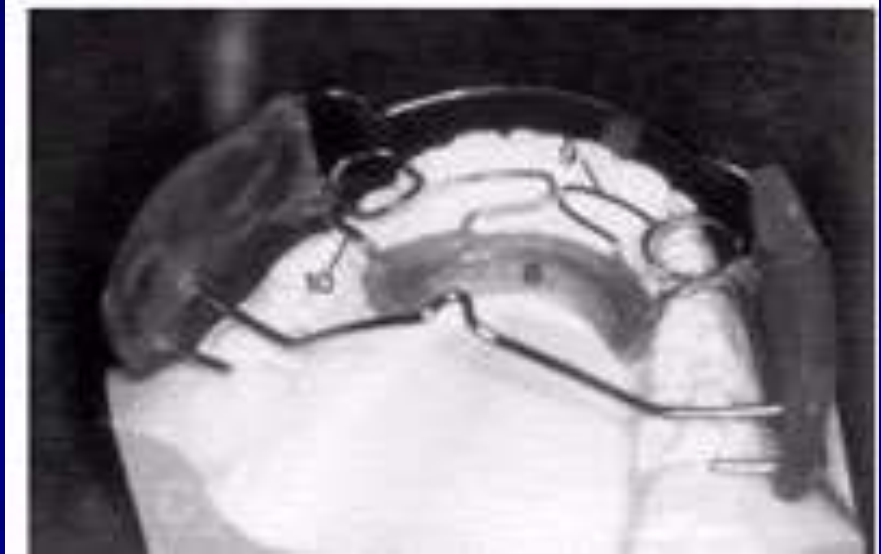
Cons:

1. Difficulty of correctly managing it since simultaneous requirements of stabilization and selective grinding for eruption guidance.
2. Vulnerability to distortion

FRANKEL FUNCTIONAL REGULATOR



FRANKEL FUNCTIONAL REGULATOR



FRANKEL PHILOSOPHY

Functional appliance which is passive in itself plays a mediating role between the orofacial muscles and skeletal-dentoalveolar structures of the maxillae and mandible.

Frankel believes that the active muscle and tissue was (buccinator mechanism and orbicularis oris complex) has a potential restraining effect on the outward development of the dental arches, that prevents full accomplishment of the optimal growth and developmental pattern.

Frankel conceives his vestibular constructions as an artificial “ought-to-be” matrix that allows the muscles to exercise and adapt.

The Frankel appliance is an exercise device, stimulating normal function, while eliminating the lip trap, hyperactive mentalis, and aberrant buccinator and orbicularis oris action.

APPLIANCE DESIGN AND MODE OF ACTION

Buccal shields

DEGLUTITION

Anterior lip seal + Posterior oral seal

↓

Negative atmospheric pressure within oral cavity

↓

Cheeks sucked into interocclusal space as mandible returns into postural rest position

↓

Constricting influence on the dentoalveolar process and prevention of eruption of buccal segments

Thus Shields prevent the pressure of the buccinator on the dentoalveolar area during deglution and at rest, inducing downward and outward movement of teeth and tissues.

APPLIANCE DESIGN AND MODE OF ACTION

Buccal shields also cause periosteal pull:

Shields and pads can be extended into the depth of the vestibule

↓

Tension without creating irritation

↓

Pull on the contiguous periosteal tissue of the maxillary bone

↓

increased bone activity in contiguous osseous structure

↓

Maxillary basal bone is widened

↓

Alveolar shell over the erupting teeth proliferates laterally.

A research project on primates at the American Dental Association Research Institute by Graber et al (1988) confirm these findings

- In a study conducted at Manipal & Davangere by A. Valiathan, P.P. Biswas and K.S. Shetty (JIOS 1993), 10 cases treated by the Frankel appliance were examine for changes in arch width post treatment. All teeth except maxillary canine exhibited buccal bodily movement due to periosteal pull provoked by the vestibular shields.

APPLIANCE DESIGN AND MODE OF ACTION

Lingual shields train protractor muscles:

Lingual shields that contact only the lingual & gingival mucosa

↓

pressure sensation as the mandible falls back

↓

activates proprioceptors in the gingiva, which are signaled to maintain the forward posture, to eliminate the painful input.

↓

Thus trains protractor muscles.

APPLIANCE DESIGN AND MODE OF ACTION

Lingual shields:

- Training of protractor muscles : induces an alteration of the postural position of the mandible. This is accomplished through a construction bite, which permits the protractor muscles to physiologically position the mandible forward. The appliance acts as an exercise device inducing changes in the postural performance of the protractors of the mandible.
- For minor sagittal problems → (2-4 mm) construction bite in an end-to-end incisal relationship.
- For larger sagittal movement → Step-by-step activation produces a better and more continuous tissue reaction and better patient acceptance.
- Frankel recommends that the construction bite not move the mandible farther forward than 2.5 – 3 mm.
- Vertical opening : should be only large enough to allow the crossover wires through the interocclusal space without contacting the teeth

APPLIANCE DESIGN AND MODE OF ACTION

Condylar growth stimulation:

Optimal prechondroblastic activity in the condyle due to anterior repositioning of mandible

But there are 2 views here !

- Thus at the right age, condylar growth can be successfully stimulated (Frankel AJO 1969, EJO 1969).
- Others state that the changes seen may be no more than might be expected with normal growth or conventional edgewise treatment.
  (Robertson; AJO 1983) ,Gianelly; Angle O. 1983) ,Gianelly; AJO 1984)

Condylar growth stimulation:

Hamilton & Sinclair (AJO 1987) in a cephalometric, tomographic and dental cast evaluation of 25 patients treated with Frankel therapy reported that treatment results were primarily dental, with little skeletal or condylar alteration.

The dentoalveolar changes are explained by Frankel (AJO 1989) who states that during sleeping hours, the suspending muscles relax. The mandible drops inferiorly and slides backwards. Thus the maxillary incisor could come into active contact with the maxillary labial bow, and the mandibular incisors were likely to contact the lingual shield or wires attached to it. Thus leading to undesirable maxillary incisor retraction and lower incisor proclination.

For this reason, he proposes that during a break-in period of approximately 2-3 months, the appliance should be worn during the daytime only.

Restraining effect on maxillary teeth and arch:

- The FR is anchored to the maxillary dental arch in a positive manner. This is achieved in the mixed dentition through wires between the contacts at the mesial of the permanent maxillary first molars and the distal of the deciduous maxillary canines.
- Maxillary molars are prevented from downward and forward movement by the appliance.
- Freeing the lower posterior teeth from acrylic or wire restraints while holding the bite open allows the unrestricted upward and forward movement of these teeth, contributing to both vertical and horizontal correction of the malocclusion.

- Graber (1993) has shown that in selected cases, the FR actually has a headgear effect, holding back the maxilla's downward and forward progression.
- The Headgear effect has been explained by Owen (AJO 1981) as follows :

1. As the patient sleeps, muscles attempt to return to their resting length.
2. The protractors (lateral pterygoid) allow the retractors (posterior temporalis) to retract the mandible to its normal resting position.
3. This retracting pressure is transmitted to the maxilla through the appliance and result is similar to headgear traction.

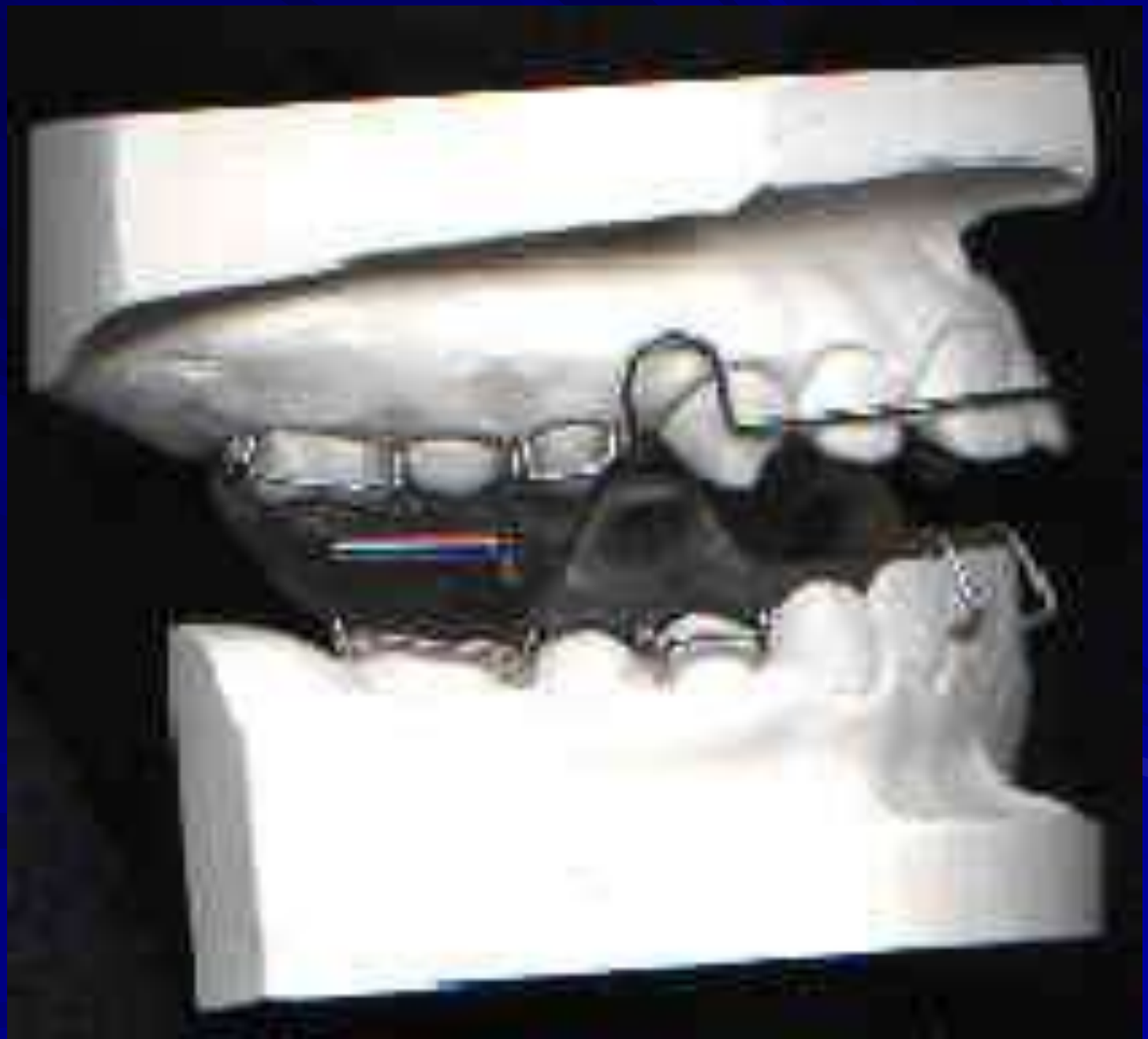
- Summary of Frankel Appliance Effects :

1. Arch expansion
2. Condylar growth
3. Guidance of eruption
4. Headgear effect

- Some important studies :

1. McNamara (AJO 1982, 1984, 1985) compared 57 FR treated patients with 3 untreated class II subjects.
2. F.R. Group Controls FR Group Mandibular growth Maxillary growth Lower anterior face height increase3.5 mm / year1 mm / year1.8 mm / year2.3 mm / year1.3 mm / year1.0 mm / year
3. Righellis (Angle 1983) → Frankel vs. Activator vs. High pull headgear in Class II div 1 cases. Frankel's appliance was found to have no restrictive effect on maxilla, but the mandibular length was significantly increased, more than activator patients.

Twin block



Twin blocks are designed on aesthetic principles to free the patient of the restriction imposed by a one-piece appliance made to fit the teeth in both jaws without overly restricting normal movements of the tongue, lips and mandible.

TWIN BLOCK PRINCIPLES

The occlusal incline plane is the fundamental functional mechanism of the natural dentition. It plays an important role in determining the relationship of the teeth as they erupt into occlusion.

A functional equilibrium is established under neurological control in response to repetitive tactile stimuli.

Occlusal forces

↓

Constant proprioceptive stimulus

↓ BONE ↓

Rate of growth Trabecular structure

TWIN BLOCK PRINCIPLES

Twin Blocks are constructed to a protrusive bite that effectively modifies the occlusal inclined plane by means of acrylic inclined planes on occlusal bite blocks.

The patient cannot occlude comfortably in the former distal position, and the mandible is encouraged to adopt a protrusive bite with the inclined planes engaged in occlusion.

The upper and lower bite – blocks interlock at a 70 degree angle. Full time wear takes advantage of all functional forces applied to the dentition including the forces of mastication.

Muscle behaviour is immediately influenced through the placement of inclined planes. The muscles of mastication must adapt to the altered balance of occlusal forces by guiding the mandible into protrusive function. This guidance results in rapid soft tissue adaptation to achieve a new position in equilibrium in muscle behaviour. Rapid improvement in facial appearance occurs during the first few weeks and months of treatment.

TWIN BLOCK PRINCIPLES

- The Twin Block Technique has 2 stages :

1. Active phase : Posterior inclined planes adjust the vertical dimension and correct the malocclusion by functional mandibular protrusion.
2. Support phase : An anterior inclined plane is used to retain the corrected incisor relationship until the buccal segment occlusion is fully established.

- Occlusal cover is maintained over the posterior teeth to prevent eruption in treatment of anterior open bite.

- Orthopedic traction : Where necessary retractive forces may be applied by the addition of headgear tubes to upper first molars.

TWIN BLOCK PRINCIPLES

Effects on the condyle:

Rapid adaptive changes in the tissues surrounding the condyle when a full-time functional appliance is fitted.

→ Intense cellular activity

→ Proliferating connective tissue and capillary blood vessels

Harvold (1983)

TWIN BLOCK PRINCIPLES

Effects on the muscles:

- Aggarwal et al AJO 1999 Electromyographic study on the adaptive changes during treatment.
- Bilateral electromyographic activity of the elevator muscles of the mandible i.e. anterior temporalis and masseter) was monitored over 6 months.
- Results revealed a significant increase in postural and maximum clenching EMG activity, attributed to enhanced stretch (myotactic) reflex of the elevator muscles, contributing to isometric contractions.
- The main corrective force for Twin Block treatment appears to be provided through increased active tension in the stretched muscles and not through passive tension.

TWIN BLOCK PRINCIPLES

- The position of the mandible did not change significantly after fatiguing the protrusive muscles. It appeared that lateral pterygoid muscle was not responsible for new position of mandible after treatment with Twin Block. It is possible that TMJ adapted to displacement of mandible by condylar growth and surface modeling of the fossa.

- Lund & Sandler (AJO 1998) compared 36 subjects (mean age 12.4 years) with 27 controls. The subjects showed favourable changes including :

1. forward positioning of mandible
2. increase in mandibular length (Ar-Pog – 2.4 mm more than controls)
3. increase in SNB angle
4. increase in lower anterior facial height
5. overjet reduction by 7.5 mm
6. buccal segment correction

- Similar favourable changes reported by
  Caldwell & Cook (EJO 1999), Mills & McCulloch (AJO 2000)
  Toth (AJO 1999) Baccetti, Franchi & McNamara (2000 AJO)

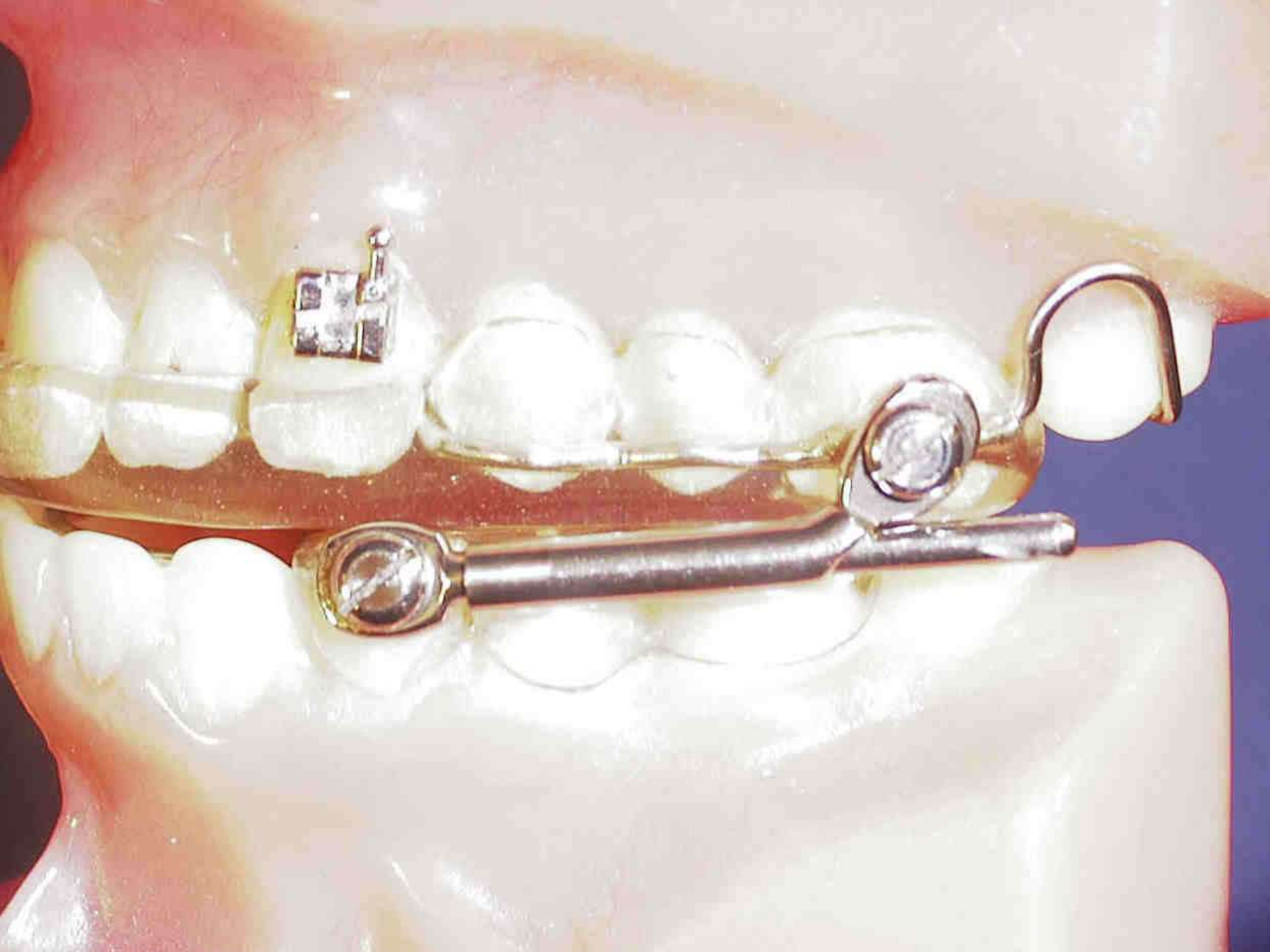
- Kevin O'Brien et al (AJO 2003) conducted a Multicenter trial in U.K. evaluating the effectiveness of early orthodontic treatment with the Twin-Block for Class II Div. 1 malocclusion.
- They concluded that early treatment with the Twin-Block is effective in reducing overjet and severity of malocclusion. Most of this correction was due to dento-alveolar change.
- D.N. Kapoor & V.P. Sharma (JIOS 2002) investigated and compared the efficacy of Twin Block and Bionator appliances in 30 patients. Both showed statistically significant skeletal Pogonion and patient B advancement, increased SNB, reduced ANB and increased mandibular base length as well as favourable dental changes. Twin Block showed better overall changes (ANB, interincisal angle and maxillary molar position).

Banks, Wright, O'Brien AJO (2004)

Effectiveness of incremental vs. maximal bite advancement in treatment of class II div I malocclusion

Incremental bite advancement produced no advantages over maximum advancement although the patient compliance was different due to operator and patient age.

HERBST



- Emil Herbst 1909
- International Dental Congress in Berlin

- “A bilateral telescopic mechanism attached to orthodontic bonds that keeps the mandible in anterior jumped position”.
- Each telescopic device consists of a tube, a plunger, two pivots and two locking screws that prevent the telescoping parts from slipping past the pivots. The length of the tube determines the amount of bite jumping.

- Effects on the dentofacial complex :

1. Powerful and effective modality in class II treatment.
2. Normalization of occlusion generally accomplished with 6-8 months of treatment.
3. Improvement in the sagittal and vertical occlusal relationships is a result of both skeletal and dental changes. (Pancherz, AJO 1982).

- Sagittal changes :

1. Restrains maxillary growth and stimulates mandibular growth (Hagg, Pancherz 1988) EJO.
2. Sagittal condylar growth increases whereas vertical condylar growth is relatively unaffected.
3. Articular fossa is repositioned anteriorly in the skull (Wieslande 1990, Pancherz EJO 1981).

- Ruf & Pancherz (AJO 1999) → TMJ remodeling was analyzed by magnetic resonance imaging in 25 adolescent and 14 young adults treated with the Herbst appliance and compared with untreated subjects with ideal occlusion.

1. Condylar remodeling at the posterosuperior border
2. Glenoid fossa remodeling at the anterior surface of the postglenoid spine was seen.

- The following changes contribute to Herbst appliance correction of class II malocclusion :

1. Stimulation of mandibular growth
2. Inhibition of maxillary growth
3. Distal movement of upper dentition
4. Mesial movement of lower dentition

Vertical changes :

1. Overbite reduction is primarily accomplished by intrusion of the lower incisors and enhanced eruption of the lower molars.

2. Hagg & Rabie (AJO 2002) investigated the effects of headgear – Herbst appliance with mandibular step by step advancement. The skeletal effects over 12 months of treatment were restrained maxillary growth, enhanced mandibular growth and reduced increase in lower facial height.

- Effects on muscle activity :

- Class II malocclusions produce deviations from the norm in electromyographic patterns of the temporal and masseter muscles compared with normal occlusion (Pancherz 1980).

- Treatment with the Herbst appliance normalizes the electromyographic pattern for these two muscles.

- This was also demonstrated in a study by Valiathan et al (JIOS 1993) where the posterior Masseter, posterior temporalis and anterior belly of digastric showed significant changes in activity which were close to those of the normal group..

Bone changes in condyle and glenoid fossa during Herbst treatment were correlated with decreased postural electromyographic activity. Lateral pterygoid muscle hyperactivity was not associated with condyle – fossa growth modification. (AJO 2003)

Reciprocal stretch forces might play a more significant role in new bone formation.

- O’Brien et al (AJO 2003) evaluated the effectiveness of treatment for class II Div 1 malocclusion with Herbst and Twin Block appliances in 215 patients. They found no differences in the treatment time or in skeletal and dental changes between the appliances.

- Higher cooperation rates with Herbst appliance.

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