

**GOOD
MORNING**

- Since inception of orthodontics myofunctional appliances has been widely used by orthodontists.



- Unlike fixed appliances they use natural forces of orofacial region for their action.



- They acts either by guiding, transmitting, or eliminating forces for correction of excess or recessive bone growth.



- They can be used to bring about growth modification in various skeletal as well as dental malocclusions.

DEFINITION

- **Frankel 1974**
- A removable or fixed appliance which favourably changes soft tissue environment

- **Mills 1991**
- A removable or fixed appliance which changes the position of mandible so as to transmit forces generated by the stretching of the muscles, fascia, and or periosteum through acrylic and wirework to the dentition and underlying skeletal structures

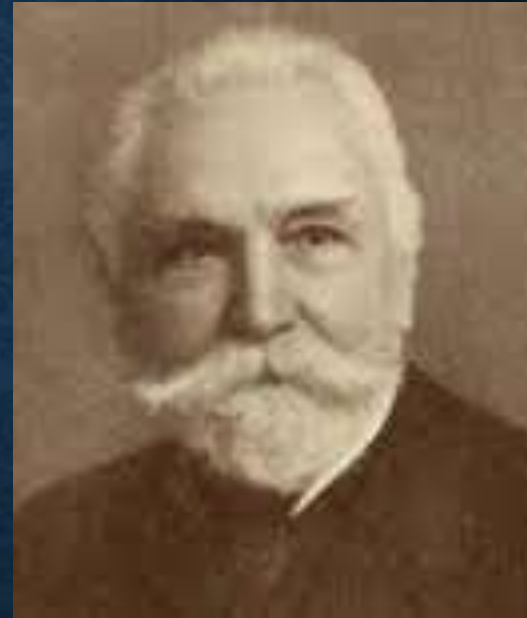
- Loose fitting or passive appliance which harness natural forces of orofacial musculature that are transmitted to tooth and alveolar bone through the medium of appliance

HISTORY

- The history of the functional appliance can be traced back to 1879, when Norman Kingsley introduced the “bite-jumping” appliance.
- In the early 1900s, parallel development began in the United States and Europe in fixed and functional techniques
- For many years, the exclusive practice of dentofacial orthopedics was in Europe, while North America was firmly following Angle’s fixed appliance philosophy, yet it was Norman W. Kingsley who first (1879) used forward positioning of the mandible in orthodontic treatment.

HISTORY

- **1879 Norman kingsley**
- Introduced Forwardly positioning of mandible by using bite jumping appliance
- Kingsley's removable plate with molar clasps might be considered the prototype of functional appliances, having a continuous labial wire and a bite plane extending posteriorly.
- he described it, "The object was not to protrude the lower teeth, but to change or jump the bite in the case of an excessively retreating lower jaw.
- The Oliver guide plane was another functional appliance at that time



1883 Wilhelm Roux

- Study of influences of natural forces and functional stimulation of form-foundation on form foundation of both general orthopaedic and functional dental orthopedic principles
- Wilhelm Roux is credited as the first to study the influences of natural forces and functional stimulation on form (1883)
- His work
- became the foundation of both general orthopedic and
- functional dental orthopedic principles



- **Ottolengui** –
- removable plate



- **1902-Pierre Robin** –
- The first practitioner to use functional jaw orthopedics to treat a malocclusion was Pierre Robin (1902)
- He used functional jaw orthopedic to treat malocclusion Monoblock appliance
- Robin's monoloc was actually an adaptation of Ottolengui's removable plate.
- a modification of Kingsley's maxillary plate. It extended all along the lingual surfaces of the mandibular teeth, but it had sharp lingual imprints of the crown surfaces of both maxillary and mandibular teeth. It incorporated an expansion screw in the palate to expand the dental arches

1906-Alfred rogers –Father of myofunctional therapy

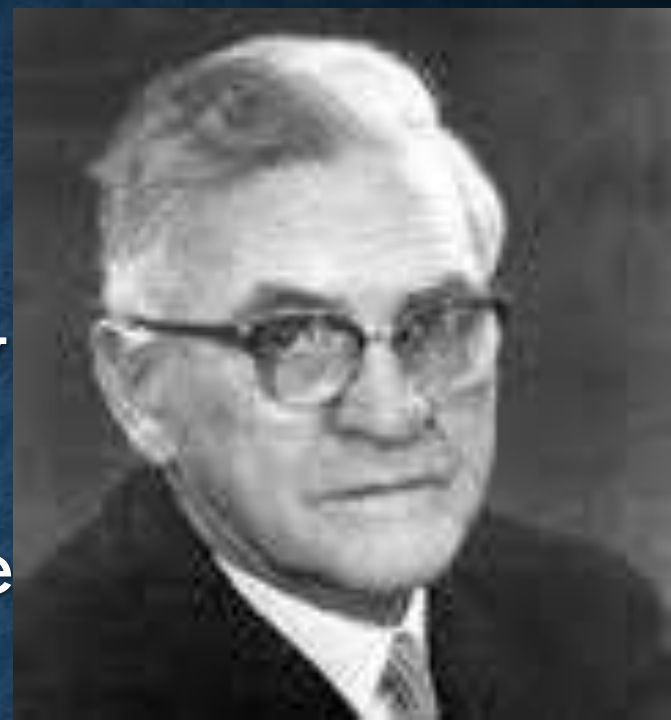
- He was first to gave role of facial and oral muscles in growth and development of oral cavity

1909 Viggo Andersen

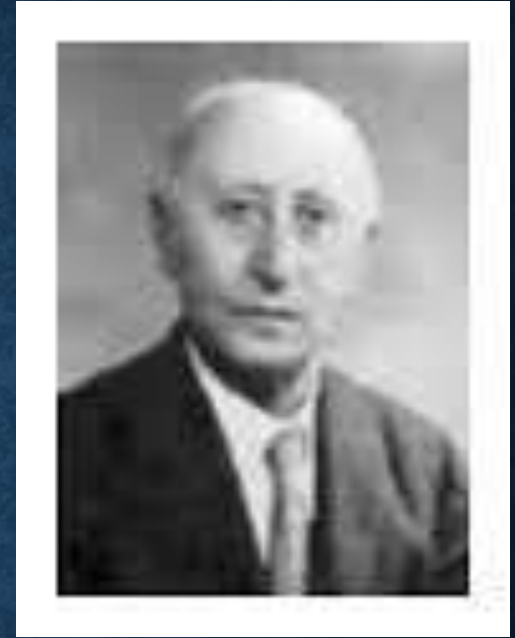
- In 1909, Viggo Andresen removed his daughter's fixed appliances before she left for her summer vacation, and placed a Hawley-type maxillary retainer with mandibular guiding plane to keep mandible 3-4 mm
- On his daughter's return, he was surprised to see that nighttime wearing of the appliances had eliminated her Class II malocclusion, and it was stable.
- Applying this technique to other patients resulted in significant sagittal corrections

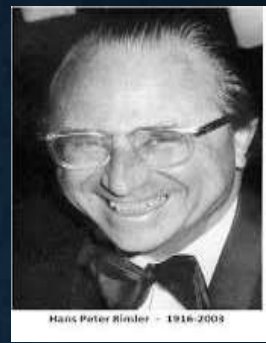


- **1938-Karl Haupl** – explained application of roux hypothesis and explained how functional appliances work through activity of orofacial muscles
- **Andresen-Haupl** modified pierre robbins initial appliance into **ACTIVATOR**
- Called it Norwegian appliance
- **1936** – both collaborated on textbook called functional orthopedics.



- **1909 –Emile Herbst**
- Gave herbst fixed functional appliance
- **Pancherz** further used appliance along with fixed orthodontic therapy in 1970s
- The typical Herbst
- consists of a telescoping mechanism connected to the
- maxillary first molars at 1 end and a cantilevered arm
- attached to the mandibular first molars at the other end;
- it forces the mandible forward.





- **1949-Hans Peter Bimler-elastic bite former**
- As a surgeon treating jaw injuries during World War II, Bimler had made a maxillary splint for a patient who had lost gonial angle. The splint was reminder of mandible.
- After several modifications, **the Bimler appliance** achieved its final form in 1949
- its reduced size made it possible to wear all day, its elasticity allowed muscular movements to translate more effectively to the dentition, and, because the upper and lower parts were connected by a wire, gradual forward positioning of the mandible became possible.

- 1944 –Dr.Harold Kesling – tooth positioner appliance
- 1948 -Adolph Mueller –Nuk saugar

- 1950 – Balterz gave Bionator



- 1956 – Martin Schwarz – Double plate



- 1957-Rolf Frankel – functional regulator



- 1977 – Clark – Twin Block



- 1989 – Magnetic Appliance - Belchmann



CLASSIFICATION

Basic

1. Removable



2. Fixed



3. Both



GRABER'S CLASSIFICATION

1. Teeth supported



2. Tooth-Tissue supported



3. Vestibular positioned appliances



PROFFIT'S CLASSIFICATION

1. **Tooth borne passive-myotonic** (it rely on the elastic properties of the muscle and fascia for their action, displace the mandible extremely)



2. **Tooth borne active-myodynamic** (are intended to stimulate muscle activity) Eg: activator



3. **Tissue borne passive-**



4. **Tissue borne active-**

FOMA –FUNCTIONAL ORTHOPAEDIC MAGNETIC APPLIANCES

1. **Group 1** - inclined planes
2. **Group 2** - activator, bionator
3. **Group 3** - frankels regulator, oral screen

BASIS FOR FUNCTIONAL APPLIANCE THERAPY

- On the basis of following theories of condylar growth functional appliance therapy can be explained

1. Functional matrix theory

2. Servosystem theory

3. Growth relativity theory

FUNCTIONAL MATRIX THEORY

- Given by – **Melvin moss**
- He gave concepts of **functional matrices and epigenetics**
- Origin, growth and maintenance of orofacial structures is influenced by functional matrices
- Functional matrices like muscles, tissues – control of growth of jaw bones





**New pattern of
orofacial
functions**



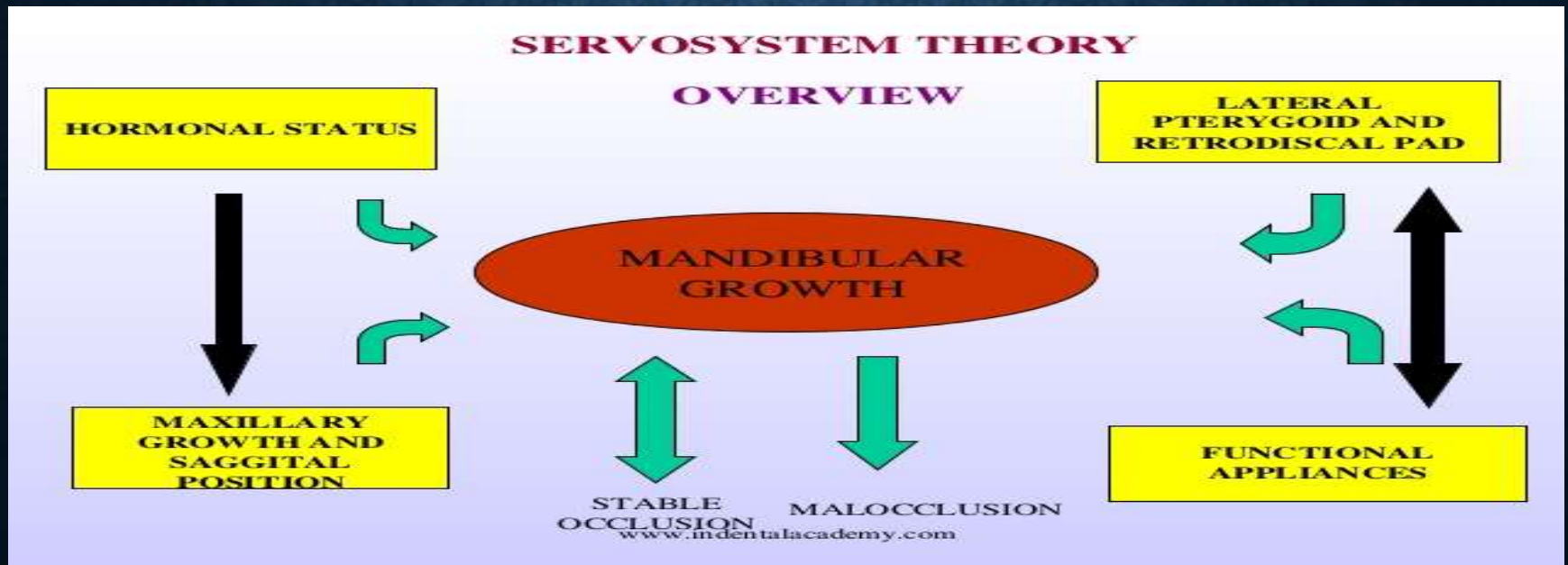
**Dictated by
Myofunctional
appliance**



**New
morphological
pattern of jaws**

SERVOSYSTEM THEORY

- Given by –Alexander Petrovic in 1982
- Can be explained in cybernetic language
- Condylar cartilage is secondary cartilage
- Growth of cartilage is influenced by **somatomedin hormone complex** by directly effecting cell multiplication not by cybernetic command
- Indirect effects corresponds to regional and local factors



- These regional and local factors involves primarily neuromuscular mechanism relative to postural adjustment.
- In which local feedback mechanism is involved
- All functional appliances follows causal feedback mechanism which relates to growth of skeletal structure

SERVOSYSTEM THEORY

OVERVIEW



APPLICATION OF THEORY TO FUNCTIONAL APPLIANCES

Forward positioning of mandible

Increased activity of lateral pterygoid pad retrodiscal(bilaminar zone)

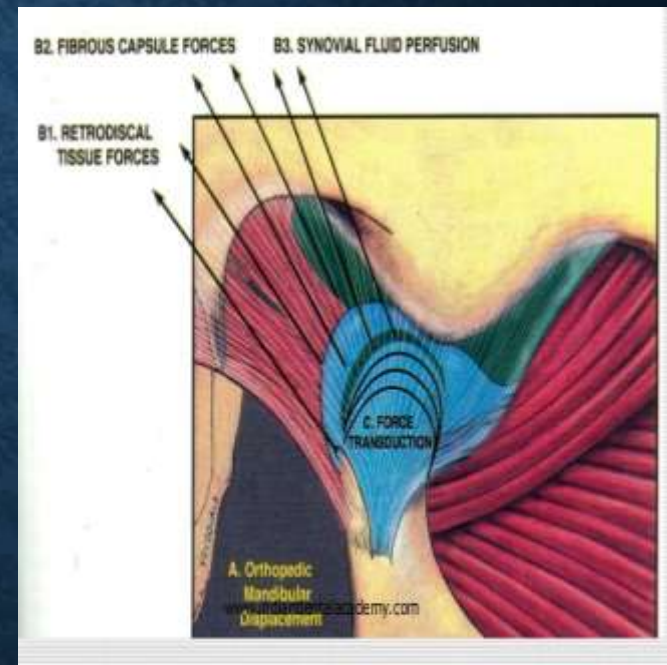
Increase in growth stimulating factors

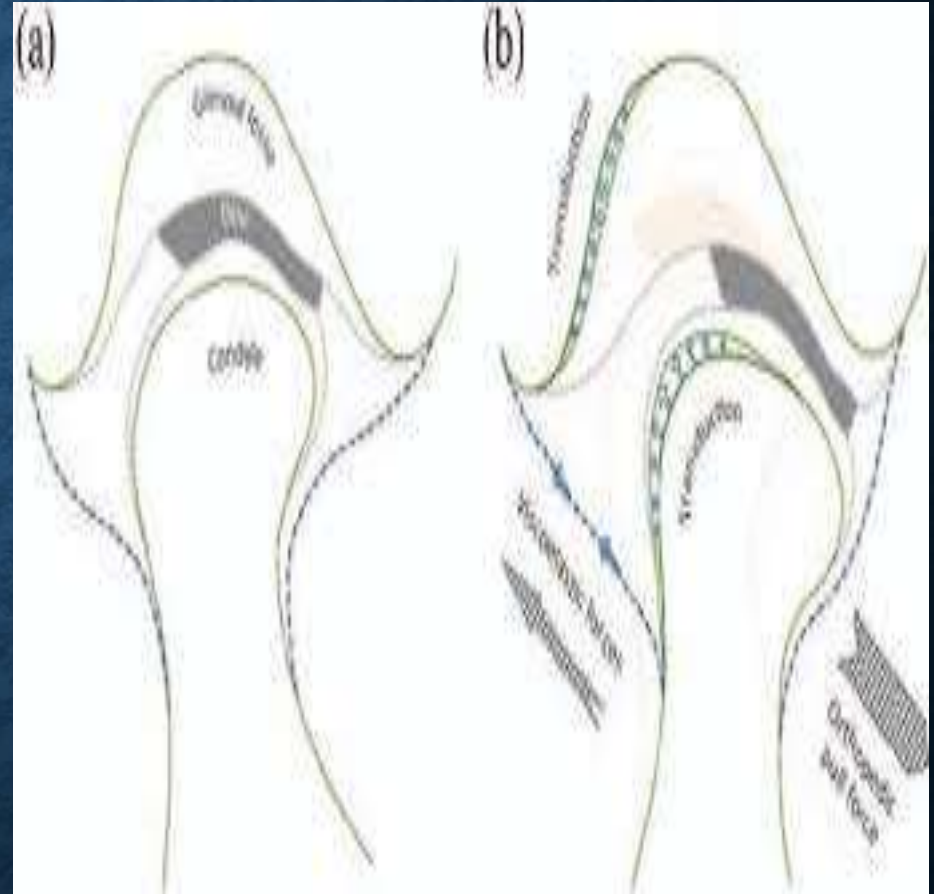
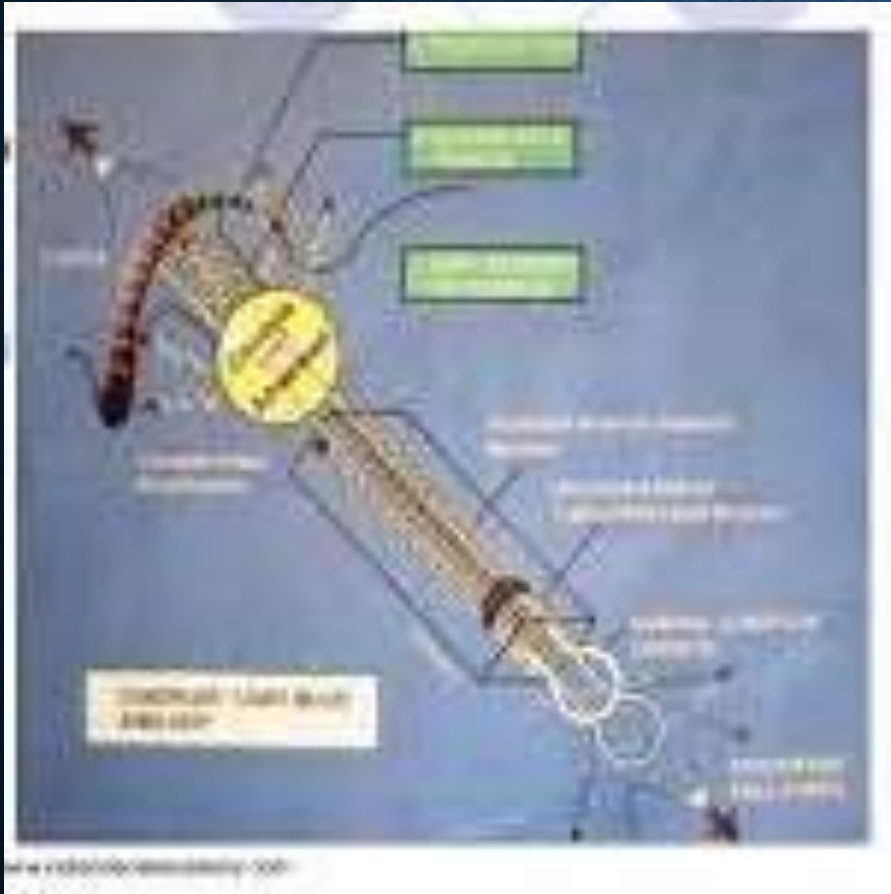
**Changes in orientation of condylar trabeculae
Growth of condylar cartilage
Subperiosteal bone deposition**

Leading to growth of mandible

GROWTH RELATIVITY THEORY

- Given by Voudoris-(bulb theory)
- Advancement of mandible and stretching of retrodiscal pad not only induces bone formation of condylar and fossa
- But also refers forces along viscoelastic tissue of TMJ to induce bone formation at site distant from retrodiscal tissue, such as the articular eminence





TREATMENT PRINCIPLES

- Functional appliances work on two broad principles

1. Force transmission

2. Force elimination

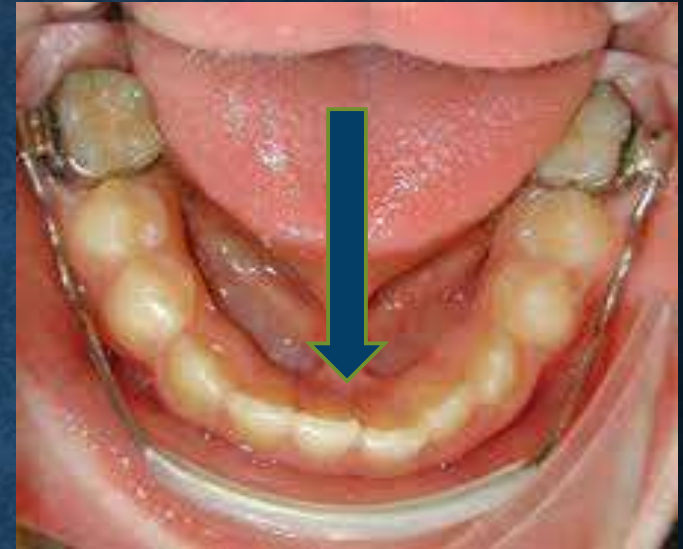


FORCE TRANSMISSION

- Compressive stress or strain is transmitted directly on the structures involved
- as a result there is a primary alteration in function of the tissue
- with secondary adaptation in morphological form of the tissue structures
- Petrovic (1982) has shown adaptive response to muscle to hyperpropulsion of mandible in rats by means of foreshortening of the lateral pterygoid muscle.



- **Directly acting appliances-**
- They transmit the forces directly on skeletal and dental structures
- Ex-lip bumper



- **Indirectly acting appliances –**
- Transmits forces through muscles while alteration of position of mandible
- Ex-Activator , twin block.



FORCE ELIMINATION

- Elimination of abnormal muscular or environmental factors which try to modify the normal function
- Elimination of abnormal forces leads to normal development of orofacial structures
- Ex-
- Frankel regulator, oral screen



NEUROMUSCULAR RESPONSE

- Success of appliance depends on neuromuscular response
- So it is contraindicated in neuromuscular diseases like cerebral palsy and polio
- Functional appliance apply mechanical forces and induces reactive muscle compensation
- They take advantage of growth and developmental processes like growth spurts or puberty which are occurring during treatment
- **Tissue kindness** - Graber quotes that this appliances shows additional tissue conservation property which have greater stability during post treatment period.

- Retention requirements are minimal
- Relapse is not as severe as fixed treatment
- And heavy forces can be used to achieve ideal occlusion

- But there are problems of outgrowth of mandible or maxilla due to functional appliances during pubertal growth
- If pattern of mandibular rotation is upward and forward ,then posttreatment stability of lower incisor region is not do good, which makes use of fixed appliance therapy necessary to get optimum results

MODE OF ACTION

- Functional appliances acts by producing following changes

1. Orthopedic changes

2. Dentoalveolar changes

3. Muscular changes

ORTHOPEDIC CHANGES

1. Acceleration of growth in the condylar region
2. Remodeling of glenoid fossa
3. Can be designed to give restrictive influence on the growth
4. Can change direction of growth of jaws

DENTOALVEOLAR CHANGES

1. Can bring about changes in sagittal ,transverse ,and vertical directions
2. inhibition of downward and forward and eruption of the maxillary teeth
3. Retraction of maxillary anteriors
4. Lower labial segment intrusion
5. Leveling of curve of spee

MUSCULAR CHANGES

1. Improvement of the tonicity of the orofacial musculature
2. Removal of the lip trap and improved lip competence
3. Removal of adaptive tongue activity
4. Removal of soft tissue pressure from the cheeks and lips

INDICATIONS FOR FUNCTIONAL APPLIANCES

1. Growing patient
2. Well aligned dentition
3. Proclination of maxillary anterior
4. Upright mandibular anteriors
5. Normal saddle angle
6. Horizontal growth pattern
7. Class 2 skeletal bases due to retrognathic mandible
8. Tendancy towards deep bite – decreased lower anterior facial height
9. Convergent jaw bases

CONTRAINDICATIONS FOR FUNCTIONAL APPLAINCES

1. Non growing patient
2. Crowding in dentition
3. Proclined mandibular anterior teeth
4. Class 2 skeletal pattern with prognathic maxilla
5. Vertical growth pattern
6. Tendency towards open bite
7. Increased lower anterior facial height
8. Divergent jaw bases

ADVANTAGES

- Elimination of abnormal muscle functions
- Can be initiated at early age
- Frequency of patient visit is less
- Do not interfere with oral hygiene maintenance
- Patient acceptance to removable appliance is good

DISADVANTAGES

- Cannot be used in adult patient
- No individual tooth movement
- Patient co-operation is essential
- Fixed appliance therapy can be required at the termination of the treatment for final detailing of occlusion

DIAGNOSIS AND TREATMENT PLAN IN FUNCTIONAL THERAPY

- Diagnosis and treatment plan in functional therapy depends on
 1. Case history and clinical examination
 2. Cephalometric analysis
 3. Functional analysis

CASE HISTORY AND CLINICAL EXAMINATION

- During diagnosis it is important not to focus too closely on one aspect of patients overall condition
- Problem oriented approach is important in diagnosis as well as treatment planning
- A good myofunctional therapy is dependent on adequate database which includes
 1. Case history
 2. Clinical examination
 3. Evaluation of diagnostic records
- With all this information one can formulate good treatment plan

CASE HISTORY

- Name –for identification,
for documentation
and rapport with patient
- Major concern about
- Assessment of Physical growth status by examination of
chronological as well as dental age –
 - a) it is important for start of either functional or other treatments
 - b) suitable growth modification procedures
 - c) developmental consideration

DENTAL AGE

- Chronological and dental age are synchronous
- Early or late developer – 2 year difference than average value
- Greater chronological age than dental age gives greater response to myofunctional treatment
- Methods to determine dental age-
 1. Demerjian in 1973 and Schopf in 1970 gave evaluation system for eruption of teeth

BIOLOGICAL AGE

- Biological age is determined by skeletal, dental ,morphological age , and onset of puberty
- Evaluation of hand wrist radiograph for skeletal maturity indicators of development and maturity which occurs at definite time periods
- This skeletal maturity indicators divides maturation process between 9 to 17 years into developmental stages.
- Early developmental stages are best time for myofunctional treatment

- Evaluation of hand wrist radiographs indicated in
 1. When skeletal changes are indicated in class 2, class 3 and open or deep bite cases
 2. Marked discrepancy in dental and chronological age
 3. Maxillary expansion cases
 4. To determine between functional or surgical treatment

GROWTH RHYTHM

- Pubertal growth spurts are dependent on gender
- And they are not dependant on chronological age

- Girls-10-12 years
- Boys-12-14 years

SEX

- a) Timing of growth spurts are different
 - b) Acceptance and compliance is different
-
- Motivational and behavioral factors.
 - Socioeconomical factors

- Chief complaint –
 - Should be recorded in patients own words
 - Helpful for identification of Patients/parents concern and priorities about problem associated with patient
1. Impaired facial esthetics
 2. Impaired function
 3. Desire to increase quality of life and social acceptance

- Family history –
 - Genetic disorders
 - skeletal malocclusion inherited in family members
- Prenatal history –
 - Trauma ,nutritional disorders, diseases to mother during pregnancy
 - Ex-viral infection and cleft palate
- Postnatal history –
 - Feeding
 - Nutritional disturbances
 - History of habits causing malocclusion

- Medical history
- Conditions affecting growth and development
- Bone disorders
- Hormonal disorders
- Diseases affecting breathing
- Conditions affecting growth modulation
- allergies

- Dental history –
- Caries and treatments
- Dental conditions affecting affecting growth modulation
- Surgeries

CLINICAL EXAMINATION

- Clinical examination is important to draw a provisional diagnosis of patients malocclusion
- Gives initial idea about tentative treatment plan

- Cephalic index

- Facial index

- Nose –
- Assessment of nose for size ,shape and position for esthetic determination of face
- Size and shape
- Contour
- nostrils

- Examination of lips

- Chin

- Tongue -

- Labial and buccal Frena

- gingiva

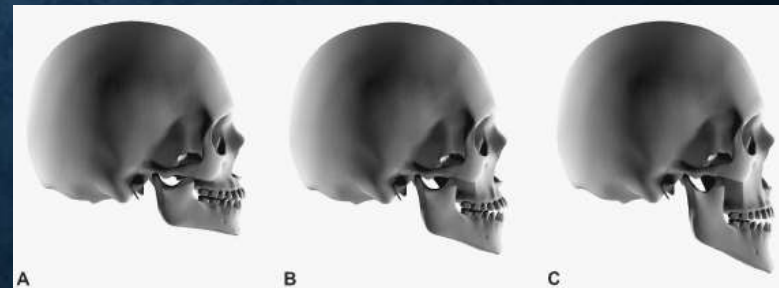
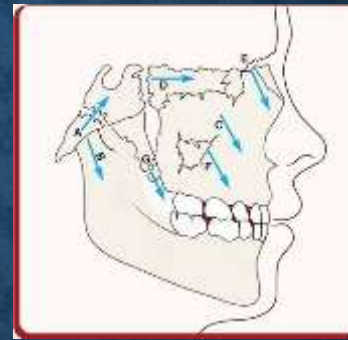
- Palate

- Dentition -

CEPHALOMETRY FOR FUNCTIONAL APPLIANCE

- Most functional treatments starts at **age of 8-10 years**
- So assessment criteria are adapted according to age while simulating it with patients future adult dentition
- According to **Graber and Rakosi** there are 4 major parts of cephalometric diagnosis for functional therapy
 1. **Assessment of growth patterns and the direction of vector of growth**
 2. **Assessment of magnitude of growth change**
 3. **Inclination and position of upper and lower incisors**
 4. **Assessment of etiology of malocclusion and treatment plan**

ASSESSMENT OF GROWTH PATTERNS AND GROWTH VECTORS



MAGNITUDE OF GROWTH CHANGE

INCLINATION AND POSITION OF INCISORS

ASSESSMENT OF ETIOLOGY

CEPHALOMETRIC ANALYSIS

- It is mainly divided into three groups
 1. Facial skeleton
 2. Jaw bases
 3. Dentoalveolar relationship

ANALYSIS OF FACIAL SKELETON

- Major three angular measurements are very important
 1. Saddle angle
 2. Articular angle
 3. Gonial angle
- Linear measurements are important during treatment

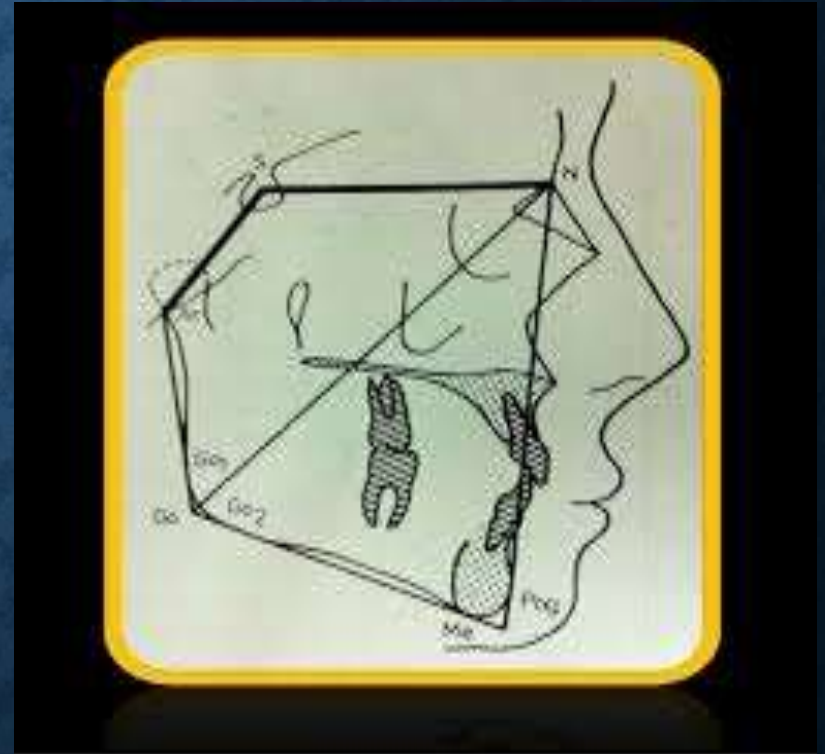
SADDLE ANGLE

- It is a valuable parameter in assessment of anterior-posterior jaw relationship
- Midpoint of the angle sella turcica is determined partly by growth changes
- Large angle-posterior condyle position to cranial base
- Large angle mostly get compensated by articular angle and linear ramal length relationships



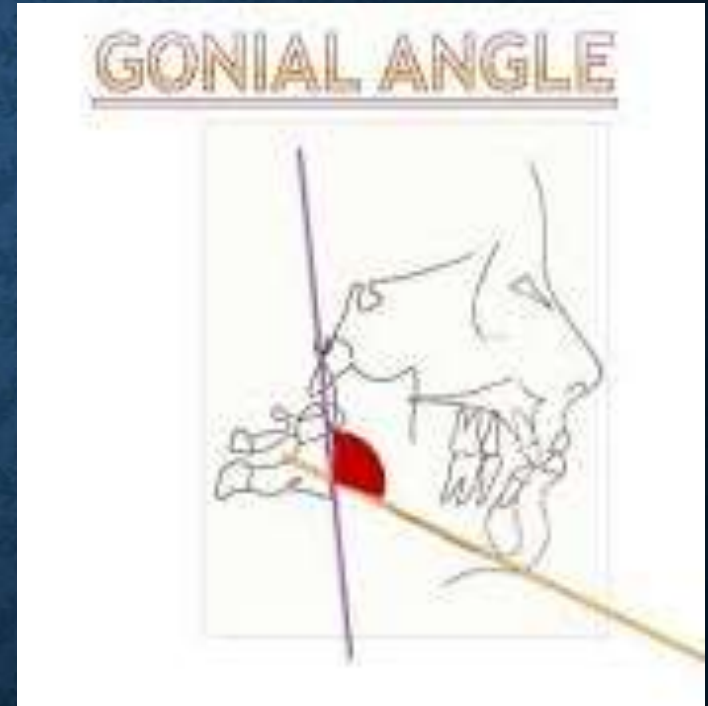
ARTICULAR ANGLE

- It is useful in assessment of posterior contours of facial skeleton
- It depends on position of mandible
- Large angle-retrognathic mandible
- It can be influenced by functional therapy, as it decreases with forward positioning of mandible
- Which leads to mesial migration of posterior segment



GONIAL ANGLE

- Gives information about form of mandible and mandibular growth direction
- Small angle- horizontal growth
- Favorable for functional therapy
- Large angle-vertical growth
- Unfavourable for functional therapy
- In this case functional therapy is used only as first measures to correct skeletal malocclusion later treating with orthopedic appliances and surgery

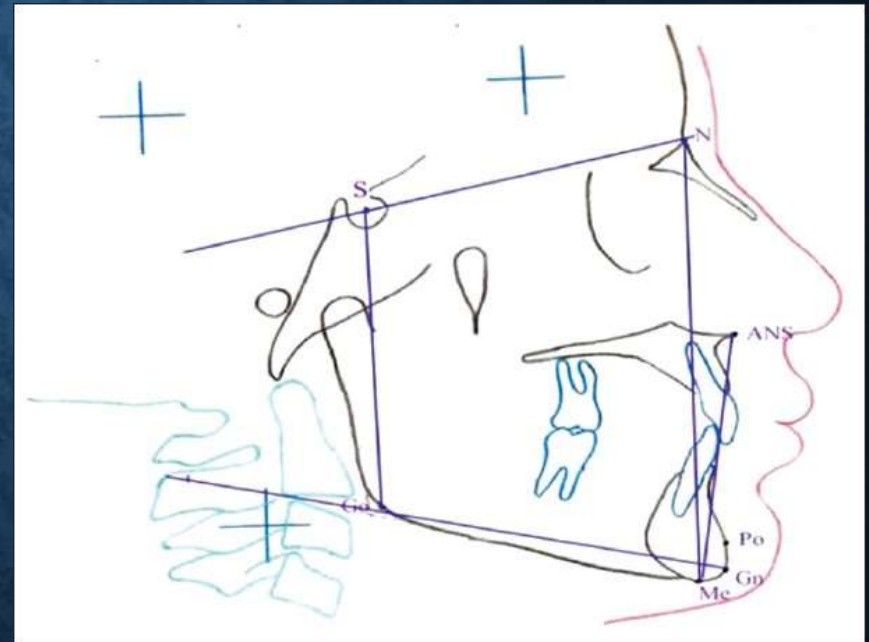


ANTERIOR POSTERIOR FACIAL HEIGHT

- Linear assessment is as important as angular measurement

It effect on

1. type of functional therapy
2. Appliance construction details
3. Type of construction bite
4. Periodic growth assessment

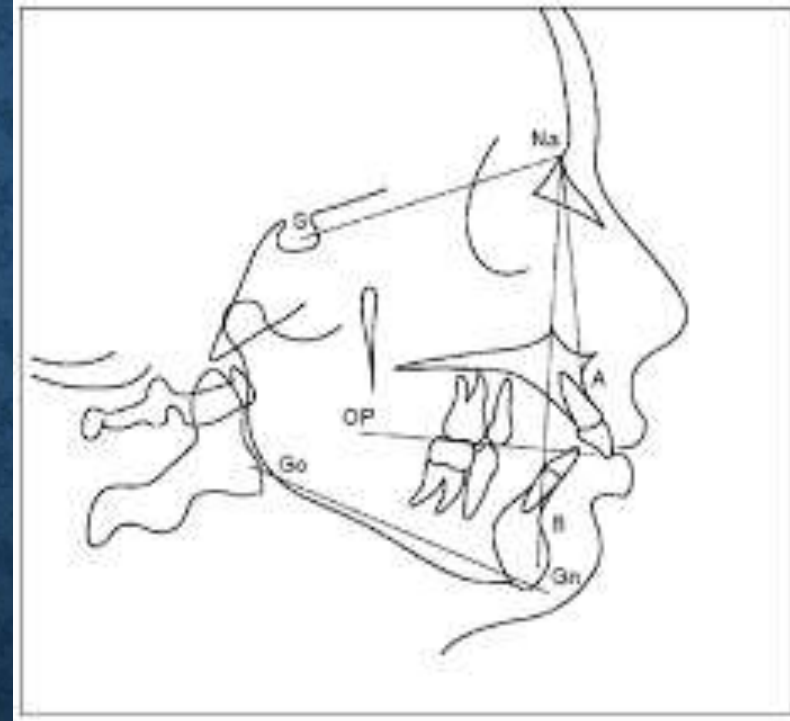


ANALYSIS OF JAW BASES

- Angles SNA,SNB –sagittal assessment
- basal plane angle, inclination angle-vertical assessment

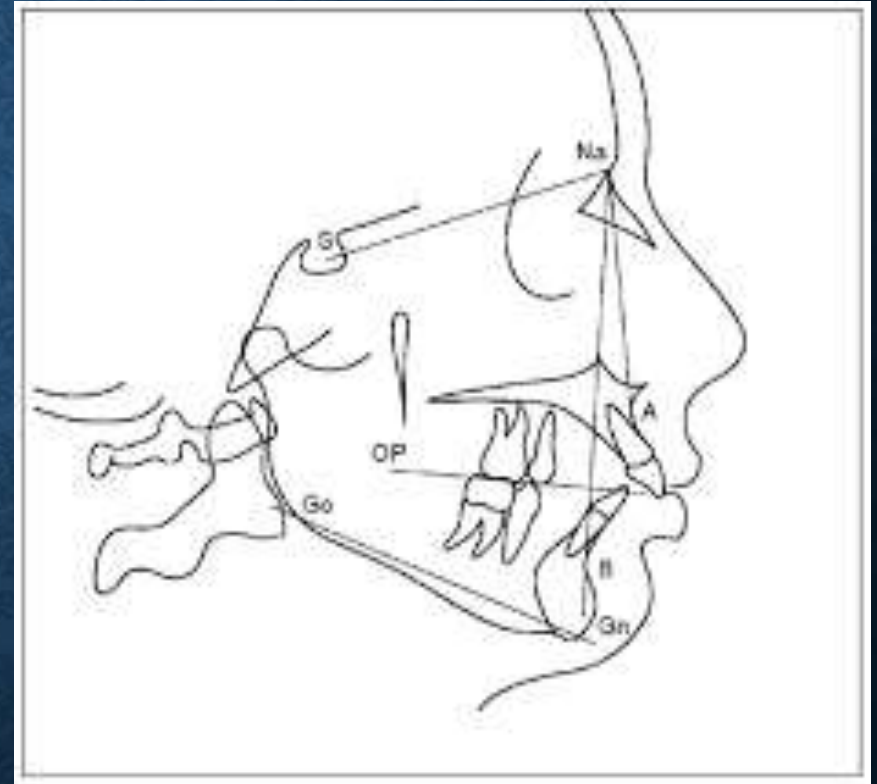
SNA

- Expresses anterior limit of the maxillary base
- MCNAMARA (1981) does not vary much in all malocclusion and there are not any major changes much with functional appliances .
- Moderate decrease of the angle- conventional activator
- Larger decrease – special activator construction with twin block appliance



SNB

- Expresses anterior limit of mandibular base
- Small SNB –retrognathic mandible.
- Functional therapy is indicated
- Up to 5 degrees growth can be expected in horizontal growth pattern
- Up to 2 degrees growth is seen in vertical growth patterns



ROTATION OF JAW BASES

- Rotation of mandible is a conditional growth depending upon direction and mutual relations of growth increments in the posterior condylar and anterior facial skeleton
- If condylar growth is increased then horizontal rotation occurs
- Functional appliances alters function and guide the growth process
- Jaw rotation can be influenced therapeutically
- Upward and forward tipping of anterior part of maxilla is often indicative of mouth breathing
- Downward backward tipping of maxillary base is seen in vertical grower
- Vertical rotation – open bite
- Horizontal rotation – deep bite

- Rotation of jaw bases is very important in treatment plan
- **Lavergne and Gasson 1982**- differentiated following types of jaw rotation
 1. Convergent rotation –severe deep bite is difficult to treat by functional therapy
 2. Divergent rotation of jaw bases – open bite ,can be corrected but need fixed and surgical therapy also
 3. Cranial rotation of both jaws – can be treated by functional therapy with achieving normal overbite
 4. Caudal rotation of both bases- can be treated with functional appliance

- Therapeutic control of vertical dimension is difficult than sagittal dimension
- So if skeletal reconstruction is not possible , compensatory treatment with tooth extraction and mandibular incisor retraction is indicated
- Orthognathic surgery is ultimate corrective procedure when the magnitude of malocclusion is cannot be treated by functional or fixed treatment

LENGTH OF JAW BASES

- Mandibular retrognathism can either have short or long jaw base.
- When a favourable growth direction is present , the prognosis is good
- Mandibular retrognathism can results from two possibilities
 1. Functionally retruded mandible position ,because of overclosure and occlusal guidance
 2. Morphologically built into posterior position

DENTOALVEOLAR RELATIONSHIP

- Axial inclination
- Upper incisors
- Upper incisor to S-N line angle is considered
- Larger angle indicates proclined maxillary anteriors
- Therapeutic objective can be achieved successfully achieved with functional appliance.

- Lower incisor –
 - Lower incisor to mandibular plane is measured
 - Ideal -90 degrees
1. Smaller angle- lingually tipped anteriors , advantage in functional treatment
 2. Larger angle – labially tipped anteriors , functional treatment is difficult , uprighting of anteriors is necessary , special appliance design is needed.

- **Position of anterior teeth-**
- Distance from N-Pog or facial plane.
- Uprighting of incisors that are tipped far to labially with respect to N-Pog line also helps to determine sagittal discrepancy
- incisors behind this line can be moved labially because space is available
- This is best achievable in growth periods, so amount and direction of the growth spurt should be considered in mixed dentition , and ideal position of anteriors at end of treatment is planned

CEPHALOMETRIC EVALUATION DURING TREATMENT PROGRESS

- It is a Objective assessment of changes induced by therapy,growth,and development as treatment progresses
- Early changes In treatment plan are possible
- Growth can be measured by seven parameters
 1. S-N Linear
 2. S-Gn
 3. S-Go
 4. N-Me
 5. Maxillary base
 6. Mandibular base
 7. Ar-A and Ar-Pog.

FUNCTIONAL ANALYSIS

- A major reason in development of functional appliances was recognition of function affects the ultimate morphological form of oral tissue.
- Work of Wolff(1895) on form and function provided major contribution to functional analysis
- Beninghoff demonstrated stress trajectories to midface and response to functional forces
- A assessment of functional status of patient is necessity for therapy
- It includes mastication , speech , repiration , deglutition etc.

- Diagnostic procedures included are
 1. Determination of postural rest position , freeway space
 2. Examination of TMJ , examination of stomatognathic system
 3. Assessment of lips , cheeks

POSTURAL REST POSITION

- Assessment of Position of mandible is prime task in functional analysis
- Mostly done in adult dentition.
- Rest position is influenced by head-body position under influence of gravity
- Patient is seated upright ,back unsupported.
- head is oriented by having patient look ahead at eye level or in the mirror
- Optimum head position is established

PHONETIC EXERCISE METHODS

- Patient can be asked to repeat a selected words while looking ahead
- Letter c can also be used
- This phonetic exercises are useful in permanent dentition patients but not useful in mixed dentition patient as their language habits are not clearly established

COMMAND METHOD

- Patient is asked perform selected function, after which mandible returns to rest position
- Usually patient is asked to lick lips and swallow
- Mandible returns to rest position after 2 seconds after exercise

NON COMMAND METHOD

- Patient has no idea about what is being examined
- Careful observation is made while patient voluntarily talks and swallows or turns his head during observation

COMBINED METHOD

- It is used in mixed dentition
- Patient first does the prescribed functions
- After asking patient not to move submental muscle is palpated and see if it relaxed
- Then patient is asked to lick and swallow then not to move
- Relationship of canine is checked
- Ideal -3mm
- Interocclusal space-4 mm is normal

EXAMINATION OF TMJ

- Tmj dysfunction affects myofunctional appliance
- Main objective is to assess severity of clicking, pain ,and dysfunction

TREATMENT PLAN BY FUNCTIONAL APPLIANCE

- Traditionally the functional appliances were given to treat class 2 division 1 with uncrowded lower arches
- But with advances into better materials and diagnostic procedures now a wider range of cases being treated in recent years with functional appliances.

AGE CONSIDERATIONS

- Growth modification is only possible in growing age in patients with growth potential.
- Optimum timing –late mixed dentition phase
- Between 10 years –pubertal growth phase

DENTAL CONSIDERATIONS

- Ideal case –
 1. Devoid of rotations
 2. No crowding – local irregularities must be taken care of
- Patients with deep bite due to overeruption of lower anteriors is ideal
- Open bite cases are assisted by orthopedic appliance
- Class 2 cases with maxillary anterior proclination and upright mandibular incisors are ideal

VTO

- This clinical test enables us to visualize expected changes in patient profile due to functional appliance
- Can be done by using Rickett's VTO using cephalogram
- Clinically performed by asking patient to bring mandible forward
- Improved patient profile is positive indication for use of a functional appliance
- In case of worsened profile other options are considered
- VTO photographs of patient can be used for motivation of patient
- Recent advances are computer aided VTO softwares where photographs can be correlated with cephalograms

CONCLUSION

- Diagnosis and treatment planning is very important aspect of myofunctional appliance therapy
- Orthodontist should always have good knowledge about cephalometry and functional information about patient