COURSE ID: ODO.37-5

REMOVABLE AND FUNCTIONAL APPLIANCES

INCLUDES PRINCIPLES AND APPLICATIONS OF FUNCTIONAL APPLIANCE THERAPY

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Goals: This series of lectures should enable the resident to:
1. Understand the potential of removable appliances and how their mode of action may differ from fixed appliances.
2. Be familiar with all categories of removable appliances, understand how the most common work, particularly functional appliances, and have in-depth knowledge of appliances commonly used in orthodontic practice.
3. Understand the basic principles for retention of removable appliances.
4. Integrate the knowledge from this course with that acquired in the laboratory course where some of these appliances are constructed.

Objectives: The resident should know:
1. The components of a removable appliance, and the general mechanical principles behind their action, and specifically:
   a. the various types of forces incorporated within the appliances (intrinsic, extrinsic, both);
   b. potential and limitations as the only mode of treatment or as adjunct to treatment.
2. The mode of action of functional appliances, particularly in treatment of Class II, division 1 malocclusion, where they have been shown to be most successful. Specifically, the resident should be able to answer these questions:
   a. what is the effect of functional therapy on mandibular behavior?
   b. which appliances are more commonly used, and what is the specific effect of each type on the basis of scientific and peer reviewed research?
   c. what is the role of functional appliances in contemporary orthodontics?
   d. which factors are considered in the decision to use functional appliances in individual patients?

COURSE DURATION AND SCOPE: This course is a component of both the Mechanics course (general mechanical principles underlying the action of removable appliances) and the Early Treatment series with a focused emphasis on functional appliances. The course is scheduled in the Spring of the first year and/or the Fall of the second year. It is given at a 2-hour session on a weekly basis for at least 5 sessions. A preferable prerequisite to this course is the course on Mechanics of tooth movement, although
the pertinent mechanical principles are defined within this series. Residents may be asked to prepare and present papers on selected appliances. The quality of the paper and presentation could represent a portion of the final grade.

POLICY ON EXAMINATIONS: At least 2 biannual examinations (progress and final) are given for all courses, if a course spans the entire year. If classes terminate before the end of a semester, the final examination is given at the semi-annual examination that is closest to the end of the course, unless the course director schedules the final examination earlier. During a course, any number of progress tests or assignments may be given. Their cumulative weight in proportion to the final grade may not exceed 50%.

REMOVABLE AND FUNCTIONAL APPLIANCES

---SUMMARY OUTLINE---

REMOVABLE APPLIANCES | FUNCTIONAL APPLIANCES

- Action
  - Development Of Functional Appliances
    - Types:
      - Activator:
        a. intrinsic forces
      - B- Principles and Construction
        b. extrinsic (muscle) forces
      - C- Mode of Action, Types
        c. combination
      - C- Posttreatment Studies
        - Advantages and disadvantages

Bionator:

A- Standard;

B- Modified

- Frankel Function Regulator

- Herbst appliance

- Combined Functional Appliances/Headgear

---COURSE OUTLINE---

REMOVABLE APPLIANCES

There are as many orthodontic appliances available as there are clinicians that will use them. Two broad categories of appliances: REMOVABLE and FIXED.

1- ACTION:
- As a general rule, removable appliances tilt (or tip) the teeth, providing mainly a movement of the crown, possibly followed -(and only to a certain extent)- by the apices.
- Extrusion
- Controlled movement of the roots cannot be easily achieved with removable appliances.

2- TYPES:
Fundamentally, two kinds of removable appliances may be recognized
A. One making use of intrinsic forces, or forces from within the appliance itself, through wires, screws, or a combination of both (ACTIVE PLATES). The device is rigidly fixed to a variable number of teeth.

B. The other utilizes extrinsic forces, i.e. muscle forces, causing these forces to exert pressure on the teeth and alveolar process. In this category, are included: the removable inclined plane, the vestibular oral screen, simple bite plates, activators and other functional appliances.

*** A third kind would combine intrinsic and extrinsic force application in one appliance (A.C.C.O., some functional appliances).

A. Removable appliances with intrinsic forces

1. ACTIVE PLATES
   BASIC ELEMENTS: - Baseplate - Clasps
   ACTIVE ELEMENTS: - labial wire - springs screws - elastics

   --Pressure is usually applied to a tooth using a spring, essentially a cantilever spring.
   --There is no attachment on the tooth, and it is impossible to grasp a tooth with a spring. Therefore, the spring must impinge on the correct point on any tooth that is to be moved.
   --There is virtually NO FRICTION in that movement, since both the spring wire and the tooth surface are hard and polished. This means that at that point of application, the pressure is perpendicular to the tooth surface.
   --The direction in which the tooth is being pushed is, therefore, determined by the point at which the spring bears and not always by the direction of movement of the free end of the spring.
   --A low-load/deflection rate of the wire increases the flexibility or range of action of the wire, with the advantage that the dimensions of the spring are not increased. This can be done, for example, by incorporating a coil at the point of attachment of a cantilever spring, or the addition of an extra limb, so forming the double cantilever spring.
   --Anchorage in active plates is provided by all the teeth that are not being moved, (and the palatal surface in the maxilla), since the acrylic lies against these surfaces.

2. APPLIANCES WITH SCREWS
   The appliance has two parts. A screw is embedded in both parts of the appliance. When the screw is turned - by means of a key or pin - the two sections of the appliance move apart. Normally, the screw is given one quarter of a turn at a time, and the rate of tooth movement is regulated by the frequency with which this adjustment is made (e.g. Rapid Palatal Expansion v/s Slow Palatal Expansion). Removable appliances can be used only with a slow rate of expansion (1 x 3 or 4 days); otherwise, they dislodge.

B. Removable appliances using extrinsic forces:
1. **LIP BUMPER**: In case of gaining space, use lip pressure to exert distal force on molars, and relieve labial force off incisors.

2. **INCLINED PLANE**: In case of anterior crossbite, the inclined plane guides maxillary incisors labially.

3. **MAXILLARY BITE PLATE (without active parts)**: Widely used in conjunction with fixed appliances and by itself for the control of excessive overbite; the mandibular incisors contact the palatal acrylic. The posterior teeth are out of occlusion and tend to erupt.

4. **FUNCTIONAL APPLIANCES**.

3- **ADVANTAGES AND DISADVANTAGES OF REMOVABLE APPLIANCES**:

A. **Advantages**
   1. NO FRICTION
   2. Easy to wear
   3. Hygiene
   4. Cost (less than fixed)

B. **Disadvantages**
   1. NO precise control of movement: no torque or bodily movement
   2. Breakage
   3. Relies on a lot of cooperation from patient

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**APPENDIX OF DEFINITIONS**

**TYPES OF TOOTH MOVEMENT**

**BODILY MOVEMENT**: A tooth is moved bodily when the action of the force exerted on it is pure translation. The force acts through the center of resistance of the tooth. The center of resistance in a single rooted tooth with a parabolic shape is at approximately 1/3 the distance for the alveolar crest to the apex.

In case of bodily movement (pure translation) the center of rotation is at infinity. Practically, a force cannot be placed to act through the center of resistance. It can only be exerted at the level of the crown, through a bracket or a tube. Therefore, when a force is exerted on the crown,

**TIPPING** of the tooth is expected to occur = no pure translation. There is distal (or mesial) movement, but also rotation (moment) = (F x d). The center of rotation is not at infinity, but approaches toward the apex (between apex and center of resistance).

**PURE ROTATION** is obtained when the center of rotation is AT the center of resistance. In this case, we are dealing with a pure moment or a couple. If a pure moment (couple) is placed on a tooth-anywhere on a tooth-, a center of rotation occurs at the center of resistance of the tooth. Generally speaking, a torque, torsion or twisting motion applied to a tooth to maintain or produce a root (or crown) movement, involves a couple or pure moment + a force to restrain the unwanted movement of the crown (or root). In this instance, we are moving the center of rotation from the center of resistance toward the incisal surface of the tooth.
PURE TRANSLATION (center of rotation at infinity) and PURE ROTATION (center of rotation at the center of resistance) can be considered as the two basic types of tooth displacement. *Other centers of rotation are a combination of pure rotation and pure translation.*

**ANCHORAGE**
Anchorage is the degree of resistance to displacement offered by an anatomical unit when used for the purpose of effecting tooth movement. 
- An active member of an orthodontic appliance is the part of the appliance concerned with tooth movement (e.g. retracting anterior teeth).
- The reactive member of an appliance = teeth supporting (anchoring) the appliance, that are not supposed to be displaced (e.g. molars).
- A member of an appliance may function as both active and reactive in case reciprocal anchorage is used (retract anterior teeth, protract posterior teeth; close an anterior diastema between two central incisors).

Where a single tooth, or a group of teeth, is to be moved in one direction only, care must be taken to ensure that the reaction does not also produce tooth movement.

Anchorage may be obtained from 3 sources:
1. **within** the same dental arch in which tooth movements are being carried out. In this case, as many teeth as possible are incorporated in the anchorage section of the appliance, and as few teeth as possible are moved at a time.
2. **between** the dental arches, by intermaxillary traction to the opposing dental arch (class 2, or class 3, elastics).
3. by **extraoral** means (head gear, chin cap).

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**1. FUNCTIONAL APPLIANCES**

Functional appliances use extrinsic (muscle) forces to effect tooth movement. Numerous appliances have been advocated for the treatment of occlusal problems. Because of the success of functional appliances mainly in the treatment of distoclusions (Class II), this lecture will deal with this malocclusion.

**A- DEVELOPMENT OF FUNCTIONAL APPLIANCES**

**B- TYPES OF FUNCTIONAL APPLIANCES**

*(most commonly used in USA)*

1. **Activator** (original and variations).
   A- Principles and Construction
B- Mode of Action, Types
C- Posttreatment Studies

2. **Bionator**
   A- Standard
   B- Modified

3. **Function regulator or corrector (Frankel).**

4. **Herbst (fixed).**

5- **Combined Functional Appliances/Headgear**

C- **MODE OF ACTION OF FUNCTIONAL APPLIANCES**

1. Muscular behavior.
3. Clinical studies.
5. Is the response the same with different functional appliances or other orthodontic appliances (e.g. Headgear)?

D- **ROLE OF FUNCTIONAL APPLIANCES IN CONTEMPORARY ORTHODONTICS**

Functional appliances as *adjunct* to orthodontic therapy.

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**REFERENCES**

**REMOVABLE APPLIANCES**

**FUNCTIONAL APPLIANCES AND TREATMENT**
5. Ghafari J, Heeley JD, Shapiro IM. Morphologic study of cartilages of the rat craniofacial skeleton: Classification as osteogenic and/or supportive. In: Biological Mechanisms of Tooth Movement and Craniofacial Adaptation, Z. Davidovitch (ed.). The Ohio State College of Dentistry, Columbus, Ohio, 1992;445-453. (Primary research data presented).