



Fixed appliances

Lec. 1,2

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Fixed appliances form the second major division of orthodontic appliance system. They include orthodontic devices, which have attachments that are fixed on the teeth surfaces, and the forces are exerted via these attachments using archwires and/or auxiliaries. These appliances cannot and should not be adjusted or removed by the patient.

They have certain important advantages, as well as certain disadvantages, when compared with removable appliances:

Advantages

1. Precise control of tooth movement.
2. Multiple and complex tooth movements can be done.
3. Less dependent on patient's cooperation.
4. No retention problems.

Disadvantages

1. Compromise Oral hygiene.
2. Un-esthetic and expensive.
3. Need experienced dentist (Specialist).
4. Increased chair side time.
5. High possibility of producing adverse tooth movement.

Indications for the use of FA

- Correction of mild to moderate skeletal discrepancies.
- Intrusion/extrusion of teeth.
- Correction of rotations.
- Overbite reduction.
- Multiple tooth movement.



- Closure of extraction spaces, or spaces due to hypodontia, to ensure a good contact between teeth.

Limitations of fixed appliances

1- Attitude of the patient

Lack of motivation on the part of the patient is a main cause of failure in orthodontics, the orthodontist should discuss the treatment aims with the patients, without the parents being present.

2- Oral hygiene

An excellent standard of oral hygiene must be maintained throughout the treatment, if oral hygiene is poor there is a great possibility of decalcification, caries is increased and periodontal problems will be more severe.

3- Implications of appliance wear

It is unfair to cement a fixed appliance without first explaining to the patient what the appliance is like, how it feels and how long it will have to be worn.

4- Cooperation

Cooperation of the patient throughout the treatment is essential, the patient must understand the necessity for carrying out special instructions, if he is unwilling or unable to do this then he is not suitable for orthodontic treatment.

5- Medical history

The patient's general medical condition must be taken into account before any orthodontic treatment.

History of fixed appliance

The orthodontic profession has gone through an evolving process to reach the current bracket system.

Dr. Edward Angle is considered the father of modern orthodontics, from early 1900 developed four major appliance systems.

A) E-arch

Depend on rigid framework to which the teeth were tied so that they could expand to the form dictated by the appliance.

B) Pin and tube.

By placing bands on the teeth and soldering vertical tube into which soldered pin from smaller wire was placed

C) Ribbon arch.

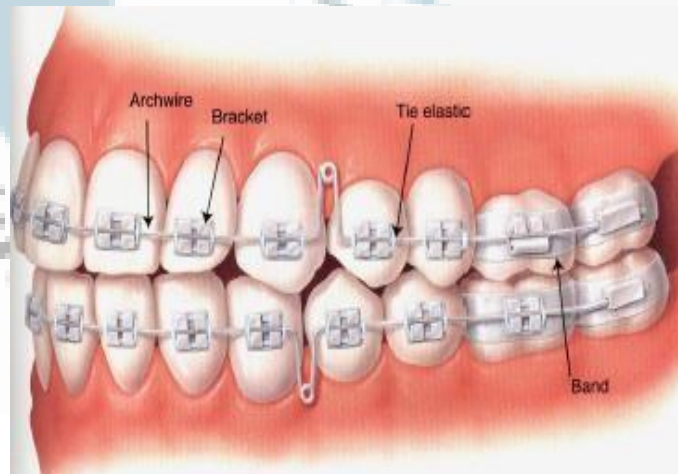
- With vertically positioned rectangular slot.
- Gold ribbon arch of 10 x 20 placed into the slot and held with pins.

D) Edgewise

Were angle reoriented the slot from vertical to horizontal and inserted a rectangular wires

Components of Fixed Orthodontic Appliances

The components which form any fixed orthodontic appliance system can be divided into three categories, attachments, archwires and auxiliaries.



A) Attachments

Include those parts which fixed on teeth surfaces. They may be welded to metal bands which are cemented to the teeth, or may be bonded directly to the teeth through acid-etch retained bonding system.

Bands

These are rings encircling the tooth to which buccal and lingual attachments are

soldered or welded, mostly used on molars and it can be used on any tooth, specially in these cases.



- ❖ Frequent failure of bonded attachment.
- ❖ Teeth that are likely experience excessive occlusal forces from opposing teeth like lower molars, premolars, or incisors in crossbite.
- ❖ Teeth that have large metal restorations (structurally weak) or having metal prosthesis.
- ❖ Teeth particularly upper molars when a headgear or cemented palatal arch needs to be used.

Sometimes bonded tubes are used. Before banding teeth are needed to be separated, tight interproximal contacts make impossible to properly seat a band, so separators must be used before banding.

Although separators are available in many varieties but the principle is the same, a device to force or wedge the teeth apart is left in place long enough for initial tooth movement to occur so that teeth are slightly separated before banding.

Three main methods of separation are available

- 1- Brass wire, which is twisted tightly around the contact and left in place for 5-7 days.
- 2- Separating springs which exert a scissor action above and below the contact.
- 3- Elastomeric separators

3-



Cementation

Cementing orthodontic band is similar to cementing cast restoration but it differs in important detail, that in restorative dentistry most if not all of enamel is removed and the cement contact the dentin, while in orthodontic the cementation is entirely on enamel. Polycarbpxylate or glass ionomer cements can be used.

Bands must be placed accurately and the teeth have to be separated from adjacent tooth contacts by using a separator around the contact area.

Brackets

The brackets were introduced with advert of acid-etch technique and the modern composite. Adhesion to the base of metal brackets is gained by mechanical interlock. A wide variety of brackets have been introduced over years to get better biomechanical properties, better esthetic appearance and less enamel damage.





Brackets can be classified according to:

1. Materials that they are made from:

- **Stainless steel,**

They are an esthetic improvement over the previously used bands, they are made from corrosion resistant stainless steel alloys, they are easy to manufacture, tough and cheap. Moreover they can be produced by casting or from thin metal strip material that is stamped to shape.

- **Titanium, Nickel.**

They have good properties such as resistance to corrosion, low density, modulus, high strength, and biocompatibility with biological tissues). But are very expensive and have high friction resistance.

- **Plastics**

The first type of plastic was made of polycarbonate and plastic molding powder. So pure plastic brackets may be useful in minimal force situation and treatment of short duration, their main disadvantage is discoloration. Advantage is esthetic.

- **Ceramics.**

They are mainly composed of aluminum oxide, they are bonded to enamel by mechanical and chemical retention, they have advantage of being esthetically acceptable but their major disadvantages are bulkiness and high friction resistance.

2. According to the slot size

Edgewise brackets are identified by the occluso-gingival dimension of the channel, commonly used sizes are 0,018 inch and 0.022 inch. Labio-ligual dimension is usually 0.028 inch.

Brackets are fixed to the teeth directly with a composite resin after acid-etching of enamel surface, and chemical or light cured resins are generally used, this procedure is called bonding. Unlike banding, there is no need for separation.

. Bonding procedure has several advantages over banding, likes:

- More esthetic.
- Less caries and gingival plaque.
- Less discomfort.
- Used on partially erupted teeth.
- Teeth separation not required.
- Detachment is more easily.
- No spaces remain after treatment.



Bonding a brackets

It involves the following steps

- 1- Polishing with pumice and rubber cup , rinsing and dryness
- 2- Acid etching for 20-30 seconds with 35% to 50% of unbuffered phosphoric acid. Then rinsing and dryness
- 3- Bonding with chemical or light cure composite.

Orthodontic bonding techniques

1) Direct bonding

In which direct attachment of orthodontic appliances to etched teeth using chemically and light cure adhesives. It is most popular due to its simplicity and reliability.

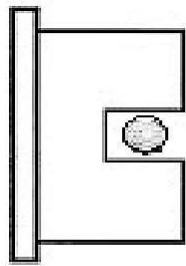
2) Indirect bonding

In this technique the brackets were first positioned on study casts with water soluble adhesive and then transferred to mouth with a custom tray.

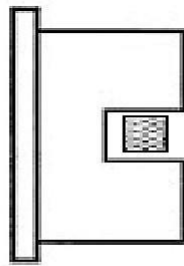
B) Archwire

Archwires are made of variable materials and dimensions. Originally archwires were made from gold alloy but because it is expensive, the stainless steel alloy becomes the material of choice. Recently a super-elastic wire is introduced, made from titanium alloy (Nickel- Titanium, Beta- Titanium). These wires are more flexible than steel wires of the same dimensions. Archwires are available in different cross section shape and dimensions, are:

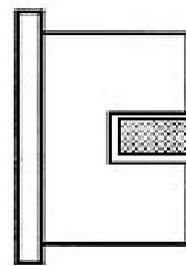
- Round archwire, described like, 0.016 or 0.018 inches.
- Square archwire, described like 0.016 \times 0.016 or 0.018 \times 0.018 inches.
- Rectangular archwire, described like 0.016 \times 0.022 or 0.017 \times 0.025inches.



Round wire



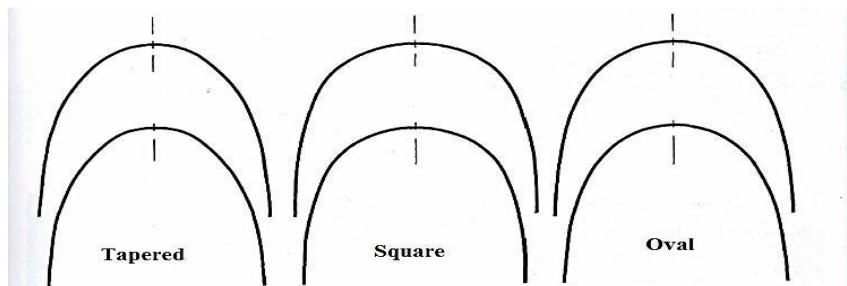
Square wire



Rectangular wire

The archwire form closest to the patient arch should be chosen. Generally there are 3 basic archwire form:

- Oval
- Tapered
- Square

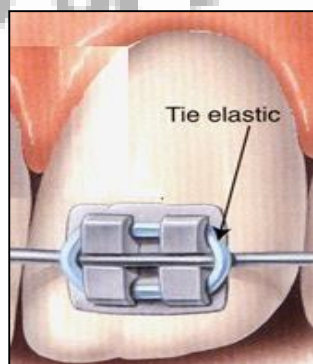


The physical properties of the arch wires:-

1. **Spring back**-----► the ability of the wire to return to its shape after removal of the force.
2. **Stiffness**----- ► the amount of force required to bend the wire.
3. **Formability**-----► the ability of the wire for being bent without fracture.
4. **Resiliency**-----► the energy stored in the particles of the wire that make it return to its normal shape.
5. **Joint ability**-----► the ability of the wire for being soldered or welded.
6. **Frictional characteristics** -----► should be in account (considered) when heavy force is needed in teeth movement.
7. **Compatibility**-----► the inability of the arch wire material to initiate irritation or inflammation in the living biological system.

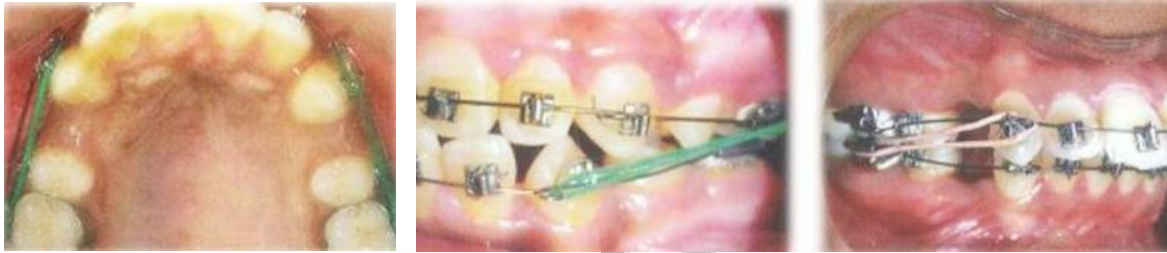
Auxiliaries

These are used in conjunction with archwires to produce tooth movement. There are very small elastic rings or wire ligatures are used to secure the archwire into the bracket slot.



Ligatures elastic

Intra- oral elastic of varying sizes are available for traction.

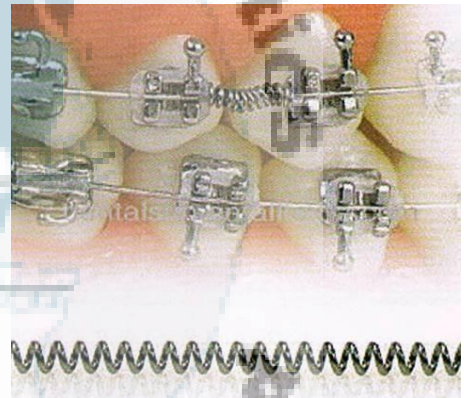


1. Intra arch elastics

2. Inter maxillary elastics

Palatal arches can be utilized to reinforce the anchorage, to achieve expansion or derotation of molars. Coil springs, either opening or closing, which made from stainless steel or nickel titanium alloys, also used to move teeth along the archwire.

Coil spring



Power chains



Expansion by fixed appliance

Expansion should continue at the rate of 2mm per month (1mm tooth movement on each side) until the crossbite is slightly overcorrected. In other words, the lingual cusps of the maxillary teeth should occlude on the lingual inclines of the buccal cusps of the mandibular cusps of the mandibular molars at the end of active treatment.

Most posterior crossbites require 2-3 months of active treatment and 3 months of retention.

Two types of expansion device they are:-

1) Quadhelix appliance

Very efficient fixed slow expansion appliance, Give an anterior and posterior expansion
Made of 1mm stainless steel wire and attached (soldering) to the teeth by bands
Cemented to the molars

2) Hyrex (Rapid expansion screw)

Very efficient fixed rapid expansion appliance, Give posterior expansion, the screw is
Turned twice daily for a period of 2 weeks (active treatment), it is designed to open the
midline suture and expand the upper arch by skeletal expansion bony infill will be of the
expanded suture will happen, it is used in early teens patients before suture fuses.

Note:- each 1\4 turn = 0.35 mm movement.

Principles of Fixed Appliance

Tooth movement with fixed appliances is achieved by interaction between the attachments on the tooth surface and the archwire which is tied into the attachments. As the fixed appliance is attached to the teeth surfaces, so is capable of a greater range of tooth movements than is possible with removable appliance. When the archwire pass through the bracket slot, a force couple can be generated by the interaction between them, thus rotational and apical movements are possible. The interplay between the archwire and slot determine the type and direction of tooth movement.

Fixed Appliance Systems

• Standard Edgewise Appliance

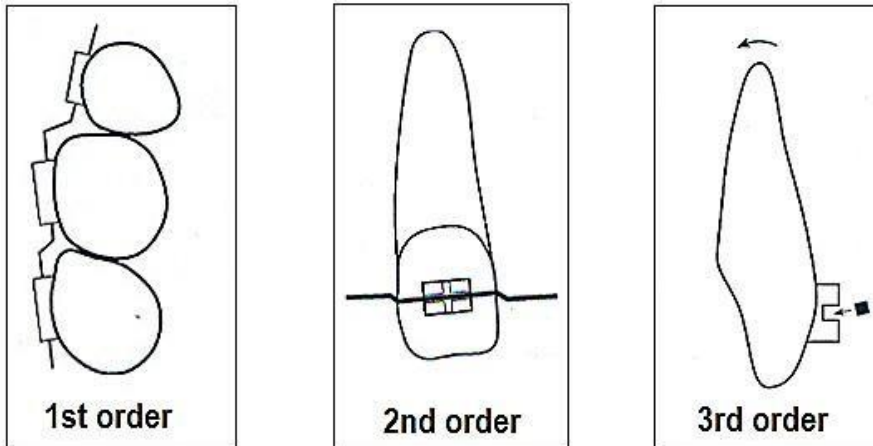
The term" edgewise" refers to the method by which a rectangular archwire is inserted into the rectangular bracket slot. In1928, the edgewise appliance was Dr.Angle's final achievement, represented the culmination of many years of effort and many different appliance designs attempting to place the teeth according to his "line of occlusion".

edgewise brackets are typically described by the vertical slot dimension into 0.018 or 1.22 inch. The depth of slot is commonly 0.028 inch.

By interaction of archwire with bracket slot, the tooth movement will occur in all three spatial planes. In orthodontics, these are described by the types of bend that are required in an archwire to produce each type of tooth movement:

- First-order bends are made in the plane of archwire to compensate tooth widths and bucco-lingual position (in/out).
- Second-order bends are made in vertical plane to achieve correct mesio-distal angulations or tilt of the tooth (tip).
- Third-order bends are applicable with rectangular archwire only. They are done by twisting of wire so that the wire exerts bucco-lingual force on

the tooth apex when inserted into rectangular slot (torque)

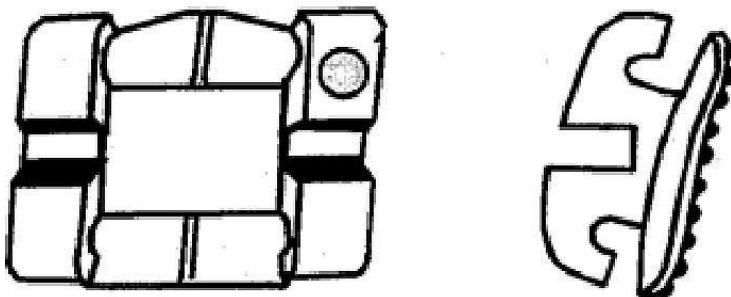


In original edgewise appliance, these bends were placed in the archwire during treatment so that the teeth were moved into correct their positions.

- **Pre- Adjusted Edgewise Appliance**

Dr. Lawrence F. Andrews introduced pre-adjusted Appliance to Orthodontic profession in 1972, and called it straight wire appliance. In this modern bracket system, the average values for tip and torque built into the bracket slot itself, and the bracket base are of differing thicknesses to produce an average buccolingual position.

These pre-adjusted systems have advantage that the amount of wire bending required is reduced. However, they do not eliminate the need for wire adjustment since average values do not always suffice. These characteristics for each tooth are called the “appliance prescription”.

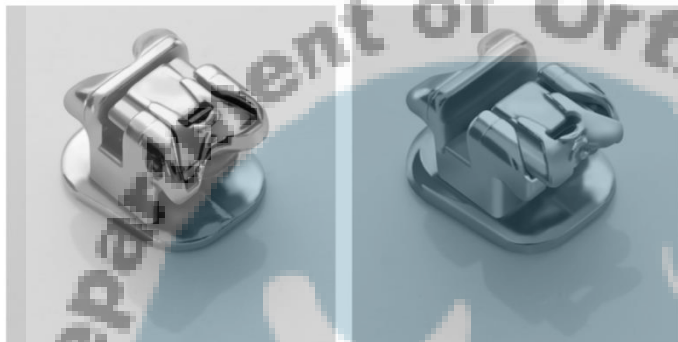


Pre-adjusted bracket, the slot is angulated with respect to the base

- **Self ligation brackets**

Friction between the bracket and the archwire can theoretically result in a loss of anchorage and slower tooth movement

In an attempt to reduce friction and appointment times, a range of brackets whose slot is closed by the use of a metal gate or clip are now available. This technique is referred to as self-ligation, as the ligation system is built into the bracket.



Self ligation brackets

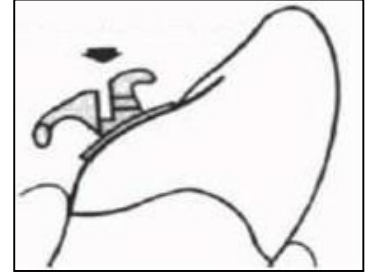
Not surprisingly, there are different opinions as to correct position of each tooth. The result is an almost bewildering array of pre-adjusted systems. All with slightly differing degrees of torque and tip. Of these perhaps the best known are the Andrews' system in 1972, the Roth system in 1976, and the MBT system in 1995.

Contemporary Orthodontic Appliances

- **Lingual Appliance**

The lingual orthodontic appliances were conceived with the simple objective of making orthodontic treatment esthetic. Dr. K Fujita introduced the Mushroom arch wire appliance in the 1979. The concept of these appliances was developed before the development of esthetic brackets, like the ceramic brackets.

In the lingual bracket, the opening of the slot was set on the occlusal surface of the teeth in order to facilitate the fitting of the wire.

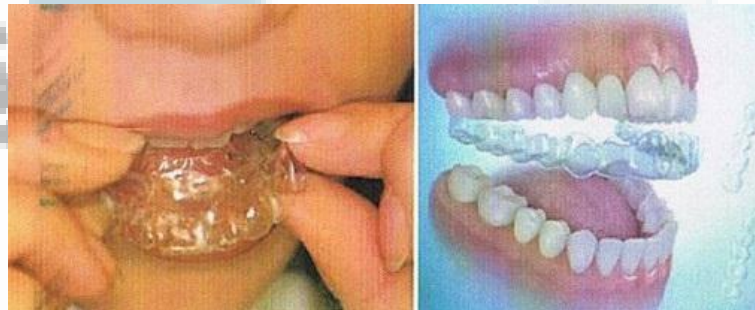


Disadvantages of the Lingual Appliances:

1. Indirect vision hampered accurate bracket placement.
2. Occlusal interferences caused frequent bond failures and at times restricted tooth movement.
3. Speech distortion.
4. The sharp edges hurt/lacerated the tongue.
5. Gingival irritation due to plaque accumulation.
6. Increased chair-side time due to difficulty in insertion and ligation of archwire.

B) Clear Aligner Therapy

Clear aligner initially used as retainers. Nowadays Aligners used as device for treatment of mildly displaced teeth into alignment for adults or adolescents in whom growth modification were not needed & interested in making n orthodontic appliance invisible or minimally visible.



Removal of fixed appliance

Bands are removed using special pliers (band removal), which exert an occlusally directed force from the gingival margin. Because of the anatomy of molar teeth, the force is applied from the palatal aspect in the maxillary arch and buccally in the mandible.

Brackets are removed by special plier, by applying a shear force across the bracket base with debonding pliers (bracket removal). This distorts the bracket base and causes failure at the junction between bracket base and composite. Residual composite is removed from the tooth, ideally using a tungsten carbide fissure bur in a slow handpiece.

Retention appliances

Retention is holding the teeth in optimal esthetic and functional position to prevent relapse.

Most commonly used retainers are:

1) Hawley retainer

An appliance made of acrylic and Hawley arch and Adams clasp, it requires adjustment every one or two visits.

2) A clear retainer

Commonly used and have the benefits of excellent aesthetics, broad tooth contact to hold alignment.

3) Fixed retainer

Retainers bonded to the anterior teeth (palataly) will prevent post-treatment movement, but hygiene can be more difficult, and more bonds are there to possibly fail.



Fixed retainer



Hawley retainer



Clear retainer