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ANCHORAGE IN ORTHODONTICS

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ABSTRACT

During orthodontic treatment, the teeth are exposed to forces and moments, and according to Newton's third law, these acting forces always produce reciprocal forces that are of the same magnitude but the opposite direction. These reciprocal forces must beappropriately diverted in order to prevent unintended tooth movements and sustain treatmentsuccess.One of the main reasons for unsatisfactory outcomes in orthodontic treatment and a potential adverse effect of orthodontic mechanotherapy is anchoring loss. Multiple factors, including the extraction site, appliance type, age, crowding, and overjet, have been identified as its causes.In order to manage anchorage, clinicians have worked hard throughout the years to identify biomechanical solutions. This article's goal is to review the fundamentals of anchorage and anchorage planning in various appliance systems.

Keywords : Anchorage, Anchorage planning, Anchorage loss, Skeletal anchorage.

INTRODUCTION

In orthodontics, force is an active element of the orthodontic appliance and the only drug in the practice. Orthodontic appliance mainly contains an active and a reactive member.[1]

An active member of the orthodontic appliance produces force that initiates and conducts tooth movement. The active components are accommodated in the body of the appliance, which is secured in the oral cavity by an ‘anchor unit’.[1]

During orthodontic treatment, teeth are subjected to forces and these forces produces reciprocal forces (i.e., forces of same magnitude but in opposite direction) causing unwanted tooth movement. To avoid this unwanted tooth movement to maintain treatment success, these reciprocal forces must be resisted.[1]

Orthodontic anchorage in simple words is the ability to divert the reciprocal forces and resist the unwanted tooth movements which can be provided by other anchorage sources i.e,teeth, palate, alveolar bone, musculature, cranium, facial bones, back of the neck or implants in bone.[2,3]

Anchorage is a word used in orthodontics that means resistance to displacement. During orthodontic treatment, the teeth are exposed to forces and moments, and according to Newton's third law, these acting forces always produce reciprocal forces that are of the same magnitude but the opposite direction. These reciprocal forces must beappropriately diverted in order to prevent unintended tooth movements and sustain treatmentsuccess.[3]

DEFINITION

Louis Ottofyin 1923 defined anchorage as 'base against which orthodontic force or reaction of orthodontic force is applied'.[4]

According to **Moyers**, anchorage is defined as 'resistance to displacement'.[2]

T.M.Graber defined orthodontic anchorage as 'nature and degree of resistance to displacement offered by an anatomic unit when used for the purpose of effecting tooth movement'.[5]

According to **Proffit,** Anchorage is'Resistance to unwanted tooth movement.Resistance to reaction forces that is provided (usually) by other teeth, or (sometimes) by the palate, head or neck (via extra oral force), or implants in bone'.[6]

Nanda defined orthodontic anchorage as 'selection of adequate and properly distributed resistance units for control and direction of force applied to the teeth for dental arch development or for lesser tooth movement'.[7]

Pullen defined orthodontic anchorage as selection of adequate and properly distributed resistance units for control anddirection of force applied to the teeth for dental arch development or for lesser tooth moment.[8]

According to **Stoner**, anchorage is defined as 'source which can resist the reactions of orthodontic forces'.[3]

Recently, **Daskalogiannakis** defined orthodontic anchorage as 'resistance to unwanted tooth movement.[1]

SOURCES OF ANCHORAGE

Intraoral Sources[9]

- Facial bones
- Teeth
- Alveolar bone
- Basal bone
- Cortical bone
- Musculature

Extraoral Sources[9]

- Cranium (occipital or parietal anchorage)
- Facial bone (frontal bone or mandibular symphysis)
- Back of the neck (cervical anchorage)

CLASSIFICATION OF ANCHORAGE

1. **PULLEN CLASSIFICATION[3,8]**

- **Based on Form of attachment**
  - Pivotal

- Reinforced
- Stationary

- **Based on source of resistance**

- Intermaxillary
- Occipital
- Cervical

2. MOYERS CLASSIFICATION[2,3,9]

I. According to the manner of force application:

- Simple anchorage
- Stationary anchorage
- Reciprocal anchorage

- **SIMPLE ANCHORAGE**

  Dental anchorage when the way and amount of force applied tends to shift or alter the axial inclination of the tooth or teeth that compose the anchorage unit in the plane of the jaw the area where the force is exerted. In other words, the ability of the anchorage unit to withstand tipping is used to move one or more teeth.

- **STATIONARY ANCHORAGE**

  Stationary anchorage (Graber) refers to dental anchorage when the way and application of force tend to move the anchorage unit physically in the plane of space where the force is being applied.

- **RECIPROCAL ANCHORAGE**

  The term describes the resistance provided by two units that are misaligned when equal and opposing forces tend to shift each unit in the direction of a more normal occlusion. To create reciprocal tooth movement, it includes pitting two teeth or two groups of teeth with equal anchoring value against one another, as in a closing diastema where two central incisors are pitted against one another and arch expansion using a removable appliance using a coffin spring.

II. According to jaws involved:

- Intra-maxillary
- Inter-maxillary

- **INTRA-MAXILLARY ANCHORAGE**

  The anchorage is referred to as intra-maxillarywhen all of theunits providing resistance are located within the same jaw. The anchorage units and the teeth that need to be relocated in this type of anchorage are both totally within the maxillary or mandibular arches.

- **INTER-MAXILLARY ANCHORAGE**
  Inter-maxillary anchorage is a type of anchorage where the resistance units in one jaw are employed to move teeth in the opposing jaw. Another name for it is Baker's anchorage.

III. According to the site of anchorage:

- Intraoral
- Extraoral:
  - Cervical
  - Occipital
  - Cranial
  - Facial
- Muscular

- **INTRAORAL ANCHORAGE**
  Intraoral anchorage is defined as anchorage where all resistance units are located within the oral cavity. The oral cavity contains both the teeth that need to be moved and the anatomical regions that provide anchoring. Some examples of intraoralanatomic units that may be used are other teeth, palate and lingual alveolar bone of mandible.

- **EXTRAORAL ANCHORAGE**
  Extraoral anchorage is a type of anchorage where the resistance units are located outside the oral cavity. Occiput, the back of the neck, the cranium, and the face are some extraoral anatomical units that are exploited as sites of resistance. Examples of extraoral anchorage are as follows:

- Cervical : e.g. neck straps
- Facial : e.g. face masks
- Occipital : e.g. head gears
- Cranial : e.g. high pull headgears

- **MUSCULAR ANCHORAGE**
  Perioral muscles have occasionally been used as resistance units. Muscular anchoring uses the forces produced by muscles to help teeth move. e.g. Vestibular shields.

IV. According to the number of anchorage units:

- Single or primary anchorage
- Compound anchorage
- Multiple or reinforced anchorage

- **SINGLE OR PRIMARY ANCHORAGE**

Single or primary anchoring refers to situations in which one tooth with more alveolar support provides resistance while another tooth with less support is moved.

- **COMPOUND ANCHORAGE**
  Compound anchorage is a type of anchorage where teeth with less support are moved by using the resistance offered by many teeth with more support.

- **MULTIPLE OR REINFORCED ANCHORAGE**
  Anchorage that strengthens the main anchorage with the aid of additional teeth or any other appliance is known as reinforced anchorage. Extraoral or muscular anchoring may be involved in reinforcing anchorage.Banding second molars is an easy approach to reinforce anchoring. To effectively distalize molars, tissue anchoring such as that achieved by a lip bumper can be used. Appliances that can be used are as follows
  - Transpalatal arch
  - Nance appliance
  - Upper anterior inclined plane
  - Lingual Arch

3. NANDA CLASSIFICATION[3,7]

- **A ANCHORAGE : critical / severe**

  In this type of anchorage, 75% or more extraction space is needed for anterior retraction.

- **B ANCHORAGE : moderate**

  In this type of anchorage there is relatively symmetric space closure i.e, 50%.

- **C ANCHORAGE : mild / non critical**

  In this type of anchorage 75% or more of space closure is done by mesial movement of the posterior teeth.

4. GIANELLY AND GOLDMAN (1971)[3,10] :

- Maximum Anchorage
- ModerateAnchorage
- Minimum Anchorage

- **MAXIMUM ANCHORAGE**

The anchor teeth migrating mesially can result in the loss of more than half the extraction space.

- **MODERATE ANCHORAGE**
  The anchor teeth can be permitted to move forward into ¼ to ½ of the extraction space.

- **MINIMUM ANCHORAGE**
  Not more than $1/4^{th}$ of the extraction space should be lost by forward movement of the anchor teeth.

- **ABSOLUTE ANCHORAGE**
  Retraction of anteriors takes up the full extraction space. Temporary anchorage devices allow for absolute anchorage. Because TADs are utilised, the anchor teeth do not migrate forward.

ANCHORAGE PLANNING[1,3]

Factors affecting anchorage requirements :

- Nature of malocclusion
- Type of tooth movement
- Periodontal condition
- Craniofacial pattern
- Friction

1. NATURE OF MALOCCLUSION

Anchorage requirements are influenced by a number of variables, including the degree and complexity of malocclusion, total arch length discrepancy (TALD), growth pattern, desired tooth/teeth movements, age, and the individual's craniofacial pattern.
The sum of crowding, the amount of retraction needed, and the space needed to level the Spee curve account for the entire discrepancy. Maximum anchorage is required to close extraction spaces when there is a huge discrepancy. In the early stages of levelling and alignment, crowding cases require maximum anchorage control. On the other hand, maximum retraction is required in situations with increased overjet and proclination, such as in bimaxillary cases, which calls for high anchorage during retraction.

2. CRANIOFACIAL PATTERN

When an individual has the same degree of discrepancy and form of malocclusion, the variation in their craniofacial pattern will affect the type of anchorage that the anchorage units supply. Because it can maintain inter-digitation and inter-cuspal posture, the biting force—which is largely influenced by the musculature—would

provide resistance. The craniofacial pattern, which can be either vertical or horizontal, is the second important component. Verticalgrowers typically lose anchorage faster as compared to horizontal grower as they possess less biting force.

3. **TYPE OF TOOTH MOVEMENT**

Different types of tooth movement require different amounts of anchorage; for example, bodily movement requires more anchorage than tipping. According to the expression of bracket prescription, which involves simultaneous unravelling of tooth axis alignment, tip, and crowding to bring the teeth into a position known as "slot line up," the modern pre-adjusted appliance system requires high demands of anchorage during the initial stages of treatment.

4. **FRICTION**

The resistance against tooth movement is increased by friction between the bracket slot and the wires, especially in sliding mechanics. When the teeth move, the retraction force must first overcome the static friction at the bracket wire junction and then continue to overcome the kinetic friction. In order to overcome the frictional resistance, more effort is used for anterior retraction, which may put strain on the posterior anchorage.

METHODS TO SAVE ANCHORAGE[3,11]

1. TRANSPALATAL ARCH[3,12]

The purpose of transpalatalarch is to prevent buccal tipping of the molars in response to forces from an occipital pull face bow head gear and to maintain arch width and molar position after buccal expansion of the maxillary arch.Due to an omega loop in the vault's centre, the TPA offers molar expansion, rotation, contraction, and torque. The orientation of the core loop is either mesially or distally. The arch is typically soldered directly to the bands when used as a space maintainer.

2. TRANSLINGUAL ARCH[3,12]

The use of a lingual arch can allow spontaneous alignment of the labial segment while inhibiting the mesial movement of distal teeth when there is excessive crowding in the permanent dentition and extractions are necessary. Arch width and length are most frequently maintained using the fixed holding arch.

3. NANCE PALATAL ARCH[3,12]

Nance palatal arch can be utilised to maintain the length of the maxillary arch. The arch is made of bands on the maxillary first permanent teeth and a wire encased in an acrylic button on the anterior palate. After early exfoliation of deciduous teeth, it has been utilised as a passive appliance, such as the Nance preventative arch, to preserve the spacing between the anchor molars and the labial segment.

4. CLASS II ELASTICS (Intermaxillary Anchorage)[3,13]

Calvin Case recommended using reciprocal elastics to move individual teeth in opposing arches in 1898.However, it was left to Baker to apply such elastics in the treatment of class II abnormalities using the Angles E arch. Intermaxillary anchorage is what Angle refers to as the ideal force in his seventh edition. He asserted that the rubber band's reciprocal activity at each end offered the finest anchorage for treating the class II condition and establishing normal occlusion.

Intermaxillary elastics are a frequent way to achieve differential tooth movement because they pit the upper teeth against the lower teeth. The terms used to describe the elastic and its force vector are determined by the direction of the elastic. The anterior teeth of the maxilla and the posterior teeth of the mandible are where Class II elastics are attached. A class II elastic acts to rectify a class II relationship by exerting a protraction force on the lower molars while simultaneously exerting a retraction force on the upper anterior teeth.

5. LIP BUMPER[3,14]

A 1.45 mm stainless steel removable arch with an anterior lip bumper is fitted into the lower molars' auxiliary tubes. The bumper is 2 to 3 millimetres in front of the lower incisors. It uses the lower lip's muscle pressure to apply a distal force to the molars. Sagittal and vertical adjustment are possible because to the loops in front of the molar tubes. It keeps the lower molars' anchorage potential and arch length.

6. SKELETAL ANCHORAGE[3,15]

To offer absolute anchorage, skeletal anchorage is a technique that makes use of a variety of bony anchor. By using screws, pins, or other removable implants anchored to the jaws, it broadens the range of biochemical possibilities by applying stresses that generate tooth movement in any direction without harmful reciprocal forces.

METHODS OF OBTAINING SKELETAL ANCHORAGE[3,15]

- Conventional Dental Implants
- Palatal Endosseous Implants

- Onplant
- Mini implant
- Spider Screw
- Micro implant
- C-orthodontic Micro implant
- Impacted Titanium Post
- Transitional Implants
- Mini Plate
- Zygoma Anchorage System
- Zygomatic Ligatures

ANCHORAGE LOSS[1]

The force involved during the movement of the teeth follows Newton's third law of motion which states that "for every action, there is an equal and opposite reaction'.

The reactive member of the appliance causes unplanned and unexpected movement of the anchor teeth during the orthodontic treatment which is termed as anchorage loss.

- **Mesial anchorage loss**

  The mesial movement of the anchor teeth has been the main cause of anchorage difficulties.

  Traditionally, buccal segments are used to pull forward teeth as anchors. The degree of retraction of the anterior teeth is compromised by the undesirable mesial movement of the buccal teeth, often known as "anchorage loss."

- **Vertical and transverse anchorage loss**

  Anteroposterior anchorage loss was the main focus of earlier researchers and doctors' attention. However, the result of the treatment should also take into account the changes in vertical or transverse relationships that may have animpact on a tooth or a group ofteeth inkey places, and consequently, the occlusal plane. The majority of orthodontic mechanics are extrusive, making it difficult to prevent extrusion. Extrusion of the back teeth can cause the jaw to rotate backward and downward.

CONCLUSION[3]

Prioritising anchorage should occur before creating a treatment plan. For orthodontic therapy to be completed successfully and with a better finish, the skeletal and dental anchorage should be carefully arranged. Utilising extraction spaces, using head gears, retraction mechanics, etc. all heavily depend on anchorage.

Finally, we will provide a quick summary of what we believe to be the "modern concept of anchorage." It entails the application of prepared, strengthened, skeletal, and pre-existing anchorage. To properly close the case, an accurate diagnostic based on the availability of anchorage must be made.

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