

ANCHORAGE IN ORTHODONTICS: A LITERATURE REVIEW

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During orthodontic treatment the teeth are exposed to forces and moments, and these acting forces always generate reciprocal forces of the same magnitude but opposite in direction which follows Newton's third law. To avoid unwanted tooth movements and maintain treatment success, these reciprocal forces must be diverted effectively. In orthodontic treatment, anchorage loss is a potential side effect of orthodontic mechanotherapy and one of the major causes of unsuccessful results. Its cause has been described as a multifactorial response in relation to the extraction site, appliance type, age, crowding, and overjet. Therefore, clinicians throughout the years have made an effort to find biomechanical solutions to control anchorage. The purpose of this article is to review the basics of anchorage and the anchorage planning in different appliance systems.

KEYWORDS: Anchorage, Anchor loss, Anchorage planning in different appliance systems.

INTRODUCTION

Anchorage is the word used in orthodontics to mean resistance to displacement. Every orthodontic appliance consists of two elements an active element and a resistance element. The active parts of the orthodontic appliance are concerned with tooth movements. The resistance units provide resistance (anchorage) that makes tooth movements possible. According to Newton's third law there is equal and opposite reaction to every action. Therefore in orthodontics, all anchorage is relative and all resistance is comparative¹.

During orthodontic treatment the teeth are exposed to forces and moments, and these acting forces always generate reciprocal forces of the same magnitude but opposite in direction. To avoid Unwanted Tooth movements and maintain treatment success, these reciprocal forces must be diverted or resisted. The orthodontist must decide where the resistance to the forces is needed to produce the desired tooth Movement. Utilization of the resistance of dental units should be the first consideration. If this proves to be inadequate, it must be supplemented by other anchorage sources, either intraoral Extra oral, or both.

Skeletal anchorage expand the range of biochemical possibilities with screws, pins or some readily removable implants anchored to the jaws, so that forces might be applied to produce tooth movement in any direction without detrimental reciprocal forces. Orthodontic forces might be applied directly to the jaws through skeletal anchorage. Intra-oral skeletal anchor units that are predictably stable, relatively non-interfering, biocompatible

and comfortable could make appliance design simplified and more efficient.

The present article will focus on anchor saving measures and anchorage concepts in different appliance systems in orthodontics.

DEFINITIONS

Louis Ottofy defined it as the base against which orthodontic force or reaction of orthodontic force is applied².

Moyers defined anchorage as Resistance to displacement.¹

T.M. Graber³ defined anchorage as the nature and degree of resistance to displacement offered by an anatomic unit when used for the purpose of effecting tooth movement.

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.⁴

Nanda defined anchorage as the amount of movement of posterior teeth (molars, premolars) to close the extraction space in order to achieve selected treatment goals.⁵

Pullen defined 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 moment.⁶

Stoner defined anchorage as source which can resist the reactions of orthodontic forces.

CLASSIFICATION OF ANCHORAGE

There are different classifications

PULLEN CLASSIFICATION⁶:

Based on Form of attachment	Based on source of resistance
a. Pivotal	a. Intermaxillary
b. Reinforced	b. Occipital
c. Stationary	c. Cervical

MOYERS CLASSIFICATION¹:

According to the manner of force application

- a. **Simple anchorage** : Resistance to tipping.
- b. **Stationary anchorage** : Resistance to bodily movement.
- c. **Reciprocal anchorage** : Two or more teeth moving in opposite directions and pitted against each other by the appliance.

Simple Anchorage:

Dental anchorage in which the manner and application of force tends to displace or change axial inclination of the tooth or teeth that form the anchorage unit in the plane of space in which the force is being applied. In other words resistance of anchorage unit to tipping is utilized to move another tooth or teeth.

Stationary anchorage:

Dental anchorage in which the manner and application of force tend to displace the anchorage unit bodily in the plane of space in which the force is being applied is termed stationary anchorage (Graber).

Reciprocal Anchorage:

It involves pitting of two teeth or two groups of teeth of equal anchorage value against each other to produce reciprocal tooth movement eg: closing diastema, two central incisors are pitted against each other.

Reinforced anchorage:

It involves reinforcing the anchorage or resistance area either by adding more resistance units or by the use of various adjuncts. A simple way of reinforcing anchorage is to band the second molars. Various other ways include,

the use of T.P.A., Nance holding arch, lower lingual arch. Tissue anchorage such as obtained by lip bumper can be efficiently used to distalize molars.

According to the jaws involved:

- 1. **Intra maxillary:** Anchorage established in the same jaw.
- 2. **Inter maxillary:** Anchorage distributed to both jaws. **Baker's anchorage (1904)**

According to the site of anchorage:

- 1. **Intra oral** : Anchorage established within the mouth.
- 2. **Extra oral** : Anchorage obtained outside the oral cavity
 - a) Cervical : e.g. neck straps
 - b) Occipital : e.g. Head gears
 - c) cranial : e.g. high pull headgears
 - d) Facial : e.g. face masks
- 3. **Muscular:** Anchorage derived from action of muscles. e.g. Vestibular shields.

According to the number of anchorage units:

- 1. **Single or primary anchorage**
Anchorage involving only one tooth.
- 2. **Compound anchorage** :
Anchorage involving two or more teeth.
- 3. **Reinforced anchorage** :
Addition of non-dental anchorage Sites.
e.g. Mucosa, muscle, head, etc.

Nanda classified anchorage as⁷

- 1. **A anchorage: critical / severe**
75% or more of the extraction space is needed for anterior retraction.
- 2. **B anchorage: moderate**
Relatively symmetric space closure (50%)
- 3. **C anchorage: mild / non critical**
75% or more of space closure by mesial movement of posterior teeth

MARCOTTE'S CLASSIFICATION (1990)⁸:

Group A Anchorage: Also refers to maximum posterior anchorage. 75% or more space required for anterior retraction. The biomechanical paradigm is to increase posterior M/F ratio (beta M/F ratio) relative to the anterior M/F ratio (Alfa M/F ratio).

Group B Anchorage: Simplest form of space closure. The requirement includes equal translation of the anterior and posterior segments into the extraction space. Equal and opposite moments and forces are indicated.

Group C Anchorage: Also refers to maximum anterior anchorage. 75% of space closure achieved through mesial movement of posterior teeth. The biomechanical paradigm is to increase anterior M/F ratio (i.e. Alfa M/F ratio) relative to posterior M/F ratio (i.e. beta M/F ratio)

GIANELLY AND GOLDMAN (1971)⁹:

1. Maximum Anchorage
2. Moderate Anchorage
3. Minimum Anchorage

SOURCES OF ANCHORAGE¹⁰

INTRAORAL SOURCES

I. ALVEOLAR BONE

II. TEETH

Roots form, Size of the roots, Number of roots, Position of tooth, Axial inclination of the teeth, Root formation., Contact points and Intercuspation are the factors which decide anchor value of a tooth .

III. BASAL BONE

Certain areas of the basal bones like the hard palate and the lingual surfaces of the mandible in the anterior regions can be used to augment the anchorage

IV. CORTICAL BONE

Ricketts floated the idea of using cortical bone for anchorage. The contention being that the cortical bone is denser with decreased blood supplies and the bone turn over. Hence, if certain tooth torqued to come in contact with the cortical bone they would have a greater anchorage potential.

V. MUSCULATURE

Hypertonicity of the perioral musculature and enhances the anchorage potential of the mandibular molars preventing their mesial movement.

METHODS TO SAVE ANCHORAGE¹¹

1. REINFORCEMENT OF ANCHORAGE

Anchorage can be reinforced by including as many teeth as possible in the anchorage unit. The ratio of PDL area of anchorage unit to PDL area of tooth movement unit should be 2:1 without friction and 4:1 with friction. By addition of teeth from the opposite dental arch

to anchor unit by patient wearing extra oral appliance (head gear) placing backward force against the upper arch. Use of skeletal anchorage systems.

2. SUBDIVISION OF DESIRED TOOTH MOVEMENT

A common way to improve anchorage control is to pit the resistance of a group of teeth against the movement of a single tooth rather than dividing the arch into or less equal segments e.g. to reduce strain on posterior anchorage – retraction of canine individually.

3. TIPPING /UPRIGHTING¹¹

Another possible strategy for Anchorage control is to tip the teeth and then upright them rather than moving them bodily.

4. FRICTION AND ANCHORAGE CONTROL STRATEGIES¹²

In a typical extraction case it is desired to close the extraction space 60% by retraction of anterior teeth and 40% by forward movement of posterior segments. This can be obtained by 3 approaches:

- One step space closure with a frictionless appliance.
- Two step procedure by sliding the canine, then retracting the incisors. (tweed technique)
- Two step closure by tipping the anterior segment with some friction and then up righting the tipped teeth.

5. CORTICAL ANCHORAGE¹³

Cortical bone is more resistant to resorption; tooth movement is slowed when root contacts it. By torquing the roots of posterior teeth outward against the cortical plate it inhibits the mesial movement when extraction spaces are to be closed.

6. TRANSPALATAL ARCH¹⁴

The purpose of these arches is to maintain arch width and molar position after buccal expansion of the maxillary arch and to keep molars from tipping buccally in response to forces from an occipital pull face bow head gear. The TPA offers the option of expansion, rotation, contraction, and torque of the molars due to an omega loop in the center of the vault. The central loop is oriented either mesially or distally. When used as a space maintainer, the arch is most commonly soldered directly onto the bands. Another method uses prefabricated lingual attachments welded to the molar bands, into which the arch form is inserted and may also be removed.

7. NANCE HOLDING ARCH¹⁴

It can be used to maintain maxillary arch length. The arch consists of a wire embedded in an acrylic button on the anterior palate and soldered to bands on the maxillary first permanent molars. As a passive appliance such as Nance preventive arch, it has been used to maintain the distance between the anchor molars and the labial segment after premature exfoliation of deciduous teeth.

8. LINGUAL ARCH¹⁴

When excess crowding present in the permanent dentition and extractions are required, the application of a lingual arch can allow spontaneous alignment of labial segment while preventing the mesial movement of distal teeth. The fixed holding arch is most commonly used to maintain arch width and arch length. A wire with adjustment loop is soldered to bands cemented on the first permanent molars. The wire should rest on the cingula of the mandibular incisors. Adjustment loops allow clinicians to shorten, lengthen raise or lower the wire into passive contact with the incisor cingula.

9. CLASS II ELASTICS (Intermaxillary Anchorage)¹⁵

In 1898 Calvin case advocated the use of reciprocal elastics to effect movement between individual teeth in opposite arches. However it remained for Baker, with the use of Angles E arch, to apply those elastics in correction of class II irregularities. In his seventh edition, Angle called intermaxillary anchorage is the ideal force. The reciprocal activity at each end of rubber band, he claimed, provided the best anchorage for correction of class II condition and creation of normal occlusion.

Intermaxillary elastics pit the upper teeth to the lower teeth and are common means of gaining differential tooth movement. The direction of the elastic defines its force vector and the terminology used to describe it. Class II elastics attach to the anterior maxillary teeth and the posterior mandibular teeth. Thus a class II elastics acts to correct a class II relationship by proving a retraction force to the upper anterior teeth and a simultaneous protraction force to the lower molars.

Alternatively class III elastic hooks from the lower anterior teeth to the upper posterior teeth creates a force for lower anterior retraction and upper protraction for the resolution of a class III occlusion.

The major limitation of elastics as an anchorage technique is their dependence on patient compliance.

10. LIP BUMPER¹⁶

A removable arch of 1.45 mm stainless steel with anterior lip bumper inserted into auxiliary tubes of lower molars. The bumper rests 2-3 mm in front of lower incisors

.It exerts distal force on molars from muscle pressure of lower lip. The loops in front of molar tubes allow for sagittal and vertical adjustment. It maintains arch length and anchorage potential of lower molars. The lower incisors may be proclined as a result of lower lip being held out of contact with labial surface of the lower incisors, which is desirable in some situations. The patient is generally asked to wear it full time.

11. DIFFERENTIAL FORCE (Tip Edge Concept)¹⁷

This technique allows initial tipping followed by root uprighting. Simple tipping free tipping requires far less anchorage than moving the same teeth bodily.

Of course tipping constitutes only half the treatment and the root uprighting, necessary to produce finishing root angulations may occupy latter half of the treatment time. However it is a striking feature of differential tooth movement that total anchorage requirement and duration of treatment, seems significantly less than straight wire or edgewise systems particularly in difficult cases.

12. SEGMENTAL MECHANICS¹⁸

Unfortunately, the many active and reactive forces produced by a continuous arch can combine to produce extrusion of the posterior teeth rather than intrusion of the incisors. Controlled distribution of forces between the anterior and posterior parts of a fixed appliance can only be accomplished by dividing the arch into segments. Each segment is consolidated into a rigid unit by a section of heavy rectangular wire, with little or no play between wire and bracket slot.

The anterior segment, usually including the four incisors and possibly the canines, forms the active unit, and the two posterior segments, including the premolars and molars, are the reactive units. When necessary, the reactive units are connected by a transpalatal bar to form a single rigid, multirouted entity.

The planned displacement of the anterior unit and the corresponding reaction of the posterior units are carried out by connecting the anterior and posterior units with active elements, such as retraction spring. Clinically, the point of force application is the bracket. If a pure force is directed distally through the bracket, the tooth will undergo a distal tipping movement.

If a pure translational movement of the tooth is desired, the moment must be neutralized. This can be done by calibrating the retraction spring to produce a couple at the canine bracket.

13. SKELETAL ANCHORAGE¹⁹

Skeletal anchorage is applied to orthodontic tooth movement when 'Absolute anchorage' is necessary. With

various skeletal fixtures forces might be applied to produce tooth movement in any direction without detrimental reciprocal forces

METHODS OF OBTAINING SKELETAL ANCHORAGE

1. Conventional Dental Implants
2. Palatal Endosseous Implants
3. Onplant
4. Mini implant
5. Spider Screw
6. Micro implant
7. C-orthodontic Micro implant
8. Impacted Titanium Post
9. Transitional Implants
10. Mini Plate
11. Zygoma Anchorage System
12. Zygomatic Ligatures

IMPLANTS IN ORTHODONTICS

Implants solve one of the orthodontists' dilemmas, anchorage control. The innate ability of an Osseo integrated implant can provide this advantage. The reliance on patient co- operation would be minimized because the use of head gear and elastics would be eliminated.

SITES FOR IMPLANT PLACEMENT

Maxillary zone	Mandibular zone	Extra orally
Infrazygomatic-crest area Maxillary-tuberosity area Anterior nasal spine Midpalatal area Alveolar ridge Extraction site	Retro molar area Symphysis area Lingual plate Interdental region	Temporal buttress Zygomatic buttress

SELECTING THE SITE FOR INSERTION OF AN IMPLANT

It involves considering several factors

- The primary purpose of the implant (is it exclusively orthodontic or will it also be used prosthetically)
- The patient's skeletal age
- The quality and quantity of bone available.
- Pathologies in operation site
- Anatomical structures
- Biomechanical requirements and The specific therapeutic indication

APPLICATIONS OF IMPLANTS IN ORTHODONTICS

The anchorage derived from implants is categorized into:

1. Direct anchorage in which an Endosseous implant used for as an anchorage site
2. Indirect anchorage in which implants are used for preserving anchorage.

The various applications of implants in orthodontic perspective includes

1. Orthopedic anchorage
2. Maxillary expansion
3. Maxillary protraction
4. Head gear like effects
5. Dental anchorage
6. Space closure
7. Intrusion of anterior teeth
8. Intrusion of posterior teeth
9. Distalization
10. In conjunction with prosthetic rehabilitation (Direct anchorage)

14. EXTRA ORAL METHOD OF ANCHORAGE²⁰

In the treatment of many types of mal occlusion, intra oral anchorage is insufficient to achieve the required tooth movements .To overcome this problem ,extra oral anchorage used to supplement the intraoral anchorage Head gear they are again classified according to the point of origin of force as follows:

1. **Cervical**-Anchorage derived from the nape of neck.
2. **Occipital**-Anchorage obtained from the back of the head.
3. **Parietal**-Anchorage obtained from the upper part of the head'

Another classification is as follows:

1. **High pull head gear:** Anchorage obtained from the upper part of the head and direction of the pull is always above the center of resistance of the dentition.
2. **Straight pull head gear:** Anchorage obtained from the back of the line of traction is parallel to the occlusal place.
3. **Cervical pull head gear:** the combination of cervical pull and high pull head gear with varying proportions of force to each, depending on case requirements.

Head straps - named according to where they are used

Face bow: Inner – Outer bow type
J – Hook type

Another variable in the head gear is the outer bow of the face bow. The outer bow can be long, medium and short. The site of the point of origin of force is the relatively fixed by the position of the head gear strap and the center of resistance of the molar remains constant till the tooth has moved. Therefore inclination of the line of action may be altered only by variations in the position of the bow. They can be achieved by varying the length of the outer bow, the angulation between the inner and outer bow or a combination of both. The center of resistance of the maxilla is in the area of postero-superior aspect of zygomatico maxillary suture. The center of resistance of the maxillary dentition is situated between the roots of the premolars. The center of resistance of maxillary molar is in the trifurcation area.

Cervical pull head gear

In this head gear when the inner and the outer bow are in the same plane there is a clockwise rotation of both the maxilla and the dentition. The incisor region will move inferiorly to a greater extent than the molar region. If the outer bow is bend upwards so that the direction of the traction between the center resistance of the maxilla and the dentition in an anticlock wise direction. Hence the molars will experience a more downward pull than incisors.

Parietal pull/high pull head gear

when the direction of traction is placed behind the center of resistance of the maxilla and the dentition, a clockwise rotational effect on maxilla and the dentition is observed. Hence the molars intrude incisors extrude. Least vertical dimension and rotational changes are observed when the applied force vector passes through the center of resistance of the maxilla and the dentition. This is therefore, the preferred setup for the vertical control. But so far it has not been possible to construct a stable head strap for anchoring such a steep force vector.

Combipull type head gear

This allows a distal force through the center of resistance of the dentition having equal parietal and cervical components when the outer bow is angled upward to pass through the center of resistance. Hence the center of rotation is at infinity. This allows for more distalization of the molar with minimum rotational effect.

Force system depends on following factors

1. Orientation of the outer bow
2. Length of the outer bow
3. Point of attachment of head strap

Most of the authors agree that the amount of force applied to the maxilla by the head gear should be between 400-800 grams. According to marcotte force value of

200grams per side in mixed dentition and 500 gms per side in mixed dentition and 500gms per side in permanent dentition for 18 hours per day is suggested.

Graber advocates force application of more than 400gms for 10 hours per day. Alexander used force of 16 ounces per side once the patient acquainted with the head gear assembly. Duration of wear depends on severity skeletal discrepancy and the ANB angle.

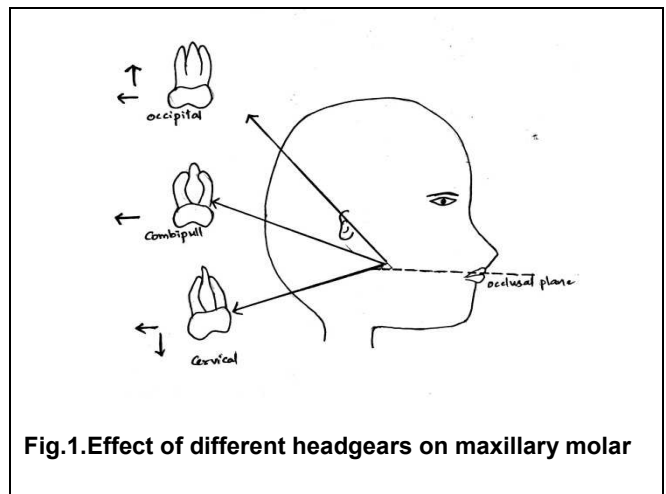


Fig.1. Effect of different headgears on maxillary molar

Roth used the Ascher's face bow on both the arches applying a force of 15 ounces to upright and retracts procumbent incisors. He uses it for short duration till they get up righted.

ANCHORAGE PLANNING²¹

The anchorage requirement depends upon

1. **The number of teeth to be moved**
2. **The type of teeth being moved**
3. **Type of tooth movement**
4. **Periodontal condition**
5. **Duration of tooth movement**
6. **Anchorage value** -Anchorage value of any tooth is roughly equal to its root surface area. Molar and 2nd premolar in each arch is approximately equal in surface area to incisors and canine.

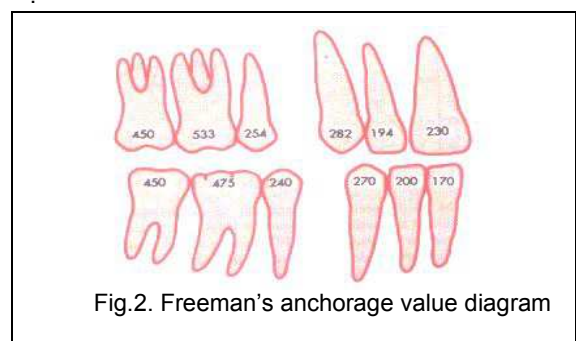


Fig.2. Freeman's anchorage value diagram

ANCHORAGE LOSS²²

In orthodontic treatment, anchorage loss is a potential side effect of orthodontic mechanotherapy and one of the major causes of unsuccessful results
Anchor loss can occur in all 3 planes of space

<p>Sagittal plane: Mesial movement of molars Proclination of anteriors</p>
<p>Vertical plane: Extrusion of molars, Bite deepening due to anterior extrusion</p>
<p>Transverse plane Buccal flaring due to over expanded arch form and unintentional lingual root torque. Lingual dumping of molars</p>

Therefore, clinicians throughout the years have made an effort to find biomechanical solutions to control anchorage Tweed²³, Holdaway²⁴ and Merrifield²⁵ developed different types of anchorage preparation to increase the efficacy of treatment. Storey and Smith³¹ introduced new concepts of force, in which an optimum range of force values should be used to produce a maximum rate of movement of the canine without producing any discernible movement of the molar anchor unit. This underlying concept encouraged Begg³² to put forth a clinical concept called “**differential forces in orthodontic treatment.**”. Retraction mechanisms and bracket designs²⁶ have also been developed to improve tooth movement and anchorage control. Bio progressive technique of Ricketts et al takes advantage of bone physiology and its reactions to applied forces. Ricketts et al¹⁸ suggested that by placing the roots of the molar teeth against the dense and laminated cortical bone with its limited blood supply, tooth movement is delayed and anchorage enhanced. In terms of mechanics, the Bio progressive technique uses sectional arches that could be more advantageous for tooth movement in force quantity and direction, without disrupting the posterior unit.

Factors such as malocclusion, type and extent of tooth movement (bodily/tipping), root angulation and length, missing teeth, intraoral/extra oral mechanics, patient compliance, crowding, over jet, extraction site, alveolar bone contour, interarch interdigitation, skeletal pattern, third molars, and pathology (i.e., ankylosis, periodontitis) affect anchorage loss.

ANCHORAGE IN DIFFERENT APPLIANCE SYSTEMS

ANCHORAGE IN REMOVABLE APPLIANCES²⁷

Removable appliances mainly obtained anchorage from base plate.

In removable functional appliance: Tooth borne appliances

Activator Bionator and Twin block

1. Capping of incisal margins of lower incisors and proper fit of cups of teeth into acrylic.
2. If deciduous molars are present, it is used as anchor teeth.
3. Edentulous areas after loss of deciduous molars.
4. Labial bow prevents anterior flaring and posterior displacement of the appliance.

Base plate	Point of attachment for the active components. Distribution of reactionary forces to the teeth and tissues.
Labial bow	1.prevents the proclination of incisors which aids in the stationary anchorage

ANCHORAGE IN FUNCTIONAL APPLIANCES²⁸

Tissue borne appliances

Vestibular screen and Frankels functional regulator Gains anchorage by extending acrylic into vestibule.
Head gears can be used as adjuncts

In fixed functional appliances

Conventionally in the maxillary arch the 1st premolars and permanent 1st molars are interconnected on each side. In mandibular arch the 1st premolar bands are connected. This type of anchorage is called **partial anchorage**.

In some instances this type of anchorage is insufficient and therefore must be increased by the incorporation of additional dental units. In the maxillary arch labial sectional wire is placed in the brackets of premolars, canines, incisors. In the mandibular arch lingual sectional wire is extended to 1st permanent molars which are banded. This form of anchorage is called **Total anchorage**.

In the deciduous and mixed dentition period bonded type of herbst is used because of absence of 1st premolars. This system is called **splint anchorage system**.

In Pellot anchorage system, the mandibular arch with the lingual arch wires acrylic pelott is fabricated and fixed touching the lingual mucosa about 3mm below the gingival margin. This system is most efficient in withstanding the stresses placed on lower anterior teeth.

ANCHOR MEASURES IN DIFFERENT APPLIANCES

1. EDGEWISE TECHNIQUE²⁹

Second order Tip-back bends are utilized to prepare anchorage. The degree of tip-back on the terminal molars should be such that when the arch wire is placed in the buccal tubes, it will cross the cuspid teeth at their dento-enamel junctions. After placing the arch wire in the molar tubes of the terminal molars when it is raised and ligated to the two brackets on the first molar teeth, the mesial cusps of the terminal molars are elevated and the first molars are depressed. At this point the arch wire will lie gingival to the brackets on the second premolar teeth. When the arch wire is placed in the slots of the second premolar brackets, first molars are elevated and the second premolars are depressed. Thus, the force necessary to tip the terminal molars transferred to the second premolar teeth. Now the arch wire lies gingival to the first premolar brackets. When the arch wire is ligated to the first premolar brackets, first premolars are depressed and second premolars are elevated. Thus terminal molars are being tipped distally at the expense of depressing the first premolar teeth.

2. BEGG APPLIANCE³⁰

The Beggs appliance offers an economy in the use of intra oral anchorage. This is brought about in the first place, through bodily control given to anchor units with the help of anchor bend (tip-back bend) and, the freedom to tilt offered to the units that are to be moved and the light Differential forces employed.

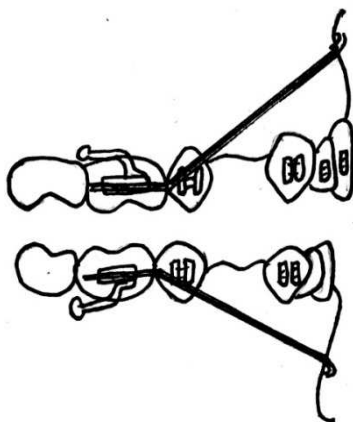


Fig.3.Anchor bend in Begg Technique.

The light forces are inadequate to cause rapid movement of the anchorage unit, and forces applied to correct the axial inclinations of the tilted units, in the later stage of the treatment partially counterbalance one another. When intermaxillary elastics are added, the two dental arches virtually becomes one unit, the whole being resistant to any displacing force created by the balance action of the spring axillaries.

Anchorage for retraction

After arch wire attached Class II elastic between intermaxillary hook of upper arch wire and hook on mesial end of lower molar tube.it will tend to pull molar forward and retract anteriors. Anchorage Bend counteracts mesial pull. If appropriate Anchorage Bend and elastics are used (proper m/f) tooth lean upright, and if teeth move- teeth will move bodily. At the same time elastics retract anteriors lingually by tipping

Anchorage Bend force in first stage and net distal movement of upper molar :

Anchorage Bend tends to tip the molar roots forward and crown backward. Net effect of widespread difference between the high resistance root tipping and the low resistance crown tipping leads to more crown movement. If molar mesially inclined at commencement of treatment, net distal movement of crown to upright position can be sig. for - class II correction and increase in arch length in nonextraction cases.

Anchorage Bend force in first stage with or without net distal movement of lower molars

Lower molar crown also have tendency to tip back that can be controlled by varying the force of class II elastics. 11/2 – 21/2 ounce (nonext.) crown may tip back more and root tip forward less. 21/2 – 31/2 ounce (ext.) both crown and root may tip, up righting the tooth but imparting little or no distal tipping .

3. ROTH PRESCRIPTION³¹

He Provides over-corrected tooth positions prior to the appliance removal. The banding of second molars at the onset of treatment can minimize the need for extra oral reinforcement of anchorage.

Leveling and alignment:

small flexible wire helps conserve anchorage. Small wires exert light forces on teeth and the overbite and occlusion hold the arches in the respective positions and prevent forward migration.

Leveling the curve Spee:

Leveling with a continuous wire will lead to slippage of anchorage. This can be avoided by assessing the incisor portion and if permitted by intruding them.

Retraction of the canines and incisors:

While attempting retraction importance should be given to position of the anteriors. Retracting procumbent incisors using reciprocal forces burn up more anchorage than that which can be anticipated. Hence initially to retract and the

upright these anterior, an Ascher's face bow can be used in both the upper and lower arches, for upto 6-8 weeks'. Once incisors upright, they offer very little resistance as anchor unit and can be easily retracted.

Space closure:

If one attempts to close the space faster regardless of wire size, tipping will occur inevitably. It is possible to close extraction spaces on an 0.016" round wire at a well-modulated rate without tipping whereas one can take a large rectangular wire with closing loop mechanics and end up tipping if the activation of the loop is done too frequently.

Counter buccolingual tip:

This feature is added only to the maxillary molar translation brackets. As the molar translates mesially during space closure, due to the presence of the prominent palatal root, it tips buccally thus rendering the buccal cusps more gingival to the palatal cusps. This effect is resolved by counter bucco-lingual tip feature in tube by placing buccal root torque.

- Minimum – 4° more torque
- Medium - 5° more torque
- Maximum- 6° more torque

Adjuncts used

Head gear: Roth does not encourage prolonged use of head gear either for distalization or for preventing forward migration of dentition. He states that the use of extra oral force can be avoided by

- a. Using small flexible wires for leveling and alignment
- b. Bonding second molars at the onset of treatment
- c. Leveling and curve of Spee using utility arches to intrude incisors.

The Ascher's face bow that he advocated connects directly to the anterior teeth, with a force of 12-15 ounces and the duration is kept to a minimum of 6-8 weeks till the anterior upright. Roth also use the Goshgarian type TPA and lip bumper.

SAGITTAL CONTROL

- Second molar banding
- Upright anteriors - little resistance to lingual tipping
- Anterior face bow is used to retract the proclined incisors
- Maximum anchorage – Asher face bow
- Moderate anchorage - Double key- hole loops

VERTICAL CONTROL

- Utility arches to intrude incisors
- Short intermaxillary elastics: 1/8", 4-8 Oz pull – no extrusion of molars
- TRANSPALATAL ARCH: 6-8mm away from the palate – intrusion of molars.

4. VARISIMPLEX TECHNIQUE³²

- Developed by Wick Alexander
- Used Single width brackets except u/incisors
- Increased interbracket distance leading to Lighter force delivery .

1. Driftodontics
2. Individual Canine Retraction.
3. Anchorage Conservation in Mandible
4. Anchorage Conservation in Maxilla
5. Headgear
6. Elastics

DRIFTODONTICS

The mandibular anterior teeth have a tendency to drift distally and the mandibular posterior teeth to drift mesially. Appliances are placed only on the maxillary arch until a class I cuspid relation is achieved. The late placement of mandibular appliance is referred to as Driftodontics.

Anchorage Conservation In Mandible

Mandibular molar has – 6 ° distal tip incorporated in it which promotes leveling and helps in gaining arch length (Tweed's philosophy)

Anchorage Conservation In Maxilla

- Tying back of orthodontic wires
- Omega loops - Preferred method
- Arch wire bend backs

HEADGEAR

DIRECTION OF PULL and INDICATION

Cervical pull	SN –MP < 37°
Combination pull	37 to 41°
High pull	SN – MP > 42°

FORCE and TIME OF WEAR

- Initially - 8 Oz , from next appointment – 16oz

ANB is 3° or less	Advised Only during sleeping
ANB 3 to 5°	10 hrs / day
ANB > 5°	14 hrs / day

ELASTICS**Anchorage considerations during elastic wear**

- Elastics are not used until the patient is in finishing arch wires - 17x25 stainless steel in both arches
- Attached from the mandibular II molar to the hook on maxillary lateral incisor

Other Intra Oral Appliances

- Trans palatal arch
- Lower lingual arch
- Nance holding arch

5. MBT TECHNIQUE³³

Anchorage control can be discussed in three planes: horizontal, vertical and lateral planes. Anchorage control in all the three planes is inter-connected and failure to control one plane can cause problems with another.

Control of anchorage in horizontal plane

Anchorage in horizontal plane includes the achievement of the correct antero posterior position of the teeth at the end of the treatment and involves limiting the mesial movement of the posterior teeth while encouraging the distal movement of the anterior teeth. This can be further divided into

1. Control of anterior segments
2. Control of the posterior segments in the upper and lower arch.

Control of anchorage in anterior segments

- Lace backs and bends backs – to prevent proclination of anterior teeth during aligning and leveling phase.
- Reduce the anchorage needs during leveling and aligning.
- Bracket design – reduced tip.
- Arch wire forces – use of very light arch wire forces.
- Avoidance of elastic chain

Control of anchorage in upper posterior segments

Posterior anchorage requirements are normally greater in the upper arch than in the lower arch because of the following reasons

- Upper molar moves mesially more easily than the lower molars.
- Upper anterior teeth are bigger.
- Upper anterior brackets have more tip built into them

- Upper incisors require more torque control and bodily movement than lower incisors which require distal tipping or uprighting.
- Most of cases are class II type of malocclusion.

Due to these factors extraoral force is the most effective way to provide Control of anchorage in upper posterior segments.

- A transpalatal arch can be used in moderate anchorage cases.
- The Nance holding arch can be used during leveling, aligning and canine retraction stages.
- Control of anchorage in lower posterior segments
- When extra anchorage support is needed in lower posterior segments it can be effectively obtained by
- Lingual holding arch.
- Class III elastics (by not taxing the lower anchorage)
- Head gear.

Control of anchorage in vertical plane

Anchorage control in vertical plane involves prevention of the vertical skeletal and dental development in the posterior segments (as with high mandibular plane angle cases) and prevention of vertical eruption or intrusion of anterior segments

Vertical control of incisors

Because of the tip built in the canine brackets a transient deepening of bite occurs in the initial aligning and leveling phases. If canines are distally tipped to begin with as the arch wire is engaged in the canine slot it lies incisal to the incisor bracket slots causing undesirable extrusion incisors when the wire is engaged. This effect can be minimized by either not engaging the wire in incisor brackets or not bonding the incisors until canines are up righted.

Vertical control of canines

High labial canines should not be engaged with arch wire because it causes unwanted vertical movement of lateral incisors and premolars. The unwanted effects of fully engaging the arch wire in the brackets of high labial canines may be minimized by lightly tying the canines into the primary arch wire with elastics thread.

Vertical control of molars in high angle cases

Vertical control of molars is critical in high angle cases:

1. Transpalatal arch should lie about 2mm away from palate so that the tongue can exert a vertical intrusive effect.

2. When head-gears are used in high – angle cases either a combination pull or a high pull headgear is used. Cervical pull headgear is avoided.
3. Upper or lower posterior bite planes in molar region is helpful to minimize extrusion of molars.
4. Upper 2nd molars are generally not initially banded, to minimize extrusion of these teeth.
5. If upper molars require expansion, an attempt is made to achieve bodily movement rather than tipping.

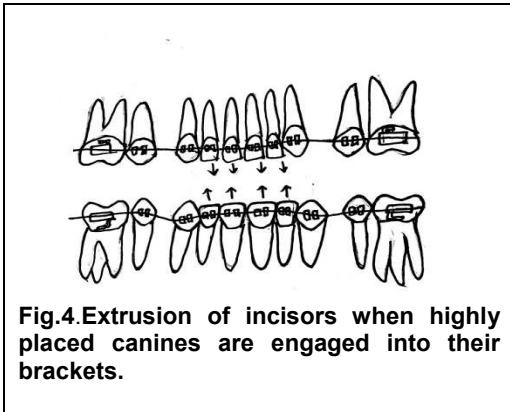


Fig.4.Extrusion of incisors when highly placed canines are engaged into their brackets.

Control of anchorage in transverse plane

Anchorage control in transverse plane involves the maintenance of expansion procedures, primarily in the maxillary arch, and the avoidance of tipping and extrusion of the posterior teeth during expansion

- Inter canine width should not be altered to great extent during the treatment. It should be kept as close as possible to starting dimensions for stability. Care should be taken to ensure that crowding is not relieved by uncontrolled expansion of the upper and lower arches.
- Molar cross bites should be corrected by bodily movement of molars. As far as possible the tipping should be avoided.
- If maxilla is too narrow, early rapid expansion should be considered prior to leveling and aligning. If adequate maxillary bone exists, a fixed quad helix expander is used. Minimal molar cross bites are usually corrected by using rectangular wires which are slightly expanded from normal and which carry buccal root torque.

5. SEGMENTAL TECHNIQUE¹⁸

Right and left buccal segments are consolidated by TPA and lingual arches. After alignment, each is treated as one large multi-rooted tooth.

Anchorage control

- Stress levels on the anchor unit should be kept low.

- Heavy rigid arch wire segments in anchor unit.
- Applying a moment for bodily control of anchor unit.
- Differential force system to control the moment to force system

Anchorage units



- Posterior units consists of buccal segments Pm,I molar, II molar.
- Connected by TPA in the maxilla and Lingual arch in the mandible.
- Buccal stabilizing segments – 19x25stainless steel

Vertical control

Deep overbite correction

- Intrusion of anterior teeth
- Extrusion of posterior teeth
- Combination

Sagittal control

Tie back:

- Buccal segment wire is bent gingivally in to a small hook
- 0.018”TMA can be welded mesial to the molar
- Omega loop – mesial to the first molar
- Washer can be crimped on the wire

Space closure

- Alpha or anterior moment
- Beta or posterior moment
- Horizontal force

Group A anchorage

- Extra oral appliances
- Inter maxillary elastics
- Applying differential M/F ratio

Group B anchorage

- Requires equal translation of the anterior and posterior segments into the extraction space
- Equal and opposite forces and moments are indicated
- T- loop is placed in the center b/w anterior and posterior attachments

Group C anchorage

- Alpha moment is increased relative to the Beta moment
- Spring is positioned closure to the anterior segment

- Anchorage reinforcement
- Intermaxillary elastics
- Protraction headgear

6. BIOPROGRESSIVE THERAPY¹³

Bioprogressive therapy given by Ricketts includes

1. Stabilization of upper and lower molar anchorage according to grade of anchorage.
2. Retraction and uprighting cuspids with sectional mechanisms.
3. Retraction and consolidation of upper and lower incisors.
4. Continuous arches for details of ideal and finishing occlusion.

UPPER MOIAR

Maximum anchorage	Moderate anchorage	Minimum anchorage
1.Nancebutton 2.Head gear 3.Combination of both	1.Quad Helix 2.Upper utility arch 3.Sectional retraction then anterior retraction	Reciprocal closure

LOWER MOLAR

Maximum anchorage

1. Buccal root torque (45⁰).
2. Expansion of molar section of 10mm on each side.
3. Tip back of 30⁰ – 40⁰ keeps the molar upright and resists the forward pull.
4. Distal molar rotation of 30⁰ -40⁰ is also placed.

Moderate anchorage: Contraction utility arch

Minimum anchorage: Round wire in the molar tube.

7. LEVEL ANCHORAGE SYSTEM³⁴

Integrated approach to orthodontic treatment.

- Pre adjusted edgewise appliance
- Preformed arch wires
- Detailed and carefully validated approach to Rx planning
- Step by step Rx procedure for ext. and non ext cases
- Timing chart, Self check chart

ANCHOR SAVER: Distal crown tip

Two choices of distal crown tip for the mandibular buccal teeth

- Regular series -10⁰,6⁰,4⁰[6,5,4]
- Major Series -15⁰,10⁰,6⁰[6,5,4]

8. INVERSE ANCHORAGE TECHNIQUE³⁵

- Anchorage preparation chiefly in maxilla
- Treatment begins in the maxilla starting from distal segment and moves sectionally towards mesial --- Distomesial sequence.so there is no strain on anchors.

Steps

1. Posterior leveling
2. Posterior retraction
3. Anterior leveling
4. Anterior retraction

9. LINGUAL ORTHODONTICS³⁶

The placement of lingual brackets invariably causes anterior bite opening and posterior disocclusion in cases with normal or deep overbite. While the contribution of an intercuspated occlusion to the provision of a degree of anchorage may be debatable and vary with different malocclusions, the bite plane effect of the lingual appliance with resulting loss of occlusion and intercuspation may in certain cases reduce the anchorage achieved with the lingual technique.

Takemoto suggested anchorage value of posterior teeth in the lingual technique is higher than that of the labial technique due to proximity of the lingual brackets to the center of resistance of the tooth. In addition, the direction of forces during space closure creates a degree of buccal root torque and distopalatal rotation of the molar crown, which in turn produces cortical bone anchorage.

In certain cases where anchorage need to be reinforced, a modified pendulum appliance can be placed to reduce anchorage loss. Good anchorage control is achieved with lingual orthodontic sliding mechanics when following simple anchorage principles. Cases presenting with difficult anchorage situations and with unusual extraction sites can be treated successfully with this technique.

CONCLUSION

Anchorage should be of prime consideration before the treatment plan is formulated. The skeletal and dental anchorage should be judiciously planned for a better finish and complete success in orthodontic therapy. Anchorage plays a prominent role in utilization of extraction spaces, use of head gears, retraction mechanics, etc

To conclude we will summarize briefly what we consider the so called modern concept of anchorage. It involves the use of existing anchorage, prepared anchorage, skeletal anchorage and reinforced anchorage. Proper diagnosis through recognition of anchorage availability must be made for better finishing of the case.

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