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Anchorage in orthodontics

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Abstract---Before starting active treatment of any orthodontic case, anchorage mustbe planned well to get rid of the problems that might accompanied the treatment procedures. This article reviewed the anchorage from all aspects starting from the definition, sources, types, planning, anchorage loss and how to avoid it.

Keywords---anchorage, orthodontics, treatment procedures.

Introduction

According to the third law of Newton, for every action there is a reaction equals in amount and opposite in direction. This can be applied in orthodontics simply when retracting canine against posterior teeth. The expected thing is distalization of the canine in the first premolar extraction site against mesial (forward) movement of the posterior teeth which called anchorage unit.

According to Graber¹, the term anchorage is referred as “the nature and degree of resistance to displacement offered by an anatomic unit when used for the purpose of affecting tooth movement”, while Gardiner et al². defined it as “the site of delivery from which a force is exerted”. On the other hand, Lewis defined anchorage simply as “the resistance to unwanted tooth movement”.

Sources of orthodontic anchorage

Basically, the sources of orthodontic anchorage can be summarized as:

A. Intra-oral sources

1. Teeth
2. Alveolar bone
3. Cortical bone
4. Basal jaw bone
5. Musculature

B. Extra-oral sources

1. Cranium
 - Occipital bone
 - Parietal bone
2. Facial bones
 - Frontal bone
 - Mandibular symphysis
3. Back of the neck (cervical bone)

Intra-oral sources of anchorage

1. Teeth: In orthodontics, teeth themselves are the most frequently used anchorage unit to resist unwanted movement. Forces can be exerted from one set of teeth to move certain other teeth. Many factors related to the teeth can influence the anchorage like: the root form, the size (length) of the roots, the number of the roots, the anatomic position of the teeth, presence of ankylosed tooth, the axial inclination of the teeth, root formation contact points of teeth and their intercuspation.

1.1. Root form

Generally, the root in cross section can be either round, flat (mesio-distally) or triangular. The distribution of the periodontal fibers on the root surface aid in anchorage. The more the fibers, the better the anchorage potential. The direction of attachment of the fibers also affects the anchorage offered by a tooth. Round roots have only half their periodontal fibers stressed in any given direction, hence offer the least anchorage. Mesio-distally flat roots are able to resist mesiodistal movement better as compared to labio-lingual movement as more number of fibers are activated on the flatter surfaces as compared to the relatively narrower. Triangular roots, like those of the canines are able to provide greater anchorage. Their flatness adds to resistance. The tripod arrangement of roots like that seen on maxillary molars also aids in increasing the anchorage. The round palatal root resists extrusion and the two flat buccal roots resist intrusion and the mesio-distal stresses.

Size (length) of the roots: The larger or longer the roots, the more is their anchorage would be. The maxillary canines, because of their long roots can be the most difficult teeth to move in certain clinical circumstances.

Number of roots: The greater the surface area of the root, the greater the periodontal support and hence, greater the anchorage potential. Multi-rooted teeth provide greater anchorage as compared to single rooted teeth with similar root length.

Anatomic position of the teeth: Sometimes the position of the teeth in the individual arches also helps in increasing their anchorage potential. As in the case of mandibular second molars, which are placed between two ridges—the mylohyoid and the external oblique, they provide an increased resistance to mesial movement.

Presence of ankylosed teeth: Orthodontic movement of such teeth is not possible and they can therefore serve as excellent anchors whenever possible.

Axial inclination of the tooth: When the tooth is inclined in the opposite direction to that of the force applied, it provides greater resistance or anchorage.

Root formation: Teeth within complete root formation are easier to move and are able to provide lesser anchorage.

Contact points: Teeth with tight intact and/ or broad contacts provide greater anchorage.

Intercuspatation: Good intercuspation leads to greater anchorage potential. This is mainly because the teeth in one jaw are prevented from moving because of the contact with those of the opposing jaw, this is especially true for teeth in the posterior segment which also show the presence of attrition facets.

Alveolar bone: The investing alveolar bone around the root offers resistance to tooth movement up to a certain amount of force, exceeding which there will be bone remodeling. Less dense alveolar bone offers less anchorage. More mature bone increases anchorage. This takes place because of two factors—one, the bone becomes more calcified and dissolution takes time and two, the regenerative capacity of the bone decreases. Forces that are dissipated over a larger bone surface area offer increased anchorage.

Cortical bone: Ricketts floated the idea of using cortical bone for anchorage. The contention being that the cortical bone is denser with decreased blood supply and bone turnover. Hence, if certain teeth were torqued to come in contact with the cortical bone, they would have a greater anchorage potential. The idea as such remains controversial as tooth roots also show resorption in such conditions and the risk of non-vitality of such teeth is also more.

Basal jaw bone: Certain areas of basal jaw bone such as hard palate and lingual surface of anterior mandible can be utilized in order to enhance the intra-oral anchorage. Nance palatal button uses the anchorage provided by the hard palate to resist the mesial movement of maxillary molars.

Musculature: Under normal circumstances, the peri-oral musculature plays an important part in the growth and development of the dental arches. Hypotonicity

of the peri-oral musculature might lead to spacing and flaring of the anterior teeth. The hypertonicity of the same muscles has the reverse effect. Lip bumper is an appliance that makes use of the tonicity of the lip musculature and enhances the anchorage potential of the mandibular molars preventing their mesial movement.

Extra-oral sources of anchorage

1. Cranium

Headgears derived anchorage from occipital or parietal regions of the cranium. These are used along with a face bow to resist the growth of maxilla or to move the maxillary teeth distally.

2. Facial bones

The frontal bone (forehead region) and mandibular symphysis (chin area) are used as resistance units during face mask therapy so as to protract the maxilla.

Back of the neck (cervical bone): The cervical headgears derived anchorage from back of the neck or cervical region. They are also used to bring about changes in the maxilla or maxillary teeth.

Classification of Anchorage

Generally, anchorage could be classified[8]:

I. According to the manner of force application:

1. Simple anchorage
2. Stationary anchorage
3. Reciprocal anchorage

II. According to jaws involved:

1. Intra-maxillary anchorage
2. Inter-maxillary anchorage

III. According to the site of anchorage:

1. Intra-oral anchorage
2. Extra-oral anchorage:
 - Cervical
 - Occipital
 - Cranial
 - Facial
3. Muscular anchorage

IV. According to the number of anchorage units:

1. Single or primary anchorage
2. Compound anchorage
3. Multiple or reinforced anchorage.

V. According to anchorage demands:

1. Maximum anchorage (Type A anchorage).
2. Moderate anchorage (Type B anchorage).

3. Minimum anchorage (Type C anchorage).
4. Absolute anchorage (direct and indirect anchorage).

Gardiner et al. [2] classified anchorage into six categories as followed:

1. Simple
2. Stationary
3. Reciprocal
4. Reinforced
5. Intermaxillary
6. Extra-oral.

5. According to the Manner of Force Application

5.1. Simple Anchorage

In this type, the manner and application of force is such that it tends to change the axial inclination of the anchor tooth or teeth in the plane of space in which the force is being applied. In other words, the resistance of the anchorage unit to tipping is utilized to move another tooth or teeth. In this type of anchorage, the appliance usually engages a greater number of teeth than are to be moved within the same dental arch. Ideally, the combined root surface area of the anchor teeth should be two times that of the teeth to be moved. The amount of force on each anchor tooth in simple anchorage is equal to the total moving force component of the appliance divided by the number of anchored teeth.

5.2. Stationary Anchorage

It is defined as dental anchorage in which the manner of application of force tends to displace the anchorage unit bodily in the plane of space in which this force is being applied. In this type of anchorage, the resistance of anchor teeth to bodily movement is utilized to move other teeth. Stationary anchorage provides greater resistance than simple anchorage to unwanted tooth movement.

5.3. Reciprocal Anchorage

The reciprocal anchorage refers to the resistance offered by two malposed units, when the dissipation of equal and opposite forces tends to move each unit towards a more normal occlusion. In some treatment procedures, it is desirable to move teeth or groups of teeth of equal anchorage potential in opposite directions. In such cases, it is possible to utilize their anchorage forces as moving forces to achieve the desirable changes. A frequently used form of reciprocal anchorage is known as intermaxillary traction in which, the forces used to move the whole or part of one dental arch in one direction are anchored by equal forces by moving the opposite arch in opposite direction, thus, correcting discrepancies in both the dental arches, also seen in cases of correction of midline diastema, bilateral symmetrical expansion and correction of single tooth crossbite.

6. According to Jaws Involved

6.1. Intra-maxillary Anchorage

Intra-maxillary anchorage is the anchorage in which the resistance units are situated within the same jaw. If appliances are placed only in maxillary or mandibular dental arches, they are considered intra-maxillary resistance units.

Class I elastic stretched from first molar to canine teeth in either of the dental arches is an example.

6.2. Inter-maxillary Anchorage (Baker's anchorage)

Inter-maxillary anchorage is the anchorage in which the units situated in one jaw are used to affect tooth movement in the other jaw. Class II elastic stretched from upper canine to lower molar to affect correction of class II malocclusion and Class III elastic stretched from upper molar to lower canine to correct class III malocclusion are good examples.

7. According to the Site of Anchorage

7.1. Intra-oral Anchorage

When intra-oral structures such as teeth and other anatomic areas are used as anchor units it is called intra-oral anchorage. Mini-screws can be considered as an absolute intra-oral anchorage.

7.2. Extra-oral Anchorage

Extra-oral anchorage is the anchorage established from extraoral structures. It included:

1. Cervical region: Use of cervical pull headgear.
2. Occipital region: Use of occipital pull headgear.
3. Forehead and chin: Use of reverse pull headgear.

7.3. Muscular Anchorage

Peri-oral musculature may be used as anchorage units in certain cases. For example, the lip bumper utilizes the force exerted by lower lip musculature to bring about distalization of mandibular first molar.

8. According to the Number of Anchorage Units

8.1. Single or Primary Anchorage

Single or primary anchorage is defined as the resistance provided by a single tooth with greater alveolar support to move another tooth with lesser alveolar support, e.g. retraction of a premolar using a molar tooth.

8.2. Compound Anchorage

It is the type of anchorage where more than one tooth with greater anchorage potential are used to move a tooth/group of teeth with lesser support.

8.3. Reinforced Anchorage/Multiple Anchorage

It frequently happens that the teeth available for simple anchorage are not sufficient in number or in size to resist the forces necessary for orthodontic treatment and that reciprocal anchorage is not appropriate to the type of treatment to be carried out. In such circumstance, it is necessary to reinforce the anchorage to avoid unwanted movements of the anchor teeth. Anchorage is said to be reinforced when more than one type of resistance units are utilized.

9. According to Anchorage Demands

9.1. Maximum anchorage (Type A anchorage)

A situation in which the treatment objectives require that very little anchorage can be lost.

9.2. Moderate anchorage (Type B anchorage)

A situation in which anchorage is not critical and space closure should be performed by reciprocal movement of both the active and the anchorage segment.

9.3. Minimum anchorage (Type C anchorage)

A situation in which, for an optimal result, a considerable movement of the anchorage segment (anchorage loss) is desirable, during closure of space.

9.4. Absolute anchorage

In this type of anchorage, mesial migration of the anchor unit is avoided conserving 100% of the extraction site space. In the last years, titanium temporary skeletal anchorage devices (TSAD) like mini-implants have been used in orthodontic treatment in order to provide absolute anchorage without patient compliance. These mini-screws are small enough to be placed in different areas of the alveolar bone. This type of anchorage can be divided into direct anchorage when the TSAD is used directly to move a tooth and indirect anchorage when a tooth or group of teeth are connected to TSAD that acts as periodontal-skeletal anchorage unit allowing for anchor tooth or group of teeth to be moved against this stabilized unit[10].

10. Planning of Anchorage in Orthodontic Cases

At the time of determining the space requirement to resolve the malocclusion in a given case, it is essential to plan for space that is likely to be lost due to the invariable movement of the anchor teeth. The anchorage requirement depends on[3,9]:

1. The number of teeth to be moved; the greater the number of teeth being moved, the greater is the anchorage demand.
Moving teeth in segments as in retracting the canine separately rather than retracting the complete anterior segment together will decrease the load on the anchor teeth.
2. The type of teeth to be moved; teeth with large flat roots and/or more than one root exert more load on the anchor teeth, hence, it is more difficult to move a canine as compared to an incisor or a molar as compared to a premolar.
3. Type of tooth movement; moving teeth bodily requires more force as compared to tipping the same teeth.

Causes of Anchorage Loss

1. Not wearing the appliance adequately.
2. Too much activation of springs or active components
3. Presence of acrylic or any obstruction on the path of tooth movement
4. Poor retention of appliance.
5. Anterior bite plane: as this withdraws the occlusal interlock.
6. Anchor root area not sufficiently greater than the root area of tooth or teeth to be moved.
7. If appliance encourage tipping movement of anchor teeth and bodily movement of the teeth to be moved.
8. Using heavy force in moving teeth.
9. Poor anchorage planning.

Signs of Anchorage Loss

1. Mesial movement of molars.
2. Closure of extraction space by movement of posterior teeth.
3. Proclination of anterior teeth.
4. Spacing of teeth.
5. Increase in overjet.
6. Change in molar relations.
7. Buccal cross bite of upper posteriors.

Means to Detect Anchorage Loss

1. Relating the position of other teeth to the teeth in the same and opposite arch.
 2. Increase in overjet.
 3. Checking the fitness of the removable appliance in the mouth.
 4. Measurements of the distance of anchor teeth from midline.
 5. Measurements from palatal rugae and frenum.
 6. Observation of the spacing mesial/distal to the anchor teeth.
 7. Inclination of the anchor teeth.
- Radiological examination (cephalometric radiograph).

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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