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ReviewArticle

UnderstandingAnchorageinOrthodontics-AReviewArticle

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1. Abstract

Beforestartingactivetreatmentofanyorthodonticcase,anchoragemustbeplannedwellto get rid of the problems that might accompanied the treatment procedures. This article reviewedtheanchoragefromallaspectsstartingfromthedefinition,sources,types,planning, anchorage loss and how to avoid it.

2. Definition

According to the third law of Newton, for every action there isa reaction equals in amount and opposite in direction. This can beappliedinorthodonticssimplywhenretractingcanineagainst posteriorteeth.Theexpectedthingisdistalizationofthecaninein the first premolar extraction site against mesial (forward) movement of the posterior teeth which called anchorage unit.

According to Graber[1], the term anchorage is referred as “the natureanddegreeofresistancetodisplacementofferedbyananatomic unit when used for the purpose of affecting tooth movement”, while Gardiner et al.[2]defined it as “the site of delivery from which a force is exerted”. On the other hand, Lewis [3] defined anchorage simply as “the resistance to unwanted tooth movement”.

3. SourcesofOrthodonticAnchorage

Basically, the sources of orthodontic anchorage can be summarizedas[4-7]:

A. Intra-oralsources

1. Teeth

2. Alveolarbone

3. Corticalbone

4. Basaljawbone

5. Musculature

B. Extra-oralsources

1. Cranium

- Occipitalbone
- Parietalbone

2. Facialbones

- Frontalbone
- Mandibular symphysis

3. Backoftheneck(cervicalbone)

A. Intra-oralsourcesofanchorage

1. Teeth: In orthodontics, teeth themselves are the most frequently used anchorage unit to resist unwanted movement. Forcescanbeexertedfromonesetofteethtomovecertainother teeth.Manyfactorsrelatedtotheteethcaninfluencetheanchoragelike:therootform,thesize(length)oftheroots,thenumber 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.

Rootform

Generally,therootincrosssectioncanbeeitherround,flat(me- siodistally) 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 ofthefibersalsoaffectstheanchorageofferedbyatooth.Round roots have only half their periodontal fibers stressed in any givendirection,henceoffertheleastanchorage.Mesio-distallyflat rootsareabletoresistmesiodistalmovementbetterascompared tolabio-lingualmovementasmorenumberoffibersareactivatedontheflattersurfacesascomparedtotherelativelynarrower

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labialorlingualsurfaces.

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 molarsalsoaidsinincreasingtheanchorage.Theroundpalatalroot resistsextrusionandthetwoflatbuccalrootsresistintrusionand the mesio-distal stresses.

Size(length)oftheroots

Thelargerorlongertheroots,themoreistheiranchoragewould be.Themaxillarycanines,becauseoftheirlongrootscanbethe most difficult teeth to move in certain clinical circumstances.

Numberofroots

Thegreaterthesurfaceareaoftheroot,thegreatertheperiodon- tal support and hence, greater the anchorage potential. Multi-rooted teeth provide greater anchorage as compared to single rooted teeth with similar root length.

Anatomicpositionofthe 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.

Presenceof ankylosedteeth

Orthodonticmovementofsuchteethisnotpossibleandtheycan therefore serve as excellent anchors whenever possible.

Axialinclinationofthetooth

Whenthetoothisinclinedintheoppositedirectiontothatofthe force applied, it provides greater resistance or anchorage.

Rootformation

Teethwithincompleterootformationareeasiertomoveandare able to provide lesser anchorage.

Contactpoints

Teethwithtightintactand/orbroadcontactsprovidegreateranchorage.

Intercuspation

Goodintercuspationleadstogreateranchoragepotential.Thisis mainly because the teeth in one jaw are prevented from moving becauseofthecontactwiththoseoftheopposingjaw,thisisespeciallytrueforteethintheposteriorsegmentwhichalsoshowthe presence of attrition facets.

2. Alveolarbone

Theinvestingalveolarbonearoundtherootsofferresistance 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. Thistakesplacebecauseoftwofactors—one,thebonebecomes morecalcifiedanddissolutiontakestimeandtwo,theregenera- tive capacity of the bone decreases. Forces that are dissipated over a larger bone surface area offer increased anchorage.

3. Corticalbone

Ricketts floated the idea of using cortical bone for anchorage. The contention being that the cortical bone is denser with decreasedbloodsuppliesandboneturnover.Hence,ifcertainteeth 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 conditionsandtheriskofnon-vitalityofsuchteethisalsomore.

4. Basaljawbone

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 anchorageprovidedbythehardpalatetoresistthemesialmovementof maxillarymolars.

5. Musculature

Under normal circumstances, the peri-oral musculature playsan important part in the growth and development of the dental arches. Hypotonicity of the peri-oral musculature might lead to spacingandflaringoftheanteriorteeth.Thehypertonicityofthe samemuscleshasthereverseeffect.Lipbumperisanappliance thatmakesuseofthetonicityofthelipmusculatureandenhanc- es the anchorage potential of the mandibular molars preventing their mesial movement.

B. Extra-oralsourcesofanchorage

1. Cranium

Headgears derived anchorage from occipital or parietal regions ofthecranium.Theseareusedalongwithafacebowtoresistthe growth of maxilla or to move the maxillary teeth distally.

2. Facialbones

The frontal bone (forehead region) and mandibular symphysis (chinarea)areusedasresistanceunitsduringfacemasktherapy so as to protract the maxilla.

3. Backoftheneck(cervicalbone)

Thecervicalheadgearsderivedanchoragefrombackoftheneck orcervicalregion.Theyarealsousedtobringaboutchangesin the maxilla or maxillary teeth.

4. ClassificationofAnchorage

Generally,anchoragecouldbeclassified[8]:

I. Accordingtothemannerofforceapplication:

1. Simple anchorage
2. Stationaryanchorage
3. Reciprocalanchorage

II. Accordingtojawsinvolved:

1. Intra-maxillaryanchorage
2. Inter-maxillaryanchorage

III. Accordingtothesiteofanchorage:

1. Intra-oralanchorage
2. Extra-oralanchorage:

- Cervical
- Occipital
- Cranial
- Facial

3. Muscularanchorage

IV. Accordingtothenumberofanchorageunits:

1. Singleorprimaryanchorage
2. Compoundanchorage
3. Multipleorreinforcedanchorage.

V. Accordingtoanchoragedemands[5,9-10]:

1. Maximum anchorage (Type A anchorage).
2. Moderateanchorage(TypeBanchorage).
3. Minimumanchorage(TypeCanchorage).
4. Absoluteanchorage(directandindirectanchorage).

Gardineretal.[2]classifiedanchorageintosixcategoriesasfollowed:

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

5. According totheMannerofForceApplication

SimpleAnchorage

In this type, the manner and application of force is such that it tendstochangetheaxialinclinationoftheanchortoothorteeth intheplaneofspaceinwhichtheforceisbeingapplied.Inother words, the resistance of the anchorage unit to tipping is utilized tomoveanothertoothorteeth.Inthistypeofanchorage,theappliance usuallyengagesagreaternumberofteeththanaretobe moved within the same dental arch. Ideally, the combined root surface area of the anchor teeth should be two times that of the teethtobemoved.Theamountofforceoneachanchortoothin simple anchorage is equal to the total moving force component of the appliance divided by the number of anchored teeth.

StationaryAnchorage

Itisdefinedasdentalanchorageinwhichthemannerofapplica- tion of force tends to displace the anchorage unit bodily in the plane of space in which this force is being applied. In this type ofanchorage,theresistanceofanchorteethtobodilymovement is utilized to move other teeth. Stationary anchorage provides greater resistance than simple anchorage to unwanted tooth movement.

ReciprocalAnchorage

Thereciprocalanchoragereferstotheresistanceofferedbytwo malposedunits,whenthedissipationofequalandoppositeforc- es 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.Insuchcases,itispossibletoutilizetheiranchorageforces asmovingforcestoachievethedesirablechanges.Afrequently used form of reciprocal anchorage is known as intermaxillary traction in which, the forces used to move the whole or part of onedentalarchinonedirectionareanchoredbyequalforcesby moving the opposite arch in opposite direction, thus, correctingdiscrepanciesinboththedentalarches,alsoseenincasesof correctionofmidlinediastema,bilateralsymmetricalexpansion and correction of single tooth crossbite.

6. Accordingto JawsInvolved

Intra-maxillary Anchorage

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

archesisanexample.

Inter-maxillaryAnchorage(Baker'sanchorage)

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. AccordingtotheSiteofAnchorage

Intra-oralAnchorage

When intra-oral structures such as teeth and other anatomic areas are used as anchor units it is called intra-oral anchorage. Mini-screwscanbeconsideredasanabsoluteintra-oralanchor- age.

Extra-oralAnchorage

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

1. Cervicalregion:Useofcervicalpullheadgear.

2. Occipitalregion:Useofoccipitalpullheadgear.

3. Foreheadandchin:Useofreversepullheadgear.

MuscularAnchorage

Peri-oralmusculaturemaybeusedasanchorageunitsincertain cases. For example, the lip bumper utilizes the force exerted by lowerlipmusculaturetobringaboutdistalizationofmandibular firstmolar.

8. AccordingtotheNumberofAnchorageUnits

SingleorPrimaryAnchorage

Singleorprimaryanchorageisdefinedastheresistanceprovided 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.

CompoundAnchorage

Itisthetypeofanchoragewheremorethanonetoothwithgreat- er anchorage potential are used to move a tooth/group of teeth with lesser support.

ReinforcedAnchorage/MultipleAnchorage

Itfrequentlyhappensthattheteethavailableforsimpleanchor- agearenotsufficientinnumberorinsizetoresisttheforcesnec- essary for orthodontic treatment and that reciprocal anchorageis not appropriate to the type of treatment to be carried out. In suchcircumstance,itisnecessarytoreinforcetheanchorageto avoid unwanted movements of the anchor teeth. Anchorage is saidtobereinforcedwhenmorethanonetypeofresistanceunits areutilized.

9. AccordingtoAnchorageDemands

Maximumanchorage(TypeAanchorage)

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

Moderateanchorage(TypeBanchorage)

A situation in which anchorage is not critical and space closure shouldbeperformedbyreciprocalmovementofboththeactive and the anchorage segment.

Minimumanchorage(TypeCanchorage)

Asituationinwhich,foranoptimalresult,aconsiderablemove- ment of the anchorage segment (anchorage loss) is desirable, during closure of space.

Absoluteanchorage

Inthistypeofanchorage,mesialmigrationoftheanchorunitis avoidedconserving100%oftheextractionsitespace.Inthelast years, titanium temporary skeletal anchorage devices (TSAD) like mini-implants have been used in orthodontic treatment in ordertoprovideabsoluteanchoragewithoutpatientcompliance. Thesemini-screwsaresmallenoughtobeplacedindifferentar- eas of the alveolar bone. This type of anchorage can be divided intodirectanchoragewhentheTSADisuseddirectlytomovea 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. PlanningofAnchorageinOrthodonticCases

At the time of determining the space requirement to resolve the malocclusioninagivencase,itisessentialtoplanforspacethat islikelytobelostduetotheinvariablemovementoftheanchor teeth. The anchorage requirement depends on[3,9]:

1. Thenumberofteethtobemoved;thegreaterthenum- ber 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. Thetypeofteethtobemoved;teethwithlargeflatroots 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. Typeoftoothmovement;movingteethbodilyrequires more force as compared to tipping the same teeth.

4. Periodontal condition of the dentition; teeth with decreased bone support or periodontally compromised teeth are easiertomoveascomparedtohealthyteethattachedtoastrong periodontium.

5. Duration of tooth movement; prolonged treatmenttime places more strain on the anchor teeth. Short term treat- ment might bring about negligible amount of change in the anchorteethwhereasthesameteethmightnotbeabletowithstand thesameforcesadequatelyifthetreatmentbecomesprolonged.

6. Space requirements; the amount of crowding or spacing should be assessed as part of treatment planning. This can bedoneusingvisualassessmentormoreformallyusingaspace analysis. Maximum anchorage support is required when all or most of the space created, most commonly through tooth extraction, is required in order to achieve the desired tooth movements.

7. Aims of treatment; the fewer teeth that need to be moved to achieve the aims of treatment then the lesser anchoragedemand,however,iftreatmentiscomplexandmultipleteeth are to be moved there will be a greater anchorage demand. The aimsoftreatmentshouldbeclear.IncaseswithaClassIImolar relationship, anchorage needs will be greater if a Class I molar (and canine) relationship is to be achieved rather than a ClassIImolar(andClassIcanine)relationship.Theneedtoachievea ClassIcaninerelationshipisessentialforthesuccessofalltreatment, anchorage planning should therefore focus not only on the intended molar movements but also importantly on the required movements of the canines to achieve this goal.

8. Growthrotationandskeletalpattern;anincreasedrate of tooth movement has been associated with patients who have an increased vertical dimension or backward growth rotation.It has been suggested that space closure or anchorage loss may occur more rapidly in these high angled cases. Conversely in a patient with reduced vertical dimensions or a forward growth rotation,spacelossoranchoragelossmaybeslower.Apossible explanation that has been proposed for this observation is the relativestrengthofthefacialmuscles,withreducedverticaldimensions having a stronger musculature.

9. The angulations and position of the teeth; usually, in caseswherethereisbi-protrusivenessorexcessiveproclination ofthe anterior teeth, a total control of anchorage will be necessary.Thiswaywecantakecompleteadvantageoftheextraction spaces.

10. The mandibular plane angle (high or low). The inclination of this angle may be modified with different extra-oral anchorage appliances (High Pull, Head Gear, and Face Bow).

11. Speecurvedepth.

12. Ageofthepatient.Dependingonthiswemusttakethe growth factor of the patient into consideration for anchorage typeselection.

13. Patient profile. In biprotrusive type patients we will needverygoodposterioranchorageinordertomodifythistype ofprofile.

14. Surroundingbonecharacteristics;whenteetharelocatedwithintrabecularbone,theyposelessresistancetomove.But, when they are located in cortical bone,their anchorage quantity increasesbecausethisboneisdenser,laminatedandmuchmore compact, with a very limited blood supply. Blood supply is the key factor in dental movement because the physiologic resorption process and the osseous apposition are delayed, so dental movement is slower.

11. Anchorage with Fixed Appliance

Manymethodshadbeenlistedtoincreaseanchoragevaluewith the fixed appliance; these included[5,9]:

1. Bandingorbondingthesecond molars.

2. Decreasing number of teeth to be moved at a given time.

3. Movingtheapicesofanchorteethclosetothecortex

4. Stopperinthewireinfrontofthemolars

5. Retro-ligature(figure of 8 ligation).

6. Toe-in and Tip back bends [Anchor bends for posterior anchorage] and “Apical torque” [for anterior anchorage] in archwire.

7. UseofcombinedNancebottomwithtrans-palatalarch in the upper and lingual arch in the lower.

8. Managingthetimingofextraction.

9. Managing the friction between the bracket’s slot and archwire.

10. Inter-maxillaryelastics.

11. Extraoraltraction–occipital,occipital-cervicalorcervical.

12. Lipbumper.

13. Tipping the molars and premolars distally prior to retraction of the anterior teeth according to Tweed philosophy to increasetheanchoragevalueoftheposteriorsegments,allowing further retraction of the canines and incisors with less anchorageloss.

14. Utilizingdentalimplantsorankylosedteeth

15. Mini-screwsandmini-plates.

12. AnchoragewiththeRemovableandMyofunctionalAppliances

Removableappliancescanbeusedaloneortoreinforceanchor- age in conjunction with a fixed appliance. By virtue of their palatal coverage they increase anchorage. Other design features which reinforce anchorage include[3]:

• Anteroposteriorly–bycolletingaroundtheposteriorteethwith acrylic; inclined bite-blocks, palatal bows or the use of incisor capping.

• Transversely – the pitting of one side of the arch against the othercanreinforcetransverseanchorage,typicallyseenwherean expansionscreworcoffinscrewisusedforincreasingthepalatal transversedimension.

• Vertically – by either reducing the vertical dimensions during treatment of a high angle patient by intruding the posterior teeth,orincreasingtheverticaldimensionbyallowingdifferen- tial eruption with the use of an anterior bite-plane.

All of these three dimensional features can be incorporated into functionalappliances,whichadditionallycanbeusedtogainanchorage in the anteroposterior direction to aid in the treatmentof a Class II malocclusion.

13. AnchorageLoss

Anchorage loss is the movement of the reaction unit or the anchor unit instead of the teeth to be moved[4,5].

14. CausesofAnchorageLoss[4,5]

1. Notwearingtheapplianceadequately.
2. Toomuchactivationofspringsoractivecomponents
3. Presence of acrylic or any obstruction on the path of toothmovement
4. Poorretentionofappliance.
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. Ifapplianceencouragetippingmovementofanchor teeth and bodily movement of the teeth to be moved.
8. Usingheavyforceinmovingteeth.
9. Pooranchorageplanning.

15. Signs of AnchorageLoss [4,5]

1. Mesialmovementofmolars.
2. Closure of extraction space by movement of posterior teeth.
3. Proclinationofanteriorteeth.
4. Spacing ofteeth.
5. Increaseinoverjet.
6. Changeinmolarrelations.
7. Buccalcrossbiteofupperposteriors.

16. MeanstoDetectAnchorageLoss[5]

1. Relating the position of other teeth to the teeth in the same and opposite arch.
2. Increaseinoverjet.
3. Checking the fitness of the removable appliance in the mouth.
4. Measurementsofthedistanceofanchorteethfrom midline.
5. Measurementsfrompalatalrugaeandfrenum.
6. Observation of the spacing mesial/distal to the anchor teeth.
7. Inclinationoftheanchor teeth.

Radiologicalexamination(cephalometricradiograph).

References

1. GraberTM.Orthodonticsprinciplesandpractice.3rded.Mosby: W.B.SaundersCompany;1972.

2. GardinerJH,LeightonBC,LuffinghamJK,ValialhanA.Orthodonticsfordentalstudents.4thed.DelhiOxford:Oxforduniversitypress.1998.

3. LewisBRK.Anchorageplanning.InLittlewoodSJ,MitchellL(ed).Introduction to orthodontics. 5th ed. Oxford: Oxford university press.2019.

4. RaniMS.Synopsisoforthodontics.1sted.Delhi:A.I.T.B.S.publishers and distributors; 1995.

5. AlamMK.AtoZorthodonticsvolume4.1sted.Malaysia:PPSPpublication;2012.

6. PhulariBS.OrthodonticsPrinciplesandPractice.2nded.NewDelhi: Jaypee Brothers Medical Publishers (P) Ltd; 2016.

7. SinghG.Textbookoforthodontics.3rded.NewDelhi:JaypeeBroth- ers Medical Publishers (P) Ltd; 2015.

8. Moyers RE. Handbook of orthodontics. 4th ed. Chicago: Year bookmedical publishers; 1988.

9. YanezEER.1001Tips'fororthodonticsanditssecrets.1sted.Miami:AMOLCA;2008.

10. MilesPG,RinchuseDJ,RinchuseDJ.Evidence-basedclinicalorthodontics.1st ed. Chicago: Quintessence publishing Co., Inc. 2012.