

Reinforcement of anchorage in orthodontics



Introduction

Orthodontics is the process of moving teeth to new and desirable locations. In fixed orthodontic appliances anchorage is the key to achieving movement of a tooth or multiple groups of teeth. 'The success of orthodontic treatment relies upon careful treatment planning' (Naish et al, 2017) this belief can be applied to fixed appliances when attempting to plan for both desirable and undesirable tooth movement. Moving teeth without first creating an anchor point would result in uncontrolled movement, this is an un-desirable occurrence during orthodontic treatment.

The resistance of movement is achieved through that of the roots, tissue, bone and other teeth, each of these processes form 'varying degrees of resistance' (Higley, 1969) that is required to be overcome before movement can occur

During tooth movement the surrounding bone goes through a biological process when the roots of a tooth press against the bone causing osteoclasts, that remove material and reform it in the space after movement by osteoblasts, much like Newton's 3rd law of motion that states that: the action of any kind of mechanical force occasions an equal and opposite reaction.

Roots

One of the most important considerations concerning the anchorage of teeth is the surface formation and area of the roots. The differing sizes and shapes can be exploited in order to resist the forces exerted during the movement of another tooth.

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Roots form, Size of the roots, Number of roots, Position of tooth, Axial inclination of the teeth, Root formation., Contact points and Intercuspatation are the factors which decide anchor value of a tooth (Krishna et al., 2016)

Roots can be arranged into three categories.

1. Round

are often found in molars, they help to resist horizontally directed forces.

2. Flat

roots resist movements in mesio-distal directions

3. Triangular

as found in the canine, centrals and laterals show the maximum defiance for displacement when compared to roots that are round or flat

' The size and number of roots can dictate their ability to withstand the pressure's involved whilst moving teeth, high forces are required to move teeth with large root surface areas.' (Lakhani, Vashishth and Gugnani, 2017)

Multi-rooted teeth with larger root surface areas, can bear more pressure than singular rooted teeth as can roots that are longer and embedded deeper into the bone. Multiple teeth, with a superior combined surface area of roots, can be used to move another tooth with a root surface area of a lesser extent than that of the anchor teeth while resisting movement themselves as described by Krishna et al

A common way to improve anchorage control is to pit the resistance of a group of teeth against the movement of a single tooth' who then goes on to

say, ' Anchorage can be reinforced by including as many teeth as possible in the anchorage unit. (2016)

' Teeth that are inclined provide superior resistance to movement, this can be exhibited when the course exerted to move teeth is opposite to that of their axial inclination'. (Alam, 2012)

Edgewise, Begg, and tip-edge

Begg developed a technique based around differential force, advantage was taken of the fact it is significantly easier to tip a tooth than to bodily move it. First, the tooth is tipped into position then a separate procedure is used to upright the roots. This technique requires far less anchorage than that of Angles, Edgewise appliance.

The standard edgewise technique uses brackets affixed to the teeth with a length of wire bent into particular dimensions as a way to control the movement of teeth. His design incorporated the placement of a rectangular wire within a horizontal rectangular slot on a bracket to control precise tooth movement.

The disadvantages of this design included the use of numerous bends that had to be formed in the arch-wire around individual teeth. The requirement for a large amount of anchorage to function as well as the time-consuming application of bends to the arch-wire.

However, Andrews, in 1972 further developed the edgewise appliance with a new pre-adjusted style of bracket, customized to individual movement requirements of teeth that reduced the detrimental time-consuming

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application of bends to the arch-wire to achieve the same movement. once the movement had occurred the bracket became a passive fit to the arch-wire.

A disadvantage to the Pre-adjusted bracket is its use of round arch wire rather than the rectangular that Angle used, this causes difficulties in achieving a precise finish.

Both Andrews and Angle use a system that requires brackets to be bonded to the teeth this can be achieved using either direct or indirect bonding

- Direct bonding, where the clinician affixes the bracket directly onto the tooth chairside, usually individually or in groups.
- In-direct bonding, when multiple or all the brackets are attached at once, using a specially made tray or blow down to place them all in one session.

Both examples can have advantages over the other. In-direct placement can require more surgical visits but can often be quicker than direct as all of the brackets can be fitted at once and is especially handy when teeth are rotated or in difficult to reach areas of the mouth.

When seated an arch-wire usually consisting of stainless steel is affixed to the bracket.

Begg however, opted for Australian Orthodontic wire ' These wires are often used in the treatment of deep bites because of their increased resistance to permanent deformation.' (Pelsue et al., 2009)

Resistance

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Begg recognized that the bone structure surrounding a tooth can be used as resistance during tipping or rotation. and that the ' centre of resistance of the tooth is defined as the point at which a direct force would cause the tooth to move completely linearly in the direction of the applied force.'

(Dolce and Alfonso, 2019)

Resistance to movements of the teeth can be caused by other structures, these structures can act as a guide and can be used to direct teeth into new, more desirable locations.

Resistance can be seen in these areas:

- Bone structure
- Surrounding teeth
- Root area
- Other teeth (in the path of movement)

Resistance can either aid or hinder the movement of teeth, the resistance of a tooth can help to guide another into a space in the dentition in order to close gaps, this can often be a requirement before further movement is carried out.

Ankylosed teeth, where the root is permanently connected to the jawbone can lend themselves as tremendous anchor's as the movement of these teeth is not possible. Alkadhimi and Al-Awadhi, describe this as ' the most important evidence of an ankylosed tooth is the inability of movement during orthodontic force applications' (2018)

Achieving anchorage

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Anchorage can be divided into three areas

1) Simple

2) Stationary

3) Reciprocal

- Simple anchorage is the resistance to tipping.
- Stationary anchorage is the resistance to bodily movement.
- Reciprocal anchorage is two or more teeth moving in opposite directions, pitted against each other by an appliance.

Anchorage can be achieved using both intra-oral and extra-oral methods.

Extra-oral headgear can be a successful method onto which additional anchorage can be achieved in some instances, such as malocclusion intra-oral anchorage is insufficient to achieve the required tooth movements. ' To overcome this problem, extra-oral anchorage used to supplement the intra-oral anchorage.' (Krishna et al., 2016)

Straps are placed around the wearer's cranium in specific positions to assist in the fixture of anchor teeth. Risk of injury through improper care can occur using this method, ' incidences of injuries to the face, eyes, oral mucosa is more due to accidental disengagement and improper handling' (Soni, Baheti and Toshniwal, 2014)

Extra-oral methods, such as headgear fall into 3 categories.

- Cranial Head-gear

Can be used alongside a face bow to restrict

maxillary growth or to move the dentition or maxilla distally

- Neck

The neck or cervical region. headgear mounted in this region can be called cervical headgear

- Facial

The frontal bone and mandible offer anchorage to help protract the maxilla.

each one of these categories requires a specific strap setup to ensure proper working ability.

Free anchorage

Free anchorage is available when the anchored tooth is to be extracted.

This means that undesirable forces placed onto the anchored tooth are not an issue due to the future removal of these teeth.

The principle is that reactive forces are transferred to teeth which are to be extracted according to the treatment plan, and so there are no adverse effects on the teeth that will remain in the arches following treatment.

(Melsen and Verna, 2015)

Reciprocal anchorage

When a tooth has been extracted reciprocal anchorage is usually required in order to fill the space, it is best described as ' the movement of one tooth (or

more) balanced against the movement of one or more opposing teeth' (*reciprocal anchorage* .' (TheFreeDictionary. com, 2019)

An equal movement of the anterior and posterior teeth is usually sufficient to close the gap.

Anchorage loss

When the undesirable movement of the anchored tooth occurs, this is called a loss of Anchorage. ' Inadequate anchorage can be the most limiting factor of the therapy and unwanted side effects are frequently seen due to insufficient anchorage'(Melsen and Verna, 2015) Anchorage loss is often the outcome of the unrealistic construction of an appliance, but it can also be due to a lack of patient understanding and cooperation, such as reluctance to wear the appliances. Any of the instances relating to this can result in unwanted tooth movement

Banding

Intra-oral anchorage during fixed orthodontics can be achieved by using bands placed around the tooth. Cementation of the band is essential to ensure a successful result; however, this can also benefit in the reduction of the risk of decalcification of the banded tooth, which causes tooth discoloration. Mitchell expresses that

' decalcification during orthodontic treatment with fixed appliances still remains a problem' however it is a recognised issue and ' there is much interest in achieving a reduction in enamel susceptibility around an orthodontic attachment' (Mitchell, 1992)

Attachments can be soldered directly onto the bands when sent to the laboratory, these can be brackets, springs or additional anchorage devices such as a Trans palatal arch (TPA) this device is used to

harness multiple teeth to create larger resistance to displacement the more teeth that are incorporated into an anchorage block, the more likely it is that desirable as opposed to undesirable tooth movements will occur. (Roberts and Sandy, 2004)

Appliances

Trans palatal arch's (TPA's) provide additional anchorage but ' does not provide absolute anchorage.' (Almuzian et al, 2015) They can also be used in conjunction with or without an acrylic Nance placed into the deepest most vaulted area of the palate to provide additional resistance through the means of bracing against the movement. Prior to active space closure, removal is necessary to avoid being embedded into the tissues causing ulceration.

./. orthodontic treatment

Patients with excessive crowding, who require extractions benefit from the application of a lingual arch, this device allows unprompted orientation of labial segments as well as preventing mesial movement of distal teeth, ' Stabilizing and supporting the molars as well as introducing anchorage.' (Ivanov, 2019) Wire with an adjustment loop is soldered to bands around the first permanent molars, to enable a clinician to lengthen, shorten, raise or lower the wire.

A lip Bumper is an acrylic buffer that sits labial to the teeth. It can be affixed to a lingual arch and is used to produce distal movement to the mandibular first molars or used to provide additional anchorage when using a trans palatal arch. However, bumpers can affect eruption ' significantly increasing both M2 impactions and may cause tipping. '(Fabrizia et al., 2011) Other forms of additional anchorage can include temporary anchorage devices, often placed palatal when used in conjunction with a TPA

Implants for anchorage

In the early days (1990's) ' Various Skeletal anchorage systems were developed for Orthodontic treatment' (Kyung, Ly and Hong, 2017) more recently however, ' the concept of using dental implants has been widely accepted as successful adjuncts for obtaining maximum anchorage in orthodontic treatment' (Chopra et al., 2016)

Implants for orthodontic anchorage rely on mechanical retention rather than osteointegration, they are shorter in length and have a larger diameter than regular implants.

In order to determine what? Or if, the many implant systems available, are suitable for the patient. Factors include:

- *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*

(Krishna et al., 2016)

When proper patient selection and use of the correct implant, anchorage with Orthodontic implants can be successful and 'is a viable alternative.'

(Chopra et al., 2016) to conventional methods

Implants can be described as mini-screws, micro-screws, and mini-implants but generally, fall under the umbrella term of Temporary anchorage devices (TAD's) these implants can provide stable anchorage points with 'one of the benefits being, that forces can truly be applied in three dimensions'(Alharbi, Almuzian and Bearn, 2018)

Critical selection of the implants is essential, the correct properties must be attained.

- Primary properties include material choice, length, and diameter.
- Secondary properties include design, site of placement, insertion technique loading forces and movement required

The threaded portion of the screw can be self-tapping, require a pilot hole or be self-drilling.

'Self-drilling can increase stability, leading to a higher success rate when compared to pre-drilling insertion' (Alharbi, Almuzian and Bearn, 2018)

In many cases, Implants are found to be better than traditional methods they can be a 'better alternative to headgear due to less anchorage loss and more anterior teeth retraction' (Kyung, Ly and Hong, 2017)

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' Bone anchorage not only prevents anchorage loss but can actually result in anchorage gain' (Alharbi, Almuzian and Bearn, 2018)

Complications

Temporary anchorage devices are a relatively modern version of anchorage, they can be placed almost anywhere in the oral cavity

Mini-screws can be loaded immediately following insertion. However, failure can result if poor oral hygiene is present or proper placement techniques aren't followed.

Alharbi, Almuzian and Bearn, suggest that their success rate is diminished by technique sensitivity, especially at the insertion state but it has been found that a failed implant that was left or replaced did not cause any complications. (2018)

For use in interproximal areas, it is recommended that implants with a length of 5-10mm and head diameter of 1.5mm should be used to ' maximise the surface area of bone engagement yet limit the proximity to dental roots'(Alharbi, Almuzian and Bearn, 2018)

These small devices as with any implants can carry complications.

' Trauma to the dental roots and periodontal ligaments can result in ankylosis, loss of vitality or osteosclerosis' (Alkadhimi and Al-Awadhi, 2018)

Insertion is usually with the guidance of a radiograph, but these are not always reliable. If resistance occurs during fitment or if the patient feels sharp pain contact of the root can be assumed.

Perforations within the maxillary sinus can be possible when the mini-screw is placed within the buccal cortical bone. Sites containing nerves should be examined prior to surgery to ensure that the risk of nerve damage is reduced.

Due to a higher success rate, ' an implant of less than 8mm is recommended in these regions.' (Alkadhimi and Al-Awadhi, 2018) however Kyung, Ly and Hong disagree with this and state that ' screws less than 8mm in length and 1. 2mm in diameter should be avoided.' (Kyung, Ly and Hong, 2017)

Summary

' Since the beginning of orthodontics, it has been important to control anchorage to achieve satisfactory treatment results' (Lee et al., 2008) Effective anchorage is essential when using fixed orthodontic appliances, whether it be from traditional methods such as TPA's or Lingual arches or more modern temporary anchorage devices such as implants and mini screws. Without the use of anchorage fixed orthodontics simply would not work, the utilization of the root area or implant site as an effective anchor point allows orthodontists to move teeth in many directions.

Both of these types of anchorage can have advantages and disadvantages.

Traditional methods often use brackets with bent wires, springs, and extra-oral headgear to gain extra anchorage, whereas modern techniques use the application of an implant,

Two versions of implants are available:

- 1) Osseointegrated
- 2) Mechanically retained

Osseointegrated implants integrate into the bone whereas mechanically retained implants such as mini-screws can be easily placed or removed, the cost of these implants can be lower than Osseointegrated and they have become popular due to their biocompatibility and low cost when compared to conventional implants.

Alharbi, Almuzian and Bearn explain that ' there is moderate evidence that anchorage using mechanical retention such as mini-screws are more clinically efficient than conventional anchorage devices' (2018)

This is confirmed by Skeggs and Benson that Found that there is evidence to suggest the reinforcement of anchorage is more effective with surgical anchorage than conventional anchorage. (2005) Using any of the techniques used for anchorage requires compliance from the patient, without this compliancy, loss of anchorage can occur.

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