Mini Implants in Orthodontics

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History, Design, and Evolution

By

Dr Rahul Paul, Dr Deepti Yadav,
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TABLE OF CONTENTS

CHAPTER ONE

INTRODUCTION

DR RAHUL PAUL AND
DR DEEPTI YADAV

By enhancing dentofacial functions and aesthetics, orthodontic therapy aims at enhancing the patient's quality of life. Although teeth alone cannot literally support an anchoring system, there are varying degrees of resistance.[(1)]

"Anchorage is a crucial factor in orthodontic treatment aimed at correcting dental and skeletal malocclusions, as it refers to the ability to prevent unwanted tooth movement". The most renowned orthodontists, including Gunnell and Angle recognized the importance of anchorage in orthodontics and proposed restrictions on moving teeth against adjacent teeth when they can be utilized as anchors.[(2)]

"Anchorage plays a critical role in orthodontics due to the need to prevent undesired tooth movement, and its ability to assist in identifying the type of resistance provided by a tooth based on its intended movement."

Additionally, anchorage is thought to play a role in determining the kind of appliance and intended tooth movement.[(2)]

It is imperative to avoid accidentally moving the anchorage unit while also moving other teeth during orthodontic therapy. Orthodontists still require anchorage that exhibits strong displacement resistance. The resistance of posterior teeth to mesial movement is referred to as anchoring in orthodontic therapy.

"The term 'reciprocal anchorage' suggests that the posterior teeth can move freely in compliance with Newton's Third Law of Motion, which asserts that every action has an equal and opposite reaction"[(3)]. The teeth are subjected to forces and moments as the orthodontic treatment continues.

All of these forces result in opposing reciprocal forces. For the therapy to be successful and to prevent unintended tooth movements, these pressures must be directed. The anchorage protocols are now here. Orthodontics is very concerned with anchor management techniques or modalities. The ultimate aim of an orthodontic therapy is to shift the patient's teeth in the desired direction while also enhancing their aesthetics.

The planning of the anchorage requirement takes up a significant amount of time and effort. "Orthodontic practitioners have proposed several solutions to address the issue of anchorage, such as incorporating supplementary oral anchorage, utilizing opposing anchors, and augmenting the number of teeth in anchorage units". [5]

Maximum anchorage denotes the addition of additional resistance to the posterior teeth, preventing them from responding to a reciprocal force. [6]

"During orthodontic treatment, reciprocal effects need to be assessed and managed to achieve optimal tooth movement while minimizing unwanted consequences."

Conventional methods of controlling anchorage came along with much dereliction. Extraoral traction was once utilised by orthodontists to strengthen extra oral anchoring. Usually, extraoral equipment like headgear is used to apply the extra resistance. On the condition that the device is worn, a headpiece that delivers a force of 12 to 18 ounces will stabilize a tooth.

Wearing a headgear while engaging in physical activity can be risky. Getting sufficient levels of patient compliance is a bigger issue. However, as patients weren't routinely wearing headgear around the clock, this source of anchorage was frequently compromised.

The concept of orthodontic anchorage dates back to the 17th century, but it was not officially defined until 1923 by Louis Ottofy, who described it as the "foundation against which orthodontic force or reaction of orthodontic force is applied." In more recent times, Daskalogiannakis has defined anchorage as "the ability to resist undesirable tooth movement." Anchorage can also refer to the degree to which the movement of the reactive unit is permitted

Ottofy's definition of orthodontic anchorage also incorporated the categories previously described by E.H. Angle and other researchers, which included simple, stationary, reciprocal, intraoral, intermaxillary, and extraoral anchorage.

Moyers built upon Ottofy's classification system by offering clear definitions for different subtypes of extraoral anchorage and dividing basic anchorage into three subcategories: single, compound, and reinforced.

Gianelly and Goldman suggested the terms maximal, moderate, and minimum to indicate the degree of movement that the teeth of the active and reactive units should undergo in response to an external force.

Marcotte and Burstone have categorized anchorage into three types—A, B, and C—based on the degree to which the anchorage unit contributes to space closure.[7]

Type A anchorage

In this anchor teeth remain stable i.e. no movement at all. Only the ankylosed teeth or dental implants which are present can provide such an anchoring because they both rely on bone to restrain movement.

Implants or miniscrew implants fixed to bone can improve the support to the reactive unit (indirect anchorage) or fix the anchor units (direct anchorage), thus providing anchorage that facilitates skeletal anchorage.

Type B anchorage

In this type of anchorage, anterior and posterior units move toward each other.

Type C or total loss of anchorage

In this the anchor teeth are free to move generally anteriorly. Anchorage loss refers to any unintentional movement of the anchor teeth.

Numerous anchorage systems have been developed for orthodontic treatment, claiming to provide compliance-free options. However, none of these systems have demonstrated the same level of anchorage control as skeletal anchorage systems.

Secure anchorage is necessary for the treatment of various malocclusions. The teeth, extraoral appliances, and intermaxillary appliances frequently provided the anchorage needed for orthodontic tooth movement. These techniques frequently result in incomplete intra and interarch alignment and anchorage loss due to insufficient mechanical devices for anchorage management.

A desirable intraoral anchorage mechanism should remain steady and not depend on the periodontal ligament, which has a proclivity to react to pressure and stress by enabling movement via bone. [5]

The introduction of skeletal anchorage in the form of temporary anchorage devices (TADs) or mini screws has been a significant advantage for orthodontists as it enables them to regulate anchorage with minimal patient involvement and without the necessity for complicated clinical insertion and removal procedures.

The management of malocclusion related to vertical problems, such as an open bite and over erupted teeth due to the absence of opposing teeth, is notably enhanced by skeletal anchorage. In cases of skeletal open bite, surgery is typically required to reduce the maxillary dento-alveolar height through forceful impaction.[7] Supra-erupted teeth were often restored with crowns and treated with endodontic therapy. Before Temporary Anchoring Device skeletal anchorage became common, the cost of tooth viability

However, if patients are willing to undergo a longer treatment period, orthodontic intrusion with Temporary Anchorage Device skeletal anchorage offers a conservative treatment method with no permanent harm.

Skeletal anchorage using TADs not only resolves vertical orthodontic issues but also obviates the requirement for patient cooperation with regards to sagittal dental movement. This includes mesial or distal movement of the entire dentition with or without tooth extraction.

Intraoral orthodontic anchorage has been recently accomplished through prosthetic osseo-integrated implants, but their usage in orthodontics has been limited due to their bulky size, high cost, and invasive nature.

Regular bone screws were initially used to establish intraoral anchorage, but they were unable to protect the gingiva from compression caused by the attached elastomers or ligatures. This frequently led to gingival irritation and inflammation, thereby reducing the effectiveness of these implants. Furthermore, the screw heads' design made it difficult to attach coil springs and other elastomers to these conventional bone screws.

Endosseous implants and implants have been utilized as direct or indirect orthodontic anchorage for numerous therapeutic objectives. Earlier implants and screws faced challenges, but those have been resolved with the introduction of small-diameter titanium micro-implants featuring specially designed heads that can accommodate ligatures, coil springs, and elastomers.

As per Cope, a "temporary anchorage device (TAD)" refers to a device that is temporarily attached to bone to enhance orthodontic anchorage by either supporting the reactive unit's teeth or bypassing the need for the reactive unit entirely. Once its use is completed, the device is removed.

They may be endosteally, transosteally, or subperiosteally positioned, and they may be biochemically or mechanically fastened to bone (osseo-integrated)

Figure 1.1 Temporary Anchorage Device

Both mini screws and mini plates together known as **Temporary anchorage devices** (TADs). They both are bone based anchorage units

Because of its compact size, ease of implantation, and increased possibility for improved orthodontic results, mini screw type temporary anchoring devices (TADs) are currently attracting more attention. Mini screws therefore not only relieve orthodontists from cases requiring anchorage but also give them a good control over the tooth movement in three dimensions.

The micro plate type has also broadened the range of orthodontics and led to notable improvements in treatment outcomes.

TADs offer a wide range of implants that can be utilized to provide support for orthodontic treatment. However, all TADs are intrusive devices and are sometimes blamed for issues that can be addressed through conventional mechanics. The anchorage component of an implant intended for prosthetic usage may be a biocompatible wire attached to the endosseous base. Additionally, a nonfunctional osseo-integrated implant could act as an abutment for a medically assisted, fast palatal expansion. The devices that have the longest clinical histories of effectiveness are integrated fixtures that were first created for prosthetic purposes. The majority of modern mini screw is made of titanium (Ti) or titanium alloy and has a smooth, machined surface that is intended for osseo-integration in line with.[8]

However, some Osseo-integrated TADs can be kept for sustained prosthetic function or covered with safe tissue (put to sleep). Mini screws are among the most popular TADs at the moment.

Several commercial firms produce these screws internationally, with sizes ranging from 5 to 12 mm in length and 1.2 to 2.0 mm in diameter. The head design can be either "post" or "flat-top." These screws are mechanically attached to the bone and are not intended to encourage or establish Osseo-integration in any manner. They should ideally be positioned with head of the screw in the connected alveolar mucosa and in locations with appropriate cortical bone. They are taken out after they have served their purpose.

Micro-implants are used as temporary anchorage devices to help guide osteo-distractions, stabilize an edentulous premaxilla, fix cants after a ramus was vertically distracted, and tooth movement into atrophic alveolar sites is achievable.

Micro-implant anchorage is a viable treatment alternative for adult orthodontic patients with insufficient dental components in terms of quantity or quality. This option is particularly useful when traditional dental mobile anchorage is not viable, or when poor patient compliance makes it difficult to wear mobile devices or elastics.

Micro-implant anchorage is the preferred choice in situations where dental anchorage may result in unfavorable side effects, such as changes in vertical dimension caused by applying standard inter-maxillary stresses.

Micro-implants, being a form of skeletal anchorage, provide a more efficient option for growth modification in individuals who are not suitable for orthognathic surgery. The success of micro-implants is dependent on the implementation of atraumatic surgical procedures, osseo-integration and regeneration, a favorable environment for primary healing, and the use of biocompatible materials.

The importance of patients' cooperation and their perceptions of pain and stress during surgical insertion and retraction procedures cannot be overstated, particularly when employing micro-implants as anchorage components.(9)

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CHAPTER TWO

REVIEW OF LITERATURE

DR ISH KUMAR SHARMA
AND DR MUDITA GUPTA

Creekmore T.D, Eklund M.K. et al. (1983)[1]: Report a case series of ten patients who presented with anterior open bite. The initial evaluation included clinical pictures, lateral cephalometric radiographs and dental casts. They were assessed according to the severity of the open bite and the cause (skeletal or dental). They all underwent orthodontic treatment as an initial step. Five patients with dental open bite underwent molar intrusion using titanium screws and five patients underwent maxillary Le Fort I impaction.

Gray J.B et al. (1983)[2]: The study evaluated the capacity of two distinct types of small cylindrical endosseous implants to withstand movement when subjected to consistent orthodontic forces. Twelve rabbits were implanted with pairs of Bioglass-coated implants and pairs of Vitallium implants with matching sizes in their femurs. Following a 28-day healing phase, the implants were subjected to loads of 60 grams, 120 grams, and 180 grams.

Roberts W. E. et al. (1984)[3]: In this experiment, acid-etched titanium implants were screwed into 3 mm diameter holes, spaced approximately 1 cm apart, which had been meticulously created in the femurs of 3- to 6-month-old rabbits using an internally irrigated surgical bur. In the initial 72-hour period following surgery, the use of fluorescent bone markers revealed significant bone growth, particularly at the surgical defect's endosteal edge, which indicated the retention of a considerable degree of osteogenic potential. Within three days, a coarse, woven bone matrix began to surround the implant. After six weeks, fully developed, organized bone had replaced the gaps around or adjacent to the implant surface, leading to the consistent formation of a strong bone-implant interface.

W M Smalley et al. (1988)[4]: Four pigtail monkeys underwent a surgical procedure to have titanium implants placed in the maxillary, zygomatic, frontal, and occipital bones. Following a four-month recovery period, the implants were uncovered, and abutments were installed. External traction devices were then connected to the abutments, with the cranial implants serving as support for the appliance framework, and those in the facial bones being utilized to attach springs that applied protraction forces.

B Melsen et. al. (1989)[(5)]: A group of thirty patients exhibiting marginal bone loss and deep overbite due to incisor intrusion received treatment utilizing three distinct techniques: (1) J hooks and extraoral high-pull headgear, (2) utility arches, (3) intrusion bent into a loop in a 0.17 x 0.25-inch wire, and (4) base arch as described by Burstone. The effectiveness of the intrusion was assessed by examining the displacement of the apex, incision, and center of resistance of the most prominent or elongated central incisor.

W.E Robert et. al. (1990)[(6)]: A two-part endosseous implant was installed in the retromolar area of the mandible to provide stable anchorage for the mesial movement of two molars, ten to twelve millimeters, into an atrophic edentulous ridge. Despite the significant anchorage requirement over a three-year period, the endosseous implant maintained its rigid state (i.e., "osseo-integrated"). Following treatment completion, the implant and nearby, in vivo labelled bone were retrieved. Subsequent micro radiographic and polarized light analyses demonstrated that roughly 80 percent of the endosseous component of the implant was in close proximity to fully developed lamellar bone. The bone labeling technique revealed a remarkable level of cortical bone remodeling (approximately 30 percent per year) occurring within 0.5 millimeter of the interface.

Block MS et. al. (1995)[(7)]: A novel tool was developed to offer a source of anchorage for orthodontic tooth repositioning. This appliance is a disc featuring a hydroxyapatite-coated, textured surface on one side and an internal thread on the opposite side. It is situated on the palatal bone and, following fusion, may be linked to teeth to serve as anchorage. This paper assesses a canine investigation showing one-sided tooth movement towards the "on plant" and a monkey trial imitating its utilization for molar anchorage during anterior retraction.

N Akin-Nergiz et. al. (1998)[(8)]: The functional and morphological responses of the peri-implant bone encircling screw implants (Bonefit) were investigated in three dogs by subjecting the implants to persistent forces of 2 (equivalent to about 204 gm) and 5 N (equivalent to about 510 gm). In the area of the lower premolars, eight implants were surgically placed to an endosseous depth of 12 mm, positioned approximately 10 mm apart. The implants were allowed to heal in a closed environment for 12 weeks before being uncovered and fitted with abutments and orthodontic equipment to induce horizontal distraction using a 2 N force (equivalent to about 204 gm) for 12 weeks. Afterwards, they were subjected to a force of 5 N (about 510 gm) for an additional 24 weeks.

Antonio Costa et al. (2005)(9): The objective of this study was to assess the depth of the hard and soft tissues in the oral cavity of 20 patients. The bone depth was evaluated using volumetric computed tomography (VCT), while the mucosal depth was measured with a needle equipped with a rubber stop. In this study, the depth of hard and soft tissues in the oral cavity was evaluated in 20 patients using volumetric computed tomography (VCT) for bone depth quantification and a needle with a rubber stop for mucosal depth quantification. The findings suggest that TADs of 10 mm in length can be placed only in the symphysis, retromolar, and palatal premaxillary regions, while TADs of 6 to 8 mm in length can be placed in the upper and lower canine fossae as well as the incisive fossa. TADs of 4-5 mm length engage mono cortically only, while the others can engage bicortically. When placing TADs in mobile alveolar mucosa, the study suggests that a transmucosal attachment may be required to traverse the thickness of the soft tissue.

Visnja Katic et. al. (2005)(10): Assess the distinctive impact of geometrical design features of orthodontic mini-implants on the maximum insertion torque, while taking into account the effect of cortical bone thickness. 100 cylindrical orthodontic mini-implants were used. Geometrical design characteristics of ten specimens of ten types of cylindrical self-drilling orthodontic mini-implants (Ortho Easy®, Aarhus, and Dual TopTM) with diameters ranging from 1.4 to 2.0 mm and lengths of 6 and 8 mm were measured.

Robert Herman et. al. (2005)(11): The Ortho Implant, manufactured by IMTEC Corp in Ardmore, OK, is a new mini-implant designed specifically for orthodontic anchorage. With a diameter of 1.8 mm and available in lengths of 6, 8, or 10 mm, it can be placed in many different intraoral locations, providing additional stable anchorage for a variety of malocclusions. The placement and removal procedures for the Ortho Implant are straightforward and can be performed by orthodontists themselves.

Jason et. al. (2005)(12): Defines and classifies temporary anchorage devices, covers their historical development, outlines some of the basic biologic parameters for their use, and articulates questions that need to be addressed with further experiments before broad scale incorporation into everyday practice.

E. Mizrahi et. al. (2007)[(13)]: Outlines a simple technique for placing mini-screws in orthodontic treatment, emphasizing the importance of proper site selection and awareness of potential complications. He provides a detailed description of appliances that incorporate mini-screws, supported by typhodont models and clinical examples. Clinicians can extrapolate this information to suit their specific treatment plans. While he describes various appliances that are used with mini-screws, modifications may be necessary depending on the individual requirements of each malocclusion.

James C.Y. Lin et. al. (2007)[(14)]: Help the clinician better understand the features of mini screw systems currently available on the market and provide a useful guideline for their clinical use. There are two types of materials commonly used for the manufacture of mini screws: commercially pure titanium (C-P titanium), which comes in grades 1 to 5 with varying levels of hardness, and titanium alloy, specifically Ti-6Al-4V. The authors find that the ideal mini screw design should include biocompatibility, bone-density–guided insertion, immediate loading, and compatibility with modern orthodontic accessories for 3-dimensional orthodontic control.

C.L. Lin et. al. (2010)[(15)]: Compare the impact of modifications in bone/mini-screw osseo-integration and mini-screw design elements, including length, diameter, thread shape, thread depth, material, head diameter, and head exposure length, on the biomechanical response of an individual mini-screw insertion. Eighteen CAD and finite element (FE) models corresponding to a Taguchi L18 array were constructed to perform numerical simulations to simulate mechanical responses of a mini-screw placed in a cylindrical bone.

Chin-Yun Pan et. al. (2011)[(16)]: Evaluates the influence of different implant materials on the primary stability of orthodontic mini-implants by measuring the resonance frequency. Twenty-five orthodontic mini-implants with a diameter of 2 mm were used. The first group contained stainless steel mini-implants with two different lengths (10 and 12 mm). The second group included titanium alloy mini-implants with two different lengths (10 and 12 mm) and stainless steel mini-implants 10 mm in length. The mini-implants were inserted into artificial bones with a 2mm-thick cortical layer and 40 or 20 lb/ft3 trabecular bone density at insertion depths of 2, 4, and 6 mm.

US Krishna Nayak et. al. (2011)[(17)]: Wrote review on indication, contraindication & clinical application of TDs in orthodontics.

Masaru Yamaguchi et. al. (2012)[(20)]: Provide clinicians with current knowledge regarding the flexible applications and clinical uses of skeletal anchorage in orthodontic treatment.

Ramzi Duaibis et. al. (2012)[(19)]: The aim of the study was to analyze different types of stress that occur in cortical bone around mini screw implants using finite element analysis. Abaqus was used to create 26 three-dimensional models of mini screw implants placed in alveolar bone blocks. The models were loaded with a linear force of 2 N in the mesial direction. The study aimed to evaluate the stress distribution and to identify potential areas of bone resorption or implant failure.

Masaru Yamaguchi et. al. (2012)[(20)]: Present the development, clinical use, benefits, and drawbacks of the mini screw and plate type implants used to obtain a temporary but absolute skeletal anchorage for orthodontic applications.

Safiya Sana et. al. (2013)[(21)]: Evaluate the current literature on the mini-implants in orthodontics with regard to their materials properties. Uses six different titanium-based biomaterials to fabricate mini-implants. Each of these materials, including four grade of commercially pure titanium and two titanium alloys and 316L Stainless steel used as a mini implant material each has distinct mechanical and physical properties.

Seong-Hun Yoo et. al. (2013)[(22)]: Compared the stability of tapered mini screws with cylindrical mini screws. One hundred and five tapered and 122 cylindrical self-drilling mini screws were placed into the maxillary and mandibular buccal alveolar areas of 132 patients (43 males and 89 females). The insertion torque and removal torque were measured and Periotest values (Ptvs) were recorded at implantation.

Visnja Katic et. al. (2014)[(23)]: Determine the unique contribution of geometrical design characteristics of orthodontic mini-implants on maximum insertion torque while controlling for the influence of cortical bone thickness. 100 cylindrical orthodontic mini-implants were used. Geometrical design characteristics of ten specimens of ten types of cylindrical self-drilling orthodontic msini-implants (Ortho Easy®, Aarhus, and Dual Top TM) with diameters ranging from 1.4 to 2.0 mm and lengths of 6 and 8 mm were measured.

Flavio Uribe et. al. (2015)[(24)]: Evaluate the failure rates of mini-implants placed in the infrazygomatic region and to evaluate factors that affect their stability. 30 consecutive patients (55 mini-implants) who had infrazygomatic mini-implants at a University Clinic were evaluated for failure rates. Patient, mini-implant, orthodontic, surgical, and mini-implant maintenance factors were evaluated.

M. Leo et. al. (2016)[25]: Carry out a review about the factors that affect the success or failure rate of orthodontic mini-implants.

Divij Joshi et. al. (2016)[26]: Explore a successful, much simpler, less cumbersome, and time-consuming technique for mini-implant placement.

Iman Abdelgader et. al. (2016)[27]: Investigate the effect of thread design of an orthodontic mini-implant on primary stability and strain pattern and magnitude in the surrounding bone structure during orthodontic loading.

Birte Melsen et. al. (2017)[28]: Talks about the development of the skeletal anchorage and its usefulness, not only as an alternative to other anchorage approaches, but when other types of anchorage were not available. Moreover, orthodontic temporary anchorage devices (TADs) can be used both to maintain and to build bone.

N. Raj Vikram et. al. (2017)[29]: Experiments with osseo-integerated brane mark-style implants for maxillary protraction in monkeys. Later the potential of Temporary Anchorage Device (TAD) in protraction of maxilla was demonstrated. Most of the procedures require surgical intervention for inserting the TAD or bone plates which is associated with discomfort and delayed healing. There is no implant which can be directly placed and force applied through elastics. The new innovative design dual ball headed mini-implant is being presented that helps to overcome all these problems.

Rajat Bajaj et. al. (2017)[30]: This article provides a comprehensive review of the indications, contraindications, safety zones for temporary anchorage devices (TADs), their insertion procedure, potential complications, failures, and medicolegal aspects.

Ashith M. V et. al. (2018)[31]: Compares the efficacy of stainless steel and titanium implants in a split-mouth controlled clinical trial, with a direct in vivo comparison. A total of 10 patients were carefully evaluated and selected for the study. Mini-implants were placed in the buccal mucosa under local anesthesia after safe zone selection through radiography. The study compared the success rates of stainless steel and titanium implants in a controlled clinical trial with 10 patients. The mini-implants were inserted in the buccal mucosa after selecting a safe radiographic zone under local anesthesia. The loading protocol involved low immediate loads followed by incremental loads up to 150g. The results were compared between the two materials, and the success rate was analyzed separately for the upper and lower jaws. The study found a significantly higher success rate with titanium implants, but the implant failure rate was higher in the upper jaw compared to the lower jaw.

Young-Young Song et. al. (2018)[32]: In this study, the goal was to evaluate how cortical bone thickness affects the maximum insertion and removal torque of self-drilling mini-screws, and to determine whether torque depends on the screw design. The study used three different types of self-drilling mini-screws: a cylindrical type (Cl), a taper type (Ta), and another taper type (Tb). The mini-screws were inserted at a constant speed of 3 rotations per minute using a driving torque tester. The results were analyzed to determine how cortical bone thickness and screw design affect maximum insertion and removal torque. The study examined the effect of cortical bone thickness on the maximum insertion and removal torque of different types of self-drilling mini-screws and the potential dependence of torque on screw design. The researchers used three different types of self-drilling mini-screws (cylindrical type [Cl], taper type [Ta], taper type [Tb]) and experimental bone blocks with varying cortical bone thicknesses as specimens. Using a driving torque tester at a constant speed of 3 rotations per minute, they found that the maximum insertion torque increased as cortical bone thickness increased for Ta and Tb. In all situations, the maximum insertion torque of Tb was the highest, followed by Ta and Cl. Cl demonstrated less torque loss in all cortical bone thicknesses and a longer removal time compared to Ta or Tb.

M. Azeem et. al. (2019)[(33)]: Evaluate the failure rates of mini-implants inserted in the RM area and to evaluate the factors affecting their stability. In 102 patients (55 males, 52 females) 110 RM mini implants were placed.

Amir Hooman et. al. (2019)[(34)]: Measure the relative effect of mini-implant design factors on primary stability of orthodontic mini-implants. Thirty-two 3-dimensional assemblies of mini-implant models with their surrounding bone were generated using finite element analysis software. The maximum displacement of each mini-implant model was measured as they were loaded with a 2-N horizontal force. Employing Taguchi's design of experiments as a statistical method, the contribution of each design factor to primary stability was calculated. As a result of the great effect of the upper diameter and length, to better detect the impact of the remaining design factors, another set of 25 models with a fixed amount of length and diameter was generated and evaluated.

Dr. Thirunavukkarasu et. al. (2020)[(35)]: This article provides a comprehensive overview of mini-implants in orthodontics, covering their historical background, different parts and materials used in their construction, various types of mini-implants, and their clinical applications. Mini-implants have gained popularity as a form of temporary anchorage device in orthodontics, and their use has increased in recent years due to their versatility and ease of placement. The article discusses the different types of mini-implants, including self-drilling, self-tapping, and mini-screws, and their unique characteristics. Additionally, the article covers the clinical applications of mini-implants, including their use for orthodontic anchorage, intrusion of anterior teeth, distalization of posterior teeth, and correction of malocclusions. Overall, the article serves as a comprehensive guide for orthodontic professionals interested in utilizing mini-implants in their practice

Nausheer Ahmed et. al. (2020)[36]: Outlines about the types of TADs, parts, techniques of insertion and removal and its clinical applications in orthodontics.

Paulo Mecenasa et. al. (2020)[37]: The aim of this study was to investigate whether there was a difference in success rates between stainless steel (SS) and titanium mini-implants (MIs) in orthodontic patients. A systematic manual search of the literature was conducted, and the references of the included articles were also searched. Only studies that compared the success rate between SS and titanium MIs were included. The risk of bias (RoB) was assessed using either the ROBINS-I (Risk of Bias in Non-randomized Studies-of Interventions) Tool or RoB 2.0 depending on the study design. The assessment of the level of evidence was conducted using GRADE (Grading of Recommendation, Assessment, Development, and Evaluation) methodology."

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Chapter Three

History of Mini Implants

Dr Deepti Yadav and Dr Vandana Gulia

Evolution of dental implants

John Hunter, a Scottish surgeon, proposed the idea of implanting human teeth in the 1700s. It was normal practise in the 18th century to replace missing teeth with the teeth of another person, but this method failed because the immune system of the recipient rejected the foreign object, resulting in infection. Maggiolo installed a gold implant the size of a single tooth in 1809, just above the gingiva. Greenfield detailed the creation and placement of an endosseous implant in 1911.

Gainsforth and Higley (1945) provided the earliest documentation of the concept of skeletal anchorage when they suggested the possibility of orthodontic anchorage in the basal bone by placing Vitallium screws into a dog's ramus in order to distalize a maxillary canine. However, the use of force led to the loss of screws in 16 to 31 days.(1)

Bernier and Canby performed an experiment on monkeys where they inserted vitallium screws into their mandible and maxilla to study the effects of vitallium on the jaw bones. Some were inserted intraorally in the alveoli of the canine, and some were inserted extraorally, projecting through the skin.

Except until when the animals aggressively removed the screws, they were in place. After three months, when the screws were still in place, microscopic inspections of the screw locations were conducted.

Although the tissues tolerated vitallium very well, according to these authors, the possibility of secondary infection could not be ruled out. However, when implanted intraorally, these screws developed a membrane covering that prevented them from being employed as orthodontic anchors. However, the following quote from Bernier and Canby caught my attention: "The chances of infection significantly reduce when vitallium is placed inside the oral cavity. Vitallium alloy appears to be inert when in contact with body tissues, which can be attributed to the absence of any electrolytic force.(2)

The decision was made to conduct an experiment on six dogs (Figure 3.1), aiming to establish a point of anchorage in the mandibular ramus using a vitallium screw hook inserted into the bone. Previous evidence suggests that oral tissues may be more tolerant of foreign objects compared to other bodily tissues.

Figure 3.1: Study Model of Dog

Coe-Loid impressions were poured in artificial stone with Snow-White art Portion and articulated for study of the occlusion and for design of appliance. (Figure 3.1)

In the animal testing that was done in connection with this study, six mongrel dogs were chosen from the University of Iowa Medical Laboratories' collection. (Figure 3.2-3.5)

The arch wire is welded to the canine band and slide freely in the perforated buccal flange of the molar overlay. (Figure 3.3)

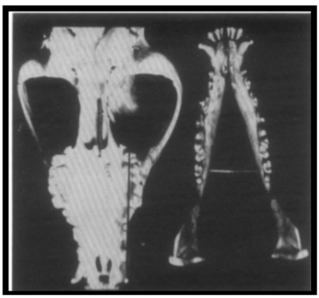

Figure 3.2: Occlusal View of Disarticulated Collie Skull

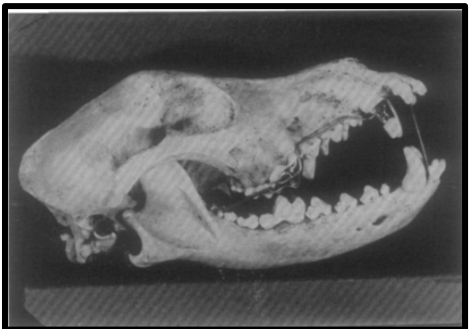

Figure 3.3: Archwire Welded to Canine Band

Screw was inserted through two cortices of bone from anterior border of ramus to massetric fossa. (Figure 3.4)

Figure 3.4: Screw Inserted through Two Cortices of Bone

Figure 3.5: Left mandible after the screw had been in place for 31 days

The facilities for radiographic examination of the growth of the face and development of the dentition in normal children, as well as in some cases, various pathologic forms of development, were established in 1951 by Bjork. An overview of the methodology for implant insertion, the radiographic approach, and the graphic procedure for generation of growth tracings are given based on experience accumulated over a number of years. With the aid of a pencil-shaped tool and local anesthesia, tiny pins of hard tantalum are driven into the bone, where the implant is then inserted. There is no need for surgical exposure. Only a few locations in the maxilla and mandible can accommodate implants due to bone remodelling, resorption, and tooth eruption.[3]

Using a unique pencil-shaped device, little pins of hard tantalum are hammered into the bone while local anesthesia is being administered. (Figure 3.6)

Figure 3.6: Insertion of Implants Under Local Analgesia

The pin must perfectly fit the instrument in order to be inserted into the bone. The device is composed of stainless steel, and its replaceable tip prevents it from being damaged by hard bone. (Figure 3.7)

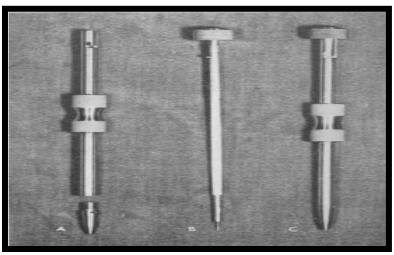

Figure 3.7: Instrument for Inserting Metallic Implants