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Bone Screws in Orthodontics – A Review.

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ABSTRACT –
For Orthodontists, anchorage control is a challenging task, and partly depends on the compliance of the patient. To ensure absolute anchorage, skeletal anchorage has gained popularity because of its uncompromised results. Temporary Anchorage Devices (TADs) are placed in the bone to obtain skeletal anchorage. One of the advancements of TADs is the development of Bone Screws for the Infrazygomatic crest and the mandibular buccal shelf region. The implantation of OBS doesn't necessitate significant surgical intervention. The purpose of this article is to give an overview of the recently developed OBS system, including its technological, biomaterial, and biomechanical differences from the widely used mini-implant system, as well as its advantages and disadvantages.

KEYWORDS – Bone Screw, Mini Implants, Micro Implants

I. INTRODUCTION –

Anchorage control is an important factor in the success of orthodontic treatment. Anchorage, defined as a resistance to unwanted tooth movement is a prerequisite for the orthodontic treatment of dental and skeletal malocclusions.[1]For orthodontists, anchorage conservation is an ongoing challenge. Anchorage requirements must be assessed in three planes of space.[2]Anchorage techniques, including as extraoral and intraoral appliances. The extraoral forces are difficult for patients to comply with and are ineffective against the constant forces that move teeth, hence they cannot be employed continuously. On the other hand, intra oral anchorage appliances are also sometimes inadequate in controlling the anchorage units.[3]Even a small reactive force can cause undesirable movements; hence it is important to have absolute anchorage to avoid them. Absolute anchorage is defined as no movement of the anchorage unit (zero anchorage loss) as a consequence to the reaction forces applied to move teeth.Such an anchorage can only be obtained by means of skeletal anchorage which includes all the devices that are fixed directly into the bone. Temporary Anchorage Devices (TADs), are gaining increased importance in orthodontic treatment, because of the limitations of conventional intra oral and extra oral anchorage appliances.[4]More recently, the usage of Orthodontic Bone Screws (OBS) has increased. These screws have an extra-radicular site of placement in the mandibular buccal shelf area as well as the infra-zygomatic crest of the maxilla. Compared to standard mini-implants, they have much lower failure rates.Compared to the mini-implants employed in the inter-radicular region, the dense cortical bone of the maxilla's infra-zygomatic crest and the mandible's buccal shelf area offers a superior anchorage.[5]

Historical Development –

The idea of using screws fixed to bone to obtain absolute anchorage goes back to 1945, when Gainsforth and Higley used a 2.4- mm pilot hole, a 3.4mm-diameter X 13mm-long vitallium screw was placed in the ascending ramus of 6 dogs.[6]The first clinical report in the literature of the use of TADs appeared in 1983 when Creekmore and Eklund used a vitallium bone screw to treat a patient with a deep impinging overbite.[7]Kanomi47 (1997) first reported the clinical use of mini-implant for

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orthodontic anchorage (5.0 mm x 1.0 mm titanium screw, Leibinger, Freiburg, Germany). He reported a miniscrew of 1.2 mm diameter and 6 to 7 mm length, which provided sufficient anchorage for intruding the lower anterior teeth.[8] In 1998, Melson B tried zygoma ligatures as a form of maxillary anchorage, in a partially edentulous patient.[9] Costa et al in 1998, used miniscrew for orthodontic anchorage in 14 patients, which were called Aarhus.[10]Sugawara and Mikako Umemori et al50 (1999) introduced the Skeletal Anchorage System (SAS). It essentially consists of titanium miniplates, which are stabilized in the maxilla or the mandible using screws. [11]Park, Bae and Kyung et al, (2001) in Korea designed a system called MIA (Micro Implant Anchorage.[12]Further, during the last decade, other means of bone anchorage have also been proposed, including zygoma wires, miniplates and zygoma anchors.

Classification –

According to their place of origin, skeletal anchoring devices fall into two major categories. Retromolar, palatal, and orthodontic mini-implants are all part of the first group, which was inspired by osseointegrated dental implants. Originating from surgical mini-implants, like the ones utilized by Creekmore and Eklund and those subsequently reported by Kanomi and Costa et al., is the second category.[7,8,10] The devices in the second group are less in diameter, have smooth surfaces, and are intended to be loaded quickly after insertion. These are the primary distinctions between the two types.

Cope similarly categorized the existing skeletal anchoring techniques as being either biologic or biocompatible.[13]Ankylosed and dilacerated teeth were part of the biologic group, whereas temporary anchoring devices were part of the biocompatible group. Based on how they are affixed to the bone, he further divided the two types into mechanical and biochemical (osseointegrated). Labanauskaite et al. proposed the following categorization of orthodontic anchoring implants in order to provide a more detailed classification:

According to the shape and size :
• Conical (cylindrical)
• Miniscrew implant
• Palatal implants
• Prosthodontic implants
• Miniplate implants
• Disc implants (onplants)
According to the implant bone contact :
• Osseointegrated
• nonosseointegrated;
According to the application :
• used only for orthodontic purposes (orthodontic implants)
• used for prosthodontic and

Types And Properties -

The primary distinctions between the miniscrew implants that are now on the market pertain to their composition, dimensions, and design. These differences include: (1) the type of alloy or metal used in their construction; (2) the threaded portion's diameter; (3) the implant's length; and (4) the head design. A number of criteria would need to be met for a miniscrew calibers, lengths, and designs (such as button or bracket heads); self-taping and self-drilling options; instantaneous loading capability; lack of expensive supplementary equipment required for removal; and low cost. Implant to be considered appropriate for orthodontic anchorage, essentially making it biocompatible and accessible in various diameters, calibers, lengths, and designs (such as button or bracket heads); self-taping and self-drilling options; instantaneous loading capability; lack of expensive supplementary equipment required for removal; and low cost.

Biocompatibility –

With the exception of the Orthodontic Mini Implant, which is fabricated from stainless steel, all other aforementioned systems are made of medical type IV or type V titanium alloy.

Osseointegration –

Most orthodontic devices are made with a smooth surface to minimize bone ingrowth and promote soft tissue attachment under normal conditions and without the need for special surface treatment regimens. This is because complete osseointegration of screws is a drawback that makes the removal process more difficult.[10, 14, 15]

Types Of Anchorage –

Direct and indirect anchoring are the two forms of anchorage that the miniscrew implants can offer. In the case of direct anchorage, they operate as an anchor unit and directly receive the reactive forces; in the case of indirect anchorage, they are connected to the reactive unit through bars or wires.

Head Design –

The majority of miniscrew implant methods come in a variety of configurations to prevent tissue irritation and allow for both direct and indirect fixation. The button-like design with a sphere, two sphere-like shapes, or a hexagonal

shape is the most common.The Aarhus Anchorage System, AbsoAnchor System, Dual-Top Anchor System, IMTEC Mini Ortho Implant, Lin/Liou Orthodontic Mini Anchorage Screw, Miniscrew Anchorage System, Orthoanchor K1 System, and Spider screw Anchorage System are among the miniscrew implants that are compatible with this design.This design is primarily used for direct anchorage and features a hole, typically 0.8 mm in diameter, through the head or neck of the screw. There is also a bracket-like design that can be utilized with the Aarhus Anchorage System, AbsoAnchor System, Dual-Top Anchor System, Spider Screw Anchorage System, and Temporary Mini Orthodontic Anchorage System for direct or indirect anchorage. Finally, the TOMAS miniscrew implant employs an additional hook design.The thread body might be parallel tapering only at the end, as in the Orthodontic Mini Implant, or conical, as in the Aarhus Anchorage System, AbsoAnchor System, Miniscrew Anchorage System, and others.To allow insertion at various sites in both jaws, miniscrew implants come in a variety of lengths and diameters. Twenty patients' hard and soft tissue depths were assessed by Costa et al., who came to the conclusion that miniscrew implants ranging in length from 4 to 6 mm are safe in most areas. However, human variability necessitates a unique assessment of bone depth for each patient. Threads with a smaller diameter make it easier to put into locations close to roots without running the danger of root contact.[16] However, a major concern regarding the thread diameter of the miniscrew implants is the increased fracture noted in diameters less than 1.2 mm. Most miniscrew implants have a thread diameter ranging from 1.2 to 2.0 mm and a length from 4.0 to 12.0 mm,32-36 although some of them are also available at lengths of 14.17 or even 21 mm.

Clinical Applications –

Generally speaking, the several miniscrew implant systems can be applied to situations where the quality or quantity of dental unit support is impaired, such as in patients with incomplete dentition or teeth with periodontal disease.Furthermore, the criterion for the minimal amount of undesirable reactive forces is an unequivocal indication.

For example, in patients who lack enough teeth for conventional anchorage, in situations where the forces on the reactive unit would cause unfavorable side effects, in patients who require asymmetrical tooth movements in all planes of space, and in certain situations as a substitute for orthognathic surgical procedure, Melsen proposed using miniscrew implants as anchorage for tooth movements that could not be achieved otherwise.Miniscrew implants have been used in a growing number of cases in the past few years, such as correcting deep overbite, closing extraction spaces, straightening a canted occlusal plane, aligning dental midlines, extruding impacted canines, extruding and uprighting impacted molars, molar intrusion, maxillary molar distalization, distalization of mandibular teeth, en-mass retraction of anterior teeth, molar mesialization, alignment of upper third molars, and using intermaxillary anchorage to correct vertical skeletal discrepancies that would otherwise need orthognathic surgery.[7, 16-18,19]

Over its evolution, orthodontics has greatly benefited from the clinical impact of micro-implants and the recently introduced infra-zygomatic crest (IZC) and buccal shelf (BS) orthodontic bone screws. In the last ten years, the concept of absolute anchorage has led to a resurgence in the area of orthodontics with the use of mini-implants and extra-radicular bone screws.

In addition to resolving anchorage-related issues, they have also successfully treated instances without requiring extraction or even retreating those with anchorage loss with the use of mini-implant mediated segmental distalization or whole arch distalization with extraradicular bone screws.

Orthodontic retreatment is a typical procedure these days due to poor mechanics. The skilled orthodontist must immediately discover a different way to treat clinical scenarios that are severely impaired. A glimmer of hope may be offered by the use of buccal and infrazygomatic shelf screws, which can also shorten the amount of time needed for retreatment. They must be handled carefully, though. The primary factors to master the method are the anatomic constraints, art, biomechanical viewpoints, and side effects.

Extra-Radicular Bone Screws V/S Microimplants –

Both extra-radicular bone screws (IZC, BS) and micro implants are classified under temporary anchorage devices. Bone screws are placed away from the roots in the infra zygomatic areas of the maxilla and the buccal shelf areas of the mandible. Mini-implants are placed in between the roots of teeth (mostly) – intraradicular.[20]An alloy of titanium, aluminum, and vanadium (Ti6Al4Va) is used to make the majority of mini-implants. The same composition as micro-implants is also available for bone screws, but pure stainless steel is the material of choice. Since bone screws

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are typically positioned in DI (>1250 HU) quality bone (IZC and BS regions), they need to be more fracture resistant than Ti alloy. This is why stainless steel is more fracture resistant than Ti alloy. Consequently, stainless steel is the material of choice for bone screws.

Bone Screws – Indications –

With the exception of interdental placement, orthodontic bone screws can be used in nearly all clinical scenarios where mini-implants are used due to their greater dimensions. One of the primary indications for bone screws is full arch distalization of the maxillary and mandibular dentition to conceal a Class II and a Class III malocclusion. Distalization of arches in retreatment cases of anchoring loss—which are otherwise challenging and time-consuming to treat with conventional mechanics or mini-implants—is another significant indicator.[20]

They can be used to molar uprighting, protraction and retraction of the dentition, intrusion of a single tooth into the complete arch, segmental or full arch distalization, and more.

Orthodontic Bone Scrwes – Sizes –

There are two standard sizes (brand specific) for orthodontic bone screws in the maxilla (IZC): 12 and 14 mm in length and 2 mm in diameter. A 14 mm screw with 7 mm of head and collar area and 7 mm of cutting spiral is the recommended option when the soft tissue in the buccal vestibule is thick, as it is in the majority of clinical scenarios.When there is thin soft tissue at the vestibule, orthodontic bone screws measuring 12 mm in length are recommended. Depending on the manufacturer, there may be variations in the proportions of the cutting spiral, head, and collar. Mandibular bone screws are typically offered in two sizes (depending on the manufacturer): 10 mm and 12 mm in length and 2 mm in diameter. Since the buccal shelf area is typically thin and deep in the Indian population, a 12mm screw is the recommended option. Both variations' head and collar sizes (10 and 12 mm) are nearly identical, though they could differ depending on the manufacturer's preference.

Orthodontic Bone Screws – Sites –

Maxilla –

Orthodontic bone screws are best placed in the infra-zygomatic crest of the maxilla. In relation to the first and second molar regions, it is lateral and higher.[20]While Liou and some other authors favor placing bone screws closer to the MB root of the first molar, in the region between the first and second molars.

Mandible –

The buccal shelf area, which is located lower and lateral to the region of the second molar, is the ideal location for bone screws to be inserted into the mandible. Buccal shelf bone screws can also be inserted into the mandible's external oblique ridge if the buccal shelf area is determined to be excessively shallow or deep, as is frequently observed in the Indian population. There is bone of D1 (>1250 HU) quality in both regions.[20]

Technique Of Placement Of Bone Screws In Infrazygomatic Crest -

The initial point of insertion for bone screw placement in the IZC is 2 mm above the muco-gingival junction in the alveolar mucosa and interdental between the first and second molars. When looking at this location from the frontal aspect, the self-drilling screw is 90° oriented toward the surface of the bone.After the initial notch in the bone is created, two to three turns of the driver is done, then the bone screw driver is reversed by one turn and then direction is changed by approximately 30° towards the tooth, downward, and subsequently 45° and then around 70°-80° which aid in bypassing the roots of the teeth and directing the screw to the infra- zygomatic area of the maxilla. The bone screw is screwed in till only the head of the screw is visible outside the alveolar mucosa. No pre- drilling, raising of flap or vertical slit in the mucosa is required for insertion of IZC screws. Immediate loading is possible and a force of up to 300–350 g can be taken up by a single bonescrews.

Technique Of Placement Of Bone Screws In Buccal Shelf Area –

In order to install bone screws in the mandible's buccal shelf area, the initial location of insertion is 2 mm below the mucogingival junction and interdental between the first and second molars. When looking at this location from the frontal aspect, the self-drilling screw is 90° oriented toward the surface of the bone. Following the creation of the first notch in the bone, the bone screw driver is turned two or three times. After that, it is reversed by one turn, and its direction is altered by about 30° toward the tooth, upward, 45°, and finally 75°, which helps to avoid the tooth roots and direct the screw to the buccal shelf area of the mandible.In the mandible, however, sometimes vertical slit or pre-drilling in the mucosa is necessary if the bone density is too thick, however,

raising of flap is never required. Immediate loading is possible and a force of up to 300–350 g can be taken up by a single bone screw.[1,2] However, there are varied concepts of bone screw placement and it is best left to the clinician to determine which is preferable for him.[20]

Complications –

Gingival overgrowth on the screw is the most common complication associated with bone screws. Early loosening of the screw is another possibility. Minor bleeding is one of the Complications associated with the insertion process of bone screws are very less. If pure stainless steel good quality screws are used breakage of tip of the screw is never a problem. Oral hygiene maintenance is of utmost necessity to avoid problems related to gingival overgrowth. The incidence of gingival overgrowth is far less with screws having larger heads. In case of early loosening of the screw– replacement of the screw is advisable in a different site.larger dimension and placement sites having excellent quality of cortical bone. Reports suggest overall failure rates of micro‐ implants to be 13.5% while bones screws to be – BSS (7.2%) and IZC (7%).[17] In the case of orthodontic bone screws, the goal of any new clinical procedure is to increase patient and clinician compliance while also expanding treatment options and improving quality of care offered in conjunction with precision.

The distalization techniques with these extraradicular bone screws when used judiciously could help in overcoming newer challenges and go beyond boundaries in achieving the ultimate goal of – "Clinical Excellence." Orthodontic Bone Screws free clinicians from the need for patient's compliance and increase the amount of treatment options, thus providing ease to cases initially seen as too complex or unfeasible in terms of conventional orthodontic treatment methods.

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