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Research Article

UPCOMING TREND OF IMPLANTS IN ORTHODONTICS: AN OVERVIEW

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ABSTRACT

Orthodontic treatment with minimal patient compliance has brought up the use of implants as tools to bring out various orthodontic movements that includes distalisation of molars, symmetrical balancing of spaces, maintaining spaces without getting shift, which were considered to be difficult by conventional treatment method. Moreover, the emergence of smaller sized implants with the advantages like shortened healing period; minimally invasive placements and simplified design have made clinicians to opt over implants in the treatment of mal-occlusion. Till date, numerous studies have been published concerning different anchorage systems from the aspect of application, function, or effectiveness. This paper aims to state a brief overview of the indications, contra-indications, classification of systems available and outline on various systems and its advantages which could enlighten the clinicians about the use of implants in orthodontics.

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INTRODUCTION

Dental implants in orthodontics

Creekmore in 1983 reported the possibility of skeletal anchorage in orthodontics. Higuchi in 1991 used titanium fixtures for intraoral anchorage to facilitate orthodontics tooth movement. Costa in 1998 used miniscrew for orthodontic anchorage. Umemori in 1999 used SAS for open bite correction. Maino in 2003 introduced spider screws for orthodontics.

Classification based on the implant morphology

Since 1995 over 10 new systems of implant have been introduced

Implant discs

- Onplant

Screw designs - These include:

- Mini-Implant
- Orthosystem implant system
- Aarhus implant
- Micro-implant
- Newer systems such as the Spider screw, the OMAS system, the Leone mini-implant, the Imtec screw etc.

Plate designs - These include

- Skeletal Anchorage system (SAS)
- Graz implant supported system
- Zygoma anchorage system

Indications and Contraindications of Implants in Orthodontics

Indications for implant in orthodontics

- To retract and align anterior teeth with no posterior support
- To close edentulous spaces in first molar extraction sites

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- To intrude or extrude teeth
- To protract or retract teeth of one arch
- To stabilize teeth with reduced bone support
- For orthopedic traction
- Implant for osteogenic distraction

Contraindication for implant therapy

Absolute contraindication

- Severe systemic disorder like osteoporosis
- Psychiatric diseases
- Alcoholics drug abusers

Relative contraindications

- Insufficient volume of bone
- Poor bone quality
- Patients undergoing radiation therapy
- Insulin dependent diabetes
- Heavy smokers

Orthodontic Anchorage with Osseointergration: bone Physiology and Metabolisum

The predictable use of implants as a source of orthodontic and dentofacial orthopedic anchorage requires a practical understanding of the fundamental principles of bone physiology and biomechanics. However, a careful evaluation of prospective patients is indicated because many candidates for implant-anchored orthodontics are affected by osteopenia, osteoporosis, or other medical problems. Optimal use of Osseo integrated implants requires a thorough knowledge of bone biomechanics, particularly when the patient is skeletally and/or periodontally compromised.

Application of Implant in Orthodontics

Orthopedic Anchorage

- Maxillary Expansion
- Headgear like effects

Dental Anchorage

- Space closure of anterior teeth
- Intrusion of posterior teeth
- Distalization

In conjunction with prosthetic rehabilitation (Direct anchorage)

Maxillary Protraction

Smalley in 1988 used Branemark implants into the maxilla, zygoma, orbital and occipital bones of monkeys. A force of 600g was delivered to maxillary and zygomatic bones. A 12mm widening at the zygomaticomaxillary suture was seen and 16mm widening at zygomaticotemporal suture was observed. The dental changes seen were a 5-7mm change in overjet. However dental tipping also occurred along with skeletal protraction.

Implants for skeletal expansion

Movassaghi in 1995 tested frontonasal suture expansion in rabbits from an implanted titanium screw device. The plates were placed in frontal and nasal bones. After4 weeks of healing, 55g force was applied. Force was applied for 5 weeks and a significant increase ingrowth to the tune of 6 mm. across frontonasal suture was seen. Parr in 1997 conducted experiments on Mid-nasalexpansion using endo-osseous titanium screws. They divided the sample into 3 groups- 1 control and 2 experimental groups. 1 Nand 3N loading forces were applied in the two experimental groups. Their results showed a 92% stability of implants. Sutural expansion of 5.2mm and 6.8 mm respectively was seen in the 1N and 3N load categories. Mineral apposition and bone formation rates were significantly higher in the experimental group. The 3N group showed more expansion but this did not affect the rate of bone formation across the suture.

Implants for intrusion of teeth

Creekmore in 1983 published a case report of usage of a vitallium implant for anchorage, while intruding the upper anterior teeth. The vitallium screw was inserted just below the anterior nasal spine. After an unloading period of 10 days, an elastic thread was tied from head of the screw to the arch wire. Within one year, 6mm intrusion was demonstrated along with 25 lingual torque. Another study by Southard in 1995 compared the intrusion 'potential of implants with that of teeth (denta1 anchors). Titanium implants were placed in extracted 4th premolar area in dogs, followed by an unloading period of three months. Then, an intrusive force of 50-60g via 'V' bend was effected. This was compared with intrusive potential of teeth on the other side using the same mechanics. No movement of implant was seen at the end of the experiment whereas, on the other side, the tooth acting as the anchor units tipped severely. Therefore, implants are definitely superior to the teeth acting as anchor units.

Implants for space closure

Extensive research relating to usage of retromolar implants for orthodontic anchorage has been done by Roberts in 1990. The first clinical trial was on an adult wherein an atrophic extraction site had to be closed. A special implant was developed of size 3.8mm width and 6.9 mm length, which was placed in the retromolar area. A 0.021" X .025" SSwire was used for used for anchorage from the screw around the premolar bracket. The extraction spaces were closed using forces from buccal as well as the lingual sides (activating the lingual arch. The premolar was prevented from moving distally with the help of0.021 X .025" wire acting as an anchorage. The modification in this technique as suggested by him in 1994 includes the usage ofa .019" X.025" TMAwire. This wire is termed as the anchorage wire. Although the retromolar implants popularized by Roberts are very efficient in preserving anchorage, they suffer from certain drawbacks, which in turn has hindered their acceptance in routine clinical practice.

SUBPERIOSTEL IMPLANTS

The Onplant

This is a classic example of a sub periosteal implant in Orthodontics. Developed by Block and Hoffman in 1995, this system consists of a circular disc 8-10 mm in diameter with a

provision for abutments in the center of the superficial surface. These abutments would enable the Orthodontist to carry out tooth movement against the Onplant. The undersurface of this Titanium disc is textured and coated with Hydroxyapatite (HA). The HA, being bioactive helps in stabilization of the implant by improving integration with bone. The average thickness (height) of the implant is 3 mm. The onplant is placed by a surgeon through a specialized procedure known as Tunneling. After making an incision in the posterior region of the palate, a sub-periosteal tunnel flap is created extending till the desired location, using an elevator. Care is taken to position the onplant as close to the midline as possible. The onplant is not disturbed for a period of 3-4 months to allow bio-integration. Later, the superficial surface of the onplant is exposed using a trephine and the desired abutment is then threaded on. Extensive animal studies have been carried out on onplants. They point out to the fact that onplants bio-integrate and can tolerate a maximum force of 161 lbs. Block and Hoffman further suggest that these onplants could be used not only for dental anchorage like retraction of anteriors or distalising posteriors, but also for orthopedic traction. Human trials are however, limited.

OSSEOUS IMPLANTS

Osseous implants are those that are placed in dense bone such as the zygoma, the body and ramus area or the mid-palatal areas. The implant systems under this category are the Skeletal Anchorage system, The Grazimplant supported system and The Zygoma anchorage system.

SKELETAL ANCHORAGE SYSTEM

Developed by Umemori in 1999. It consists of titanium miniplates, which are stabilized in the maxilla or the mandible using screws.Different designs of miniplates are available which offers some versatility in placing in different sites. The 'L' shaped miniplates have been the most commonly used ones, while the 'T' shaped ones have been proposed for usage while intruding anterior teeth. The advantages of miniplates are, the shape of the miniplate can be adjusted to the type of tooth movement: intrusion of molars, intrusion of incisors, distalization or protraction of teeth.

Distalization of molars

It is possible to distalize the mandibular molars with anchor plates placed at the anterior border of the mandibular ramus or mandibular body. Distalization of the mandibular molars enables the clinician to correct anterior crossbites, mandibular incisor crowding, and mandibular dental asymmetry without extracting premolars

Distalization of the entire buccal segments

Direct retractive force is applied from the anchor plates to the first premolars to perform en masse distalization of the buccal segments. Elastic modules or nickel titanium closed coil springs usually provide the retractive orthodontic force

Intrusion of lower molar for correction of open bite

Intrusion of the lower molars was achieved with the application of elastic orthodontic force on the SAS, Lingual crown torque was applied to the lower molars with Burstone's precision lingual arch to avoid buccal flaring during intrusion

Advantage of SAS

The SAS enables tooth movement to be controlled 3-dimensionally, so that treatment goals can be accomplished, even when the amount oftooth movement required is more than the mesiodistal width ofthe premolars. The molar relationship in patients with symmetric orasymmetric Class III molar relationships can be corrected without having to extract mandibular premolars. SAS also does not interfere with tooth movement

ZYGOMA ANCHORAGE SYSTEM

Introduced by **De Clerck** in 2002. It is comprised of a titanium miniplate with three holes, slightly curved to fit against the inferior edge of the zygomaticomaxillary buttress. A round bar, 1.5mm in diameter, connects the miniplate and the fixation unit. A cylinder at the end of the bar has a vertical slot, where an auxiliary wire with a maximum size of .032" to .032" can be fixed with a locking screw.The plate is attached above the molar roots by three self-tapping titanium miniscrews, each with a diameter of 2.3mm and a length of 5mm or 7mm. Orthodontic forces can be applied to the anchor immediately after implantation. Miniscrews are small enough to be placed between the roots of the teeth in the alveolar bone.By connecting two or more miniscrews, the orthodontic reaction forces can beneutralized. Miniscrews can be used in the anterior or posterior region and attached with elastics or coil springs to the fixed appliance for direct anchorage.The main disadvantage of these screws is their proximity to the roots, which may be damaged during placement of the screws or when the adjacent teeth are displaced.

GRAZ IMPLANT SUPPORTED PENDULUM

Introduced by Kärcher in 2002. Consists of a modified titanium miniplate, with provision for four miniscrews, and two oval shaped cylinders. This was used mainly as a support for the Nance button of a pendulum appliance in the palate. This system can be loaded within 2 weeks to distalize and anchor maxillary first and second molars. It consists of a simple surgical plate (15 X 10 mm). Two cylinders (10 mm long and 3.5 mm in diameter) are soldered at right angles to the center of the plate.No auxiliary wires are bonded to the premolars, making the GISP removable. In the palatal portion of the resin body are 2 cylindrical slots that correspond to the 2 cylinders. The system is based on a telescopic principle: the 2 slots of the removable pendulum (RP) are placed over the 2 fixed cylinders of the implant. Osseous implants, specially the mini plate designs offera fair chance of success in effecting complex tooth movements such as molar intrusion. True intrusion of upper and lower molars in moderate anterior open bite cases converts a borderline orthognathic case into an orthodontic one. This emerging new area of implant application has been termed as *'Orthognathic Orthodonticslimitations of osseous implants*'

INTERDENTAL IMPLANTS

These implants are endosseous implants but of smaller diameter, which allows placement in interdental areas. They rely more on mechanical retention than complete Osseo integration. They are favored over the retromolar implants

dueto the following reasons that its placement is very simple and can be done under L.A, equally effective in resisting forcesas the larger root form implants. Also they can be used for bringing about all types of tooth movement.

MINI-IMPLANT

Introduced by Kanomi in 1997. The mini-implantsare only 1.2mm in diameter and 6mm long, making it much more useful in orthodontic applications like horizontal traction, molar intrusion, provide anchorage for molar distalization and for distraction osteogenesis. Advantages of mini-implants is that, it is small enough to place in any area of alveolar bone, even apical bone and could be easily removable after orthodontic traction

MICROIMPLANT

Micro-implant Anchorage (MIA) is a customized implant system developed by a team of Korean Orthodontist. These are small diameter implants, which can be placed interdentally either in the buccal sulcus or palatal interdental areas.The screwsare available in different lengths and diameters but standard as1.2mm in diameter, 8mm in length. The maxillary implants are longer than the mandibular ones owing to the difference in the thickness of cortical bone. A micro-implant is most commonly used for molar uprighting tooth movement. was placed in the retromolar area distal to the second molar, and a ligature wire was extended outward for elastomeric force application. To avoid root damage, only 50g of orthodontic force was applied. The molar was uprighted after eight months of treatment, and a bracket was bonded to it for further movement A micro-implant (1.2mm in diameter, 12mm in length) was placed in the maxillary tuberosity. A longer microscrew was used than in the lower retromolar area because the cortical bone is much thinner in the maxillary arch than in the mandibular arch. After two weeks of healing, 70g of force was applied width between the microscrew and lingual cleats on the buccal and lingual surfaces of the second molar. Four months later, the second molar showed considerable uprighting.

Spider screw

The Spider Screw is a self-tapping miniscrew available in three lengths--7mm, 9mm, and 11mm--in single-use, sterile packaging. The screw head has an internal .021" × .025" slot, an external slot of the same dimensions, and a .025" round vertical slot. It comes in three heights to fit soft tissues of different thicknesses: *regular*, with a thicker head and an intermediate-length collar; *low profile*, with a thinner head and a longer collar; and *low profile flat*, with the same thin head and a shorter collar. All three types are small enough to avoid soft-tissue irritation, but wide enough for orthodontic loading. The biocompatibility of titanium ensures patient tolerance, and the Spider Screw's smooth, self-tapping surface permits easy removal at the completion of treatment.

MINISCREW ANCHORAGE SYSTEM (M.A.S)

Developed by Carano in 2004 and are available in three diameters. Type A has a 1.3 mm diameter at the height of the neck of the implant, and 1.1 mm at the tip. Type B has a 1.5 mm diameter at the neck and 1.3 mm at the tip. The overall length for both Type A and Type B is 11.0 mm. Type C has a 1.5 mm at the neck and 1.3 mm at the tip with 9mm of total length. Clinical application of M.A.S system includes space closure, symmetric intrusion of incisors, molar intrusion, mesialization and intermaxillary anchorage. Advantage of miniscrew anchorage system is that its independency from the number or position of the teeth present, Optimal pulling forces and shorter treatment time (not need to prepare dental anchorage)

FUTURE OF IMPLANT

The ideal implant design for orthodonticsshould be one that could be placed minimally invasive thus causing minimum discomfort to the patient. At the same time, they should be optimum in resisting the conventional Orthodontic forces. Newer designs and simplified procedure should beinvented which could be placed by an Orthodontist himself. Also, the implants in orthodontics need not last for a very long time, biodegradable implants may be a rewarding option. Biodegradable screws made of L-polylactide have been introduced by Glatzmaier in 1996 and are currently undergoing clinical trials. The system, termed as the BIOS (Bioresorbable implant for Orthodontic systems) consists of resorbablepolylactide with a metalabutment.

Conclusion

Implants for the purpose of conserving anchorage are comfy additions to the armamentarium of a clinical Orthodontist. They help the Orthodontist to overcomethe difficulties of unwanted reciprocal tooth movement. The presently available implant systems are bound to change and evolve into more patient friendly andoperator convenient designs. Long-term clinical trials with large population are awaited to institute clinical guidelines in using of implants for both orthodontic and orthopedic anchorage.

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