

# The Role of Implants in Orthodontics

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## ABSTRACT

In this article, a review of the development of implants in orthodontic treatment and use of dental implants is done. The use of implants has greatly increased over the last three decades, largely as a consequence of their successful long-term osseointegration. This has led to increased orthodontic use with appropriate modifications in the design, when required.

**Keywords:** Orthodontic implants, Absolute anchorage, Osteogenic distraction.

**How to cite this article:** Mehan P, Bhutani R. The Role of Implants in Orthodontics. *Int J Oral Implantol Clin Res* 2012;3(1):36-38.

**Source of support:** Nil

**Conflict of interest:** None declared

## INTRODUCTION

It is well established that implants can offer an option when replacing missing teeth, following orthodontic treatment. This article, however, will concentrate on the use of implants during orthodontics, to enhance the orthodontic treatment, with particular reference to the following:

- Implants as a source of absolute anchorage
- Implants used for anchorage and as abutments for restorations
- Implant in osteogenic distraction

## HISTORY OF IMPLANTS

The work of Branemark in the 1960s on osseointegrated implants is well known.<sup>1,2</sup> His definition of 'a direct contact between living bone and an implant, on the light microscope level'<sup>1</sup> describes the objective of osseointegration, but the essence of its clinical success is the reliability of long-term implant fixation, even in the presence of functional loading. This has been supported by many studies, including a meta-analysis,<sup>3</sup> which reported a 90% success rate for osseointegrated implants used for bridge abutments.

## Types of Implants

The rise in the use of dental implants has led to a great diversity in their design and manufacture. The classification of implants can be based on their position, material of construction, or design.

The position of the implant can be subperiosteal, transosseous, or endosseous, the last of which is the most commonly used type of dental implant.

Titanium is the accepted ideal material for implant fabrication, but other variants include gold alloys, vitallium, cobalt-chromium, vitreous carbon, aluminium oxide ceramics or nickel-chromium-vanadium alloys.<sup>4</sup> Even with the favored titanium metal, the implant surface may be rough or smooth and may have an additional hydroxyapatite or titanium-spray coating.<sup>5</sup>

There appears to be a lack of consensus among researchers and clinicians regarding the best design for an implant. The main area of dispute focuses on how an implant gains its support from the surrounding bone. A screw thread around the implant surface aids loading of the surrounding bone in compression, whereas a smooth cylindrical design increases implant support, when shear forces are exerted on the bone. Both these varieties show a more uniform stress distribution under loading when compared to other designs.<sup>6</sup>

## Implants as a Source of Absolute Anchorage

During active treatment, orthodontic anchorage aims to limit the extent of detrimental, unwanted tooth movement. There are methods available to reduce anchorage loss during treatment. However, these techniques are often only partially successful, e.g. transpalatal arches or headgear. The ability of osseointegrated implants to remain stable under occlusal loading has led orthodontists to use them as anchorage units without patient compliance.

Implant-based anchorage can be of particular benefit in treating certain aspects of malocclusions, e.g.:

- Retracting and realigning anterior teeth with no posterior support
- Closing edentulous spaces in first molar extraction sites
- Center-line correction, when missing posterior teeth
- Reestablishing proper transverse and anteroposterior position of isolated molar abutments
- Intruding/extruding teeth
- Protraction or retraction of one arch
- Stabilization of teeth with reduced bone support
- Orthopedic traction.

Block and Hoffman<sup>7</sup> addressed the issue of bone height by developing a disk-like structure called an 'onplant' which is designed to be placed under local anesthetic. After a 10-week healing period, the onplant is surgically exposed and a ball-shaped abutment (which replaces the cover screw) is attached. This is subsequently connected to orthodontic bands on the upper molar teeth by a transpalatal arch. This mechanism has been shown to resist greater than 300 gm of

continuous orthodontic force, which is comparable to the force required for conventional space closure of orthodontic extraction sites. After correction of the malocclusion, the onplant is removed using an osteotome, but the authors do not elaborate on any complications associated with this removal technique. Although the onplant requires less bone depth compared to conventional endosseous implants and the period of consolidation is approximately half as long, the surgical procedure is complex. The secondary surgical procedure to uncover the integrated onplant involves a large area of soft-tissue being reexposed, which is quite traumatic to the patient. In addition, the use of an osteotome to remove the onplant under local anesthetic may be disconcerting for the patient.

### Orthopedic Traction

Implants have been suggested in treatment aimed at orthopedic change. One study describes osseointegrated implants inserted into the zygomatic buttress. These were used in combination with intraoral extensions, to act as attachments for facemask therapy.<sup>8</sup> The orthopedic changes observed in the maxilla over an 8-month treatment time occurred without any dental change. Implants may therefore be used to provide an alternative to conventional orthopedic facemask therapy, while avoiding potentially unwanted dental movements.

### Implants used for Anchorage and as Abutments for Restorations

The previous section discussed implants used as a source of absolute anchorage. At the end of the orthodontic treatment, they were then removed. However, implants can also be placed in a position that allows them to act initially as a source of anchorage, but then as an abutment for restorative work.

Cases requiring implants for both restorative management and orthodontic anchorage require extensive planning involving the orthodontist, restorative specialist, oral surgeon and periodontist. There are cost and time implications, and the potential surgical difficulties of access and local anatomy that may prejudice against the ideal positioning of a conventional implant should be borne in mind. The restorative specialist decides on the exact location of the implants. A diagnostic wax-up of the final occlusion and a comparison of this with the original model are used to define the precise location of the implants. When this has been decided, a placement guide or stent is fabricated to ensure accuracy of placement of the implants.<sup>9</sup> This process may be aided by the recently developed simplant software system which provides information on the optimal

dimension, orientation, and inclination of the endosseous implant, through an interactive computer program.<sup>10</sup>

The dimensions of the implant should conform closely to the desired emergence profile of the final restoration without compromising the interdental bone. For optimal esthetics of the emergence profile, the implant head should be 2 mm below the cemento-enamel junction of the adjacent teeth.

If orthodontic treatment is necessary to create space prior to the implant being placed, then the roots of the adjacent teeth should be upright and parallel once this is complete. Adequate space is important not only in the mesiodistal dimension but also for the buccolingual width of the implant.

### Orthodontic Implant Attachments

Once successfully implanted and after the bone has consolidated, the implant must be incorporated into the orthodontic appliance. It is possible to attach an orthodontic archwire directly to the implant cover screws, but movement of the teeth is faster and better controlled, if single crowns or denture teeth are used as superstructures. The type of attachment used depends on factors such as:

- The magnitude of force required.
- The need for esthetics.
- The method of force application.

The most durable options are all metal or bonded metal crowns. The incorporation of a class V cavity in the fabrication of these prior to casting, allows a mechanism for orthodontic bracket retention with composite resin. Other options include soldering the orthodontic bracket to a second-stage, nonrotating implant abutment<sup>11</sup> bending a loop in orthodontic archwire to secure it to part of the implant.

It is important that endosseous implants required for restorative management are not compromised during their use for orthodontic anchorage. To ensure maintenance of osseointegration during and beyond treatment, orthodontic loading of a single two-stage endosseous implant should not commence for 6 months in the mandibular arch. However, if multiple implants are placed, occlusal loading of the implants can start sooner. This is because the cross-arch splinting that results from loading the prosthesis allows integration to occur around the functioning implants.

### Implants in Osteogenic Distraction

Osteogenic distraction may provide a stable method of addressing facial skeletal deformities through bone generation, which allows adaptation of the surrounding soft tissues, due to its gradual process. It has, however, been suggested that distraction devices that are fixed using

conventional bone screws, may not transmit forces evenly across the distraction site. Pilot studies on the maxilla and mandible undertaken by Ueda et al<sup>12</sup> have illustrated the use of osseointegrated implants to transfer continuous distraction forces through the full width of the distraction site. This has been successfully completed in mandibular lengthening, maxillary advancement and alveolar ridge augmentation but requires further research prior to becoming an established technique.

## CONCLUSION

Osseointegrated implants may now be used to enhance more traditional orthodontic techniques. In particular, they may have the potential to provide a useful method of anchorage reinforcement, particularly in cases otherwise dependent on patient compliance. The continuing development of orthodontic implants has led to the production of smaller designs which are easy to insert and remove and do not require a long healing period prior to loading.

With astute planning in hypodontia cases, osseointegrated implants can be used for orthodontic anchorage to correct a malocclusion, prior to acting as the coping for the definitive restorative prosthesis.

In the future, as developments occur in implant technology, they may have a significant role as anchorage reinforcement aids and make headgear obsolete. However, there is a need for high quality research in this area.

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