Implant collars and connections-pioneers of implant success: A review.

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Abstract

Objective: Determination of the type/design/shape of implant collar and implant connection most favorable for increasing the rate of osseointegration surrounding an implant.
Background: Implant collars are frequently located at the superior part of the crest module in designs that incorporate microscopic components into the implant bodies through coatings with hydroxyapatite. For single tooth restorations, the implant/abutment connection needs to be exact, stable, and should incorporate an anti-rotation mechanism.
Method: We have reviewed the impact of various implant collar and connection designs and forms, which have become modern dental practice trends, on the peripheral bone and the rate of osseointegration.
Results: Depending on the designs and shapes of implant collars and connections, the condition of the peri-implant tissues and aesthetic considerations are seen to alter remarkably after placement of the implant.
Conclusion: Collars and connections being integral parts of dental implant system help in determining peri-implant tissue health, rate of osseointegration and thereby help in determining success of an implant to a great extent.
Application: Selection of the design of collar and connection prior placement has to be done precisely in order to achieve implant success.

Keywords: Barrier membrane, Guided bone regeneration, Immediate implants, Indirect sinus augmentation, Surgical guides.

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Introduction

Dental Implantology has revolutionized the treatment modality for replacing missing single or multiple teeth with implant supported crown/prostheses. Criteria for success of an implant include its ability to osseointegrate with the bone bed in the host, to support a prosthesis and to sustain occlusal stresses during function.[1]

In the 1970s, the biological concept of osseointegration applied to the dental field changed the face of dentistry by offering us a completely new approach to the treatment of edentulism (Branemark et al., 1977).

Undoubtedly, one of the most important developments in clinical dentistry during the previous 25 years has been the notion of osseointegration. A reliable treatment option for partial and complete edentulism is now thought to be the use of osseointegrated dental implants. Dental implants can now be inserted practically anywhere in a clinical setting because of advancements in bone and soft tissue augmentation techniques. It has been determined that improvements in the utilization of growth factors for the treatment of localized ridge augmentation are favorable. Thus, even though esthetics continues to be the most difficult criterion to meet, the vast majority of patients can have an implant-borne restoration that is both functional and aesthetically pleasing.

Implant collars

The implant fixture's crest module is the component that connects the implant to the abutment or attachment. It provides axial and occlusal loading force resistance. It has anti-rotational properties and comprises of a platform. A region of extremely concentrated mechanical stresses is present in the transosteal region of an implant body, which is known as the crest module. They are made to prevent the buildup of any form of plaque once bone loss has already taken place. In a two-piece implant system, the section of an implant body designed to hold the prosthetic component is called the crest module. It also represents the transition zone from the implant body design to the transosteal region of the implant at the crest of the ridge.[2]

At the superior aspect of the crest module, implant collar designs cover the implant bodies with hydroxyapatite to add a microscopic component. They have a height of 0.5–1 mm for submerged implants and 3-5 mm for non-submerged implants.

The titanium plasma and hydroxyapatite surface coatings of implant bodies, which play important roles in accelerating osteoblastic adhesion to the bodies and increasing the bioactivity of the surface of the body, are protected from exposure by implant collars. These coatings allow for the functional remodeling of bone and improve the abutment-fixture interface. As dental implantology has advanced, a variety of implant collar forms and shapes have been put into use, each with a distinctive effect on the peri-implant tissues.

Implant connections /implant-abutment connections

As the point where the fixture and the prosthetic abutment meet, this is referred to as the interface. An abutment screw is always used to hold this interface, which may have a variety of configurations. An accurate and secure connection between the implant and abutment is required. For restorations on single teeth, it has an anti-rotation device built in. The contact between the implant and abutment should be mechanically stable and adequately load-distributed. The connection ought to make it possible to clinically index (or record) the three-dimensional implant position while making an impression for a prosthetic.

Discussion

It is believed that an implant collar's design and shape significantly affect the general state of the peri-implant tissues. To determine how the shape and layout of implant collars affected the wellbeing of the peri-implant tissues, the following studies were conducted:

While an angled collar/roughened collar is perceived to send compressive stresses to the bone, the surrounding bone is seen to receive shear stresses from a polished collar/straight crest module (Figure 1). Compressive pressures are far more able to endure the crestal bone than shear forces since they are the opposite of unaligned forces, which are significantly more harmful to the surrounding bone and increase the likelihood of bone resorption.

Crestal Compact Bone Stress and Strain Distribution and the Effect of Implant Collar Design:

During loading, implant collars exert stress on the crestal compact bone. Commercial implant collar designs that are divergent, straight, and convergent are available (Figure 2). Around some implant types, radiographic evidence of "saucerization," or crestal compact bone loss up to and including the first thread of a

titanium screw implant, has been discovered in several retrospective clinical investigations. It has been demonstrated that some newer implant designs are effective at avoiding the loss of crestal compact bone. Misch and Bidez have claimed that an implant collar with a surface texture meant to increase bony contact and an angle more than 20 degrees may exert withstand-able compressive and tensile components on the surrounding compact bone and lessen the chance of bone loss. The implant collar design affected the stress and strain distributions in the adjacent compact bone, according to a study employing a "Three-Dimensional Finite Element Analysis".
The divergent implant collar design was associated with the lowest stress and strain concentrations in the crestal compact bone in comparison to other designs of implant collars.[3]

The Effect of Surface Texture of Implant Collars on Bone Level and Soft Tissue:

When Branemark first introduced the concept of osseointegration in 1952, a new era of oral reconstruction emerged.[4] For a long time, machined type of implant was clinically and histologically considered successful for osseointegration. In response to clinical demands, roughened surface implants were introduced in the late 80's in order to enhance bone–implant-contact (BIC) (Figure 3). However, plaque can attach up to 25 times more easily to rough surfaces than to machined surfaces [5,6] which may hamper the biological seal around the implant collar. Dental implant surface roughness first started with a hydroxy- appetite layer, then titanium plasma sprayed, titanium oxide [TiO_2] blasted, acid-etched, blasted and acid-washed/etched, anodized, laser ablation).[7,8,9] The introduction of a one stage implant designed by Straumann Standard Implant, formerly known as the "ITI Implant" in 1985 and later, sandblasting large grit and acid-etched surface, applying the smooth transmucosal neck supracrestally, led to decreasing the healing time and reducing the stress at the peri-implant region under the crest of the bone.

The transition from turned (machined) to textured surface of the implant collar started when research showed that this surface modification has a beneficial effect on early osseointegration and it decreases time of loading. [10-12]
If the roughened surface of the implant collar is exposed to the oral environment and is exposed by recession, there is a risk of faster loss of osseointegration.[13-15] A roughness thickness of 0.5 to 1.0 mm up to the collar of the implant may help maintain oral hygiene and provide an appropriate peri-gingival complex as well as maintenance of the biological seal.[16] A meta-analytical study comparing the effect of smooth and roughened implant collars on the surrounding soft tissues and bone levels revealed that roughened implant collars have got significantly less marginal bone loss as compared to smooth surfaced implant collars.[17]

Variations of roughened implant collars and their impact on the surrounding crestal bone:
There have been trials using turned neck (TN), micro-threaded (MT), and micro-grooved (MG) neck implants (Figure 4). The TN implants featured a 1mm turned surface at the fixture's neck, however the whole implant surface was treated using RBM (Resorbable Blasting Media). The remaining bigger square threads were treated with acid etching and blasting, while the coronal 2 mm of the MT implants had smaller threads with a 400 m pitch. The Exciner laser (Laser-lok, Bio-lok international Inc. Deerfield Beach, USA) was used to create finer threads on the MG implant at the coronal 2 mm of the neck. 12 and 8 m pitched threads made up these micro-grooves.

A 0.5 mm turned surface is on top of it, followed by 0.7 mm of micro-grooves with an 8 m pitch. The bone implant contact was found to be maximum in cases of microgrooved (MG) implant collars compared to the other two. Marginal bone loss has also been found to be least in cases of micro-grooved implant collars in comparison to TN and MT implant collars.[18]

It is believed that the connection design has an impact on implant problems, marginal bone loss, and implant survival rates, which is the key area of concern. In general, there are three different implant-abutment connection designs: Morse taper, internal hexagon, and external hexagon (Figure 5).

External Connection/External Hexagon

This part of the implant that is located superior to the coronal portion is called as the external hexagonal connection. The first implants that were ever created included flat butt-joint interfaces and external hexagons to enable for the recording of the implant location and to prevent rotation for single unit restorations. Because of this very well-documented connection, the interface can move slightly more easily during the transfer of occlusal loads.

Internal Connection/Internal Hexagon

This section of the implant that lies inferior to the coronal portion is called as the internal hexagonal connection. Commercially available internal connections come in a variety of designs, such as internal hexagon, morse taper, and cylindrical forms. A geometric recording device (triangle, hexagon, octagon, or dodecagon) is typically added to a Morse taper connection, which is an internal connection with a conical design (5–10° of conicity), in a number of implant systems. A very close contact between implant and abutment is provided by the Morse taper design. It is intended to prevent rotation of the abutment and eliminate the microgap.[19]

Aesthetic considerations in external and internal connections

The buccal region of the prosthesis needs enough ceramic volume to give the correct color and aesthetic result for esthetic zone restorations. For the restoration to seem aesthetically pleasing, there must be coronal space between the implant-abutment connection and the marginal gingiva. This conceals the unsightly metal connection while maintaining the proper emergence profile (Figure 6).

The depth of transition needed for cosmetic fixes cannot always be provided by external connections. They frequently have an emergence profile that looks like a large restoration. Since the external connection of the implant requires an expanded abutment cuff height, external connections commonly have metal exposed at the finish line level.

The ability of internal connections to restore aesthetics is superior. They facilitate the existence of an adequate amount of repair while also allowing for a smooth buccal contour. A better prosthetic emergence profile is also offered by the internal connection compared to external connections.

Platform Switching /Platform Matching Concepts:

Infiltrates of inflammatory cells close to the microgap, next to the bone crest, are associated with the implant/abutment connection. This is observed to be linked to certain crestal bone loss. It has been proposed to move the inflammatory infiltration horizontally, reduce the size of the micro-gap, and so prevent the loss of crestal bone by decreasing the width of the prosthetic component (platform switching) (Figure 7).

In a recent study, implants placed in fresh sockets showed no difference in bone level alternations between platform-matching and platform switching configurations (Crespi.et.al.)

The effects of different implant-abutment connections on stress distribution in single tilted implants and peripheral bone

Numerous variables, such as the kind of loading, the material qualities of the implant and prosthesis, and the geometry, length, diameter, and form of the implant, all affect how much weight is transferred through the implant-bone contact. A study was done to determine the stress distribution in single tilting bone-level implants with varied connections and peripheral bone under vertical and oblique loads using three-dimensional finite element analysis (FEA). Four different implant systems namely internal hexagon, tube-in-tube, cross-fit and friction-fit connections were created along with their abutments in three dimensions from the data (computer-aided design) of original implants and abutments that were scanned with an optical scanner (Figure 8). The angles at which the implants were placed within the bone block ranged from 0° to 15° and 30°. Then, a three-dimensional model of the metal-ceramic crown was created, and a total load of one hundred Newtons was applied both vertically and obliquely. The results of the stress tests differed depending on the connection design and tilting level. However, the tube in tube (TIT) connection type displayed lower stress values in the majority of loading and tilting scenarios. [20] A greater tilting angle had varied effects on each connection design.

Conclusion

Dental implants with their widespread armamentariums/parts have been the mainstay treatment option in the field of prosthetic dentistry over years. Among the various parts, selection of a particular design/shape of implant collar and connection is of utmost importance which will help in determining any marginal bone loss, soft tissue loss, longevity and any further complications after implant placement. Implant collars are essential for the bone remodeling that occurs around the implant and the various types of collars including smooth or roughened type, divergent, convergent and straight types influence the success of osseointegration surrounding dental implant to a huge extent. Similarly, abutment-fixture interfaces (connections) depending upon the location with the adjoining bone and soft tissue levels influence the rate of osseointegration remarkably. Hence prior placement of an implant, consideration regarding all these factors determining the success of an implant is of utmost importance.

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FIGURES

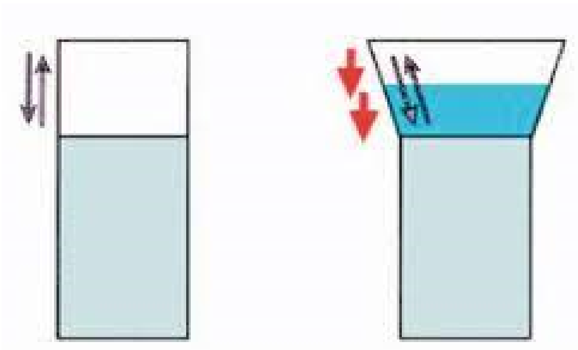

Figure 1

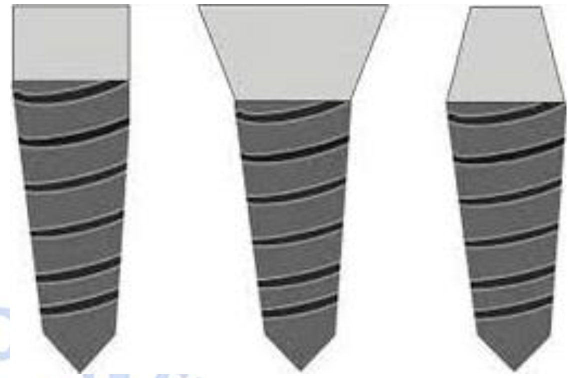

Figure 2

Figure 3

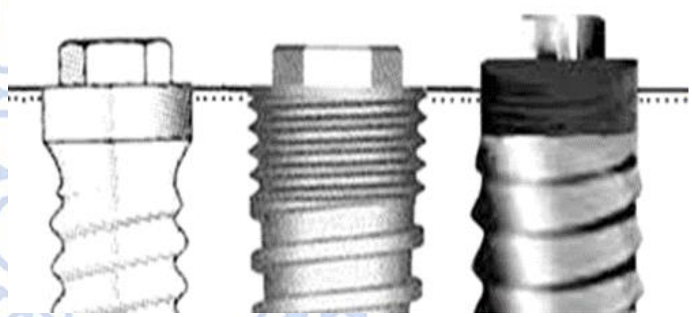

Figure 4

Figure 5

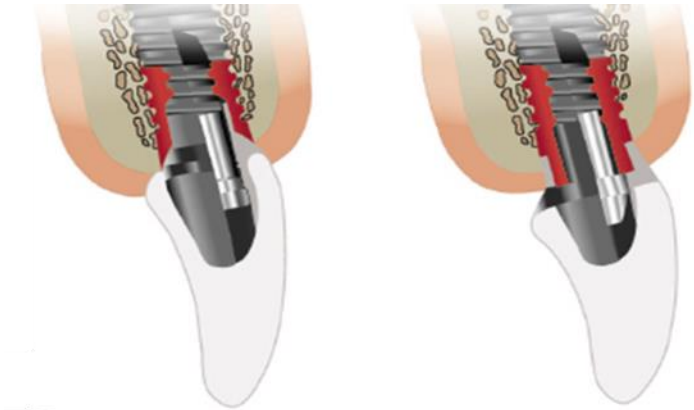

Figure 6

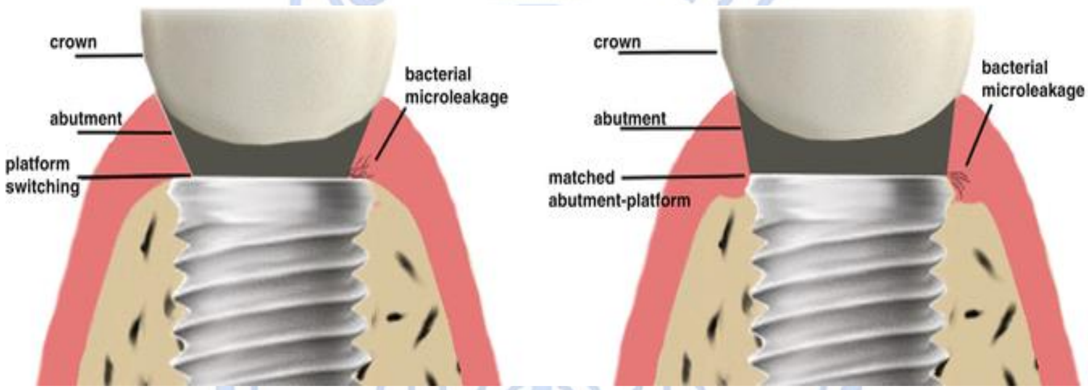

Figure 7

Figure 8