A review on the design and sur face characteristics of modern dental implants

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Implants have become a popular treatment method in today's dental practice. The first twenty years focused mainly on gaining acceptance for the treatment method. With more and more design variations and surface characterizations, dental implants have become more popular in dentistry. Endosteal implant systems are placed into the alveolar bone of the mandible or maxilla and are used to support a prosthesis. A dental implant designed to replace a single tooth is composed of three parts: the titanium implant that osseointegrates with the bone; the abutment, which fits on the implant and protrudes through gingiva; and the crown, which is fitted onto the abutment for a natural appearance. They can be either of one of the two basic shapes viz. root form or cylinder form. A root-form implant manufactured with threads similar to a hardware screw. The sides may be parallel or tapered. The threaded surface provides for retention during initial bone fixation as well as an increased surface area for osseointegration. Threaded implants reduce shear force at the bone-implant interface. Cylinder form is an endosteal root-form implant featuring parallel-sided, nonthreaded walls. Cylindrical implants are usually pushed or tapped into a prepared bone site and rely on a variety of manufactured coatings to support osseointegration.[1] An antirotational feature in the implant fixture is either included in the platform when it is called external hex, or can extend in to the implant body called an internal hex. The antirotational feature can be in the form of a hexagon, octagon, morse taper or cone screw, internal grooves or cam tube and pin slots.[2]

Even though dental implants have a success rate of upto 90% for five years, the remaining 10 % of failure is still a big number. This failure of dental implants is mainly observed in soft bone. In order to achieve a predictable outcome even in poor density bone the surface topography of dental implants have been enhanced in the recent past. It has been observed that the microscopic and macroscopic topography of dental implants affect the primary initial stability of the dental implants. Hence manufacturers have come out with an array of different screw thread profiles and surface coatings in order to create a stable implant to bone contact.

Design principles that need to be considered are:

1) The implant design should provide good initial stability and minimize the waiting-period required for loading the implant.

2) Incorporate design factors, that would diminish the effect of shear forces on the interface (such as surface roughness related and thread features) so that marginal bone is preserved.

3) Design features that may stimulate bone formation, and/ or facilitate bone healing.[3]

Threads have been incorporated into implants to improve initial stability, enlarge implant surface area, and distribute stress favorably. Kohn et al demonstrated the presence of a bone-bridge from the depth of one thread to another, when the implants were laterally loaded.

The original Brånemark screw (introduced in 1965) had a V-shaped

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threaded pattern. While some manufacturers modified the basic V thread, others used a reverse buttress with a different thread pitch for better load distribution.

Thread patterns in dental implants currently range from microthreads near the neck of the implant (Astra Tech, Lexington, MA) to broad macrothreads on the mid-body (Biohorizons, Birmingham, AL; Steri-Oss, Nobel Biocare) and a variety of altered pitch threads to induce self-tapping and bone compression (Implant Innovations, Palm Beach Gardens, FL; Nobel Biocare).

Implant neck (crest module) : The highest bone stresses have been reported to be concentrated in the cortical bone in the region of the implant neck as demonstrated in Finite Element Analysis (FEA) of loaded implants with or without superstructure. The implant neck design is one of the areas of development. Micro-textured and the macro-textured surfaces were explored. These designs mainly aimed to enhance the stability of interface for both soft and hard tissue and minimise the marginal bone reduction in the first year of implantation Tarnow et al have shown that the soft tissue height adjacent to the implant depends upon the marginal bone height. To maintain the soft tissue height adjacent to the implant especially in the esthetic zone, the crest module has to be smooth. If it is rough then the soft tissue will shy away from the implant surface. Apart from hard and soft tissue grafting, distraction osteogenesis, implant fixture design also have been modified to achieve better esthetic outcome. There are three basic types of a turned neck (TN) Avana implantsystem, Osstem co., Ltd., Seoul, Korea)implant, micro-threaded (MT) neck implant Oneplant, Warantec, Seoul, Korea and micro-grooved (MG) neck implant (Laser-lok, Bio-lok international Inc.Deerfield Beach. USA). The MT and MG implants, especially MG implants had advantageous tissue response in comparison to the turned neck implants.[4]

Platform switching : In many two part systems the Implant abutment interface (IAI) can give rise to an area of local inflamation causing bone resorption. A biological width of 2-3mm is needed above the bone inorder to establish a soft tissue barrier. It has been found that the bioligical width need not be a vertical dimension but can have a horizontal component, platform switching provides this horizontal distance and so preserves the crestal bone.

Histologic and radiographic observations suggest that a biologic dimension of hard and soft tissues exists around dental implants and extends apically from the implant-abutment interface. The vertical repositioning of crestal bone and the subsequent soft tissue attachment to the implant that occurs when an implant is uncovered and exposed to the oral environment establishes a biological width in an implant. Traditionally a matching-diameter restorative components are attached. Historically, two-piece dental implant systems have been restored with prosthetic components that locate the interface between the implant and the attached component element at the outer edge of the implant platform. The concept of platform switching refers to restoration of wide diameter implant with narrow diameter abutment. Long-term radiographic follow-up of these "platform-switched" restored wide-diameter dental implants has demonstrated a smaller than expected vertical change in the crestal bone height around these implants than is typically observed around implants restored conventionally with prosthetic components of matching diameters.[5]

Surface treatments of implants : Currently the trend of clinical implant surface modifications is shifting towards changes in surface chemistry rather than machined surface. The various surface modifications presently available are : turned surface, Sand blasted surface,acid etched surface,Titanium plasma spray, Sand blasted- surface etching, Hydroxyapatite coating, Anodized surfaces, Laser induced surface roughening, Ion implantation, Glow discharge, Electrochemically oxidized TiUnite implants (Nobel Biocare), Fluoride treated osseospeed implants (Astra Tech), Nacl treated hydrophillic sand blasted large grit acid etched implants (Straumann)The titanium porous oxide implant surface serves as an effective carrier for BMP- 7. This has a clinically significant potential to stimulate local bone formation. Bone formation will occur due to induction as well as interaction of growth factors. Osseotite Implant Combined with a nanometer-scale discrete crystalline deposition of calcium phosphate (CaP) creates a more complex surface topography.

Implants have come to stay here changing the entire profile of Prosthodontic treatment. The first decade of 21st century has really stabilized the implant design and surface. But definitely there will be exciting changes that will happen in the next decade.

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