ISSN: 2581 – 3633
PubMed - National Library of Medicine - ID: 101745081

International Journal of Medical Science and Advanced Clinical Research (IJMACR)

Available Online at: www.ijmacr.com

Volume – 4, Issue – 2, March - April - 2021, Page No. : 01 – 15

Recent Trends in Dental Implantology-Review

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How to citation this article: Dr Shilpa Jaryal,, Dr Jageer Chhina, Dr Gurpreet Kaur **,** "Recent Trends in Dental Implantology-Review", IJMACR- March – April - 2021, Vol – 4, Issue -2, P. No. 01 – 15.

Type of Publication: Review Article

Conflicts of Interest: Nil

Abstract

The science of implantology is highly dynamic. Ever since its introduction into the field of dentistry by Dr. Branemark, it has undergone numerous modifications and improvements. Tooth loss is a very common problem; therefore, the use of dental implants is also a common practice. Although research on dental implant designs, materials and techniques has increased in the past few years and is expected to expand in the future, there is still a lot of work involved in the use of better biomaterials, implant design, surface modification and functionalization of surfaces to improve the long-term outcomes of the treatment. This paper provides a brief history and evolution of dental implants. It also describes the types of implants that have been developed, and the parameters that are presently used in the design of dental implants. Finally, it describes the trends that are employed to improve dental implant surfaces, and current technologies used for the analysis and design of the implants.

Keywords: Dental Implants, Osseointegration, Implant Design, Diagnostic Imaging.

Introduction

Dental implants are a common treatment for the loss of teeth. This paper summarizes current knowledge on implant surfaces, immediate loading versus conventional loading, short implants, sinus lifting, and custom implants using three-dimensional printing. Most of the implant surface modifications showed good osseointegration results. Regarding biomolecular coatings, which have been recently developed and studied, good results were observed in animal experiments. Immediate loading had similar clinical outcomes compared to conventional loading and can be used as a successful treatment because it has the advantage of reducing treatment times and providing early function and aesthetics. Short implants showed similar clinical outcomes compared to standard implants. A variety of sinus augmentation techniques,

grafting materials, and alternative techniques, such as tilted implants, zygomatic implants, and short implants, can be used. With the development of new technologies in three-dimension and computer-aided design/computer-aided manufacturing (CAD/CAM) customized implants can be used as an alternative to conventional implant designs. However, there are limitations due to the lack of long-term studies or clinical studies. A long-term clinical trial and a more predictive study are needed.

Advances in Implant Materials

Implant Surface Topography

Dental implants have a long and successful history with only approximately 5% failure rate. The failure is most likely due to infection, accelerated bone loss, rejection and poor osseointegration with loosening of the implant. [1] Of these, the most frequently reported cause of implant failure is the inability of the bone to form around the biomaterial immediately after implantation. [2]

Osseointegration is the apparent structural and functional connection between ordered living bone and the surface of a load carrying implant and it is this interface that should be appropriately and satisfactorily formed during the healing period as well as maintained throughout the post prosthetic loading period for an implant to be successful. [3]

Development of the implant bone interface is complex and involves numerous factors. Several modifications have been made in the morphological and chemical characteristics of implant surfaces, thereby increasing its interaction with the surrounding bone.

Morphological and Chemical Variations

Implant design features are one of the most fundamental elements that have an effect on implant primary stability and implant ability to sustain loading during or after osseointegration. Dental implants have been designed to provide textures and shapes that may enhance cellular activity and direct bone apposition. [4]

Implant design refers to the macro and microstructure of an implant system, such as shape, type of implant-abutment connection, and presence of thread, thread design and surface treatment. Various implant systems with different implant thread configurations are currently available in the market.

The number of threads, width of the thread, depth of the thread, thread face angle and thread pitch are the various geometric combinations that affect final bone-implant contact (BIC) and the load distribution. The greater the number of threads and greater the depth of the thread, greater is the available surface area for load distribution. Threads with triangular face are subjected to greater shear stresses when compared to those with square-shaped thread face. [5]

Square-shaped threads achieve greater BIC when compared to V shaped or the reverse buttress.[6] Increasing the functional surface area of an implant will improve the way stress is distributed resulting in lesser forces at the crest. Use of threaded implants than the cylindrical implants for crestal bone preservation has been well documented in the literature. When cylindrical implants were compared to tapered implants, studies have shown that the use of tapered implants could reduce peak stress in both cortical and trabecular bone. [7]

Besides, effective stress decreases as screw pitch decreases and as implant length increases. [8] Recently, the concept of micro threads in the crestal portion of the implants has been introduced with the prime concern of maintaining the marginal bone and soft tissues around the implants.

Bone loss in the crestal region has been attributed to 'disuse atrophy' by some authors. [9] In the presence of a smooth neck, negligible forces are transmitted to the

marginal bone leading to its resorption. However, the presence of retentive elements up to the crestal module of the implant will dissipate some forces and might provide a potential positive contribution on BIC, as well as, on the preservation of marginal bone leading to the maintenance of the crestal bone height. [10]

Endosseous dental implants are available with various surface characteristics ranging from relatively smooth machined surfaces to more roughened surfaces. The surface roughness of the implants can significantly alter the process of osseointegration because the cells react differently to smooth and rough surfaces.

Fibroblasts and epithelial cells adhere more strongly to smooth surfaces, whereas osteoblastic proliferation and collagen synthesis are increased on rough surfaces. [11]Several dental implant manufacturers produce implants with smooth necks as they are believed to cause less plaque accumulation. However, implants with machined neck do not effectively distribute the occlusal load and result in crestal bone loss up to the first thread by the end of first year of function. [12]

In several studies, rough surfaces have been found to have a better fixation in bone than smooth surfaces. [13] Implant surface roughness is divided, depending on the dimension of the measured surface features into macro, micro, and nano-roughness.

Macro-roughness ranges from millimeters to tens of microns while micro-roughness ranges from 1 to 10 μm. Both enhance the interlocking between mineralized bone and implant surface. The use of surfaces provided with nanoscale topographies are widely used in recent years. Nanotechnology involves materials that have a nano-sized topography or are composed of nano-sized materials with a size range between 1 and 100 nm. Nanometer roughness plays an important role in the adsorption of proteins, adhesion of osteoblastic cells and thus the rate of osseointegration. [14]

Currently, alterations of the implant surface are made using two methods:

- **Additive methods:** Titanium plasma spraying, hydroxyapatite (HA) coating etc
- **Subtractive methods:** Sand blasting, acid etching etc.

Implants in the field of dentistry have evolved from being just simple turned implants (machined implants) to acid etched, double acid etched, Sandblasted, grit blasted and implants with various different kinds of coatings on them, all with the primary intention of enhancing the surface roughness, composition and wettability/surface energy thereby improving the adhesion, proliferation, and differentiation of cells. [15]Of the various surface treatments, SLA implants i.e., sandblasted and acid etched implants have been found to have greater bone integration. Sandblasting results in surface roughness and acid etching leads to micro texture and cleaning. SLA implants can be considered the reference standard surface for dental implants. [16]

Several attempts have been made to improve and accelerate Osseo integration by incorporating biologically active drugs on the dental implant surface. Incorporation of bone antiresorptive drugs, such as bisphosphonate, might be very relevant in clinical cases lacking bone support. It has been shown that bisphosphonates incorporated on to titanium implants increased bone density locally in the peri-implant region with the effect of the antiresorptive drug limited to the vicinity of the implant. [17] Another such biologically active drug includes statins. Simvastatin-loaded porous implant surfaces were found to promote accelerated osteogenic differentiation of preosteoblasts, which have the potential to improve the nature of osseointegration. [18]

Antibacterial coatings such as Gentamycin along with the layer of HA or tetracycline-HCl treatment has been regarded as a practical and effective chemical modality for decontamination and detoxification of contaminated implant surfaces. Further, it inhibits collagenase activity, increases cell proliferation as well as attachment and bone healing. [19] Several growth factors and cytokines have also been suggested to stimulate a deposition of cells with the capacity of regenerating the desired tissue. [20] These surface treatments are the future directions in implant surface modifications. The adhesions of plasma proteins, polypeptide growth and differentiation factors and cytokines have been suggested as potential candidates to play an essential role in the process of osseointegration. Researchers have shown that growth factors released during the inflammatory phase have the potential of attracting undifferentiated mesenchymal stem cells to the injured site. These growth factors include PDGF, EGF, VEGF, TGF-β, and BMP-2 and BMP-4. Among these, bone morphogenetic protein (BMP) has shown considerable potential to stimulate bone formation both in extra skeletal sites and in defect models in different species. [21] The limiting factor regarding the use of growth factors in surface treatment of implants is that the active product has to be released progressively and not in a single burst. Poor efficacy and a possible undesirable overproduction of BMPs are a few disadvantages associated with their coating on the implant surface.

Implant-Abutment Interface

These include

- External hex
- Internal hex
- Morse taper.

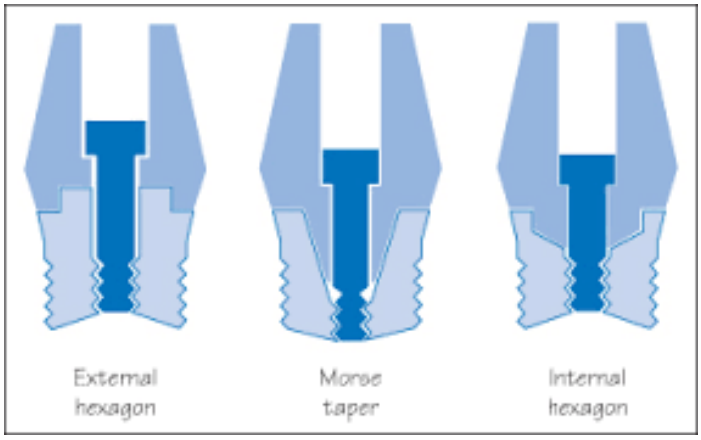


Figure 1: Implant –Abutment Interface.

External hex a distinct projection extends external to the body of the implant whereas in internal hex the implant-abutment connection is recessed into the body of the implant.

Internal connection implants were developed to overcome the clinical complications of the external hex implants. These include:

- Higher Incidence of abutment screw loosening
- Fracture
- Dynamic micro motion at the implant-abutment interface. [22]

Advantages of internal hex include

- Reduced vertical height platform for restorative components
- Distribution of lateral loading deep within the implant
- A shielded abutment screw
- Long internal wall engagements that create a stiff, unified body that resists joint opening
- Wall engagement with the implant that buffers vibration
- The potential for a microbial seal
- Extensive flexibility
- Ability to lower the restorative interface to the implant level esthetically. [23]

Internal implant-abutment connections can be either passive fit/slip fit joint with 6 or 12 point internal hex or it may be friction fit with no space between the mating components. This is also referred to as the Morse taper connection.

Morse taper implant abutment connection design includes a tapered projection from the implant abutment, which fits into a tapered recess in the implant. There is a friction fit and cold welding at the implant-abutment interface to prevent rotation under function. The taper may be 8° as seen in ITI Straumann or Ankylos implant systems or 11° as seen in Astra. 1.5 degree tapered rounded channel is seen in the Bicon implant system. [24]

A new internal connection implant design (e.g. Osseotite Certain, 3i Implant Innovations, Inc., Palm Beach Gardens, FL) has recently been introduced to the profession. This design incorporates an audible and tactile "click" when the components are properly seated. The advantage of this unique feature is that it eases placement for the clinician and may reduce the need for radiographs following placement of the restorative components. [25]

Platform switching was another concept introduced with the promise of efficiently minimizing the crestal bone loss when compared to the conventional implant-abutment junction (IAJ).

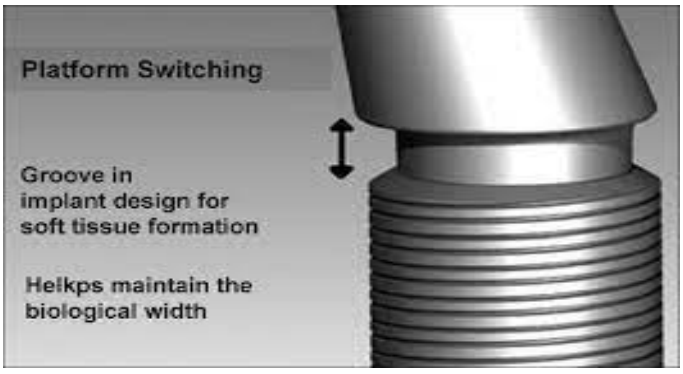


Figure 2: Platform switch

It refers to the use of a smaller diameter abutment on a larger diameter implant collar which shifts the margin of the IAJ inward, toward the central axis of the implant. The inward movement of the implant-abutment junction is believed to shift the inflammatory cell infiltrate to the central axis of the implant and away from the adjacent crestal bone, which is thought to limit crestal bone resorption. [26]

A complete elimination of the implant-abutment interface and the problems associated with it such as micro leakage, bone loss, gingivitis etc., was achieved by the advent of one-piece implants. One-piece implants mimic the natural tooth in its construction with a seamless transition from the implant body to the abutment. These implants offer.

Many advantages such as. [27]

- Strong unibody design
- No split parts
- Single stage surgery with either flap or flapless approach
- Simple restorative technique.

When cement retained abutments were compared with the screw retained abutments, studies have proven that higher complications may be expected from screw-retained prosthesis in the posterior region than the cemented one, particularly during the first year of loading. Hence, the use of screw-retained prosthesis to ensure retrievability may be of limited applicability. [28]

Implant Abutments

Esthetics is the need of the hour. It is not quite achieved with the use of titanium abutments in the anterior region, in individuals with thin gingival biotype. A recent study showed that soft tissue discoloration occurs when the soft tissue thickness is 2 mm or less. [29] This leads to the advent of ceramic implant abutments, which do not result in gray discoloration of the gingival tissues.

They are primarily used in the anterior region of the jaw. However, their use in the premolar region with success has also been documented.

Clinical survival studies of ceramic abutments have shown clinically satisfactory performance at 2 to 5 years. [30] Both *in vitro* and *in vivo* studies show that the indication for ceramic abutments is restricted to the fabrication of single-tooth, implant-supported all-ceramic restorations.

The abutments are available in pre-fabricated or customizable forms and can be prepared in the dental laboratory either by the technician or by utilizing computer-aided design ⁄ computer-aided manufacturing techniques.

The materials of preference are densely sintered high-purity alumina (Al_2O_3) ceramic and yttria (Y_2O_3)-stabilized tetragonal zirconia polycrystal ceramics, zirconia being the stronger of the two. [31] Ceramic abutments can be restored using all ceramic crown systems. Future improvements in the ceramic are focused on its color and long-term stability. Attempts are being made to add coloring oxides to zirconia ceramic before the sintering process in orderto change its whitish color and enhance the esthetic outcome.

Ceramic Implant Material

The ceramic coating available includes the bioactive type, such as the calcium phosphates and inert type ceramics, such as aluminum oxide and zirconium oxide. The bioactive ceramics include the bioglasses, have been documented to produce a calcium phosphate layer on the unmodified surface when used in vivo or in a simulated physiological solution.

Various types of methods of coatings are: Plasma spraying, Vacuum deposition techniques, Sol-gel and dip coating methods, hot isostatic pressing, Electrolytic process. [32]

Carbon and Polymeric Implant Surfaces

Carbon compounds are often classified as ceramics because of their chemical inertness and absence of ductility.

Advantages

(i) Tissue attachment

(ii) Can be used in the regions that serve as barrier to elemental transfer of heat and electrical current flow

(iii) Control of color and provide opportunities for the attachment of active biomolecule or synthetic compounds.

Limitations

- Mechanical strength properties are relatively poor.
- Biodegradation that could adversely influence tissue stability.
- Time dependent changes in physical characteristics.
- Minimal resistance to scratching or scraping procedures associated with oral hygiene.

Bioactive Glass Ceramics

Bioglass (US: Biomaterials) is composed of calcium salts and phosphates in similar proportions found in bone and teeth. This graft is amorphous material, hence its developers believed that degradation of the material by tissue fluids and subsequent loss of the crystal would cause the material to lose its integrity.

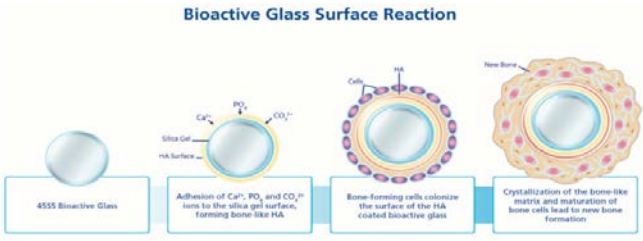


Figure 3: Bioactive Glass Surface Reaction.

The Graft Has Two Properties

- Relative quick rate of reaction with host cells
- Ability to bond with collagen found in connective tissue. It has been reported that the high degree of

bioactivity induces osteogenesis. Since the bioactivity index is high, reaction develops within minutes of implantation. [32]

Zirconia Dental Implants

The zirconium dioxide is a hot isostatic pressed, high-strength ceramic material with a flexural strength of 1,250 MPa which makes the implant suitable for interdental spaces and for single tooth replacement. New tooth-colored implants are made from zirconium dioxide, for esthetic restorations. It does not cause any allergic reactions and hence fulfills the wish of particularly sensitized patients for full biocompatibility. Moreover plaque accumulation is also excluded; this way hygiene and durability of the implant restoration are ensured.

Figure 4: Zirconia Implants

Due to the absence of the free electron, zirconium oxide ceramics are electric insulators and hence entirely free from characteristics found in metals. Consequently, it does not conduct heat and can be ground in the mouth and the risk of osteonecrosis is avoided. Besides, the white color renders it the ideal material for aesthetic tooth and implant reconstructions.

Advantages

1. Utmost biocompatibility
2. Very easy to clean
3. Natural tooth shade
4. Ideal for allergy patients
5. High strength [33]

Hydroxyapatite-Coated Metals

HA plasma coating process involves first roughening the metal to be coated in order to increase the surface area available for mechanical bonding with HA coating.

Then a stream of HA powder is blown through a very high temperature flame that partially melts and ionizes the powder, which emerges from the flame, hits the metallic surface to be coated and condenses to form a ceramic coating that is partially glossy and partially crystalline in nature.

These coatings are built up in thin layers using robotic techniques, until the final thickness (usually 40-l00 μ) is achieved. The major shortcoming of HA ceramics is their lack of mechanical strength.

The major strength of HA is a chemical composition, which fools living bone tissue behaving as if the HA implant were natural autogenous bone. [34]

Hydroxyapatite-Tricalciumphosphate Bioceramics

The two calcium phosphate systems that have been most investigated as bone implant material are HA and tricalcium phosphate.TCP system became eclipsed by a succession of commercially introduced HA containing implantable products.

HA, commonly called tribasic calcium phosphates, is a geologic mineral that closely resembles the natural vertebrate bone tissue.

These materials must not be confused with tricalcium phosphate (TCP), which is chemically similar to HA but it is not a natural bone material. [34]

Advances in Size

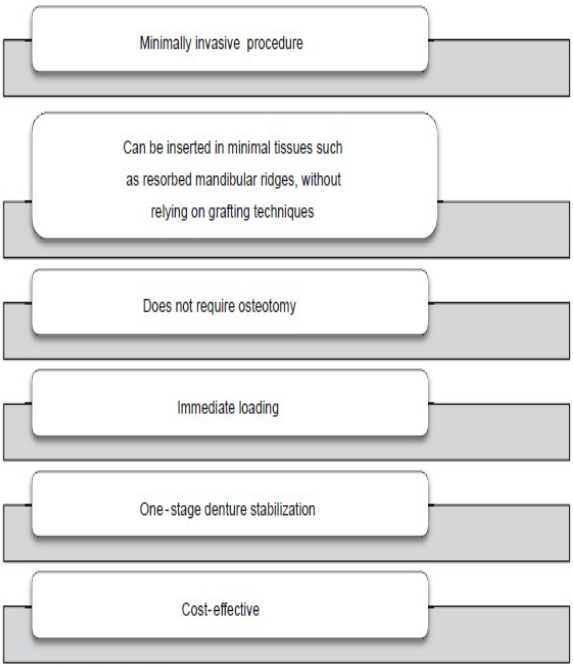
Mini-Implants

Mini-dental implant (MDI) is in fact a trade name for the most widely used small diameter implant, the 3M ESPE MDI. Some small diameter implants are used as anchors

in orthodontic cases and are called temporary anchorage devices. A single minimally invasive surgery is needed for insertion of MDI. Immediate loading can be done due to their self-tapping design. Fixed crowns or bridges can be cemented directly to the square or cubic head of the mini implants. Anatomic locations, bone quality, esthetic considerations, and protective occlusal schemes are keys to ensure successful treatment outcomes. [35]

Figure 5: Mini Implant

Advantage of Mini Dental Implant



Flow Chart 1: Advantages of mini dental implant system

Transitional Implants

Transitional implants are narrow diameter implants that were developed to support provisional fixed restorations during the phase of osseointegration of the definitive implants and are usually placed simultaneously with definitive implants. They are fabricated with pure titanium in a single body with treated surface. They are placed in a non-submerged fashion in a single stage surgical procedure and are designed to be immediately loaded. The primary function is to absorb masticatory stress during the healing phase, ensuring stress free maturation of bone around the submerged implants and allowing them to heal uneventfully. The main rationale for use of transitional implants is to provide retention, stability and support for a fixed provisional prosthesis during the time required for osseointegration of conventional implants.

Figure 6: Transitional Implants

The other applications documented for transitional implants are

- To provide a fixed provisional for protecting an osseous grafted site.
- To provide a vertical stop for a fixed prosthetic reconstruction during the healing period.
- To provide stability to the surgical stent during implant placement.
- To eliminate need for a temporary tissue borne restoration.

- Act as an orthodontic anchor for quick and effective movement of other teeth.

Transitional Implants are also used to

- Stabilize existent dentures.
- Replace congenitally missing maxillary lateral incisors.
- Repair of broken bridges. [36]

One-Piece Implants

Abutment and implant body are in one piece and not separate; they are commercially available in 3 mm diameter and 12, 15, and 18 mm length.

Figure 7: One –Piece Implant

They have unique properties such as:

- Maximum strength
- Minimum Profile.

Since it is one-piece, titanium alloy construction provides maximum strength. It allows placement in areas of limited tooth-to-tooth spacing.

- Minimal surgery
- Maximum Esthetics.

Because one-piece implants are placed using a single-stage protocol, the soft tissue experiences less trauma than typical two-stage protocols. [37]

Immediate Extraction And Implant Placement

Immediate implantation has provided implant dentistry the opportunity to achieve better and faster functional and esthetic results. Several studies have been done which state that immediate implant placement in a fresh extraction socket is not an absolute contraindication and they may be successfully placed as long as primary stability is achieved.

The rationale behind implant placement in fresh extraction socket is the preservation of soft tissue esthetics, reduced treatment time and reduced cost for the patient. However, the localized bone defects surrounding implants placed immediately into fresh extraction sites present a challenge to the surgeon. Success was reduced when implants were placed in morphologically compromised jaw bone sites. [38]

Besides, immediate implant placement must be avoided in extraction sites with a previous history of periodontal disease.

Figure 8 : Immediate Implant Placement

Peri Implant Surgery

Alveolar resorption following trauma, extraction, or infection resulting in ridge form with deficient width and/or height is one of the most common clinical situations that a dental specialist comes across today. This can be well taken care of, with tissue preservation or augmentation procedures, using the various graft materials available in the present time.

Onlay bone grafts may be used for external augmentation of horizontal or vertical alveolar ridge deficiencies while the bone splitting technique may be used to reduce

surgical morbidity and complications associated with grafting procedures.

Distraction osteogenesis is one of the newest procedures which allows for a vertical bone gain of 3-20 mm without the use of graft material bone ring augmentation is another such technique which allows bone transplantation and implantation to be performed on large three-dimensional bone defects in a single operation.

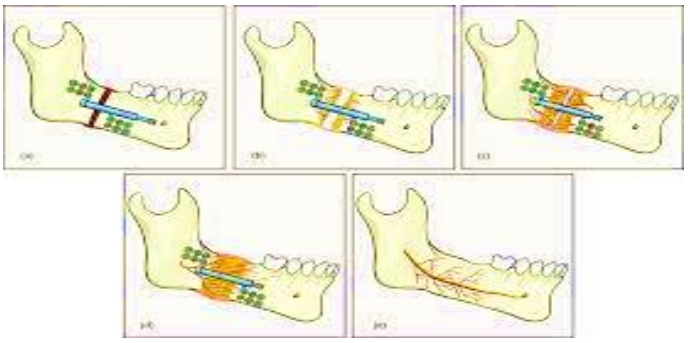


Figure 9: Distraction Osteogenesis

Soft tissue defects due to atrophy may be taken care of using several surgical techniques to obtain an adequate emergence profile of the restoration with sufficient keratinized gingiva. [39]

Advances In Diagnostic Imaging

Diagnostic imaging techniques are an essential tool in developing and implementing a comprehensive treatment plan. The exceptional imaging modalities that exist today are employed to ascertain vital information concerning both preoperative and postoperative phases. The current trend in implant imaging is cone beam computed tomography (CBCT), which provides three-dimensional images with axial, coronal, and sagittal views and a stream of useful data with reduced amounts of radiation to the patient.

Advanced Imaging Techniques Includes

Zonography A modification of the panoramic radiographic machine for making cross-sectional images of the jaws. The tomographic layer is ~5 mm. For better appreciation of the spatial relationship between the critical structures and the implant site. [40]

Tomography It enables visualization of a section of patient's anatomy by blurring regions other than the site of interest. For interest of dental implant a high-quality complex motion tomography is required. [41]

Computed Tomography CT is a digital and mathematical imaging technique that creates tomographic sections. With latest CT scanners, images with sectional thickness of 0.25 mm can be obtained. This is useful in determining the implant site in terms of parameters like bone density, and location of adjacent anatomic structures. [41]

Recent Advances In Computed Tomography CBCT

Use of CBCT is becoming increasingly popular and widespread among clinicians globally. It provides details of anatomic landmarks and vital structures, such as neurovascular canals and bundles, being at risk during implant placement. It uses a cone beam and reconstructs the image in any direction using special software. It provides advantage of CT diagnosing at one-eighth of the radiation dose and at a much lower cost. The special software is used to display and visualize the anatomy in a clinically efficient manner.

Microtomography

Micro-CT allows a fully three-dimensional characterization of the bone structure around the implant.and is non-destructive and fast modality, its high resolution enables visiualisation of individual trabeculae. Multi-slice helical computed tomography. The rapid volumetric data acquisition offers higher accuracy of images as compared to CT. [42]

Dentascan

Dentascan imaging provides a programmed reformation, organization and display of the imaging study. The cross-sectional and panoramic images are spaced 1 mm

apart thus enabling accurate pre-prosthetic treatment planning. Limitations Images require compensation for magnification as they may not be of true size. Hard copy dentascan images includes only a limited range of the diagnostic gray scale of the study. [42]

Interactive Computed Tomography

- This technique enables transfer of the images to a computer file. An important element of ICT is that the clinician and radiologist both can perform 'electronic surgery (ES).
- ICT enable the development of three-dimensional treatment plans. [41]

Computer-Aided Design and Computer-Aided Manufacturing Technology

(CAD) and Computer-Aided Manufacturing (CAM) have arrived in the form of commercial software and hardware products for planning and placing dental implants. Three-dimensional imaging systems that can penetrate the body without damage are increasingly regarded as the modality of choice for detailed planning in 3D prior to the surgical intervention itself. This newly emerging use of 3D data in planning and device manufacturing has provided the profession-treatment modalities such as operative support devices (surgical templates) and subperiosteal implant manufacture. These new methods help practitioners respond to an ever-increasing demand for improved patient benefits. Implants and abutment fabrication has and continues to undergo significant metamorphosis, and since nowadays, complicated shape implants and abutments are used, CAD/CAM techniques are being implemented. The advantages of the technique are accuracy and less time required for manufacturing the parts. [43]

Figure 10: The surgical guide for implant placement. CBCT and CAD/CAM are used to produce a surgical guide for implant placement.

Other Advances in Implant Dentistry

All on Four

The all on four systems is used for edentulous jaws with minimum bone volume. It is developed to make the best use of available bone and to allow for immediate function using only four implants. The system takes the benefits of tilting the posterior implants to provide a secure and optimal prosthetic support for a bridge that can be fabricated and can function within just a few hours after surgery.

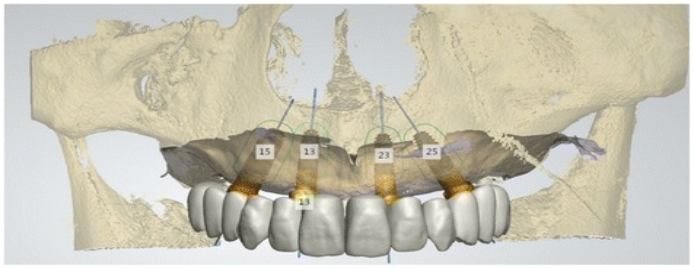


Figure 11: The all-on-4 concept for complete edentulism. It is a concept that rehabilitates the complete edentulism using four implants. The anterior implants are placed vertically and the posterior implants are tilted to avoid anatomical structures such as the maxillary sinus.

Zygoma Implants

Zygomatic implants are a good rehabilitation alternative for upper maxilla with severe bone reabsorption. These implants reduce the need for onlay type bone grafting in

the posterior sectors and for maxillary sinus lift procedures - limiting the use of bone grafts to the anterior zone of the upper jaw in those cases where grafting is considered necessary. Zygomatic implants are designed for use in compromised upper maxilla. They allow the clinician to shorten the treatment time, affording an interesting alternative for fixed prosthetic rehabilitation. zygomatic bone offers predictable anchorage and acceptable support function for prostheses in atrophic jaws. Teeth in an hour concept Teeth in an hour concept provide patients with fixed, well-functioning, and esthetic prosthesis on implants in less than an hour time.Healing time is greatly reduced by a flapless procedure no temporaries and no significant pain or swelling is seen. It allows replacing missing teeth with permanent dental implants in an easy, quick, and comfortably manner. [44]

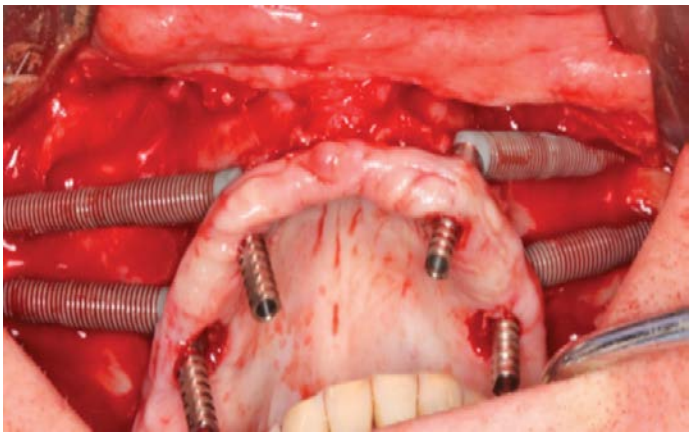


Figure 12 : zyomatic implant

Nanotechnology-Based Implants

Nanotechnology approaches require novel ways of manipulating matter in the atomic scale. Currently, extensive research on techniques to produce nanotechnology-based implants are being investigated. Nanotechnology-based trends for dental implants consist on surface roughness modification at the nanoscale level to promote protein adsorption The possibilities introduced by nanotechnology now permit the tailoring of implant chemistry and structure with an unprecedented degree of control. For the first time, tools are available that can be used to manipulate the physicochemical environment and monitor key cellular events at the molecular level. These new tools and capabilities will result in faster bone formation, reduced healing time, and rapid recovery to function. [45]

Laser Treatment

Although peri-implantitis has been commonly treated with systemic administration of antibiotics, the success has been limited due to resistant strains of bacteria and ineffective antibiotic dosages[45]. Dental lasers have become popular for sterilization and cleaning of implant surface[46].

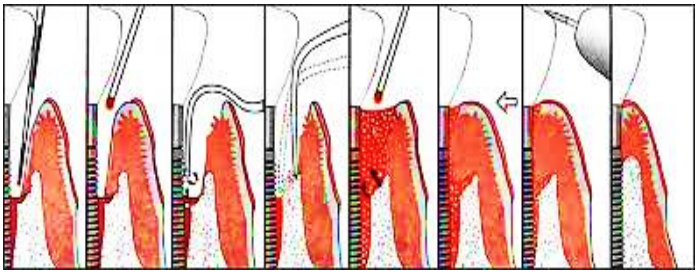


Figure 13: Peri- Implantitis treated with laser.

It is believed that the decontamination of the implant is caused by the physical properties of the laser energy and its interaction with tissues, due to reflection, scattering, transmission, absorption and slight temperature elevation[45,47]. Other technique, laser peeing consists on surface bombardment with small spherical particles that causes small indentations or dimples using a laser beam striking a protective layer on the metallic surface.[48]

Conclusion

Implant dentistry enables the restoration of nearly every clinical situation ranging from partially to totally edentulous patients with greater success and predictability. With all the advancements that have been made so far in the field of implantology, the goal still remains to further simplify the existing procedures, reduce the time duration of implant therapy for both the

patient and the clinician, make the treatment cost effective and improvise the success rate. Efforts to achieve this goal along with a thorough training of the dental professionals to perform as a team and long-term maintenance by the patients surely make implants the future of dentistry.

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