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Review Article

Current Trends in Implant Dentistry: A Review

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Abstract: *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 scope involved in the use of better biomaterials, implant design, surface modification of surfaces to improve the long-term outcomes of the treatment. This paper describes the types of implants that have been developed, and the parameters that are presently used in the design of dental implants. It also describes the trends that are employed to improve dental implant surfaces, and current technologies used for the analysis and design of the implants and future trends.*

Keywords: *Dental implants, Design, Surfaces, Osseointegration*.

INTRODUCTION

Tooth loss is very common and it can be due to disease or trauma; therefore, dental implants are widely used to provide replacement of missing teeth has a long and multifaceted history.

Progress in implantology has been focused at increasing patient's comfort by reducing the treatment time and achieving esthetic and functional rehabilitation as early as possible. Research on dental implant designs, materials and techniques have increased in the past few years and is expected to expand in the future due to the rising in the demand for cosmetic dentistry and high expectations by the patients.

ADVANCES IN IMPLANT MATERIALS

Ceramics implant material[1]

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.

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.

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Bioactive Glass Ceramics[1]

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.

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.

Zirconia Dental Implants[2]

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. 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 biocompatiblility
2. Very easy to clean
3. Natural tooth shade
4. Ideal for allergy patients
5. High strength

Hydroxyapatite-Coated Metals[3]

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.

Hydroxyapatite-Tricalcium Phosphate bioceramics[3]

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.

ADVANCES IN FORMS, SHAPE, AND SURFACE TOPOGRAPHY

Mini-implants[4]

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

Transitional implants[5]

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. 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.

One-piece implants[6]

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.

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.

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 [7]

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.

Tomography[8]

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.

Computed tomography[8]

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.

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[9]

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[10]

The rapid volumetric data acquisition offers higher accuracy of images as compared to CT.

Dentascan[10]

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.

Interactive computed tomography[9]

- 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.

Computer-aided design and computer-aided manufacturing technology[13]

(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.

ADVANCES IN IMPLANT DENTISTRY

All on four

The all on four system 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.

Zygoma implants[14]

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.

Nanotechnology-based implants[15]

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. Thesenew tools and capabilities will result in faster bone formation, reduced healing time, and rapid recovery to function.

CONCLUSION

With a long history of dental implantology and ever since modern dental implants were introduced more than 40 years ago, the development of the ideal implant has been a major research subject in the field, thereby changing the practice of implant dentistry. Through research, dental implant technology has been constantly improving in the recent years, providing patients with unparalleled levels of effectiveness, convenience, and affordability.

Several design parameters have been evaluated and many designs have also been tested. Although design and implantation requirements such as biomaterials, biomechanical behavior, geometry of the implant, medical condition of the patient, and bone quality have been defined, it is still necessary to further evaluate and understand the correlation of those variables in the long term success of the dental implant.

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