



CHANGING TRENDS IN IMPLANT DENTISTRY

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ABSTRACT

Implants as treatment modality for edentulous patients have emerged from past 20 years. In present times with emergence of newer imaging modalities for pre-operative evaluation of implant placement site, such as 'computed-tomography' and 'cone-beam computed-tomography' bone can be visualized in all 3 – dimensions and the position of important anatomic structures like canal in mandible, nerve, mental foramen, sinus in maxilla can be determined which leads to successful implant placement. The various studies had been conducted by different authors regarding dental implant treatment modalities. In this article the previous studies regarding the current topic are briefed in a simplified manner to cover the latest advancements in each topic like implant surface characteristics, advancements in implant materials, implant shape and forms, advancements in implant imaging techniques and other advancements like introduction of CAD-CAM techniques in implantology and nano-technology based implants.

KEYWORDS : Dental Implants, Implant Surfaces, Recent Advancements**INTRODUCTION:**

Implants as treatment modality for edentulous patients have emerged from past 20 years. This concept primarily evolved from the Egyptians civilization and in the today's scenario has turned to be most successful treatment for replacing the missing tooth.¹ During middle of 1960's Dr Per-Ingemar Brånemark Swedish researcher discovered the phenomenon stating that there could be growth of bone around titanium without being rejected and further termed this phenomenon as 'osseointegration'.² The newer imaging modalities have also eliminated the limitations of previous 2 – Dimensional X rays like distortion of image and superimposition along with difficulty in processing of X rays.^{3,4}

The main concern present article is to review researchers previously conducted on the advances in implant dentistry and briefing each topic such as implant surface characteristics, implant shape and forms, newer implant materials, advancements in imaging techniques for dental implants and other advancements in implants treatments such as All-on-4 concept, zygomatic implants, nano-technology based implants in a simplified manner for understanding of the clinicians and dental students.

Implant Surface Characteristics:

Implant surface are altered for improving surface features of an implant which can support osseointegration. The surface of an implant can be roughened with utilization of techniques such as coating with plasma spray, sand blasting and acid etching, grit blasting, biomimetic coating and anodizing.^{5,6,7} First-generation surface of an implant include machined surface design.⁵ In plasma sprayed surfaces of implant the Hydroxyapatite and titanium deposited by dissolving at a higher temperature on the implant surface. In grit blasting technique spraying of ceramic material or silica is performed. Hydroxyapatite (HA), titanium dioxide or alumina can be used and excess blasting material is removed using acid etching. Acid etching of an implant surface can be performed with the application of hydrofluoric acid, sulfuric acid and nitric acid.⁶ In SLA technique after blasting with sand i.e.larger grit particles 250-500 micro meter size acid etching is performed.⁸

In anodizing process the breakdown of TiO₂ layer is done with application of higher voltage for generation of micro-arc.⁹

Advancements In Material Of Implants:

The newer implant materials are introduced regarding there wetting properties due to micro and nano roughness which effects the biological response.¹⁰

The different implant materials include a. ceramics, b. carbon and polymer, c. hydroxyapatite

a. Ceramic material for implant: The ceramic used for implant consist of high strength with completely inert properties and minimum release of ion. The ceramic implant surface is highly ionized with oxidation property, stable thermodynamically and hydrophilic with minimum loss of ion reported for zirconium oxide and aluminum oxide. The ceramic implant surfaces can also be covered by bone morphogenetic protein and growth factors favoring osseointegration.¹¹

Zirconium as the choice of implant material possesses properties such as better esthetics, high compatibility, bio-mechanical properties superior to that of alumina, corrosion resistant, greater flexion and fracture resistance.¹²

b. Carbon and polymer for implant material: The use of carbon as constituent of implant structure is termed as turbostratic which is the altered graphite structure with a highly biocompatible property. The implant surfaces with polymer structure are for enhancing there shock absorption capacity but such polymer based implant structures frequently wear and hence frequently require replacements.¹³

c. Hydroxyapatite (HA): The use of hydroxyapatite as implant material and there biological properties are mainly based upon the size of there particle. The hydroxyapatite is most commonly termed as tribasic calcium phosphate system and this mineral resembles vertebrate bone tissue.¹⁴

Advancements In Shape And Implant Form:

Mini Dental Implants: The commercially used smaller

diameter implants are also termed mini dental implants as classified by 3M ESPE MDI. The small diameter implants are utilized for achieving anchorage in orthodontics are also termed as temporary anchorage devices e.g. Unitek Temporary anchorage Device System and such devices are subjected to be removed after completion of the treatment.¹⁵ The implants with different lengths of 6, 8, 10, 13, 15 and 18 mm available for insertion directly through the gingival with minimum invasive surgery required for placements of these mini dental implants (MDI). The MDI can be loaded immediately successfully due to their self tapping design.¹⁶

Transitional implants: The transitional implants are smaller diameter implants with range of diameter from 1.8 to 2.8 mm and length varies from 7 to 14 mm. These implants were introduced for supporting interim restorations during osseointegration phase of actual implants and placed simultaneously along with actual implants. Transitional implants constitute of pure titanium in uniform body with modified surface. These implants are placed in non submerged pattern with a single stage surgery to be loaded immediately. The main purpose of such implants is to absorb stress generated due to mastication during healing stage, thus resulting in stress less maturation of bone around submerged actual implants for their successful osseointegration. The rationale for utilization of transitional implants includes in achievement of stability, retention and support for interim prostheses during osseointegration stage of definitive implants.¹⁷

Transitional implants can also be used for following purposes:¹³

- a. For providing vertical stop in case of fixed prosthesis during healing phase.
- b. Supporting of interim restoration for protecting graft sites.
- c. These implants provide stability to surgical guide for insertion of definitive implants.
- d. Eliminates the requirement of interim tissue supported restoration results in better healing around the implants.
- e. Transitional implants can also be used as anchor for faster and efficient orthodontic movement of other teeth.

Contraindications for transitional implants:¹⁶

- a. Transitional implants are contraindicated in situations where depth of underlying bone is ≤ 10 mm with lower cortical bone for providing efficient primary stability to implant.
- b. In situations where inadequate space is present for placement of required number of implants.
- c. In case of parafunctional habits like bruxism.

One-piece implants:

The one-piece implants constitutes of implant and abutment as one entity which are non separable and such implants are available in dimensions of 3 mm diameter and different lengths of 12, 15 and 18mm respectively.¹⁷

The characteristic features of one-piece implants include:^{19,16}

- a. Maximum strength with minimum profile: The one-piece implants with their titanium alloy structure provides maximum strength and due to smaller diameter of 3 mm such implants can be placed in minimum area of spacing between adjacent teeth.
- b. Requirement of minimal surgery and better esthetic results: The soft tissues surrounding one-piece implant undergo least trauma as one stage surgical procedure is adopted for placement of such implants.

Indications Of One-piece Implants:

The one-piece implants are indicated of replacing missing mandibular incisor and maxillary lateral incisors due to limited space available for insertion of wide 2-piece implants

and such one-piece implants can also be an option for supporting over denture prosthesis.¹⁷

Advancements In Imaging Techniques In Dental Implants:

The clinicians are dependent upon the imaging modalities for the diagnosis and treatment plan for implants. The newer imaging modalities which come into existence in latest times provide essential information regarding formulation of treatment plan for both pre and post operative treatment phases. The latest trend in implant imaging technique incorporates cone- beam computed-tomography (CBCT) as this imaging technique provides 3- Dimensional images with all the 3 cross sections i.e. axial, coronal and sagittal views with relevant details of the surrounding tissues and anatomic structures while inducing lesser exposure of patient to radiation.¹⁸ Latest imaging techniques include following techniques:

a. Tomography: Tomography is a term originated from Greek words 'Tomos' applying to section or slice and 'Graphy' meaning picture which allows visual examination of anatomic sections of patient due to blurring of other adjoining regions above and below the location of interest of clinician. In imaging for implant treatment procedures, high level compound motion tomography is essential.¹⁹

b. Computed-Tomography: This technique is a type of imaging modality which utilizes the mathematical calculation for creation images in form of tomographic sections. In present times recently developed scanners can produce the images of 0.25 mm thickness which are helpful in assessment of diagnostic parameters like density of bone, proximity to adjacent vital anatomic structures in the implant placement sites.²⁰

Advancements In Computed-tomography: Cone-beam computed-tomography (CBCT): Previous CBCT scanners in clinical practice were introduced by Mozzo et al.²¹ and Arai et al.²² in 1990s. Presently highly advanced versions are accessible commercially, which resulted in enhancement of researches in implant dentistry. Majority of scanners possess dose between $30\mu\text{Sv}$ and $80\mu\text{Sv}$, which depends upon parameters of exposure and 'selected field of view' (FOV) size. In a comparative study it was found that standard panoramic radiograph delivers $13\mu\text{Sv}$ whereas multidetector CT with similar field of view delivers $86\mu\text{Sv}$.²³

CBCT uses software which can construct image in any direction with utilization of one-eighth of radiation dose and at less cost to the patient. The recently developed CBCT spiral scanners can reconstruct images of body in continuous spiral motion, which resulted in gapless production of images.²⁴

c. Microtomography: This technique is recent alteration in CT technique which is helpful in achieving serial sections of bone implant junction. Microtomography is faster, non-damaging and permitting complete- D characterization of bone structure surrounding the dental implant reproducing even the fine bony trabeculae due to its higher resolution property. The exact accuracy of micro-CT was determined histologically as in a closer approach to implant bone interface no artifacts were determined. This micro-CT technique provides high resolution images of body with inter slice distance of 4.4 to $11\mu\text{m}$.²⁵

d. Multi-slice helical computed tomography: This imaging modality is helpful in acquiring volumetric data rapidly as speed was enhanced by multi-slice CT which offers higher preciseness of pictures in contrast to CT.²⁵

e. Dentascan: This imaging modality is a special type of computed tomographic scan which is performed on a conventional CT scanner, to obtain cross sectional view of mandible and maxilla. The dentascan formats routine axial CT scan into 3 planes axial, panoramic (coronal), and oblique

sagittal (or cross-sectional) imaging.^{26,27} The computer software is as such programmed to produce referred cross-section and tangential/panoramic images of residual ridge along with 3 dimensional images of whole arch. These panoramic and cross sectional pictures are located at distance of 1 mm separation from each other to provide exact preprosthetic treatment plan for the clinician.²⁶

Limitations:

Images obtained may require compensation due to magnification may not reveal the actual size.

2. The hard copy of dentascans images may incorporate only restricted limit of diagnostic gray scale of study.
3. Tilting of patient head is mandatory while evaluation of the patient via this scan.

Interactive computed tomography: In this interactive imaging technique the computer of operator becomes as workstation with all the needful tools. The prime feature of this interactive CT technique is that operator along with radiologist can pursue electronic- surgery i.e. with electronically derived diagnostic stent electronic surgery can be pursued for developing treatment plan electronically in 3 - D. Electronic surgery and interactive CT resulted in formulation of appropriate treatment plan which can exactly be transferred to the patient for conduction of successful surgical procedure upon the patient.²⁷

Limitation:

1. Repositioning and actual allocation of position of implant is difficult and challenging.
2. Implementation of treatment plan exactly as performed electronically may be difficult for the operator.

Computer-Aided-Design and Computer-Aided-Manufacturing as new advent in implant dentistry:

In present times CAD-CAM has been established as marketed software and hardware utilized by dental practitioner and labs for planning and placements of the dental implants.

3-D imaging technologies which can penetrate body parts without damaging are gaining popularity in present times for detailed treatment planning and diagnosis prior to surgical procedures. These 3-D treatment modalities have helped clinicians in gathering the information in form of data which can further be transferred to a computer aided manufacturing device for formulation of the operating supportive appliances such as surgical template for guiding the implant surgeries. The newly introduced complex implant and abutment designs requires perfection of techniques which can be achieved by proper diagnosis and treatment planning assisted by the CAD CAM modality.²⁸

Advantages of CAD CAM techniques in implant dentistry: Perfect fit of the final prosthesis, lower level of rotational freedom resulted in precise implant-abutment connection.

Other advancements in implant dentistry:

The other current advancements in the field of dental implants include All-on-4 concept, zygomatic implants, teeth in an hour concept and nanotechnology based implants.

1. All-on-4 concept: The All-on-4 concept has originated from research of Branemark and colleagues in 1977, whereby they used 4 to 6 vertical implants inserted within the anterior region of edentulous jaw cantilevered for accommodating full arch prosthesis. This concept of All-on-4 is utilized by clinicians for restoration of completely edentulous jaw with minimum amount of residual bone volume. It is introduced to utilize available bone for allowing immediate functioning with prosthesis supported by only 4 implants. In this concept the posterior two implants are tilted to increase the bone-implant contact area to provide maximum support and to avoid longer

cantilevers due to increase in inter implant distance for supporting fixed restorations just in few hours after surgery.²⁹

2. Zygomatic implants: These implants are alternative option for bone grafting procedures in extensively resorbed maxillary bone where fixed restorations can be provided with 4 zygomatic-implants with standard 2-stage or single-stage surgical technique or flap less template driven implant surgery. These zygomatic implants when placed in resorbed maxilla can prevent other complex surgical procedure like sinus lift or ridge augmentation surgeries.³⁰

3. Teeth in an hour concept: This concept resulted in formulation and fixation of the functional prosthesis with their esthetic considerations within an hour supported by implants. The template guided surgical procedures are followed for placement of implants resulted in faster healing, do not require interim restorations, less painful for patients and resulted in insignificant post operative swelling.

4. Nano-technology based implants: Nanotechnology based concept of implant requires surface roughness of dental implants at nano scale levels for promotion of adsorption of protein and adhesion of cell, biomimetic coatings of calcium-phosphate, and incorporation of factors needed for growth and speeding up of bone healing process.³¹

The nano particles like biomimetic calcium phosphate, titania, alumina, zirconia can also be coated to Ti surface of an implant. Implant surface can also be layered with factors stimulating growth like 'transforming growth factor- ', 'bone morphogenetic proteins (BMPs)', 'platelet derived growth factor IGF-1 & 2', 'anti resorptive medications like bisphosphonates' can also be deposited for faster bone healing process.^{31,32}

CONCLUSION:

The dental implants along with the modern implants have history of a period more than 40 years from the present times, and the research on the ideal dental implant is still a matter of a subject, with the introductions of newer concepts in the changing trends of today's modern implant dentistry. The advancements that had been made till date in field of implant dentistry the aim still remains to simplify the present techniques, reducing the time period of implant treatment for both patient and operator, to lower the cost of treatment and to enhance implant success rates. The constant efforts are required to achieve this aim with proper institutional training of dental professionals for successfully performing implant treatment procedure.

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