REVIEW ARTICLE

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Current trends in Dental Implantology - Change is inevitable

Aarti Kochhar, Sanchit Ahuja[1]

Department of Prosthodontics and Oral Implantology, I.T.S CDSR, Delhi- Meerut Road, Ghaziabad, U.P., India, [1]Registrar, Department of Critical Care, Indraprastha Apollo Hospital, New Delhi, India.

Address for Correspondence:
Dr. Aarti Kochhar, Post Graduate Student, Department of Prosthodontics and Oral Implantology, I.T.S CDSR, Delhi- Meerut Road, Ghaziabad, U.P., India. E-mail: aarti.kochhar.noida@gmail.com

ABSTRACT:
The dental implant has contributed considerably towards the rehabilitation of edentulous and partially edentulous patients. Since their introduction in the 1960s, extensive research has been conducted in order to adjudge the long-term stability and improve the prognosis. Tremendous research and modifications have been done that endeavor to improvise the reliability and safety of the conventional method.

Keywords: Current implantology, Latest loading protocol, Surface modifications.

INTRODUCTION:

The dental implant therapy has contributed tremendously towards the rehabilitation of patients with all or few missing teeth. Since Professor Branemark and collaborators described the original two-stage surgical protocol in the 1960s, extensive research has been conducted in order to appraise the long- term stability and improve the treatment outcome. These studies have assured the reliability and safety of the conventional method.[1]

RECENT IMPLANT EVOLUTION

History—subperiosteal to endosseous, blade to root form

The history of implant dentistry belongs to the ancient cultures of the world. The concept began when man started substituting missing teeth with shells, stones and ivory. The idea of metal replacements for teeth was endowed in the 18th century when surgeons began to use gold, silver, lead, and platinum sculpted into different designs that kept modifying until a more acceptable form was achieved.[1]

Dr Dahl manufactured the first clinically acceptable dental implant in 1940. It was a periosteal implant that rested on bone below the periosteum, with a mesh frame, containing screws to connect the abutment to the framework. However, they were condemned due to frequent infection and bone resorption. Leonard Linkow extensively studied this concept and after years of research, he developed the blade form of implant.[2]

During the 18th century, came the most remarkable contribution to the field of implant dentistry by Dr Brånemark with the introduction of root form implant,

which is the current standard shape. He also emphasized that osseointegration occurs between bone and titanium, which is the material of choice for implant manufacturing.[3]

Implant Surface Changes- cylindrical to threaded, machined to rough

As the surface area affects the osseointegration, many attempts have been made to alter the implant surface in order to increase the area for bone-implant contact. Among many alterations, the most accepted was the threaded design. Some of the reasons for its success are immediate primary stability, better osseointegration and self-tapping mechanism that facilitate its atraumatic placement. Other modifications have been done to threaded form that includes etching, hydroxyapatite coating, plasma spraying and grit blasting.[4]

Surgical Technique- two stage to one stage

According to the protocol advocated by Sir Brånemark in 1977 for complete osseointegration, a non-disturbed submerged healing period of 4 months was advised after implant placement. Loading was allowed only after this stipulated time period in order to achieve results. The technique was widely popularized and followed religiously for years, however with the advent of latest implant surface modifications and surgical techniques, clinicians have successfully attempted to place supracrestal implants with transmucosal abutments. Thus early loading was possible.[5] Added advantages of this technique were patient compliance due to single stage surgery and avoidance of surgical re-entry and immediate temporization and loading as early as 48 hours, thus reducing the cost and chair side time for the patient as well as the clinician.[6]

Loading protocol[8]- delayed to immediate

According to the 2014 ITI consensus for dental implant loading protocols, following definition regarding the time of loading have been given:

- Conventional loading- 2 months after implant placement.
- Early loading- Between 1 week and 2 months subsequent to implant placement.
- Immediate loading- Less than 1 week subsequent to implant placement.

The consensus statements regarded the following as prerequisites for immediate and early loading of single implant crowns

- Insertion torque $\geq$ 20 to 45 Ncm and/or implant stability quotient (ISQ) $\geq$ 60 to 65 at the time of implant placement.
- Absence bone defects or need for augmentation.
- When the clinical benefits exceed the risks.

In cases of partially edentulous patients with extended edentulous sites, the following treatment guidelines were laid down for early or immediate loading.

- Solid-screw–type implants with a microtextured surface after 4 to 8 weeks in posterior areas.
- Sporadic immediate loading of anterior implants
- Factors such as primary implant stability, need for bone augmentation, implant design, occlusal scheme, parafunctional habits and systemic health must be pre-evaluated.

For rehabilitation of completely edentulous Jaws with fixed prosthesis, following criteria must be included for immediate loading.

- Insertion torque ≥ 30 Ncm, ISQ ≥ 60, and minimal implant length ≥ 10 mm.
- Minimum number of implants in mandible should be ranging from 2-10 and in maxilla should be 4-12.

DENTAL IMPLANT DESIGN

Microdesign

When compared to smooth surface implants, modified roughened titanium surfaces have superior osseointegration due to micromechanical locking at the micrometric scale and also assisst in absorbing ions and proteins after implant-bone contact has been established.[7]

Bioactive coating

In an attempt to accelerate the osseointegration and bone-implant integration, coating the implant neck with Nanoscale calcium phosphate (CaP) and collagen-CaP (col-CaP) composite coatings has been advocated.[9]

Macrodesign

Implant macrodesign has also been associated with achieving long-term stability. Decreasing the implant thread pitch has shown positive results while excessive helix angles jeopardize the ability to sustain axial load. Increasing the thread depth increases the surface area, thereby proves beneficial in cases with poor bone quality. Attempts have been made to increase the bone-implant contact by addition of threads or microthreads extending to the crest module, thus limiting the crestal bone loss.[10]

Another modification by adding laser microgrooves of 6 to 12 mm has been rewarding in controlling the cellular processes in vitro and in vivo investigations, leading to enhanced osseointegration and soft tissue attachment, along improved crestal stress distribution.[11]

Narrow Diameter Implants

Areas in proximity to vital anatomic structures or space obliteration due to bony defects can be restored using implants with narrow diameter ranging from 3.0-3.75mm. It prevents subsequent perforation or thinning of labial plate, soft tissue loss or implant exposure.[12] Narrow diameters of 3.3 to 3.5 mm are well indicated in load-bearing posterior regions. Smaller implants with diameters 3.0 to 3.25 mm can be used for restoring single-tooth or non-load-bearing regions. Mini-implants < 3.0 mm in diameter can be employed for the edentulous jaw and single-tooth non-load-bearing regions.[12]

Zirconium Implants

Titanium has been the material of choice for dental implant manufacturing. However, due to potential immunologic and esthetic compromises, novel materials such as zirconia have been endeavoured. Zirconia is considered suitable due to its esthetic appearance, advantageous mechnical properties, high biocompatibility and low bacterial colonization. The stress distribution pattern has been found to be similar to titanium, although osseointegration is still under consideration.[13]

ROXOLID

A combination of titanium and zirconium(13-17%) has been introduced as

implant material with incresed strength as compared to pure titanium.[14]

Tantalum Implants

With enormous research in the field of implantology in search of a material that best resembles bone structure has led to the development of a porous tantalum biomaterial with a structure and elasticity similar to trabecular bone.[15]

Dental Imaging and Planning

In guided implant placement with a surgical guide, CBCT aids in the visualization of the many important anatomical aspects involved in planning implant treatment that includes, height and width of available bone acting as implant bed, thickness of soft tissue, proximity of prospective implant location with the adjacent teeth, roots and vital anatomic structures such as maxillary sinuses, mandibular canal, mental foramen, and incisive canal.[16]

Once the CBCT images are imported into proprietary software programs such as SimPlant, Nobel Clinician so on and so forth, the operator can virtually visualize the most optimum position of implant specific to the patient's anatomy. The process of virtual planning begins with fabrication of radiographic guide using patient's existing prosthesis and converting it into guide for scanning by adding radiographic markers such as gutta percha. Two CBCT scans are done, first only the guide and second with the patient wearing the radiographic guide. Surgical guides that are used to guide the surgical drills during implant bed preparation can also be fabricated from the virtual treatment plan to ultimately attain the desired implant position. Such precision reduces patient morbidity and follows a predicted treatment plan.[17]

Indications

- Multiple implant placement
- Close proximity to vital anatomic structures
- Proximity of adjacent teeth
- Limited bone volume
- Implant placement in anterior areas involving esthestic restoration
- Flapless implant placement
- Implant placement following immediate extraction

Navigation

Navigation is a real-time technology based on the global positioning system (GPS) concept, transferred to the human dental anatomy. The patient's dental anatomy is captured on the CT using fiducial markers and planning is transferred to the real patient during surgery by superimposing the markers. The system guides the operator to prepare the recipient site according to the predetermined virtual planning in terms of angulation, depth and position of an implant. In case of deviation from the planned path of drilling will trigger an audio and visual alert. This helps the surgeon to maintain the planned pathway and avoid damaging vital anatomical structures during surgery.[18]

Immediate Implants

Earlier concepts of implantology focused on the need for healed alveolar ridge for implant placement. With the advent of modified implant surfaces and changing drilling protocols, clinicians have been successfully placing implants immediately after extraction. It is believed that healing takes place faster due to an accompanying

healing of the extraction socket. Also, the drilling time is reduced due to pliable socket.[20]

Indications[21]

- Trauma
- Endodontic lesion
- Root fracture
- Root resorption
- Root perforation
- Bony walls of alveolus intact

Contrindications[21]

- Active infection
- Less than 3mm bone beyond socket

Immediate temporization

The concept of All-on-Four protocol put forward by Paulo Malo implies that the placement of four strategically positioned implants, two mesially and two distally placed and tilted can avoid bone augmentation procedures in cases with reduced residual bone volumes. As in any other immediate function application when sufficient primary stability is achieved, the probability of a successful treatment outcome is high. Performing extractions when indicated, simultaneous implant placement, and immediate loading within 3–6 hours after surgery with a fixed acrylic hybrid prosthesis.[19]

Abutment and connections

Implant sites that require abutments placed at an angle from the implant body to compensate the esthetic or functional requirements were often restored using commercially available angled abutments with not more than 15 degree. With the introduction of CADCAM in dentistry, implantology has also gained much needed to customize implant abutments in order to restore cases that require offset or angled abutments while maintaining the shape.[26]

Indications[27]

- Insufficient interocclusal distance
- Angle correction more than 15 degree
- Need for ideal emergence profile such as esthetics
- More than 3 splinted implants

Platform Switching

With continuous attempts to reduce the crestal bone loss subsequent to implant placement, the concept of reducing or switching the abutment diameter relative to implant platform was introduced by Lazara[29] in 2009 and termed it as Platform Switching.

Advantages[30]

• Creates a step between the abutment and implant, thus the inflamed connective tissue does not extend laterally unlike in same diameter implant-abutment.

• It moves the micro gap away from the inter-implant bone that supports the papilla in esthetic areas.

• Less stress dissipation to the crestal bone.

Tissue regeneration

A Recent addition to implantology is the addition of tissue engineering technology to enhance bone and soft tissue regenration and also accelerates the healing phase. These are available in the following forms and cab be used by the clinicians as per their compliant.

Platelet Rich Plasma (PRP)

It is an analogous source of plasma prepared from patients own blood and mixing it with growth factors mixing

blood plasma enriched with platelets is added to the bone graft material which aids to enhance the healing and promote better bone and soft tissue regeneration.[22]

rhPDGF

Platelet-derived growth factor is a well-known wound healing protein with characteristic chemotactic and mitotic potential for cells of mesenchymal origin, such as osteoblasts and chondrocytes. It forms biocompatible scaffolds combined with growth factors such as PDGF-BB and fastens repair and regeneration of cartilaginous tissues. [23]

rhBMP-2

Bone morphogenetic protein originates from transforming growth factors and are employed in implantology owing to its potential to stimulate bone formation. Regenerating potential of recombinant human bmp-2 (rhBMP-2) has significantly improved the bone augmentation procedures and benefitted osseointegration by increasing the bone-implant contact by many folds in coated or sprayed titanium implants.[24]

Enamel Matrix Derivative Protein

Enamel matrix derivative promotes regeneration, diffrentiation and migration of osteoblasts, cementoblasts, and fibriblasts. Amelogenin is the main constituent along with enamelin and ameloblastin. Applying EMD in osteotomy sites and implant surfaces enhences quantity and quality of bone ariund implants by promoting formation of osteoblasts and production of bone matrix.[25]

DISCUSSION

Replacement of lost teeth has long been an area of interest and constant development. From 15th till 17th century, teeth were bought for the purpose of allotransplantation, thus leading to acquired infections. In the year 1969, an accidental discovery of titanium being integrated with bone by Sir Branemark lead to the finest discovery in the history of dental field, the dental implants. A significant number of changes have been made since then. Cylindrical implants are replaced with root form implants, machined implants with rough surface, and much more. The material of choice for implant body manufacturing has been pure titanium due to biocompatibility and osseointegration property. Nevertheless, newer materials such as zirconia are making their mark. Constant efforts are being made by the implantologists throughout the globe to reduce crestal bone loss, preserve available bone and reduce the overall time associated with this treatment category.

CONCLUSION

Clinical success of implants in restoring completely and partially edentulous sites is well documented. But never the less, continuous attempts to improvise the technique have been made. It may be realized that the basic intention behind every new discovery is to reduce the crestal bone loss and preserve as much bone as possible. Treatment time and cost involved in dental implants has been an important criterion for its low popularity among the majority of population striving for their existence. Thus, these attempts also endeavor to combat the same.

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