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Review Article

Recent Advancements in Immediate Loading and Single Piece Implants in Full Mouth Rehabilitation

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ABSTRACT:
Dental implants are one of the most commonly procedures employed these days for prosthetic rehabilitation of missing teeth. 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. In the present review, we have highlighted some of the important aspects of the recent advancements in immediate loading and single piece dental implants in full mouth rehabilitation.
Key words: Immediate, Implants, Recent, Rehabilitation

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INTRODUCTION

Originally, dental implants were considered as "last resort" for treatment of the edentulous patients. As implant dentistry progressed, the original Brånemark protocol required long healing periods of several months for osseointegration to take place before beginning fabrication of the definitive prosthesis. Dentists consequently became profoundly aware of time-dependent relationship between form and functional changes in the masticatory system. Such knowledge helped nurture the development of new materials and knowledge about the relationships between esthetics, occlusion, and patient's personalities.[1] Although a favorable treatment outcome often was achieved, few patients were not able to tolerate removable complete dentures. This failure is neither an indictment of one's professional skills nor necessarily a condemnation of the patient's response to the clinician's efforts. There is a growing need of patients to be rehabilitated with a fixed, implant-supported prosthesis immediately after surgery, not only to minimize patient discomfort but also to restore functionality and esthetics quickly so that patients can return to their normal routine within a short period of time.[2]

Immediate loading dental implants

There are three basic approaches to replace a missing tooth or teeth including removable dental prosthesis, fixed dental prosthesis, and dental implants. Each alternative has its own benefits and shortcomings. It is important to consider the patient's financial, medical, and emotional condition for the best treatment.[3]

Most advanced way to replace missing teeth is dental implant which is designed to replicate the natural tooth root and crown of the natural tooth. This procedure preserves the gingival mucosa and bone with no damage to adjacent teeth. Conventional procedure for implant placement involves extraction of offending tooth, waiting 2–4 months for extraction socket to heal, insertion of implant, and again waiting for 3–6 months for integration of implant with surrounding bone; after this procedure, another surgery is necessary to expose the implant and to place a prosthetic abutment. Taking into consideration the prosthetic treatment, the patient had to wait up to 8–12 months for a lost tooth to be replaced. Because of these

shortcomings related to conventional technique, strategies were developed to substantially shorten the entire treatment by placement of implant immediately after extraction of tooth followed by immediate loading of implant with prosthesis.[4]

Immediate loading versus conventional (delayed) loading

According to many previous studies, many researchers believed that after implantation in the jaw for a future prosthesis, titanium implants should be left submerged to undergo a healing process before they are capable of functional loading. This healing process, which is called osseointegration, could be completely achieved in a period from 3 to 6 months. The reason for the delayed loading was to avoid micro-movement on the implant, which could interfere with the healing process. If this situation occurs, connective tissue can develop at the interface between the implant surface and the bone. The result would be failure of the implant due to not being able to resist the masticatory forces.[3]

Following the progressive development of technologies and the wide spread of implantation in dentistry, more recent research has focused on the mechanism of bone healing. It has provided a better understanding of osseointegration. It was suggested that it would be possible to reduce the period between implantation and the placement of a prosthesis.[4]

RECENT ADVANCEMENTS

Implant surface

Modification of the implant surface has been studied and applied to improve biological surface properties favoring osseointegration. The surface roughness of implants has been increased by various methods such as machining, plasma spray coating, grit blasting, acid etching, sandblasted and acid etching (SLA), anodizing, and biomimetic coating. The key factor in implant osseointegration is surface roughness, which shows increased osteoblast activity at 1 to 100 μm of the surface roughness compared to a smooth surface. It is believed that rough surfaces have better osseointegration than smooth surfaces, but the results of the research have been diverse and it is not clear that multiple treatments provide better predictive results.[5]

The machined implant surface is the first-generation implant surface design with a turned surface implant. Plasma spray coating generally forms a thick layer of deposition such as hydroxyapatite (HA) and titanium by spraying a material dissolved in heat on the surface of the implant. Grit-blasting is a process of spraying particles onto the surface of the implant using ceramic material or silica. Sand, HA, alumina or titanium dioxide (TiO2) particles are used and acid etching is performed to remove the remaining blasting particles. Acid-etching is the roughening of the titanium implant surfaces using strong acids such as hydrofluoric acid (HF), nitric acid (HNO3), and sulfuric acid (H2SO4) or combinations of these acids. SLA is acid etching after sandblasting with 250–500 μm large grit particles. Anodizing is the dielectric breakdown of the TiO2 layer by applying an increased voltage to generate a micro-arc. This process forms a porous layer on the titanium surface.[6]

Sinus lifting

In the immediate time period after maxillary posterior tooth extraction, initial decrease in alveolar width is by resorption and/or loss of buccal bone. With continuous bone remodeling, absence of stimulation, loss of bone height, and density leads to an increase in antral pneumatization. The maxillary sinus pneumatization is caused by progressive hallowing out of alveolar process of apical aspect mediated by osteoclasts and by increase in positive intra-antral pressure. In such a situation, the residual vertical bone height is decreased making standard implant placement difficult.[5]

To adapt, circumvent, and treat this local physiological as well as anatomical limitation; maxillary sinus floor elevation has become an important preplacement procedure in dental implant treatment planning. Various methodologies have evolved to increase the thickness of maxillary sinus floor. The treatment goal of all such procedures is to increase residual bone height. Few of the technique involve simple, minimal elevation of maxillary sinus membrane, Schneiderian membrane, while other include placement of various type of grafts including allografts, autografts, bone morphogenetic proteins, and hydroxyapatite crystals. The factors that contribute to survival rate of sinus augmentation and dental implant placement are still the subject of discussion.[7]

Short implant

In an atrophic alveolar ridge, there are many anatomical limitations (maxillary sinus, nasal floor, nasopalatine canal, inferior alveolar canal) that make placement of a standard implant difficult. To overcome these limitations and vertical bone deficits, additional surgical procedures, such as guided bone regeneration, block bone grafting, maxillary sinus lift, distraction osteogenesis, and nerve repositioning, are performed to place a standard implant. However, the procedure is sensitive, challenging, costly, and time-consuming and increases surgical morbidity and causes many complications such as sinusitis, infection, hemorrhage, nerve injury, and gait disturbance.[8]

Short implants are considered to be simpler and more effective by reducing the likelihood of such complications, patient discomfort, procedure costs, and procedure times in rehabilitation of the atrophic alveolar ridge. The term of a short dental implant is subjective, and there is no clear criteria for the length of a short dental implant. Some articles defined 10 mm or less as the criterion of a short dental implant, and some defined less than 10 mm as a short dental implant. Some defined the short implant as 8 mm or less. Implant companies have recently offered short implants of less than 8 mm. In this paper, a short dental implant was defined as less than 8 mm, which is similar to other papers.[9]

Alternative techniques

Despite the reliability and efficiency of various sinus augmentation techniques, there is still a high rate of complications and complexity for such procedures. With

the advances in technology and improvements in design and manufacture of implants, some alternative concepts suggested implantation without sinus augmentation could be possible.[10]

The use of a tilted (angulated) implant in the posterior maxilla was suggested to avoid sinus augmentation. In this study, an evaluation was made to compare the efficiency between tilted and axial implants with no sinus grafting. After 5 years of follow-up, the implant success rate was 95.2% (survival: rate 100%) for the tilted implants and 91.3% (survival rate 96.5%) for the axial implants. The average marginal bone loss was 1.21 mm for the tilted implants and 0.92 mm for the axial ones.[11]

Zygomatic implants offer another option treatment modality to sinus augmentation. Almost similar to trans-sinus tilted implants, zygomatic implants are long implants that pass through the sinus or laterally to the sinus. The difference was the anchorage position. While the tip of a trans-sinus tilted implant is positioned in the bone between the anterior sinus wall and the nasal cortical bone, a zygomatic implant will anchor itself into the zygomatic process for stability.[12]

Advanced dental implant placement techniques

The virtual planning for the precise placement of dental implants using CT scanning, rapid printing and prototyping, optical scanning, and CAD CAM milling can now be utilized in a unified manner. As a result of this progress from the digital technology, surgeons have improved diagnosis, with more accurate implant placement, and superior long term results. CT guided dental implant surgery allows decreased operating time, flapless procedures, and decreased postoperative pain and swelling, and immediate temporization. The development of CT scanning from fan beam to spiral methods has resulted in the development of in office Cone Beam CT (CBCT) scanners with decreased radiation dosage which are now widely available as standup, lie down, sitting and mobile CBCT units.CBCT has become an important in office or scanning center based dental imaging technology, providing powerful diagnostic capabilities and practical applications. Software planning for dental implant placement allows preoperative diagnosis, precise planning and trajectories, and the fabrication of rapid printed surgical drill guides. New technologies of CAD CAM milling, optical scanning, and modular implant fabrication will allow further advances in this rapidly developing aspect of dental implant treatment.In addition to the decision of choosing the optimal 3D data between the pre-extraction or post-extraction tooth for fabrication of a customized implant, the intactness of the tooth must also be taken into account, particularly in the root area.[13, 14] Teeth that need to be replaced by implants are commonly damaged or even already extracted; thus, it is suggested that recreating a 3D model based on the contra-lateral tooth could be a suitable option. Additionally, the concept of using 3D data of the tooth without extraction could achieve better accuracy because there was no damage to the tooth by the elevator or dental forceps. With the ongoing development of new technology in 3D and CAD/CAM, it is predicted that customized implants could be the promising future of implant dentistry as an alternative to conventional implant designs. However, more clinical trials are needed to evaluate the effectiveness of this approach.[15- 18]

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 and cell adhesion, biomimetic calcium phosphate coatings, and the incorporation of growth factors for accelerating the bone healing process.[19- 22]

Most attempts to get nanoroughness have used processing methods like lithography and surface laser-pitting, but only a few studies have reported modifications to the roughness as well as the chemistry at the nanometer scale in a reproducible manner. Other technique is the deposition of nanoparticles like biomimetic calcium phosphate, alumina, titania, zirconia, and other materials to coat Ti surfaces. The surface of Ti dental implants can also be coated with bone-stimulating agents such as growth factors (transforming growth factor-β, bone morphogenetic proteins [BMPs], platelet-derived growth factors and insulin-like growth factor [IGF]-1 and 2) and antiresorptive drugs (biophosphonates) in order to enhance the bone healing process locally. In one study, a Ti machine smooth implant was compared to a Type-1 collagen coated Ti implant and a Type-1 collagen-BMP-2 coated implant. The results of this animal study showed greatest peri-implant bone formation within the grooves of the endosseous screw for the collagen-BMP implant when compared to the collagen-coated implant. In this example, both collagen and BMP-2 serve as bioactive molecules. In addition to adding biomolecules which promote bone growth, molecules such as biophosphonates which prevent bone resorption may also be added.[23- 26]

CONCLUSION

Implant dentistry has evolved into the mainstream of restorative practices all over the world. Maintenance of bone after tooth loss to improve or maintain facial esthetics and improved retention, function, and performance of removable restorations are only some of the advantages for the edentulous patient. Long-term clinical trials and more predictive studies are required for better exploration of this field of dentistry.

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