Recent Advances in Dental Implants

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Abstract

Dental implant treatment is gaining increasing acceptance by Patients. There is wide acceptance in the adopting a minimal invasive approach on restorative dentistry and when combined with the improvement in reliability of implants, dental implant treatment has been transformed from the last choice to the first choice of treatment being offered to patients. With the increasing research both in basic science and clinical trials coupled with improvement in dental implant designs, the success rate of the dental implants has been steadily improving to over 95%. The success rate is better in denser bone and particularly in the anterior mandible; the success rate reaches 99%. The critical factors of success in the dental implant treatment are related to the training of surgeons, the design of implants, the intra-operative control of implant placement, the consideration of the occlusal loading and the long term maintenance. The present paper reviews the recent advances in the field of implantology.

Key Words: Implant, clinical trials, design, occlusal loading, implant placement.

Introduction

Dental implants (also known as oral or endosseous implants) have greatly evolved over the past 20 years. The idea of permanently being able to replace teeth has been a desire of civilizations since the days of the Egyptians. The most common cause of teeth loss is periodontitis, and other causes include dental caries, trauma, developmental defects, and genetic disorders 1. The use of dental implants to rehabilitate the loss of teeth has increased in the last 30 years. Before dental implants, dentures and bridges were used, but dental implants have become a very popular solution due to the high success rate and predictability of the procedure, as well as its relatively few complications. Today our modern-day methods of dental implantation are much more successful and painless than attempts from 3000 years ago.

In this paper, recent advances in the field of implantology has been summarized in the following sections (Implant surface, sinus lifting short implant, All on four, Tilted and zygomatic implants. immediate loading versus conventional loading, Peri implant surgery and Image-guided implantology).

Difference between Implant and Natural Teeth

Implants are basically different from natural teeth starting from composition to the vascularity. The implant behaves as an ankylosed unit, whereas the natural teeth show physiologic mobility by the viscoelastic properties of periodontal ligament. There is no proprioception with respect to implants due to the absence of ligament receptors. Adaptive capacity in case of implants is less compared to natural tooth where the width of the ligament helps in mobility with increased occlusal forces [1]

Gingival fibres are inserted into the cementum above the crestal bone, whereas there is no collagen fibre attachment in case of implants. There is less vasculature in the gingival tissue surrounding the dental implants compared to natural teeth. This reduced vascularity together with parallel oriented collagen fibres adjacent to the body of any dental implant makes implants more vulnerable to bacterial insult [2, 3].

Oral implants when evaluated after 10 years of service do not surpass the longevity of natural teeth even of those that are compromised, for either periodontal or endodontic reason. Proper evaluation, monitoring and maintenance is essential to ensure the longevity of the dental implant and its restoration by combining regular check up, professional care and effective home care.[3,4]

Recent Advancements

Implant surface: Modification of the implant surface has been studied and applied to improve biological surface properties favoring vosseointegration. 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. To adapt, circumvent, and treat this local physiological as well as anatomical limitation; maxillary sinus floor elevation has become an important preplacement procedure

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How to cite this Article: Punia S.H., Punia H., Recent Advances in Dental Implants . HTAJOCD.2020;12(3):21-25

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]

All on four: The all on four for edentulous jaws has been developed to make the best use of available bone and to allow for immediate function using only four implants in edentulous jaws, the solution takes advantage of the benefits of tilting the posterior implants to provide a secure and optimal prosthetic support for a prosthetic bridge (even with minimum bone volume), that can be fabricated and functioning within just a few hours after surgery.[2]

Tilted and Zygomatic implants: 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.[10]

Zygomatic implants offer another option treatment modality to sinus augmentation. Almost similar to transsinus 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.[11]

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 [12]. It was suggested that it would be possible to reduce the period between implantation and the placement of prosthesis. Over the past 20 years, a number of studies and trials have reported similar results with trans-mucosal implants compared with submerged implants. As a result, it is not necessary to submerge the implants under the mucosa during the healing period, which eventually introduced the immediate loading protocol [13].

This protocol was initially developed for the treatment of edentulous patients, and its main purpose was to restore immediate function and aesthetics, which are usually the main concerns of patients.

Numerous recent studies that focused on this concept have shown excellent results because the primary outcome was survival of the implant.

A 100% survival rate was reported in 11 edentulous patients treated with immediate full-arch implants [14]. A systematic review reported a survival rate of 98.2% in the immediate loading versus 99.6% in the conventional loading when reviewing 29 randomized control studies [15].

This trend could also be found in many studies that focused on edentulous cases. When immediate loading four implants with a pre-existing denture converted to a fixed dental prosthesis compared with conventional loading (3–6 months), it was reported that the same change of 1.2 mm in marginal bone over 5 years in both groups was observed. Also an insignificant difference in mean MBL between the two treatment modalities in both late and immediate inter-antral implantation in the nonaugmented edentulous maxilla was reported [16]

Peri implant surgery

The loss of teeth will result in a concomitant resorption of the alveolar bone and with time, there may be insufficient bone height or width for the placement of implants and this is being known that adequate implant length and width are important to improve the longevity of dental implants. Various bone augmentation methods from simple onlay bone graft for small depression, inlay bone graft for sandwich osteotomy to the maxillary sinus floor augmentation are developed for enhancing the bone volume. One of the newest procedures for augmenting areas of bone is called distraction osteogenesis. Osteoinductive and osteoconductive substances are now available to assist in accelerating healing and present great promise for future applications. When there is a lack of soft tissue due to atrophy or from ablative surgery, vestibuloplasty and palatal graft transplant are gaining wider acceptance. The use of free gingival graft transplant has been developed and was found to be technically easier and produced less morbidity to the patients. Different peri-implant surgeries may be combined to treat the problems related to either the bone or soft tissue deficiency around the implant placement and in implant maintenance.[17]

Image-guided implantology

The placement of dental implants requires meticulous planning and careful surgical procedures. A radiographic prescription is often needed to provide a more complete visualization of the current clinical situation and to guide in further clinical steps. A revolutionary development in field of imaging now allows a real-time navigational implant surgery[18] wherein the implant surgery is guided by an on-screen computer guidance thereby allowing

easy intra-operative adjustments. However, a major drawback is an expensive machine and long hours of calibration may be needed. Another option available is the use of stereolithographic surgical splints which help to place implants at the predetermined sites. This greatly enhances the speed of implant placement and reduces the chair side time. However, any error in the planning or fabrication of the splint cannot be corrected by the surgeon unless he abandons the use of the splint.[19]

Conclusion

Recent findings about surface modifications, immediate loading, short implants, sinus lifting, and custom implants have improved the success rate of implants regarding. However, there are limitations due to the lack of long-term or clinical studies. A long-term clinical trial and a more predictive study are needed.

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