

A Literature Review on the Suitability of Dental Tech Implant Ora Systems

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Abstract

Dental implants considered as an important dental treatment modality as it substitutes missing or damaged teeth with maximum life like acceptability. It consists of various parts such as crown portion, abutment and the root portion. Several medical devices are assembled together to achieve the functionality of the dental implants. It is available in several geometry, lengths and diameter. Different implant systems available in the market and are focused mainly on the factors such as implant/abutment interface, body shape and implant to bone interface. The success rate of implant is greatly depended on the osseointegration and implant bone interface stability. In addition to these factors, the safety concerns and compatibility aspects are significant in deciding the suitability of any implant system. Therefore, the current review seeks the suitability of dental tech implant system. A range of products are available from this implant system to fulfil the need of professionals in diverse clinical situations. Concluding this review, it is found that the dental tech implant system utilizes various interdisciplinary science and technology to accomplish the requisites of implant system and to maintain their safety and standards concerns. In addition, this system satisfies the safety, compatibility and surface texturing requirements and may be considered suitable option for various implant treatments.

Keywords: Dental Implant Requisites; Implant System; Dental Tech System

Introduction

Dental implants are recommended to maintain the function, aesthetics and moreover the psychological empowerment of patients who have missing teeth because of disease, trauma or developmental anomalies [1]. These are considered as a major evolution in dentistry as it replaces the missing teeth with high success rate. It is concerned with the replacement of missing teeth and their supporting structures with artificial prosthesis affixed to the jaw bone [1,2]. Aging population, age related tooth loss, anatomic consequences and psychological problems due to edentulism, unsatisfactory outcome of removable prosthesis and long term successful performance of the implant supported prosthesis increased the demand of dental implant treatments [3]. Dental implant consists of biocompatible artificial tooth root positioned surgically in the jaw bone to anchor and support the dental prosthesis such as crown, bridge, denture and facial prosthesis [3,4]. Dental implant system thus considered as a set of medical devices that are used to anchor the missing tooth. It consists of various types of implants, its superstructures and instruments. Implants are made of different materials and available in various shapes, lengths and diameters [5]. A variety of surface treatments are performed before implants insertion in order to provide superior osseointegration [5-7].

Osseointegration is the biological process that promotes the fusion of artificial material into the bone so that it cannot be separated from the bone without fracture. This biological phenomenon is the prime requisite for the stability of implants in place as it restricts the progressive movements between implant and the bone [8-10]. Osseointegration is a biologically determined program follows three stages such as incorporation by woven bone formation, adaptation of bone mass to load by lamellar and parallel fibered bone deposition and adaptation of bone structure to load by bone remodeling [8]. However, the effectiveness of this process greatly depended up on the surface topography of the implant as this is the only one area exposed to surrounding oral environment [11]. The surface properties play an important role in enhancing the adhesion and differentiation of the osteoblasts during the osseointegration phase and bone remodeling [10]. Therefore, certain manufacturing techniques are employed for improving the surface roughness by mechanical, chemical and physical treatments. Mechanical treatments include grit blasting, machining and sand blasting procedures. Acid etching, alkali conduction, hydrogen peroxide treatment, chemical vapour deposition and anodization are chemical treatment methods. Plasma spraying and ion deposition are considered as physical treatment procedures [11-13]. Moderate roughness and improved osteoconductivity obtain by anodization process and physical treatment techniques as it increases the surface thickness rather than rough surface. Surface compositional alteration can also be achieved through the chemical deposition techniques. Acid etching and other mechanical treatment processes enhances the surface roughness by adhesion, proliferation and differentiation of cell. Rough surface such as pit, grooves and protrusions are therefore increases the surface energy and promote the osseointegration [8-18]. Considering these factors, manufacturers fabricate implants in various designs, shape and surface morphology. A variety of implant systems with various diameters, length, surfaces, platform, interfaces and body shapes are currently available. The difference between each system is based mainly on the following factors such as implant/abutment interface, body shape and implant to bone interface [3]. The present literature review aimed to determine the suitability of Dental Tech implant systems by considering various aspects and requisites for an implant system.

The present review is performed from the published article related to implant system and dental tech implant system using internet search databases such as EBSCO, pubmed, google scholar and manual key words searching.

Major concerns on implant system

Geometry and surface topography of implants are critical in achieving the clinical success and long term performance of the implanted prosthesis [16-19]. Primary implant stability and load bearing ability during and after osseointegration are influenced mainly by the design features of the implant. There are two major types of implant designs such as macro design and micro design. Macro design comprises the implant body shape, thread design, geometry, face angle, thread pitch, thread depth or height, thickness or width and thread helix. Micro design includes implant materials and surface coating [19]. The implant body design is crucial during loading periods. The primary objective of implant body design is to distribute the applied occlusal load into the surrounding body tissues. Implant body design consists of three zones such as thread geometry, crest module and apical design consideration. Different designs such as cylinder type, screw type, press fit and combination of these types are used for implant body design. The nature of applied force and functional surface area to dissipate the applied load are two major concerns in biomechanical load management. A cylindrical type and tapered threaded implants do not have advantage on functional surface area rather provide surgical advantage during insertion down within the osteotomy halfway before engaging the bone. This is because the compressive load borne by the thread of the screw and the lesser surface area increases the stress at crestal portion. In addition this type is less deep and therefore initial fixation of the implant is also limited. A smooth cylinder body design generates shear loading at the implant to bone interface. Bone growth occurs during initial healing, but the retention may be achieved with chemical procedures such as acid or alkali etching and surface depositions and physical procedures such as plasma spraying or coatings. Hence the integrity of the implant bone interface is depended on the initial shear load and the direction of the force applied. As the angle of load increases, the stress around implant increases [19-22].

Threads are intended to increase the surface area, initial contact and to dissipate the load at bone-implant interface. Thread design is important to distribute the load and to provide implant stability. Thread parameters such as thread shape, pitch, depth and face angle describes the thread geometry. Five different thread shapes are currently available in the implant market. These are standard V shape, square shape, buttress thread, reverse buttress thread and spiral thread. The amount and type of force transfer is different for each thread shape [19,23]. A mild load aids in bone remodelling response and woven bone formation, whereas an excessive load cause micro-fracture and osteoclastogenesis. The defected areas later filled with fibrous tissues and microorganisms and severe bone loss occurs in future which in turn decreases the bony support and increases the risk of implant failure. A standard 'V' shaped thread and broader square shaped thread can generate mild stress in cancellous bone compared to narrower thread designs. In cortical bone the thread design did not show difference among threads. Apart from these, the bone quality, the amount and direction of force differ from one person to another [22-25].

Thread pitch is another significant design variable that changes the surface area of the threaded implant. It is used to resist the forces to bone. It is the distance between centres of one thread to the centre of next thread measured parallel to the axis of the screw. The thread number is inversely related to the pitch. Thus, if the thread number is less, pitch is increased. From previous studies, it is reported that it is good to have more number of threads to achieve more bone interface contact and the stress applied is decreased with lower pitch. As the pitch decreases, the surface area increases with better stress distribution. Shorter and longer pitch is unfavourable during stress generation [23,26]. Lead is the distance from centre of one thread to the centre of same thread after one turn. Therefore, in a single threaded screw, the lead is equal to pitch, whereas in a double threaded screw, the lead is double the pitch and in a triple threaded screw, lead is triple the pitch. Lead usually determines the speed in which the implant is placed in the bone. So that the single threaded implant requires more time for insertion compared to double threaded and the least time for triple threaded implant [19,27].

Face angle is the angle between the face of the thread and a plane perpendicular to the long axis of the implant. A small face angle leads to increase the tensile and compressive force and large face angle increases the shear type of force along the bone to implant interface [23].

Crest module represents the neck portion of the implant is another key consideration during implant system as it is critical to reduce marginal bone loss. Crest module usually extends from implant body to the anti-rotation components of the abutment implant connection. This region is very important as it determines the overall implant body design. It has the surgical, biological and mechanical influence. It seals the osteotomy and provides a barrier against fibrous tissue formation and bacterial attack. This in turn leads to initial implant stability as it compresses the crestal bone region. Therefore, slightly larger crest module compared to outer thread is preferred [19]. Initially the crest module was manufactured smoothly to avoid plaque retention and possible bacterial adhesion. But the smooth surface created more shear force and marginal bone loss. This led more pockets and bacterial invasion. Therefore, recently microthreads are used in crestal portion as a retentive element to dissipate the applied stress and to conserve the crestal bone height [23].

Implant diameter determined by the peak of the largest thread to a similar point on the inverse side of the implant. Generally, the implant thread diameter varies from 3 to 7 mm. stress distribution is greatly depended on the implant diameter. A wider implant facilitates maximum pressure distribution. Implant length is another major factor that needs to be considered during manufacturing. In general, there are three implant lengths such as short, medium and long types. Short types are 6 - 9 mm long, medium implant lies between 10 - 12 mm and long variety ranges from 13 - 18 mm. However, implant length less than 7 mm is not preferred due to risk of failure. Recently finite element analysis is performed to attain optimum implant design with maximum biological, mechanical and physical properties. Because in each clinical situation is different and operators need to select the design based on the requisites [28].

Requisites of the implant systems

There are several requirements for an implant system including safety and compatibility concerns, surface texturing, patient concerns such as adult or child patient and materials properties [3].

Safety concerns are the prime requirements for dental implants devices. It is an integrated system of science and technology with macro scale to nano scale manufacturing technology. Specifications and standards have been developed for the manufacturers, operators and consumers [29]. Dental implants need to undergo various tests including group I, II and III tests. Group I involves cytotoxicity tests ISO 7405, 6.1, 6.2 and ISO 10993.5, group II contains subchronic systemic toxicity ISO 10993.11.6.7.1 skin irritation, intra- cutaneous reactivity ISO 10993.11.5.2, inhalation ISO 10993.11.6.7.3, genotoxicity ISO 10993.3 and local effects after implantation ISO 10993.6 tests. Group III comprises pulp capping and pulpotomy ISO 7405.6.4 and endodontic usage test ISO 7405.6.5 [3].

Compatibility concerns related to the biological, mechanical, morphological and image compatibility. All intraoral devices are always in the presence of saliva and body fluids. The fluctuating oral temperature and pH based on the food or drinks taken into the mouth also affect the artificial materials inside the mouth. In addition to these, constant forces are also generated during mastication and speech. Thus, any material which is kept in these oscillating atmospheres tends to deteriorate due to corrosion. Therefore, selection of implant system is critical for the compatibility aspect [30]. Currently, titanium metal, its alloys and ceramic zirconium materials are employed for the implant fabrication. Titanium and titanium contained alloys exhibit passivation effect by forming surface oxide layer and increases the resistance to corrosion, whereas zirconium is ceramic material which is inert in nature does not react in the surrounding environment. Therefore, both are biocompatible and as per food and drug administration (FDA) requirements, these materials are safe as dental implant. The stress distribution factors are regarded as the mechanical compatibility element. The type of material, the geometry, diameter and lengths are the decisive components for mechanical compatibility [3,31-33]. Morphological compatibility includes the surface roughness, composition and surface energy of the implanted device. An average roughness about 1 - 50 micrometres with particle size ranging from 10 to 500 micrometer are preferred regardless of the material type. If the particle size is less than 10 micrometres, the surface become toxic to fibroblastic cells and pore size larger than 500 micrometres affect the structural integrity and morphological compatibility [3]. In addition, surface treatments performed to achieve better osseointegration and implant stability. Mechanical, chemical and physical properties are improved due to surface modification. The modifications are broadly classified into two types such as surface concave texturing and convex texturing. Concave texturing involves the removal of surface layer by chemical or mechanical methods. Convex texturing involves addition or deposition of certain particles by chemical deposition, plasma spraying, diffusion bonding and other such techniques. However, the rough surface is maintained for long term implant stability [8-18].

Discussion

Considering all these factors and requisites, dental tech implant system provide a wide range of products with safe, compatible and versatile implant systems. Therefore, professionals can avail a range of products to fulfil their vast clinical requirements. The products like IMPLASSIC FTP, IMPLASSIC FT3, IMPLASSIC FT2 SHORT, IMPLOGIC®AT, IMPLOGIC® GII, IMPLASSIC HX3, IMPLASSIC TR2, IMPLASSIC TRW2, LOGIC SPHERO are the commercially available materials from dental tech system. Each variety exhibit special characteristic features. IMPLASSIC FTP has spiral conical profile with hybrid progress. The flat radiating external triangular shape facilitates the easy penetration into the incompletely prepared site. Microgrooves are provided to improve the bone interface stability and prevention of bone resorption. Atraumatic apex with helicoidal progress enhances the positioning and stable penetration. It is made of titanium and available in various diameters and length. IMPLASSIC FT3 has cylindrical morphology and similar to IMPLASSIC FTP except the range of diameters and morphology. IMPLASSIC FT2 SHORT is short cylindrical type available in two lengths (6,7 mm) and three diameters (4.25, 4.75, 5.5mm). IMPLOGIC®AT is spiral shaped conical system with less risk of adjacent teeth damage. It is available in three diameters and range of lengths. It possesses exceptional self tapping ability, which is suitable for bone condensation and primary stability. It exhibits the

advantages of bone maintenance over time with lower bone reduction and considered suitable for post extraction sites. IMPLASSIC HX3 exhibit universal connection with external hexagon and other properties are similar to IMPLASSIC FTP. The crestal module of IMPLASSIC TR2 contains microgrooves which are favourable for retention and stress distribution. This version do not have conical apex, instead it is non traumatic in nature. Therefore, these types are suitable for maxillary sinus and alveolar nerve regions. It possesses apical cutting areas and thereby decreases the bone compression. Range of diameters and lengths are also available in this type. IMPLASSIC TRW2 is designed for posterior sectors. The properties are similar to the IMPLASSIC TR2 category. LOGIC SPHERO exhibit maximum mechanical resistance. It has small diameter with maximum bone implant contact. The surgical phase is easy with this type and implant insertion and prosthesis stabilisation can be done in single session. A traditional or flapless surgery is recommended with this implant system [34].

All dental tech products are subjected to surface texturing by sand blasting to avail surface roughness and thereby increased fibrin adhesion and short healing time. Argon cold plasma treatment is then employed to reduce the carbon contamination. The surface is evaluated using scanning electron microscopic analysis. Gamma ray sterilisation is performed to minimize the bacterial adhesion and packaging done in controlled atmosphere ensures the safety concerns. Moreover, this system operates with requirements of European Directive 93/42/EEC and ISO certified (UNI EN ISO 9001:2008 EN ISO 13485: 2012+AC2012) [35].

Conclusion

In summary, dental tech implant system may be considered suitable option for various implant treatments as it satisfies the safety, compatibility and surface texturing requirements. In addition, these are multifaceted and satisfy the need of clinicians involved in implant treatment procedures.

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