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**EFFECTIVENESS OF DIFFERENT TECHNIQUES ON VERTICAL MISFIT OF  
IMPLANT FRAMEWORK IN DENTISTRY: A REVIEW**

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**ABSTRACT**

In evaluation of the long-term success of a dental implant, the reliability and the stability of the implant–abutment interface plays a great role. Tapered interference fits provide a reliable connection method between the abutment and the implant. Based on the literature, there is no fully successful technique for dental implant. So, it is acceptable among dentists to use much more useful methods or introduce new techniques using their knowledge. Numerous articles emphasize the importance of passivity of implant-prosthetic component interfaces. Non passive interfaces can lead to bone loss, abutment fracture, and connecting screw breakage. It is important to compare techniques for the correction of non-passive fit between a cast bar superstructure and its interface with an implant abutment. So the aim of the current review was to determine effectiveness of different techniques on vertical misfit and detorque value of implant framework in dentistry. Also, we tried to introduce new techniques and/or ideas. We hope in this literature review we can cast light on hidden side of this prosthodontics.

**Key words: Vertical misfit, Implant framework, Teeth**

**INTRODUCTION**

Dental implant–abutment systems are used as anchors to support single or multi-unit prostheses for partially or fully edentulous patients. A dental implant system consists of an implant that is surgically implanted in maxilla or mandible, and an abutment that

mates with the implant once the implant successfully osseointegrates to the bone. Depending on the specific system used, an abutment can include a machined connection mechanism within itself or can be clamped onto the implant by means of an abutment screw. The dental prosthesis is then fabricated over the abutment. In general, the success of the treatment depends on many factors affecting the bone-implant, implant-abutment and abutment-prosthesis interfaces [1].

Several authors have referred to the importance of passive fit of prosthesis frameworks on implants. Due to the absence of a periodontal ligament, osseointegrated implants lack the ability to adapt to prosthesis misfit [2]. Poor framework fit has been shown to induce compressive and tensile forces around implants and within the framework. Subsequently, mechanical and biological complications are thought to arise. However, the evidence correlating the complications to the level of fit is limited. In addition, the degree of acceptable framework fit has not yet been quantified [3, 4]. Nevertheless, it is important to emphasize that a well-defined clinically relevant definition of passive fit is still lacking. Because of this, many authors have disputed the clinical relevance of passive fit and have instead concluded that well-controlled fabrication techniques are

appropriate and sufficient to provide adequate implant treatment [5, 6]. New technologies introduced in the fixed prosthodontics in dentistry during past decades but controversial reports exist for success and/or usefulness of these techniques [7]. Achieving esthetically and functionally ideal restorations has been the goal of dental clinicians, prosthodontists and manufacturers throughout the history of dentistry [8]. Misfit could contribute to cement dissolution, so, obtain the best technique minimize subsequent abnormalities. In this literature review we studied accuracy and reliability of available methods to determine effectiveness of different techniques on vertical misfit and torque value of implant framework in dentistry.

### **What is the Misfit in prosthodontics?**

Since the early literature on osseointegration in dentistry, the significance of controlling the load to the implants has been emphasized and the internal stress associated with misfit of frameworks has been discussed. Based on early biomechanical publications, many authors have claimed a relation between clinical complications and poor fit of screw-retained implant prostheses [9]. Implant bars fabricated using the conventional lost-wax casting technique may not routinely produce the desired fit between implants and implant

bars. This misfit is due to multiple factors, in particular the inconsistency of volumetric and linear expansion/ contraction of the materials used. These include metal alloys used for casting, as well as gypsum, impression material, wax, and investment. Different post-casting techniques, such as soldering and electronic discharge machining have been advocated to correct misfit resulting from the fabrication process [10].

#### **Relation between implant/abutment vertical misfit and torque loss of abutment screws**

The implant/abutment interface has been referred to as a significant factor in stress transference, possible adverse biological response and complications on prosthetic rehabilitation. The fabrication of implant components and the effects of clinical and laboratorial phases can contribute to misfit between implant and prosthesis. Two possible complications emerge from this scenario [11]. First one, biological- increase of the load transfer to the bone, and presence of mucosal inflammation due to the development of microflora in the micro-gap between the implant and the abutment with subsequent bone loss; and second one, the prosthetic - loosening/ fracture of implant and/or prosthesis. In case of misfit between implant and abutment as well as between abutment and prosthesis,

compressive and traction loads could be directed to the restoration, resulting in loosening of the prosthesis and abutment screws, fracture of the restoration, bone microfractures surrounding the implants and even fracture of the implant body. The contact between abutment and implant platform is a key factor because it reduces the load over the abutment screw, warranting a high efficiency of these components. Even little misfit could result in changes in screw geometry and incidence of strain over the screws. The success of a screwed connection is directly related to the preload reached during torque and the maintenance of this preload with the time [12]. It is suggested that the screw loosening originates from the separation between the screw and abutment surfaces, as well as the high stresses levels generated over the screws [13]. Several studies have evaluated the misfit effect between the external hex of the implant and the abutment screws, verifying a direct correlation between rotational freedom and abutment screw loosening at the abutment/implant interface [14].

#### **Techniques have been used to this purpose**

##### **Lost-wax**

This is one of the traditional techniques for fabricating the metal substructure is the lost-wax technique and using various metal

alloys for casting [15]. Conventionally, wax patterns were fabricated with wax and waxing instruments for example the popular PKT instruments. Wax is used to make the patterns because it can be conveniently manipulated, precisely shaped and can also be completely eliminated from the mold by heating. The fabrication of the wax pattern is the most critical and labor-intensive step in making the porcelain fused-metal crown [16]. To fabricate a restoration prepared using the lost-wax technique, the dentist must first make an impression and the impression appointment may be uncomfortable for the patient because of the retraction procedure and need for anesthesia. Subsequently, time is required by the dental laboratory technician for careful pouring of the stone die or cast from the impression, preparation of the cast, then fabrication of the wax pattern, investing, and casting. Lost-wax technique is the old-fashioned technique for fabricating the metal substructure and using various metal alloys for casting [3].

### **Electron beam melting (EBM)**

The development of a dental implant with a profile optimized to the anatomic dimensions is ideally accomplished with an abutment customized to the desired tooth dimensions and soft-tissue contour.1 Proper angulation and easy preparation of subgingival margins can then also be

achieved. One of the most frequently used custom abutments in the anterior tooth area is a custom zirconia (Zr) abutment, designed using computer aided design/computer-aided manufacturing Computer-designed and -generated abutments technology [17]. Computer-designed and -generated abutments for implant restorations will fundamentally transform the present restorative protocols for implant dentistry. Computer-aided design and computer-aided manufacturing (CAD/CAM) technology is rapidly supplanting traditional labor intensive laboratory methods for implant abutment fabrication. The lost wax technique, a mainstay of prosthetic laboratory procedures and a principal method of implant abutment fabrication, was introduced to dentistry in 1907. The accuracy of this process is limited by the expansion and contraction of impression materials, gypsum, wax, casting investment, and alloy [18]. In the early 1970s, CAD/CAM technology quickly began replacing conventional manufacturing processes in commercial uses, particularly aerospace and automotive applications [19]. In 1971, Francois Duret introduced the CAD/CAM process to restorative dentistry and, in 1983, he produced the first CAD/CAM dental restoration. Other researchers, including Aoki, Rekow and Caudill, were instrumental in developing

this technology for dental systems. Brandestini and Mörmann, in 1985, then used this process to develop CERAC (Siron, Bensheim, Germany), one of the first commercial CAD/CAM dental system for making ceramic inlays. Dental applications of CAD/CAM technology in dentistry remained restricted to finished ceramic restorations, such as inlays and crowns, for nearly 2 decades. Beginning in the 1990s, its applicability expanded into restorative aspects of implant dentistry by transforming the manufacturing process of implant abutments [20]. Other authors have studied the accuracy of fit between implants and implant frameworks made with different techniques, protocols, and materials. The results have tended towards CAD/CAM protocols resulting in better-fitting frameworks than the results obtained with traditional casting protocols. Multiple CAD/CAM protocols have been developed and tested [10].

The method, which is often called, layered manufacturing, solid free-form fabrication, and 3D printing, is a significant technological breakthrough in the product manufacturing industry. Compared to the conventional material forming processes, the part is fabricated by additive processes through a gradual-building of solid material from powder layers to the required shape from profiles created using CAD, X-ray

computer tomography (CT), magnetic resource imaging (MRI) scanning, etc. Since this method requires no fixtures and tooling, a considerable reduction in the cost and lead time can be achieved. The first RP technology emerged as early as 1987 and used a laser for materials processing. More recently developed systems employ an electron beam in sintering and melting materials. In this article, these processing methods are referred to as laser beam melting (LBM) or selective laser melting (SLM) processes; or electron beam melting (EBM) processes. The LBM process is also commonly called selective laser melting (SLM). At first, this method was developed to produce industrial parts has now been considered as an economical processes for the fabrication medical and dental prostheses. A number of articles have been published with respect to the capabilities of these methods, the mechanism of the additive fabrication processes, properties of products made with these technologies, and applications [21].

#### **EBM V.S lost wax**

Lost-wax used to make the patterns for many reason such as conveniently manipulated, precisely shaped and completely eliminated from the mold by heating [3]. The fabrication of the wax pattern is the most critical and labor-intensive step in making the porcelain

fused-metal crown. Disadvantages of this system includes: time consumption, quality of wax-up's is dependent on the skilled labor of the individual. Also, because of the wax pattern's color and glossy surface, small defects cannot easily identify [16]. Considering the lower unit cost of base metal alloys, a more economical dental laboratory technique would be helpful to replace the this technique for preparing cast restorations [15].

Titanium alloys are widely used for medical implants. Exposed to oxygen the titanium is spontaneously covered by a surface oxide layer, a property which contributes, in part, to its excellent biocompatibility, including low toxicity, high stability with low corrosion rates, and favorable mechanical properties compared with other metals [22]. Titanium and its alloys have also found applications in biomedical applications as hard tissue replacement due to excellent biocompatibility, specific strength and corrosion resistance [23]. In comparison to other metallic materials like stainless steel and Co-Cr alloys, better biocompatibility is the result of instant formation of TiO<sub>2</sub> layer resulting in high corrosion resistance and low toxicity in fluid body environment [22]. Among all the titanium alloys, Ti-6Al-4V is by far the most commonly used titanium alloy accounting for 50% to 70 % of total titanium output in the world [24]. It is a two

phase alloy. The microstructures of Ti- 6Al-4V are processing history and heat treatment dependent [25]. The mechanical properties of Ti-6Al-4V show strong dependence on the metallurgical microstructures. The control of texture and microstructures is necessary to control the physical and mechanical properties of Ti-6Al-4V [26]. Due to the presence of two phases and transformation between two phases provides an opportunity to prepare functional parts with tailor made combination of microstructures and properties. The extensive use of Ti and its alloys especially Ti-6Al-4V, in many industries like aerospace, where reliability and functionality of the components are of major interest, requires better understanding of the process and procedures by which these components are fabricated. The high cost of raw material also requires the processes that are cost and material efficient, in order to keep the final price of the components affordable.

The surface topography of medical biomaterials plays a fundamental role in regulating cell attachment, proliferation, and differentiation and in determining biocompatibility as the biological performance of biomedical implants strongly depends on the first interaction between implant surfaces and the biological environment [27]. Various chemical and

physical surface modifications have been investigated to improve biomaterial tissue [28]. The manufacturing process determines the roughness of the material surface. A variety of fabrication processes have been established, resulting in smooth, rough and porous implants. In order to determine the effects of topographic features on cells, there is a need to design implant surface chemistries and topographies intentionally. Initial adhesion of cells is mainly responsible for later success of osseointegration. Several in vitro studies on bone-derived cells grown on titanium surfaces of varying roughness have reported changes in osteoblasts morphology, proliferation, and differentiation. With the applied EBM process, nearly every required three-dimensional metallic object with the favored surface structure and porosity can be produced directly from a virtual computer model by melting together metal powder particles layer-by-layer with a computer controlled electron beam in a high vacuum with high precision and quality [22].

#### **Other factors responsible in implant success**

The long-term success of osseointegrated implants in the treatment of completely and partially edentulous patients with a sufficient amount and quality of bone has been well documented in the literature.

However, several long-term studies indicate reduced survival rates for osseointegrated implants in the maxilla compared with the mandible. Usually, the presence of sufficient bone in some areas of the maxilla allows placement of implants of sufficient length to support a prosthetic reconstruction. However, it has been suggested that the quality of maxillary bone is inferior to that in the mandible and is responsible for the higher rate of implant failure observed in this area [29].

#### **Torque and Detorque**

Although there is little documentation on the correlation between closing torque and potential damage to the bone implant connection, reverse torque-to-failure studies in animals and human volunteers give an indication of the amount of torque needed to break the osseous bond between implant and bone. With manual torque drivers, the chances of suboptimal preload and subsequent screw loosening is greatly increased, even when maximum manual closing force is applied. Recently, mechanical torque drivers, specific for each implant system, have become available; yet, it is likely that many clinicians are still using manual torque drivers. Some reports indicate that mechanical drivers also produce inconsistent closing torque values. Nevertheless, these devices generate closing torque in a range close to the manufacturers'

recommended levels that is well above the range of torque values that can be generated with manual drivers. Thus, to obtain torque and optimal preload in this range, it is desirable to use an appropriate mechanical torque driver [30].

### **Clinical complications with implants and implant prostheses**

#### **Surgical complications**

Many surgical complications have been identified in the implant literature, including hemorrhage-related complications, neurosensory disturbance, adjacent tooth devitalization/damage, mandibular fractures, life-threatening hemorrhage, air emboli, implant displacement into the mandibular canal, screwdriver aspiration, descending necrotizing mediastinitis intraocular hemorrhage and singultus (hiccups) [31].

#### **Implant loss**

Implant loss was evaluated in relationship to the following factors: prosthesis/arch, time of loss, implant length, bone quality, and systemic conditions [31].

#### **Bone loss**

Marginal bone loss occurs during the first year. The mean bone loss was 0.9 mm (range from 0.4 to 1.6 mm). The mean loss per year in subsequent years was 0.1mm (range from 0 to 0.2 mm). One study [17] of mandibular implant fixed complete dentures measured an average total bone loss of 0.9

mm after 10 years and a total of 1.2 mm after 15 years [31].

#### **Mechanical complications**

A large number of mechanical complications have been reported and they include the following items listed in their order of reported frequency: overdenture loss of retention/adjustment (30%); resin veneer fracture of fixed partial dentures (22%); the need for overdenture relines (19%); overdenture clip/attachment fracture (17%); porcelain veneer fracture of fixed partial dentures (14%); overdenture fracture (12%); opposing prosthesis fracture (12%); acrylic resin base fracture (7%); prosthesis screw loosening (7%); abutment screw loosening (6%); prosthesis screw fractures (4%); metal framework fractures (3%); abutment screw fractures (2%); and implant fractures (1%) [31].

#### **CONCLUSION**

Researches confirm the relation between inappropriate marginal integrity and gingival inflammation and reports the most important factor in periodontal disease prevalence is an unsuitable marginal fit. Marginal fit is one of the most important criteria for the long-term success of all implants. This paper is heading of our recent research which based on that we want to compare effects of lost-wax and EBM techniques on vertical misfit and detorque value of implant framework. So, we are

trying to introduce new methods instead of old time consuming and costly methods which have been used in implant framework in dentistry. This paper is part of our incoming research which based on that we want to compare effects of lost-wax and EBM techniques on vertical misfit and detorque value of implant framework. So, using the literature review of current paper, we started our incoming research project which the results will publish in recent future.

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