A COMPARATIVE RADIOGRAPHIC ASSESSMENT OF THE CHANGE IN THE CRESTAL BONE LEVEL AROUND DELAYED IMPLANTS AFTER IMMEDIATE VERSUS DELAYED LOADING TECHNIQUES

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بسم الله الرحمن الرحيم

وَمَا أُوتِيتُم مِّنَ الْعِلْمِ إِلاَّ قَلِيلاً

صدق الله العظيم

سورة الإسراء

آية ٨٥

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Introduction

Despite the applications of dental implants in new areas such as maxillofacial prosthodontics, the anchoring of hearing aids and in orthodontic therapy, it is principally used for prosthodontic rehabilitation. If the potential benefits of such uses are to be maximized, then it is essential that implant treatment be selected on a logical basis, and placed within the context of the full range of treatment modalities available in restorative dentistry. [1]

Treatment should not be based on hope, but rather on accurate information, an understanding of the patient's problems, recognition of suitable treatment alternatives and the agreed selection of the one most appropriate to their needs. This may not necessarily be the most complex procedure or involve the use of dental implants. Their use is most likely to succeed where it has been selected on a sound base. The correct insertion of dental implants is essential for their optimal utilization and. The technique must involve appropriate planning and consultation by the dental team. [2]

While an integrated dental implant is essential for success, it is of little use if it is inappropriately located. Treatment with dental implants can be a very complex procedure in terms of planning, execution and management of the subsequent problems. Despite the high success rate of the technique, these are not unknown and are best managed by avoidance rather than correction after the event. There is a close relationship between the tooth and the alveolar process throughout life. Every time the function of bone is modified a change occurs in the internal architecture and external configuration. Bone requires stimulation to maintain its form and density. When a tooth is lost, the lack of stimulation to the residual bone causes a decrease in trabeculae and bone density in the area, with loss in height and width of bone. [3]

A partial or complete denture does not maintain the bone and in fact may accelerate bone loss if the prosthesis is ill-fitting. These types of patients are often not told about the anatomical consequences of bone loss when their teeth are extracted, they are not informed that bone loss will continue to occur over a period of time and this continual resorptive process has many consequences. The bone loss can be so severe that even if the patient desires implant therapy there may not be sufficient bone for implant placement and aggressive adjunctive surgical procedures would be required such as grafting from the iliac crest. So Patients should be made aware and informed of the preventive nature of dental implants. [(4)]

Osseointegration :

Without osseointegration between the bone and implant surface, there is no restorative options. Today's surgeons and restorative doctors must work together to achieve the expected results to produce fully integrated, functional, aesthetic, and hygienic prostheses. Surgeons must place implants in appropriate positions to allow for functional, aesthetic restorations. Implant materials and designs continue to evolve in efforts to increase the frequency of and decrease the time for integration. So specific interest to achieve successful osseointegration has always been the first step for the correct and perfect implant therapy.[(5)]

Concept of osseointegration

Per-Ingvar Brånemark at the University of Goteborg in Sweden developed the concept of osseointegration while studying microcirculation in bone repair. Brånemark and others (1977) defined osseointegration as "a direct structural and functional connection between ordered, living bone and the surface of a load carrying implant". During the 1950s, Brånemark discovered that there was a strong bond between titanium and bone. Over the next 25 years, Brånemark continued to modify and improve the technology and protocol associated with predictable, long-term oseointegration of dental implants. Brånemark presented the first two-staged threaded titanium root-form implant in

North America in 1982. Since Brånemark's research was originally presented, there have been multiple modifications to the original protocol to enhance biocompatibility and retention for dental implants. [6]

Bone biology has three phases of healing around the dental implant. These phases are the osteophytic, osteoconductive, and osteoadaptive phase. In the osteophytic phase, when an implant with a rough surface is inserted in the mandibular or maxillary spongy bone or marrow, only a small quantity of the bone proceeding from trabecular bone of the interior of the marrow is in contact with the implant surface. The coagulation phenomenon will be produced as an initial response. These processes are managed by platelets and will lead production of the osteoid tissue on the implant surface. This phase lasts approximately 1 month. [7] In the osteoconductive phase, which is prolonged for 3 months, the bone will continue being placed on the surface of the metal. In the osteoadaptative phase, there is no increase or loss of the bone on the metal, and when implants are loaded functionally, thin bone layers will continue being enlarged.[7]

Implant surface topography:

Implant surface topography has been shown to enhance implant-to-bone contact. Adding titanium to implant surfaces through plasma-spray technology is one technique that modifies the surfaces of the implant. Dental implants have also been modified by reduction techniques involving blasting and or acid etching implant surfaces. Cordioli.[8] reported five-week bone-to-implant contact values to be 72.4% for acid-etched surfaces, 56.8% for titanium plasma-sprayed surfaces, 54.8% for gritblasted titanium surfaces, and 48.6% for machine surface implants (Cordioli and others 2000). [8]

Virtually all major implant manufacturers use some form of roughened surface texture for their endosseous dental implants. Different surface treatment of implants to improve their microstructure has been the goal of much experimental and clinical research during the last few years.

Scientific evidence accumulated over the last 10 years suggests that titanium implants with roughened surfaces achieve significantly improved anchorage in the bone than do implants with machined surfaces. The first attempt at increasing surface roughness was made almost two decades ago with the application of titanium plasma sprayed onto the surfaces of the implants. Results obtained with this surface have been very satisfactory, as studies have shown. [(9)]

Other treatments designed to alter the surface morphology of implants include grit blasting with different sized particles of sand, glass, or aluminum oxide to create varying degrees of roughness and acid etching, which produces a uniformly rough texture over the entire implant surface. These techniques have also been used with promising results. [(10)]

changing the morphology by creating varying degrees of surface roughness (the sandblasted macro texture and the inhabiting acid etched micro pores was biologically demonstrated to accelerate the initial bone healing process at the implant bone interface and quadruple interfacial shear strengths. [11) (12),]

Except for the difference in surface roughness techniques between the sandblasting, acid-etching and other techniques, the results were consistent with the findings of the other studies concerned with the surface modification to create some sort of surface roughness. All these studies were geared to reveal that topography, especially on the scale of cellular dimensions, could work as a biocompatibility-influencing factor as well as a biomechanical factor, improving the process of osseointegration . [(13)]

Based on cytological experiments, Martin[(14)] and Boyan[(15)] found that topography could influence protein synthesis and differentiation of osteoblasts which confirms that surface topography is a biomechanical and biocompatibility-influencing factor affects the process of oseointegration.

The Masticatory Forces

The osseointegration process may be affected by functional forces directed to the supporting bone as a result of masticatory forces. and mechanical loading, in fact, is thought to be the critical factor determining the long-term survival of endosseous implants(16) According to some authors, overloading (*i.e.*, para-functional habits, bruxism) might be responsible for a loss of osseointegration(17). This phenomenon is witnessed when the physical stresses placed upon the implant system exceed its physiologic threshold, thereby creating failure at the bone-implant interface.(18)

Animal experiments have demonstrated that excessively high dynamic implant loading can lead to pathological changes in the bone tissues, which will result in either peripheral, apical, or cervical marginal bone loss and, if uncorrected, to complete loss of osseointegration. More important than the magnitude of the forces is the direction from which they act on the implant, as it may put the implant in a force magnifying situation. .(19) (20)

Bone Loss:

The determination of the etiology of bone loss around dental implants is needed to minimize its occurrence which will determines implant prosthesis survival. Bone remodeling at the cellular level is controlled by the mechanical environment of strain. Strain is defined as the change in length divided by the original length, and the units of strain are given in percent. The amount of strain in a material is directly related to the amount of stress applied. Occlusal stress applied through the implant prosthesis and components can transmit stress to the bone-implant interface. (21)

Bone density is directly related to the strength and elastic modulus of bone. Hence, in denser bone there is less strain under a given load compared to softer bone. As a result, there is less bone remodeling in denser bone compared to softer bone under similar load conditions. [22]

The amount of bone strain at the bone implant interface is directly related to the amount of stress applied through the implant prosthesis. Mechano-sensors in bone respond to minimal amounts of strain, and micro-strain levels 100 times less than the ultimate strength of bone may trigger bone remodeling.[23]

The mechanism of bone loss :

There are many theories explaining the relationship between the applied stress and the magnitude of bone remodeling since 1997s. [24]. Frost. [25] Reported a study on the cellular reaction of bone to different micro-strain levels. He observed that bone fractures at 10,000 to 20,000 micro-strain units. However, at levels 20 to 40% of this value (4,000 units), bone cells may trigger cytokines to begin a resorption response. Therefore, excessive bone strain may not only result in physical fracture, but may also cause bone cellular resorption. Therefore, the hypothesis that occlusal stresses beyond the physiologic limits of bone may result in strain in the bone significant enough to cause bone resorption is plausible from a cellular biomechanics standpoint. [25]

The relationship between stress and strain determines the modulus of elasticity (stiffness) of a material. Hence, the modulus of elasticity conveys the amount of dimensional change in a material for a given stress level. The modulus of elasticity of a tooth is similar that of to cortical bone. Dental implants are typically fabricated from titanium or its alloy. The modulus of elasticity of titanium is 5 to 10 times greater than that of cortical bone. [26]

An engineering principle called “the composite beam analysis” states that when two materials of different elastic moduli are placed together with no intervening material and one is loaded, a stress contour increase will be observed where the two materials first come into contact.