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IMMEDIATE LOADING OF DENTAL IMPLANTS: A REVIEW-Part I

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ABSTRACT:. The ideal goal of prosthetic dentistry is to restore the form and function of the missing structures as close to natural as possible. The introduction of implants have revolutionized the field of restorative dentistry and this article evaluates the merits and demerits of the immediate loading implants

KEYWORDS: **Implants, loading, Immediate . osseointegration, Bone**

INTRODUCTION

The ideal goal of modern dentistry is to restore the patient to normal contour, function, comfort, esthetics, speech, and health. Among these rehabilitation of aesthetical appearance and masticatory function with artificial prosthesis has tremendous impact on outcome of success of the treatment.[1] There are different methods involved in the replacement of missing teeth which includes complete denture prosthesis for complete edentulous while removable and fixed prosthesis for partial edentulous and implants for both. But introduction of implants into the dentistry has revolutionized dental treatment modalities and provided excellent long-term results. The use of dental implants to provide supp rt for prostheses offers a multitude of advantages compared with the use of removable soft tissue-borne restorations..[2]

Implant dentistry has become popularized with the discovery of the biologic properties of titanium and its Osseo integration with the alveolar bone. studies conducted by Branemark and collaborators emphasized that a complete surgical protocol was required, with the implants submerged in the soft tissue and alveolar bone, to allow for stress healing without loading followed by surgical uncovering of restoration after 3 to 6 months. After achieving proper healing only progressive loading of implants should be done. But this two stage protocol described by Branemark et al made the implant treatment lengthy. However the discomfort, inconvenience and anxiety associated with such a long waiting period remains a challenge to both the patients and clinicians.[4]

Immediate loading can be defined as an¨ implant that carries a prosthetic superstructure that makes occlusal contact within the first 1 or 2 days after placement. It should be distinguished from early loading, which means the occlusion is re-established within 2 weeks. When loading is only allowed after several weeks, it should be called 'delayed' loading independent of the fact whether it is a one- or two-stage procedure.[9]

Later on, many clinical & experimental studies by Chiapasco et al.[6]; Schnitman et al.[7]; Tarnow et al.[8] on early and immediate loading protocols are reported in order to offer the patients the prospect of expected dental rehabilitation. This research led to the introduction of the concept of immediate loading. The main intention of this article is to provide critical analysis of immediate loading implants.

REVIEW OF LITERATURE

Schnitman PA et al (1997) [6] showed that mandibular implants can be successfully placed into immediate function in the short term to support fixed provisional prostheses, long-term prognosis is guarded for those implants placed into immediate function distal to the incisor region. Ericson I et al (2000)[10] conducted that loading can be done successfully via permanent fixed rigid cross arch suprastructure titanium dental implants soon after installation. But the treatment is strictly limited to inter foramina area of the edentulous mandible. Bone resorption was found to be same in both implantation protocols. Szmukler-Moncler S et al (2000)[5] conducted a literature review to evaluate the reasons that led Branemark and collaborations to require long delayed loading periods. It is shown that successful premature loading protocols require a careful and strict patient selection for the achievement of primary stability. Ganeles J et al (2001)[11] concluded that immediate loading with fixed provision restorations accompanied by appropriate surgical and restorative techniques could be a predictable procedure with a high success rate. Holt R et al (2001)[13] conducted a study to evaluate the effect of early implant exposure on the clinical findings of pre restoration and 6 months post restoration. The authors concluded that a one-stage implant approach should provide similar post loading clinical results as the two-stage surgical approach. Romanes G et al (2001)[14] concluded that immediately loaded implants can be Osseo integrated with a similar hard and soft tissue peri implant response as delayed loaded implants in the posterior mandible. De Lange G et al (2002)[16] conducted a histomorphometric study on six retrieved loaded hydroxyapatite (HA)-coated titanium implants. The results showed that HA-coated implants used achieved excellent osseointegration and must be considered clinically safe and effective in maxillary grafted bone. Apparicio C et al (2003)[21] defined immediate loading as a situation where the super structure / prosthesis is attached to the implants in occlusion with the opposing dentition on the same day. The study of Glauser R et al (2005)[26] concluded that the applied immediate loading protocol, in combination with a slightly tapered implant design and a modified implant surface texture, was successful treatment alternative in regions exhibiting soft bone. Abboud M et al (2005)[2] conducted a study to evaluate the clinical response and the predictability of immediately loaded single tooth implants. The authors concluded that immediate loading of unsplinted single tooth implants in positive region is a viable treatment option with an esthetic outcome.

A study conducted by Achilli A et al (2007)[30] demonstrated that if accurate surgical and prosthetic protocols are followed, immediate and early function are predictable and safe approaches even in premolar and molar areas with low bone density. The retrospective study of Malo P et al (2007)[31] results concluded that the cumulative survival rate of 91% at 5 years for the retrospective group is low compared to protocols for noncompromised situations, but the use of a standardized protocol together with oxidized surface implants seems to improve the treatment outcome and bring the survival rate to levels comparable to noncompromised situations. Becker Get al (2007[32], conducted a study to evaluate the survival rate of immediate and early-loaded implants placed immediately after extraction of teeth with endodontic and periodontal lesions or root fracture in the maxilla. The results showed a high 1-year survival rate for immediately placed and immediately/early-loaded implants in the maxilla, despite the presence of infection in the location of the extracted teeth.

HISTORICAL BACKGROUND OF LOADING OF IMPLANTOLOGY

In retrospect, the evolution of implantology can be viewed under 3 phases or periods.[4] They are

DEVELOPMENT PERIOD: Relatively long healing times were recommended and primary stability (stability at the time of implant placement) was considered to be very important. This period occurred roughly in the 1960s and 1970s.

EXPLORATION PERIOD: (1980s and 1990s) During this period, many technological and procedural advances took place. These advances included changes in implant surface characteristics, surgical procedural changes such as ***under drilling***,& changes in the restorative procedures such as ***progressive loading*** and ***tissue shaping*** using the temporary restorations. May be most importantly, however, was the realization that stability during the healing process was critical.

REFINEMENT PERIOD: Shortened healing protocols have been investigated and immediate loading protocols have been examined under defined conditions. This Refinement Period has been occurring since 2000.
These evolutionary periods have translated to patient care such that in the Development Period, techniques were developed to replace teeth in edentulous patients. During the Exploratory Period, these techniques were extended to provide tooth replacement in partially edentulous patients, and in the Refinement Period all these techniques are being optimized.

EVOLUTION OF CONCEPT OF IMMEDIATE LOADING

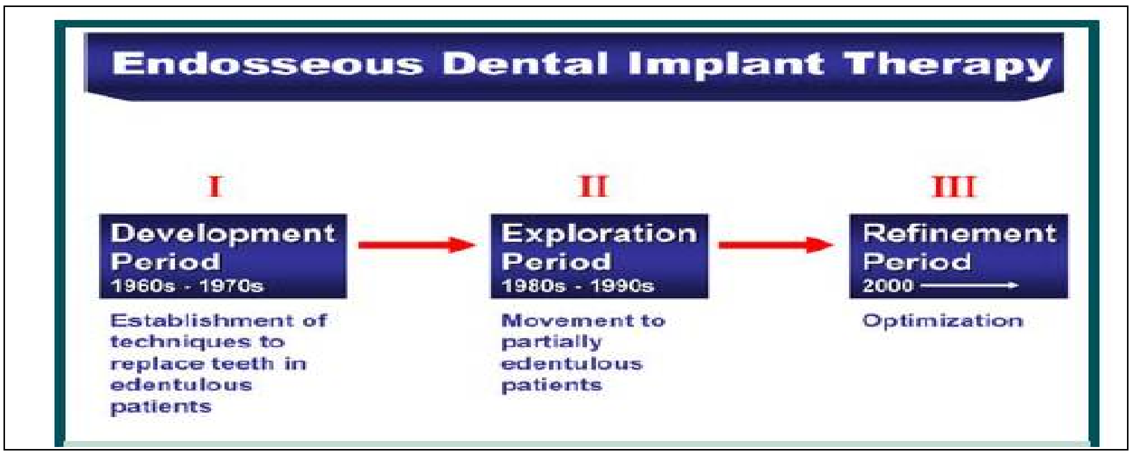
Early loading was identified as a detrimental factor for osseointegration by Branemark et al. During the course of their clinical trial (Branemark et al 1977), various delayed loading periods were tried. Consequent to their 10-year clinical experience, they asserted that osseointegration required a long healing period of at least 3 months in the mandible and at least 5-6 months in the maxilla.[13]
The rationale for such a long delayed loading period was that-[4]

1. Premature loading may lead to fibrous tissue encapsulation instead of direct bone apposition
2. The necrotic bone at the implant bed border is not capable of load bearing and must be first replaced by new bone
3. Rapid remodeling of the dead bone layer compromises the strength of the ossesous tissue supporting the bone-implant interface
4. Integrity of the periosteal margin may be threatened by undermining remodeling of adjacent bone during late healing period.

Branemark et al concluded that “a minimum healing period of 3 months is required, otherwise the risk of immediate or late implant mobility greatly increases” was in retrospection however drawn from particularly demanding clinical conditions involving simultaneously. Branemark felt that a strict protocol was imperative

Need for re-evaluation of Branemark protocol[34] :

The following 4 reasons may provide cause to reevaluate the mandatory aspect of a long delayed loading period. They are :



1. Consideration to be given to the specifically demanding conditions met during the original Branemark follow-up
2. Loading per se does not impede the healing process to occur,
3. Prematurely loaded implants are capable of clinical integrationas observed by various authors. [8]
4. Prematurely loaded implants are capable of integration as demonstrated in several experimental studies. [7]

In the past, it has been asserted that "too – early loading of an implant leads to interfacial formation of fibrous tissue instead of bone". Presently, it appears that premature loading per se does not lead to fibrous tissue encapsulation. Rather, it is due to an excessive amount of micro motion at the bone-implant interface, during the healing phase.

INDICATIONS & CONTRAINDICATIONS

Not every patient or every tooth site is indicated for the immediate loading approach. Patients must understand the limitations of such treatment and be willing to accept the scientifically based precautionary measures. Chief among them is the fact that, in order to limit the functional forces during osseointegration, patients need to abstain from chewing anything but soft food or otherwise applying force to the restoration for approximately 3 months.[35]

Indications:

1. Single tooth replacement
2. Partial edentulism
3. Complete edentulism.

Contraindications

1. Severe metabolic disease
2. Heavy cigarette smoking
3. Inadequate bone volume for correct implant placement
4. Very poor bone density (D4)
5. Severe parafunction such as bruxing, clenching, tongue thrust.
6. Non-compliant patient types such as those with diet limitations, gum chewing etc.

Advantages:

1. Immediate function and esthetics of the patient thus reducing the treatment time. The prosthesis enhances the esthetics by sculpting the soft tissues.
2. No need for a temporary denture or multiple fixed temporaries. This reduces the number of the visits, cost and the problems with micromotion.
3. Elimination of the second stage surgery.
4. Increased rate of healing with early daily periods of cyclic micromotion.
5. Adjacent papilla are well preserved contributing to the final esthetic result.
6. Since the patients are spared from wearing a temporary denture, monthly soft relines are not required.
7. When the loading forces are controlled, the concept result in long-term clinical success in similar areas of poor bone quality.
8. Countersinking the implant below the crestal bone is eliminated reducing the early crestal bone loss

Disadvantages:

1. Unpredictable nature of the concept.
2. Difficulties of the implant placement especially in the posterior arch.
3. No procedure representing a reliable guideline for this type of the treatment.
4. Micromovement of the implant that can cause crestal bone loss or the implant failure is greater than with the two-stage approach.[1]
5. Impression material or acrylic may become trapped under tissue or between the implant and the crestal bone.
6. No chance for the dentist to evaluate the crestal bone as with the two stage technique.

7. More chance for the parafunction from tongue or foreign habits like pen biting causing the implant failure.
8. Increased number of the implants makes increased fees and decreased patient acceptance.
9. Risk of complications to the neurovascular bundle is more

PRINCIPLE OF IMMEDIATE LOADING

When a controlled load is applied to the bone through the implant, bone remodels to architecture - related to the magnitude and the direction of the load. According to the mechanostat theory of Frost, bone adapts by different biologic processes within 4 mechanical usage windows: trivial, physiological, overload and pathological. Remodelling is a simultaneous process of formation and resorption that replaces previously existing bone, tends to remove or conserve bone and is activated by reduced mechanical usage in the trivial loading zone or micro damage in the pathological loading zone. One goal for immediately loaded implant prosthesis is to decrease the risk of occlusal overload and its resultant increase in the remodeling rate of bone. Of the two types of bone forming at the interface viz. woven and lamellar types, woven bone is produced in response to extraordinary loading condition and is less mineralized. Lamellar bone forms at a rate between 1-5 microns each day whereas woven bone forms at more than 60 microns each day. So higher turn over rates lead to higher risks for the bone-implant interface.[34]

IMPORTANCE OF MICROMOTION [7, 8]

Micromotion of more than 100 micrometers should be avoided. Motion greater than 100 micrometers causes the wound to undergo fibrous repair which happens with certain early loading protocols. Interactive loading, which involves frequent cycling of tension and compression stress, is one of the requirements of healing. So continuous loading has to be avoided. According to Brunski[3] as long as there is no macromovement and no micromovement of more than 100 micrometers, the concept of immediate loading of the implants can still allow for osseointegration. The critical threshold has now been fixed in the range 50-150 micrometers depending on the type of the implant morphology and the implant. For this reason the immediate loading is usually limited to healed sites rather than the immediate extraction sites

PRIMARY STABILITY

The primary stability of the fixture is a prime requisite for the success of any implant .It is influenced by two factors:
a) Surgical Trauma
b) Bone Loading Trauma

SURGICAL TRAUMA

The bone is most often lamellar but during the repair process may become woven bone, so it may respond more rapidly to the surgical trauma. Lamellar bone and woven bone are the primary bone tissue types found around a dental implant. Lamellar bone is organized, highly mineralized, is the strongest bone type, has the highest modulus of elasticity, and is called load-bearing bone. By comparison, woven bone is unorganized, less mineralized, is of lower strength, and is more flexible (lower modulus of elasticity). Woven bone may form at a rate up to 60 microns per day, whereas lamellar bone forms at a rate of up to 10 microns per day.[36]

The two-stage surgical approach to implant dentistry permitted the surgical repair of the implant to be separated from the early loading response by 3 to 6 months. The surgical process of the implant osteotomy preparation and implant insertion cause a regional accelerated phenomenon of bone repair around the implant interface. As a consequence of the surgical placement, organized, mineralized lamellar bone in the preparation site becomes unorganized, less mineralized woven bone of repair next to the implant. At 4 months, the bone is still only 60% mineralized & organized lamellar bone. However, this has proven to be sufficient in most bone types and clinical situations for implant loading. Therefore, a rationale for immediate loading is to not only reduce the risk of fibrous tissue formation (which results in clinical failure) but also to promote lamellar bone maturation to sustain a continued occlusal load.

The immediate implant loading concept challenges the conventional healing time of 3 to 6 months of no loading before the restoration of the implant. Often, the risks of this procedure are perceived to be during the first week after the implant insertion surgery. In reality, the bone in the macroscopic thread design is stronger on the day of implant placement compared with the 3 months later, since there is more mature lamellar bone in the threads of the implant. However, the cellular connection of the implant surface condition does not yet exist. On the day of surgery, there is residual cortical and trabecular bone around the implant. When the implant is inserted, it has some contact with this prepared bone. Early cellular repair is triggered by the surgical trauma and begins to form an increased vascularization and repair process to the injured bone. Woven bone formation by appositional growth may begin to form as early as the second week after insertion at a rate of 30 to 50 microns per day.

The implant-bone interface is weakest and at highest risk of overload at approximately 3 to 5 weeks after surgical insertion, since the implant bone interface is least mineralized and unorganized during this time frame. Buchs [36] et al. found that immediate loaded-implant failure occurred primarily between 3 to 5 weeks postoperative from mobility without infection They reported a devitalized zone of bone for 1 mm or more around the implant as a result of the surgery.

One method for decreasing the risk of immediate occlusal overload is to have more vital bone in contact with the implant interface by decreasing the surgical trauma at implant placement. Causes of surgical trauma include thermal injury and mechanical trauma that may cause microfracture of bone during implant placement, which may lead to osteonecrosis and possible fibrous and granulation tissue encapsulation around the implant. Ericksson [10] and Albrektsson reported bone cell death at temperatures as low as 40°C. Sharawy[17] et al. reported that the amount of heat generated in the bone next to the implant drills was dependent on their design and revolutions of the drill.

The temperature next to the drill ranged from 38°C to more than 41°C from a 37°C baseline and required 34 to 58 seconds to return to baseline. The two implant drill systems tested with internal cooled drills cut at a higher temperature than the two systems with external irrigation. The drill rpm of 2,500 produced less heat .Other factors related to heat generated within bone while drilling include the amount of bone prepared, drill sharpness, depth of the osteotomy, variation in cortical thickness, and the temperature and solution chemistry of the irrigant.[37]

The implant-bone interface will have a larger zone of repair when the implant is significantly compressed against the bone. For example, a self tapping implant may cause greater bone remodeling (woven bone) around the implant during initial healing compared with a bone tap and implant placement technique .

The implant should be nonmobile upon insertion, but excess strain within the bone from additional torque and space filling may also increase the risk of microdamage at the interface. A proposed protocol for immediate load has been to insert the implant within the bone to 45 to 60 Ncm.[38] This concept helps ensure that the implant has relatively rigid fixation in good quality bone. However, the additional torque used to secure or evaluate fixation of an implant in bone may actually result in pressure necrosis and/or increase the strain magnitude at the interface and therefore increase the amount of damage and remodeling, which could decrease the strength of the bone implant interface.

BONE LOADING TRAUMA

Once the bone is loaded by implant prosthesis, the interface begins to remodel again, but this time, the trigger for this process is strain transfer caused by occlusal function rather than the trauma of implant placement. The woven bone of surgical trauma has been called repair bone, whereas the woven bone formed from a mechanical or loading response may be called reactive woven bone. The remodeling from mechanical strain may also be called bone turnover and not only repairs damaged bone but also allows the implant interface to adapt to its biomechanical situation. The interface remodeling rate is the period of time for bone at the implant interface to be replaced with new bone. Microstrain conditions 100 times less than the ultimate strength of bone may trigger a cellular response. Bone fractures at 10,000 to 20,000 microstrain units (1-2% strain); however, at levels of 20 to 40% of this value, bone starts to disappear or form fibrous tissue and is called the pathologic overload zone. Hence, when the mechanical situation is too severe, fibrous tissue may form at the implant interface rather than bone. Fibrous tissue at an implant interface may result with clinical mobility rather than more rigid 'bone-like' fixation.

According to Frost, the ideal Microstrain level for bone is called the physiologic or adapted zone and is called ideal load-bearing zone for an implant interface. The remodeling rate of the bone in the jaws of a dentate canine or human, which is in the physiologic zone, is approximately40% each year. At these levels of strain, the bone is allowed to remodel and remain an organized, mineralized lamellar bone structure. The mild overload zone corresponds to an intermediate level of microstrain between the ideal load-bearing zone and pathologic overload. In this strain region, bone begins a healing process to repair microfractures and/or the bone, which is in a fatigue risk of failure**.** Histologically, the bone in this range is called reactive woven bone. Rather than the surgical trauma causing this accelerated bone repair, it is the Microstrain from overload. In either condition, the bone is less mineralized and less organized and is therefore weaker and has a lower modulus of elasticity.

Measurement of primary stability:

Periostest and various frequency signal values have been used to evaluate implants at the time of insertion as an indication of whether fixation was adequate for immediate load. Periotest system (Siemens, Bensheim, Germany) [8]is a biologic physicometer having readings from –7 to +18. It measures the damping characteristics of the surrounding tissues of the implant. The more negative the value, the more stable the implant. An implant with a Periotest value of more than +5 is considered a failure .Even the Periotest procedure can hamper the stability of implants especially in immediate extraction sites. An alternative approach is to use a reverse torque test of 20 Ncm to evaluate the quality of the bone and interface initial fixation, first suggested by Sullivan[51] et al. for evaluating delayed healing. If the implant does not unthread at 20 Ncm, the resistance indicates that the bone is of sufficient density to consider immediate loading.

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