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RESEARCH ARTICLE

REVIEW OF SCIENTIFIC LITERATURE ON IMMEDIATE LOADING CONCEPT OF DENTAL IMPLANTS AND ITS CLINICAL PROCEDURAL METHODS

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ABSTRACT

Today immediate loading (IL) of dental implants is an eminent and acknowledged treatment strategy which is extensively being used for the rehabilitation of missing teeth in healthy as well as medically compromised individuals. IL may be described as functional loading (with occlusal contacts) immediately after implantation (or within 3–4 days after surgery) without waiting for the healing period. IL has gained popularity due to less tissue trauma, reduced overall treatment time, decreased patient's anxiety and discomfort, high patient acceptance and better function and aesthetics. A fundamental prerequisite for implant success is substantial primary stability at the time of insertion and following loading of the implant. Hence, in the present literature review, we aimed to assess and clarify the significance of immediate loading and its various modes surfaced over the years comprising All-on-Four Concept, Weld One Concept, Basal Implants and Zygomatic Implants.

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INTRODUCTION

The earliest possible restoration to achieve proper form and function is the hallmark of all surgical specialities. This principle underlies the concept for immediate loading of dental implants. Misch *et al.,* in 2004, offered several classifications of implant loading:

- *Immediate occlusal loading* refers to full functional occlusal loading of an implant within 2 weeks of placement.
- *Early occlusal loading* refers to functional loading between 2 weeks and 3 months of implant placement.
- *Nonfunctional immediate restoration* refers to implant prostheses placed within 2 weeks of implant placement with no direct functional occlusal loading.
- *Nonfunctional early restoration* refers to implant prostheses delivered between 2 weeks and 3 months from implant placement.
- *Delayed occlusal loading* refers to the restoration of an implant more than 3 months after placement.

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Immediate Loading has gained popularity due to less tissue trauma, reduced overall treatment time, decreased patient's anxiety and discomfort, high patient acceptance and better function and aesthetics.

ALL-on-4 Concept of Immediate Loading

Stress analysis studies have demonstrated that four implants placed as "cornerstones": two angled posteriorly and two straight anteriorly, with good anterior-posterior distance (AP-spread) is an optimal number for complete-arch prosthesis. This concept of using two axially implants in the anterior region and two tilted posterior implants has been popularized as the All On four concept.

Weld One Concept of Immediate Loading

The inventors of this concept is Dr. Marco Degid from Bologna, Italy. With the help of the Weld One Welding Unit and special welding components, a titanium wire is permanently connected to the abutment with precisely the correct force to achieve an optimum weld. An electric current leads to fusion of the titanium material in the contact points between the titanium wire and the abutment in milliseconds. The permanent joint between the titanium wire and the abutment enables an immediate and stable titanium framework

to be made which will provide the optimum support for temporary or durable restorations. The Weld One concept provides a stable, passively fitting framework for temporary or durable prostheses for immediate restorations on the same day of surgery.

Basal Implants

Basal implantology also known as bicortical implantology or just cortical implantology is a modern implantology system which utilizes the basal cortical portion of the jaw bones for retention of the dental implants which are uniquely designed to be accommodated in the basal cortical bone areas. The basal bone is always present throughout life; it is very strong and forms the stress bearing part of our skeleton. Dental implants when placed in this bone can also be loaded with teeth immediately even in cases exhibiting severe jaw bone atrophy. Thorough utilizing horizontal, vertical and oblique bone support, these devices can be implanted, under all anatomical conditions even after immediate post extraction

Zygomatic Implants

Severe resorption of the maxilla may preclude routine treatment with dental implants for support of a fixed bridge because of the lack of bone for implant integration. Different surgical techniques with varying degrees of success rate have been described in the literature to deal with cases of maxillary atrophy. Techniques such as major reconstructions using bone graft from the iliac crest associated or not with Le Fort I osteotomy are the most common ones used for these cases. The emergence of the zygomatic implants from Brånemark's studies gave the surgeons the possibility to obtain a firm anchorage of implants to the zygomatic bone, making the rehabilitation of an atrophic maxilla possible with two or four implants in the anterior maxilla. There are several treatment options for these cases, including bone grafting and the use of zygomatic implants. The Brånemark zygomatic fixture was originally developed for prosthetic rehabilitation of cases with extensive defects of the maxilla caused by tumor resections, trauma, and congenital defects. The bone of the zygomatic arch was used for anchorage of a long fixture that together with ordinary fixtures could be used as anchorage for epistheses, prostheses, and obturators. Since then the technique has been widely used in cases with severe atrophy of the maxilla. A typical totally edentulous case is treated with one zygomatic implant on each side, going from the palatal aspect of the first to the second premolar region, through the maxillary sinus and into the body of the zygomatic bone, and with additional regular implants in the premaxilla. High primary stability can also be achieved with zygomatic implants and it is possible that an early loading protocol could be used also for this implant.

MATERIALS AND METHODS

A literature search analysis was performed to demonstrate the survival rate of immediately loaded implants, as well as data from the histologic and histomorphometric evaluation in comparison with conventional loaded implants. This analysis showed high survival rates of immediately loaded implants along with osseointegration, with high percentages of bone to-implant contacts based on histologic evaluation from human and animal studies of immediately and conventionally loaded implants. Ledermann was the first to document successful healing after IL of implants placed in the anterior part of the mandible and splinted together with a bar to support the overdenture. However, Schnitman *et al* were the first to discuss the possibility of using a fixed partial prosthesis to immediately load implants without compromising long-term implant survival. Exact indications and considerations for an IL protocol were defined for the first time in 2002 at the World Congress Consensus Meeting in Barcelona. Immediate occlusal loading of full-arch mandibular fixed prostheses and overdentures supported by implants was accepted as a therapeutic option; this was supported by adequate clinical documentation. Dr Branemark's published implant survival rated at 10 years for the mandible was 88.4% with 4 implants supporting the prosthesis and 93.2% with 6 implants under the prosthesis. In the maxillary arch, he reported 78.3% with 4 implants and 80.3% with 6 implants. Subsequent articles by Adell and Branemark confirmed the success of these procedures in longer time periods. Cochran *et al* in a more recent Consensus Conference reviewed the requirements for clinical procedures using IL protocols. One important consideration for the success of immediately loaded implants was adequate initial implant stability. Stability of the implant was found to be influenced by various factors, including implant geometry and length, surface morphology, splinting of implants, control of the occlusal load, quality of bone, and absence of detrimental patient habits. Primary implant stability can be measured via insertion torque values or resonance frequency analysis (RFA) and cutting torque resistence analysis.

Methods of evaluation of the primary stability of the immediately loaded dental implants

Stabilization of IL implants in the surrounding lamellar bone has been standardized using a variety of techniques including the periotest, resonance frequency analysis (RFA) and cutting torque resistance analysis.

Patient Selection

Several factors determine whether a patient is a candidate for immediate loading of his or her dental implants. These factors can be divided into four categories:

- Surgery-related factors
- Host-related factors
- Implant-related factors
- Occlusion-related factors

The surgical factors pertain primarily to implant stability and surgical technique. Host factors include not only bone quality and density but also proper healing environment. Implant factors are based on the structure and design of the implant system utilized, and occlusal factors relate to the importance of proper prosthetic design under occlusal forces. Studies have reported that implants placed with an insertion torque greater than 30-35 Ncm resulted in higher success rates for immediate loading. Teeth associated with a history of trauma, infection, or periodontal disease with active inflammatory response may not be candidates for immediate implant placement or immediate loading. The quality of bone often controls the prosthetic choices when immediate loading is considered. Bone quality can be described in many ways. The system proposed by Lekholm and Zarb places bone into four classifications based on the relative amounts of cortical and trabecular bone. In the

first classification almost the entirety of bone is composed of compact cortical bone. In the second classification, compact trabecular bone is surrounded by a thick layer of cortical bone. The third classification is described as a thin layer of cortical bone encompassing high-density trabecular bone with favorable strength properties. Finally, in the fourth and least desirable bone type, a thin layer of compact bone surrounds loosely arranged trabecular bone. Higher failure rates have been reported in type IV bone for immediate loading of implants. The recommended occlusal scheme for immediately loaded implants is one of maximal interocclusal contacts without lateral contacts. 26 Patients with parafunctional habits or compromised occlusion should not receive immediate loading options. Studies by Balshi and Wolfinger demonstrated that approximately 75% of failures with immediate loading occurred in patients with parafunctional habits.

The role of primary implant stability

Osseointegration occurs in two levels: primary and secondary. Primary osseointegration is associated with the mechanical engagement of an implant with the surrounding bone after implant insertion; whereas bone regeneration and remodelling offers secondary osseointegration (biological stability) to the implant. Primary stability, defined as the biometric stability immediately after implant insertion, is a critical factor that determines the long-term success of dental implants. In other words, primary stability is the absence of mobility in the bone bed after the implant has been placed. The phenomenon behind this is the same as that applied for reduction of fractured long bones; that is, there should be utterly no movement between the fragments when the ends of a fractured long bone are reduced to endorse fracture healing. This is because movements even at the micrometer range can induce a stress or strain that may hinder the formation of new cells in the gap. Likewise, during implant healing a micromotion between 50 and 150 micrometre may negatively influence osseointegration and bone remodelling by forming fibrous tissues at the bone-to-implant interface thereby inducing bone resorption. Several studies have reported high success rates with IL of dental implants, which are attributed to high primary stability. In some clinical studies an immobilization using splinting (cross-arch restorations or partial splinting) was necessary to increase the stability of the implants after surgery.

Advantages and Disadvantages of Immediate Occlusal Loading

The immediate occlusal loading of implants continues to be the subject of clinical investigations due in part to the advantages that it presents to dental professionals. Among these benefits are the following:

- Eliminates the need for and maintenance of a removable provisional prosthesis
- Provides emotional benefit for a patient scheduled to be rendered edentulous
- Improves bone healing
- Facilitates soft tissue shaping
- Eliminates premature implant exposure often associated with wearing of a removable denture during healing period.

All-on-four concept

Principle

Four Implants - two straight implants in the anterior segment and two angled implants in the posterior segment supporting a provisional, fixed and immediately loaded full-arch prosthesis. In the maxilla two distal implants are placed in the posterior region which is tilted anterior to the maxillary antrum, while in the mandible implants are positioned anterior to the mental foramen. The degree of tilt is at angulation of 30-45 degrees. A prefabricated All-on-4 surgical guide is used which helps in correct positioning, angulation and emergence of implant. Vertical lines are marked on the guide which helps for drilling at the correct angulation, which should not be greater than 45 degrees. An implant of appropriate diameter and length with a good osteoconductive surface is placed. Abutments straight, 17º multiunit abutments or 30ºangulated abutments with different collar heights are placed onto the implants.

Indications

- Maxillary/mandibular bone quality which allows for placement of at least four implants of at least 10mm in length in either healed or immediate extraction sites
- Good systemic health with satisfactory oral hygiene
- Implants should achieve good primary stability at insertion

Advantages of All-on-Four concept

- Fewer implants required for immediate loading of implant supported prostheses
- Longer implants can be placed with good cortical anchorage in resorbed ridges.
- Immediate function and aesthetics.
- Reduced posterior cantilever.
- Final prostheses can be fixed or removable.
- Shorter treatment times, Good success rate and better patient satisfaction.
- Cost effective since less number of implants are involved
- Improves functionality to 90% compared to natural teeth.
- Angled posterior implants help eliminate the need for bone grafting by increasing bone to implant contact.
- Angled posterior implants help avoid relevant anatomical structures, can be anchored in better quality anterior bone and offer improved support of the prosthesis by reducing cantilevers.
- Replaces roots and teeth, preserves bone and soft tissue
- Never decay – 95% success rate over 30 years
- Natural-looking esthetics
- Able to clean fixed implant bridge like natural teeth

One of the hallmarks of All-on-Four concept is tilting of the posterior implants. Tilting of implants may actually be beneficial both anatomically and biomechanically. In the mandible tilting gives good cortical anchorage without interfering with mental foramina and in severely resorbed posterior maxilla the need for sinus floor augmentation is reduced. Tilting also increases inter-implant space and reduces

cantilever length thus improving the bio-mechanics of implant and bone.

Final prosthetic protocol - The final prosthesis can be a

- CAD/CAM designed fixed prosthesis with Zirconia or Titanium framework with individual crowns is cemented to the final bridge framework.
- Fixed prosthesis with CAD/CAM designed Titanium or Zirconia framework with a wrap around of acrylic resin.
- Fixed prosthesis with cast metal and veneering porcelain.
- Removable prosthesis: bar overdenture, attachment overdenture.

Weld one concept

Principle

The Weld One concept offers the first complete, proven and sophisticated concept for intraoral welding based on resistance spot welding principle. With the help of the Weld One Welding Unit and special welding components, a titanium wire is permanently connected to the abutment with precisely the correct force to achieve an optimum weld. An electric current leads to fusion of the titanium material in the contact points between the titanium wire and the abutment in milliseconds. The permanent joint between the titanium wire and the abutment enables an immediate and stable titanium framework to be made which will provide the optimum support for temporary or durable restorations. Welding the implants together leads to a different mode of distributing the stresses acting on the structure; the implants no longer act individually, but rather, they participate in a joint effort in providing mechanical support for the prosthesis. The Weld One concept provides a stable, passively fitting framework for temporary or durable prostheses for immediate restorations on the same day of surgery. It is a fast and economical solution to deliver partial and full arch restorations suitable for immediate or late loading.

The peri-implant bone adjusts its architecture according to its capacity to withstand functional loading. Consequently, the strains induced by these loads affect the bone remodelling process. It has been suggested in the literature that the magnitude of the load forces between the implant and the bone determines the implant success. Microstrain may be a favourable stimulus during the healing period of implants resulting in an increased bone density. According to Brunski and colleagues, implants can be loaded early or immediately, if micromovements above a threshold of 100 micrometres can be avoided during the healing phase. Stronger movements would lead to soft tissue ingrowth at the interface rather than to the desired bone apposition. Cameron and colleagues reported that osseointegration can be achieved even with micromovements but not with so called macromovements. It has been suggested that a movement of 30micrometre or less has no adverse affect on integration, while a movement of 150micrometres or more results in soft connective tissue apposition to the implant.

In this context, it can no longer be assumed that immediate loading per se leads to fibrous encapsulation of implants. A successful accelerated protocol for implant rehabilitation depends upon several interactive factors: besides accurate presurgical diagnostics and treatment planning, implant macro and micro design, the adequate fixation and immobility of the implant are of utmost importance to prevent the risk of micromovements related to the surrounding bone. Rigid splinting seems to have a significant impact on the peri-implant tissue response since it is able to reduce the mechanical stress exerted on each implant. If rigidity is lost implant failure is likely to occur due to uncontrolled masticatory forces. Consequently, the stability of the prosthetic restoration and the ability to keep the micromovents below the critical threshold are considerably increased by rigid splinting.

Advantages

- **Meets the patients‘ demand for immediate restorations**
  Surgical procedure and prosthetic delivery on the same day of surgery.
- **Significant time and cost reduction**
  Standardized protocol with specially designed components for a reduction of appointments to a minimum and the opportunity to reduce total treatment costs.
- **Less risks of fractures on temporaries**
  Immediate reinforcement of the temporary by a titanium framework.
- **Safely and predictably for immediate loading treatment**
  As a consequence of reduced mobility of implants due to immediate rigid splinting a risk of implant failures during healing phases can be minimized.
- **No additional impression-taking of implants necessary**
  Simultaneous delivery of a titanium framework on implant abutments at one time. Advantage of the one abutment at one time philosophy in case of abutment level restorations.

The intraoral welding is very effective in immediate loading of dental implants positioned in atrophic edentulous ridges. So, in case of immediate loading, adequate fixation and stability of implants are very important conditions to prevent the risk of micromovements and loss of implants. In this context, a rigid splinting seems to have an important role in response of peri-implant tissues, since it is able to reduce stress exerted on implants. Degidi and coll have published numerous studies about immediate loading of multiple implants by welding a titanium bar directly on abutments in order to create a metal reinforced temporary or definitive restoration. The results showed that one-piece implant is better than two-piece for intraoral welding. In 2006 Degidi and coll published a new method defined syncrystallization. This technique consists in splinting multiple implants with a rigid titanium bar welded on abutments. It presents the advantage of immediate restoration on the same day of surgery, stability, and retention of implants in the early stages of bone healing and less implant fractures due to reducing time of restoration. The welding process is electrical and protected by an argon gas supply (Syncrystallization). The welding cycle is subdivided in three stages: Pre-gas phase, welding, and post-gas phase. While the pre-gas phase allows an oxygen-free welding point prior to the actual fusion, the post-gas phase ensures the absence of oxygen and subsequent oxidation during cooling. The process is carried out without producing any heat, causing no discomfort to the patient or damage to surrounding tissues.

Basal implants

In the mid-1980s French dentist, Dr. Gerard Scortecci, invented an improved basal implant system complete with matching cutting tools. Together with a group of dental surgeons, he developed Disk-implants. Since the mid-1990s, a group of dentists in Germany have developed new implant types and more appropriate tools, based on the Disk-implant systems. These efforts then gave rise to the development of the modern BOI (Basal Osseointegrated Implant or lateral basal implants. In this design, load transmission was supposed to take place both in the vertical and in the basal implant part. Soon Dr. Stefan Ihde introduced bending areas in the vertical implant shaft. In 2005 the lateral basal implants were modified to screwable designs (BCS).

Rationale of using basal implants

Teeth are present in less dense bone portions of the jaw bones called the alveolar bone. This is also known as the crestal bone of the jaw. The less dense alveolar or crestal bone gradually starts getting resorbed and receeds once the teeth are lost. The bone which ultimately remains after regression of the alveolar bone following loss of teeth is the basal bone which lies below the alveolar bone. This basal bone is less prone to bone resorption and infections. It is highly dense, corticalized and offers excellent support to implants. The conventional implants are placed in the crestal alveolar bone which comprises of bone of less quality and is more prone to resorption. The basal bone, is less prone to bone resorption because of its highly dense structure. The implants which take support from the basal bone offer excellent and long lasting solution for tooth loss. At the same time, load bearing capacities of the cortical bone are many times higher than those of the spongious bone.

Indications

- All kinds of situations when several teeth are missing or have to be extracted.
- When the procedure of 2-stage implant placement or bone augmentation has failed.
- All kinds of bone atrophy
- In cases of very thin ridges- i.e., deficiency of bone in buccolingual thickness.
- In cases of insufficient bone height.

These two situations develop due to the following reasons

- Using removable dentures for so many years will resorb the bone and reduce the height available.
- After extraction of teeth, not replacing the teeth, living without teeth for many years will also resorb the bone.
- Untreated periodontal disease (especially in diabetics) will resorb the available bone.
- Trauma to jaw which damages not only the teeth but also the alveolar bone.

Contraindications

1. **Special Cases**: Cases where bilateral equal mastication cannot be arranged, e.g. when chewing muscles or their innervations are partly missing (these cases may lead to problems under immediate load protocols).
2. **Medical conditions**: There are a number of medical conditions that preclude the placement of dental implants. Some of these conditions include: Recent myocardial infarction (heart attack) or cerebrovascular accident (stroke), Immunosuppression (a reduction in the efficacy of the immune system).
3. **Medicines**: A dentist will need a complete listing of all of the medicines and supplements that their patient takes. Drugs of concern are those utilized in the treatment of cancer, drugs that inhibit blood clotting and bisphosphonates (a class of drugs used in the treatment of osteoporosis)

Complications of basal implants

Functional overload osteolysis: Masticatory forces transmitted through the basal implants may create local microcracks in the cortical bone. These microcracks are repaired by a process called remodelling. This, however, will temporarily increase the porosity of the affected bone region and temporarily reduce the degree of mineralization additionally. Basal implants in this status have a good chance of getting reintegrated at a high degree of mineralization, if loads are reduced to an adequate amount.

Infection: It spreads submucosally. This may result in infected vertical parts if the implants are submerged below the mucosal level over time, eliminating the necessary gateway for suppuration as the area of penetration is closed with scar tissue. Any inflammation of this type will spread just like a submucosal abcess and is treated in the same way. It is recommended to make generous incisions to open the abcess. The mucosal area immediately adjacent to threaded pin can be excised by electrosurgery.

Zygomatic implants

The classical zygomatic fixture design (Brånemark Osseointegration Centre and Exopro, Gothenburg, Sweden) was a self-tapping implant in commercially pure titanium with a well defined machined surface. It was available in different lengths ranging from 30 to 52.5 mm, and was slightly tapered (coronal diameter of 4.5 mm and apical diameter of 4.0 mm). This diameter variation was due to the necessity of increasing the anchorage at the alveolar process while reducing the risk of complications (orbital bleeding, infraorbitary nerve affectation, etc.) in the apical region. The coronal portion of the implant presented a tilted connection of 45° to facilitate the prosthetic rehabilitation. At present, this implant has a rough surface and the coronal portion of the implants may present different angles ranging from 25° to 55°. Boyes-Varley *et al*. 7 proposed a 55° angle in order to avoid the palatal emergence of the prosthetic connection, which is one of the most discussed inconveniences of these fixtures.

Description of the zygomatic implant

The zygomatic implants are self-tapping screws in c.p. titanium with a well-defined machined surface. They are available in eight different lengths ranging from 30 to 52.5 mm. They present a unique 45° angulated head to compensate for the angulation between the zygoma and the maxilla. The portion that engages the zygoma has a diameter of 4.0 mm and the portion that engages the residual maxillary alveolar process a diameter of 4.5 mm

Indications of the technique

According to Malevez *et al.* and Aparicio *et al.* The zygomatic implants are a valid alternative to bone grafting in patients with advanced maxillary atrophy. This technique would be suitable when the following conditions are present:

- Light to moderate bone atrophy in the anterior region of the maxilla, with a posterior resorption of the alveolar process: This situation allows the placement of two to four implants in the anterior region, but the resorption of the posterior maxilla makes the placement of standard fixtures in this area unfeasible. In this case two zygomatic implants will be placed, one for each side.
- Advanced atrophy of the maxilla (anterior and posterior): In this case two options are available: the use of bone grafting techniques in the anterior region can be performed and the placement of two zygomatic implants for the posterior region; or the placement of four zygomatic implants, two on each side without any anterior standard implants.

Complications

The reported complications associated with zygomatic implants include postoperative sinusitis, oroantral fistula formation, periorbital and subconjunctival hematoma or edema, lip lacerations, pain, facial edema, temporary paresthesia, epistaxis, gingival infl- ammation and orbital penetration/injury, maxillary sinus posterior wall and infratemporal fossa perforation, intraoperative bleeding, nerve lesions (infraorbitary nerve), sinus pathology, lip lesion during the drilling, among others. Post-operative concerns regarding difficulty with speech articulation and hygiene caused by the palatal emergence of the zygomatic implant and its effect on the prosthesis suprastructure have been reported. Nevertheless, only some of these were actually registered in the reviewed studies (26 cases of sinus pathology, seven cases of infraorbitary nerve impairment six cases of lip lesion during drilling and nine cases of suborbital haematoma). It is important to stress that most of the cases with sinus pathology were favourably solved. Some of them only needed pharmacological therapy, while others were treated with an antrostomy surgery. Only three zygomatic implants, all from the same report, were removed due to their association with recurrent sinusitis.

DISCUSSION

Immediate loading vs delayed loading

The high ISR of immediately loaded implants has significant relevance in that this protocol can reduce treatment time and provide a definite benefit for patients. There is no doubt that the concept of delayed loading has been used successfully for many years, and therefore the number of placed implants in different studies is higher that the number of immediately loaded implants. In addition, the histologic validity of this concept has been evaluated without differences compared with the IL concept. However, Attard *et al* in a prospective longitudinal study investigated IL protocols in terms of clinician-related and patient-based outcomes. The authors reported a significant improvement in satisfaction and quality of life following treatment with implants when the IL treatment protocol was used. Today, in selected cases, the IL of full-arch mandibular fixed prostheses and overdentures supported by implants placed in healed sites has become accepted as a clinical option. This protocol is supported by a high number of clinical studies. In a meta-analysis of articles from 1966 to 2003 found with MEDLINE, Chiapasco with an IL protocol showed an ISR of 95% for implant supported fixed prostheses and 98% for overdentures in the mandible. Recently, in a systematic review of survival rates for immediately loaded dental implants, Del Fabbro *et al* reported that 55% of the articles on IL were published in the last 4 years, and the average overall ISR was 96.39%.Balshi *et al* showed a cumulative survival rate of 98.6% for full-arch maxillary immediately loaded implants in 55 patients over an average of 3 years. The same authors discussed the importance of cross-arch stabilization in the outcomes of immediately loaded implants in the maxillary arch. Glauser *et al* in a 4-year prospective clinical study on 38 patients evaluated the survival rate of implants for single-tooth replacement and fixed partial prostheses placed predominantly in bones of poor quality. Their results showed a cumulative ISR of 97.1% after 4 years of prosthetic loading. It was concluded that the applied IL protocol, in combination with a slightly tapered implant design and a modified implant surface texture, was shown to be a successful treatment alternative in regions exhibiting bone of poor quality. Other authors emphasized the importance of a progressive thread implant design to achieve good primary stability in areas of bone of poor quality. Recently, Romanos and Nentwig, when comparing immediately loaded implants vs delayed loaded implants using a split-mouth design protocol, reported a 100% implant success rate (no bone loss) in a 2-year prospective clinical study of 12 consecutive cases in the posterior mandible.

Another study reported a 100% implant and prosthetic survival rate when 96 MKIV or the Nobel Speedy Groovy implants (Nobel Biocare AB) were placed in 24 edentulous patients treated in the mandible according to the All-on-Four concept. In addition, a 100% implant survival and prosthetic survival rate was reported in a prospective study when 80 Branemark implants were placed in 20 patients with a extremely atrophic mandible. Each patient received 2 axially placed and 2 tilted implants, supporting a fixed full-arch prosthesis (All-on-Four concept). Previously published literature reporting survival rates using the All-on-Four concept in both the mandible and maxilla is similar to the results of this analysis. In a pilot study, a survival rate of 98.9% was reported in a case series when 189 NobelSpeedy implants were placed in 46 patients, supporting 53 full arch, all-acrylic prostheses (44 maxillae, 9 mandibles) using the All-on-Four concept. Malo´ *et al* reported a survival rate of 97.2% and 100% in the maxilla and mandible in a 1-year prospective study when 92 Nobel- Speedy implants were placed in 23 consecutively treated patients. Each jaw was restored by a immediate fixed full-arch prosthesis according to the All-on-Four concept. Pomares reported a 96.9% implant survival (96.7% in the maxilla and 97.2% in the mandible) and a 100% prosthetic survival rate in a prospective study when 127 MKIII Groovy implants were placed in 20 patients (restoring 19 maxillae and 9 mandibles) using the All-on-Four or Allon-Six concept. A survival rate of 98.4% and 99.7% (maxilla and mandible) at the end of 1 year was reported in another single-cohort study in which 173 edentulous patients received 2 distal and 2 anterior axial MKIV or NobelSpeedy Groovy implants. In this study, each patient received a full-arch fixed prosthesis supported by 2 distal and 2 axial implants (All-on-Four). Other studies confirm successful oral

rehabilitation of edentulous atrophic maxilla with a fixed definitive restoration supported by an intraorally welded titanium bar on the same day of implant placement surgery. Avvanzo demonstrated that dental abutments, intraorally welded with a titanium bar, allow immediate loading implants and provisional or definitive restoration during healing of bone, without problems of micromovements and implants loss. Immediate denture improves patient's compliance due to a more comfortable prosthesis. Immediate loading of implants may be successfully achieved with intraoral welding technique when they are positioned in zygomatic bone too. In fact it is possible to successfully rehabilitate the edentulous atrophic maxilla with a permanently fixed prosthesis supported by an intraorally welded titanium framework attached to standard and zygomatic implants on the day of surgery. They show stability and prosthetic success rate at the 12-month and 3-year follow up. The intraoral welding technique seems to have no adverse effect on marginal bone loss and implant survival too. Successful oral rehabilitation has been demonstrated in the edentulous mandible using SynCone &-degree abutments for an immediate and definitive restoration supported by an intraorally welded titanium bar. Another method to connect the abutments to the bars is represented by the laser welding. Kuo *et al*. in 2006 described a new technology for immediate loading implants using laser welded bars applicable to various implant systems and clinical situations. In today's dental literature, most frequently, esthetics are addressed with fixed restorations. This technique gives the opportunity to provide patients with very good esthetic outcomes with a hopeless dentition utilizing dental implants, laser-welded titanium components, and characterized acrylic resin prostheses. The definitive prostheses provide excellent facial support, phonetics, esthetics, smile line, and function. Laser-welded titanium frameworks offer many advantages for the patient, clinician, and dental technician. Supporting the data that laser welding is safe for patients and implant survival, Fornaini *et al*. published a case report suggesting that there are no side effects in using intraorally laser welding technique.

A study by Silva investigated the influence of laser welding and electroerosion procedure on the passive fit of fixed implant-supported titanium frameworks, concluding that frameworks may show a more precise adaptation if they are sectioned and laser welded. In the same way, electroerosion improves the precision in the framework adaptation. De Aguiar in his study compared the accuracy of fit of three types of implant-supported frameworks cast in Ni-Cr alloy: specifically, a framework cast as one piece compared to frameworks cast separately in sections to the transverse or the diagonal axis and later laser welded. Results of this study showed that casting diagonally sectioned frameworks lowers misfit levels of prosthetic implant-supported frameworks and also improves the levels of passivity to the same frameworks when compared to structures cast as one piece. Lack of passivity has been associated with biomechanical problems in implant-supported prosthesis. De Castro evaluated the passivity of three techniques to fabricate an implant framework from a Co-Cr alloy by photoelasticity. It was concluded that there were no differences in forces exerted on implants.

Intra-oral welding is a beneficial procedure to create a very precise rigid framework quickly and directly inside the oral cavity when immediate functionalization is planned. With this technique, time-costly laboratory steps can be avoided, such as the creation of a customized impression tray, while a passive fit of the framework is easily obtained. This procedure has been reported by Degidi *et al.* in several studies and has shown to be reliable for the immediate restoration of edentulous patients, both in terms of implant survival and marginal bone preservation. The 6-year cumulative survival rate that they report for implants placed in the maxilla and intraorally welded was 92.12%. Bedrossian and colleagues reported no loss for 28 zygomatic and 55 routine implants in 14 patients after more than 12 months. In another study, Davo and colleagues lost none of 36 zygomatic but three of 68 conventional implants after a follow-up from 6 to 29 months. Although the available studies are short-term investigations, the findings show that immediate/early loading is a viable treatment modality also when zygomatic implants are included in the treatment. Moreover, it is reasonable to believe that any negative effects from immediate/early loading per se should be seen soon after commencing loading and not after a long period of time. A recent review of over 1,143 zygomatic implants demonstrated a survival rate of 98.2 % after 6 months to 10 years, which is encouraging. Immediate/early loading has many advantages and apart from the fact that the treatment time is reduced to a minimum and only one surgical intervention is needed, the patients do not need to wear a removable denture. Several clinical reports have reported good outcomes with immediate/early loading of conventional implants in the totally edentulous maxilla. For instance, Östman and colleagues reported the loss of one (0.8%) of 123 implants in 20 patients after 1 year of loading. The reasons for the good results reported may be because of careful patient selection and concern about primary stability having in mind that bone density often is low in the posterior maxilla. In fact, Östman and colleagues did use inclusion criteria based on primary stability as assessed with insertion torque and resonance frequency analysis measurements, and also took measures to improve primary stability. However, in a randomized clinical study, Fischer and colleagues compared early and delayed loading during 5 years of loading using no such inclusion criteria. After 5 years of follow-up, they concluded that there were no differences between the groups.

According to the literature, sinusitis seems to develop in 2.3 to 13.6% of cases treated with zygomatic implants. Intraoral infections have been reported at a similar rate, ie, from 3.8 to 6.5% and in some studies from 29 to 32%. Al-Nawas and colleagues reported that 9 of 20 zygomatic implants showed bleeding and increased probing depths that may be because of difficulties for proper hygiene caused by the positioning of the zygomatic implant head and abutment and the design of the prosthesis. Other authors have described problems with recurrent sinusitis that led to removal of zygomatic implants. The authors speculated that deficient osseointegration of the coronal part of the zygomatic implant had resulted in the formation of an oroantral fistulae and infection. In the present study, caution was taken to avoid extensive countersink preparation, and to avoid fracture of the thin alveolar crest during insertion. Moreover, the use, from the beginning, of the definitive abutment probably benefits the desmosomal adhesion of the soft tissue to the titanium abutment surface. Those factors may explain the absence of sinus problems. According to Stiévenart and Malevez, the incidence of sinusitis ranges from 14 to 30 %. In a previous retrospective study involving patients submitted to the Stella and Warner's technique, Peñarrocha *et al* found two cases of sinusitis among the 42 implants; one case was treated with antibiotics and the other was submitted to the removal of the implant.

Conclusion

There is a significant biological response by the hard and soft tissues to IL of dental implants. Within the limitations of the present literature review, it is evident that the core issue to observe during IL is the establishment of a good implant primary stability. There is sufficient evidence to suggest that the degree of achieved primary stability during IL protocols is dependent on several factors including bone density and quality, implant shape, design, surface characteristics and surgical technique. Further research is required in situations, such as poor bone quality and quantity and multiple implants or augmentation procedures, which may challenge the attainment of primary stability during IL. Of the greatest and most advantageous application of immediate restoration of implants are those cases in which aesthetic needs and soft tissue preservation are most important. The overall implant survival rate of immediately loaded implants is similar to long-term results achieved with the conventional 2-stage implant protocol. Histologic evidence based on human and animal studies reinforces the idea that osseointegration with implants under immediate functional occlusal loading can be successfully achieved. Finally to conclude immediate loading of implants using All-on- Four concept is an excellent treatment option both edentulous maxilla and mandible. The cumulative survival rates, marginal bone loss and other bio-mechanical factors are similar to better than that of conventional implant treatment. Also since less of numbers of implants are involved the cost of this procedure is reasonably less when compared to conventional fixed implant prostheses.
Rigid splinting of multiple implants with intraoral welding technique results in a predictable fixation in the early stage for bone healing with a significant reduction of the micromovement problem and implants loss. Using such an orthopedic splint on the implants could help during healing time by allowing implant primary stability and immediate loading on provisional restorations. The syncrystallization technique allows an expidite and adequate rigid splinting of multiple immediately loaded implants. Advantages of the technique are : 1) Reduction of treatment time for immediate temporization at stage 1 surgery. 2) Predictable fixation and immobility of implants in early stages of bone healing. 3) Less time for repairing provisional restorations as a result of no or rare fracture.

Basal implants are used to support single and multiple unit restorations in the upper and lower jaws. They can be placed in the extraction sockets and also in healed bone. Their structural characteristics allow placement in bone that is deficient in height and width. They can be placed with flap or flapless technique. A thorough understanding of the maxillofacial anatomy is recommended so that bi-cortical engagement is achieved. They can be used to bypass the mandibular nerve in the mandible and for engagement of the cortical bone at the fusion of the pterygoid with the maxilla. Also with respect to the accepted principle *"primum nihil nocere"*, i.e., limiting treatment, basal implants are the devices of first choice, whenever (unpredictable) augmentations are part of an alternative treatment plan. The technique of basal implantology solves all problems connected with conventional (crestal) implantology. It is a customer oriented therapy, which meets the demands of the patients ideally. Basal implantology does not include any augmentation. In addition to that flapless approach with minimal surgical effort (thin mucosal penetration) minimizes postoperative pain, avoid any swelling and reduce discomfort. Therapeutic options for peri-implantitis around crestal implants are limited; usually the disease stops as soon as it reaches basal (i.e. resorption resistant) bone areas. Peri-implantitis is not found with basal implants. For sterile loosening of basal implants, numerous therapeutic options exist; functional adjustments or combined surgical/ functional treatment of bone/implant/restoration systems are required and in some cases the reduction of muscle forces is part of the therapy plan. Such options are not given for crestal implants. Even the replacement or addition of basal implants is easily possible, since there is usually sufficient cortical bone available for additive therapy. The zygomatic implant is an alternative procedure to bone augmentation, maxillary sinus lift and to bone grafts in patients with posterior atrophic maxillae. The zygomatic implant technique should be regarded as a major surgical procedure and proper training is of course needed. However, in comparison with bone grafting procedures, the technique is less invasive and complicated and has a lower risk of morbidity due to the fact that harvesting of bone graft is usually not needed. Based on the current literature review, zygomatic implants show excellent survival rates (>90%) and a low incidence of complications, so this should be considered a valid and safe treatment option when dealing with patients with advanced maxillary atrophy.

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