Bone Quality and the Immediate Loading of Implants—Critical Aspects Based on Literature, Research, and Clinical Experience

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Immediate loading of oral implants has been extensively described in the international literature and the requirements for long-term success are evaluated. The author presents here the critical aspects of the criteria for success as well as describes the characteristics of an implant macro- and microdesign for immediate loading to control the periimplant crestal bone loss and secure the long-term stability. Information from the literature and the clinical experience will be presented. (Implant Dent 2009;18:203–209)

Key Words: immediate loading, review

Immediate loading (IL) of oral implants has been extensively described in the international literature as a common surgical procedure if certain requirements are considered.[1] In general, primary implant stability is necessary to successfully use this treatment concept in daily practice.

Definition of Immediate Loading

The clinician must always use *objective* criteria to determine the presence or absence of micromovements at the interface, and *subjective* criteria such as the surgeon's impression of the mechanical stability of the implant during placement. Different standardization methods such as the Periotest and resonance frequency analysis have been utilized to evaluate the implant stability more objectively.[2,3] Loading implants immediately after insertion is a sensitive technique that is dependent on different parameters and should not be used routinely by an inexperienced clinician. The possibility of IL has been described differently by researchers and clinicians and there is some confusion regarding the determination of appropriateness. Some authors describe IL as the placement of provisional restorations after the first 20 days of implant placement.[4] Whereas most of the authors define IL as the placement of the provisional restoration within the first 2 to 3 days after implant placement.[5–8] The First Consensus Conference on IL made a distinction between "immediate occlusal (functional) loading," and "immediate provisionalization" or "immediate nonocclusal (nonfunctional) loading." The difference is based on the presence or absence of occlusal contacts in the provisional restoration on the day of implant placement.[5] Cochran *et al*[7] at the second conference on IL, defined exact criteria and treatment classification types. To prevent misunderstanding among authors presenting scientific data, the presence or absence of occlusal contacts on implants at the time of or immediately after surgery must be noted and well documented.[9]

Criteria for "Success"

There are different definitions of "success" in implant therapy. Some authors demonstrate "success rate" without measurements of crestal bone levels and/or evaluation of clinical parameters during the entire observation period, but present "failure rate" simply based on the presence of "implant mobility." They are actually showing the "survival rate" and not the "success rate." To avoid misunderstanding and confusion, these terms should be more specifically defined in the dental literature, and the criteria used in each study must be specified. A conference focused on the topic of "Implant success" and "failure" has been held in Pisa and the results of this Conference were published recently.[10] Because of the increasing number of implants being placed and the increasing number of implants being loaded immediately, a more critical analysis of the periimplant hard and soft tissues, as well as the amount of midfacial bone resorption, must be carried out and discussed in each individual study and publication. This is especially important in esthetic implant dentistry if patients with implants have a high smile line and present midfacial recession, and the implants have already osseointegrated. There is no doubt that a more precise diagnostic evaluation of the

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ISSN 1056-6163/09/01803-203
Implant Dentistry
Volume 18 • Number 3

DOI: 10.1097/ID.0b013e3181991248

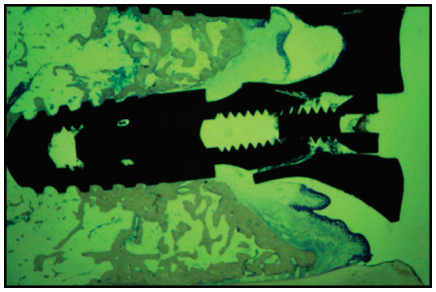

Fig. 1. Healthy periimplant soft tissues around immediately loaded implants with platform switching (monkey).

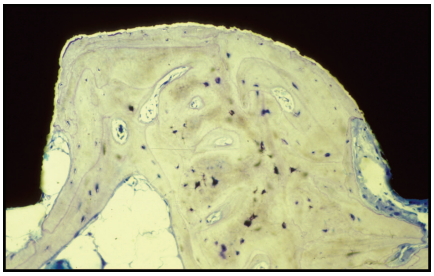

Fig. 2. High density of bone at the interface of immediately loaded implants (monkey).

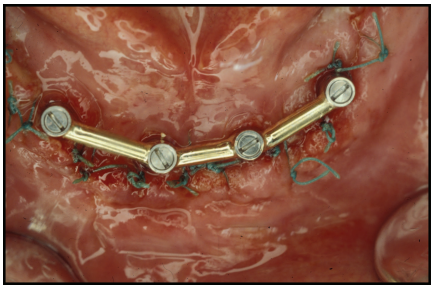

Fig. 3. Implants placed in the mandible, splinted together with a bar for immediate loading.

Fig. 4. Immediate loading in the maxilla using a temporization (cross arch stabilization) immediately after surgery.

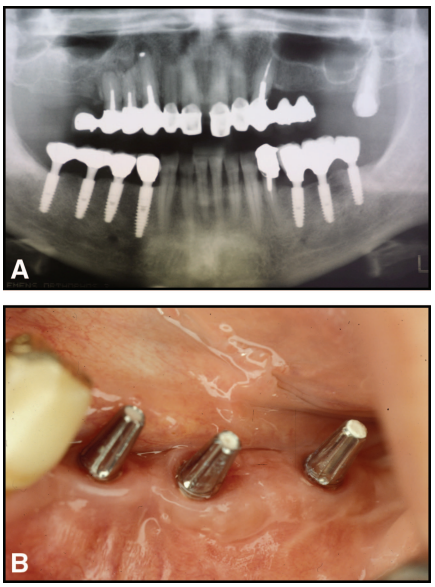

Fig. 5. Immediately loaded implants in the posterior mandible 5 years after surgery presenting crestal bone stability (**A**) and excellent periimplant soft tissues (**B**).

periimplant bone quality is of importance to increase the long-term prognosis of the implant. For these reasons, different treatment concepts such as "subcrestal" implant placement[11] and the use of an implant system with "platform switching"[11–14] have been demonstrated.

Other parameters of importance are the use of systems with implant/abutment microbial sealing to prevent bacterial invasion and further bone loss because of inflammatory reactions. The conical (tapered) implant/abutment connection minimizes the gap (microgap) and *in vitro* studies have shown no bacterial invasion.[15] Furthermore, if the final abutments are placed and are not disconnected during the entire loading period, no changes of the crestal bone have been described histologically in monkeys[16] and radiographically[8,17] in humans. Using such treatment concepts, recent discussions have shown that periimplant soft tissue recession may be avoided.[18] Experimentally, when the healing abutments are disconnected, an apical migration of the long junctional epithelium and further loss of crestal bone have been histologically and histomorphometrically demonstrated.[19]

Periimplant Bone Response

Because we know that bone resorption takes place with or without implant placement in the socket, the issue of hard and soft tissue stability is extremely important to maintain the integrity of the periimplant tissues.[20] Specifically, further changes in the hard and soft tissues occur when such implants are loaded immediately, and it is important to evaluate the quality and stability of the hard and soft tissues using clinical and radiographic parameters over the entire observation period. Previous histological and histomorphometrical studies in monkeys with immediately loaded and delayed loaded implants confirm that there is no significant difference in the soft periimplant tissues (Fig. 1),[21] and the periimplant bone presents no differences at the osseointegration level, meaning that the bone-to-implant contact percentage is similar between the 2 loaded groups. Measurements of the bone density (Fig. 2) and bone mineralization around immediately loaded implants gave significantly higher volume (density) compared with the delayed loaded implants.[8,16] These studies utilized an implant system with a smaller abutment diameter when compared with implant diameter ("platform shifting"), and during loading, there was no disconnection of the abutment for any subsequent prosthetic procedures.

Learning from the Literature

Searching the literature on the subject of IL, the first study involved the placement of 4 implants in the anterior portion of the mandible, and immobilization of the implants with a connecting bar.[22] Because the implant used was a 1-piece implant (Lederman screw), there was no microgap. The bar-retained restoration provided rigid immobilization of the implants (Fig. 3). Other studies using implants in the mandible and maxilla showed high success rates when the implants were loaded and supported by cross-arch restorations.[23–28] Such cross-arch stabilization significantly reduces the bending forces on the implants (Fig. 4). Other studies with unilateral fixed implant-supported restorations in the posterior mandible presented high success rates and no crestal bone loss (Fig. 5) when the diet protocol was strict and a soft/liquid diet was used

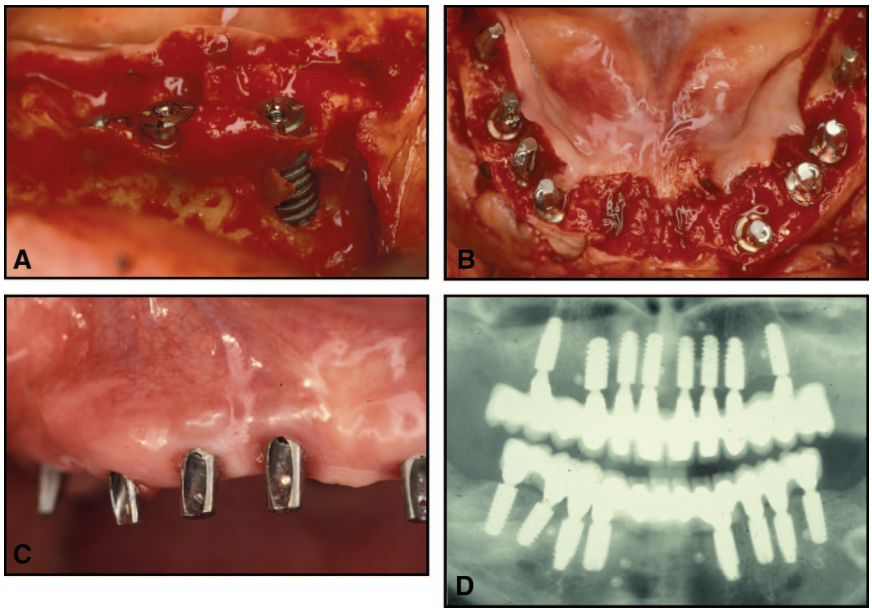

Fig. 6. A Implants placed in fresh extraction sockets; **B** combined with augmentations and immediate loading; **C** excellent soft tissues after healing and crestal bone level stability; **D** after 5 years of loading.

during the initial healing stages.[8,17] A soft/liquid diet was also recommended by other clinicians.[26,27]

There are no many studies involving implants placed in fresh extraction sockets or placed simultaneously with bone augmentations and IL that have demonstrated successful long-term results (Fig. 6). Today there is no standardized method to determine the bone quality of the residual bone, even though there are advanced diagnostic techniques available for presurgical bone evaluation. Initially, the implant may not be very stable because of poor bone quality at the osteotomy site. Bone condensation and/or surgical augmentation with simultaneous implant placement should be used when the residual ridge is compromised (width and height).

Role of the Implant-Abutment Connection

An additional problem of IL is the need to apply mechanical torque (25–30 Ncm) needed for interlocking the implant and the abutment (prosthetic torque). Some authors suggest that implants having an insertion torque of less than 40 Ncm should only be loaded after healing.[29] Thus, IL of implants may not be used in cases with compromised bone quality and/or using implant systems with external/internal hexagonal implant-abutment connections. In such clinical conditions, the ideal final torque could not be achieved, allowing a gap between the implant and abutment, which could lead to implant failure. Implants with Morse-taper (conical) implant-abutment connections need a final torque of 15–20 Ncm because of the higher mechanical friction and the stability of the conical geometry. This allows the IL of implants using this type of implant-abutment configuration even if the bone quality is not ideal.

Role of the Implant Design

On the basis of our clinical experience over a loading period of 5 years, we have a success rate of 97%; however, we demonstrated a high success rate (100%) after 2 years of loading in fixed prostheses in the posterior mandible, even in the presence of bending forces, which could have the effect of causing deterioration of osseointegration.[17,30] Unquestionably, the initial implant stability is dependent on the implant geometry. Tapered implants showed a higher insertion torque when compared with cylindrical implants.[31,32] Therefore, only tapered implants, because of their better primary stability, should be used for IL. When implants with a progressive thread design were compared with other implant designs, histomorphometric studies at the implant-osseous tissue interface demonstrated higher bone to implant contact percentages immediately after insertion.[33] The high clinical success of implants with a progressive thread design has also been confirmed with the histological evaluation of an autopsy specimen (human, heavy smoker, history of chemotherapy). The bone to implant contact percentage was greater than 60% and dense bone was noted at the interface after 7 months of IL in the maxilla and the mandible.[34]

CONCLUSIONS

Based on the critical observations of IL studies in the international literature, there is a problem with the definition of the treatment concept. Most researchers present survival rates (not success rates) of the implants without providing exact measurements of the implant crestal bone levels. Even though most studies present high survival rates in immediately loaded cross-arch restorations, inadequate data are present today for implants placed in fresh extraction sockets that have undergone advanced augmentation procedures and loading. Focusing on the integrity of the periimplant hard and soft tissues after implant placement and IL, the need for changes in implant design and more advanced technology is evident to eliminate the microgap at the implant-abutment interface, prevent or control bacterial invasion, and reduce crestal bone resorption. To successfully use the concept of IL in conditions of compromised bone quality and quantity, the mechanical properties of the implant-abutment interlock are important. The biomechanical aspects of the implant system and the magnitude of the loading forces (diet protocol, etc.) are of importance in compromised osteotomies when IL protocols are used.

Disclosure

The author has no financial interest in any company or in any of the products mentioned in this article.

ACKNOWLEDGMENTS

The author thank Michael Yunker, DDS for his help in preparing this manuscript.

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ID Abstract Translations

GERMAN / DEUTSCH

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Die Qualität des Knochengewebes und die unmittelbare Belastung von Implantaten - Kritische Aspekte auf der Grundlage von Fachliteratur, Forschung und klinischen Erfahrungswerten

ZUSAMMENFASSUNG: Das Thema der unmittelbaren Belastung von Zahnimplantaten wurde in der internationalen Literatur bereits ausgiebig behandelt, die Anforderungen für einen langfristigen Erfolg einer solchen Behandlung wurden entsprechend beurteilt und festgeschrieben. Der Autor dieses Berichts stellt die kritischen Aspekte der Erfolgskriterien heraus und beschreibt die Eigenheiten eines Implantatgestützten Makro- und Mikrodesigns für unmittelbare Belastung, um den Verlust des Kammknochens im das Implantat umlagernden Gewebe kontrolliert zu halten und die langfristige Stabilität zu gewährleisten. Es werden Informationen aus Literatur und klinischen Erfahrungswerten vorgestellt.

SCHLÜSSELWÖRTER: unmittelbare Belastung, Überprüfung

SPANISH / ESPAÑOL

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La calidad del hueso y la carga inmediata de los implantes: Aspectos críticos según las publicaciones, la investigación y la experiencia clínica

ABSTRACTO: La carga inmediata (IL por sus siglas en inglés) de los implantes orales ha sido descrita extensamente en las publicaciones internacionales y se evalúan los requisitos para el éxito de largo plazo. El autor presenta aquí los aspectos críticos de los criterios necesarios para el éxito así como las características del micro y macrodiseño del implante para la carga inmediata y para controlar la pérdida del hueso crestal periimplante y asegurar la estabilidad a largo plazo. Se presentan la información de las publicaciones y la experiencia clínica.

PALABRAS CLAVES: carga inmediata; revisión

PORTUGUESE / PORTUGUÊS

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Qualidade do Osso e a Carga Imediata de Implantes – Aspectos críticos baseados na literatura, pesquisa e experiência clínica

RESUMO: A carga imediata (IL) de implantes orais tem sido extensamente descrita na literatura internacional e os requisitos para o sucesso de longo prazo são avaliados. O autor apresenta aqui os aspectos críticos dos critérios para o sucesso, bem como descreve as características de um macro e microdesign de implante para IL para controlar a perda de crista óssea do periimplante e assegurar a estabilidade de longo prazo. Informações da literatura e da experiência clínica serão apresentadas.

PALAVRAS-CHAVE: carga imediata, revisão

RUSSIAN / РУССКИЙ

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Качество кости и немедленное нагружение имплантатов – критические аспекты, основанные на литературных источниках, исследовании и клиническом опыте

РЕЗЮМЕ: Немедленное нагружение имплантатов в ротовой полости широко описано в международной литературе, а требования для обеспечения долгосрочного успеха проанализированы. В данной работе автор представляет критические аспекты критериев успеха, а также описывает характеристики микро- и макроконструкции имплантата применительно к немедленному нагружению, чтобы компенсировать потерю костной массы альвеолярного гребня в периимплантатной области и обеспечить долгосрочную стабильность. Будет представлена информация из литературных источников и клинического опыта.

КЛЮЧЕВЫЕ СЛОВА: немедленное нагружение, обзор

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Kemik Kalitesi ve Hemen Yüklenen İmplantlar – Literatür, Araştırma ve Klinik Deneyime Göre Kritik Unsurlar

ÖZET: Oral implantların Hemen Yükleme (HY) tekniği, uluslararası literatürde büyük ölçüde tanımlanmış olup, yöntemin uzun vadede başarısı için söz konusu koşullar değerlendirilmiştir. Bu çalışmada yazar, başarı kriterlerinin kritik yönlerini sunmanın yanı sıra peri-implant kret kemik kaybını kontrol altına alma ve uzun vadede stabilite sağlama amaçlarını güden bir HY implant makro- ve mikro-tasarımının özelliklerini de tanımlamaktadır. Bu çalışma ayrıca, literatürden ve klinik deneyimden elde edilen bilgileri de sunmaktadır.

ANAHTAR KELİMELER: hemen yükleme, inceleme

JAPANESE / 日本語

骨質とインプラント即時負荷ー文献と研究ならびに臨床経験に基づいた決定的局面

共同研究者氏名: G・E・ロマノス（G.E. Romanos）DDS, Dr. med.dent., PhD.

研究概要:
口腔インプラントの即時負荷(IL) については国際的文献で幅広く既述されており、長期間にわたる成功を目指す諸条件が評価されている。著者は本文で成功への基準で決定的となる局面だけでなく、インプラント周辺歯槽頂骨損失をコントロールし、さらに長期安定性を確実にするインプラントの即時負荷マクロとマイクロデザインの特徴を説明する。また文献から引用した情報ならびに臨床経験も発表する。

キーワード: 即時負荷；再検討

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CHINESE / 中国語

骨品質與植體立即載入 – 以文獻、研究與臨床經驗為基礎的關鍵面向

作者：G.E. Romanos, DDS, Dr. med.dent., PhD.

摘要：
國際文獻有許多關於口腔植體立即載入 (IL) 的描述，對長期成功的條件也有所評估。作者在本文中提出成功標準的關鍵面向，並描述控制植體周圍骨脊骨流失並確保長期穩定性的植體立即載入的巨觀和微觀設計之特性，也提出文獻和臨床經驗的資訊。

關鍵字：立即載入、評論

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KOREAN / 한국어

골형질과 임플란트의 즉시 식립 – 문헌, 연구와 임상적 경험에 근거한 주요 측면

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요약:
구강 임플란트의 즉시 식립(IL)은 국제 문헌에서 광범위하게 기술되어왔으며 장기간 성공을 위한 필요요건들이 평가되어왔다. 저자는 본서에서 임플란트 주위 융기 골 소실을 조절하고 장기간 안정성을 확보하기 위한 IL의 거대 및 미세 설계의 특성을 기술함과 동시에 성공 기준의 주요 측면을 서술하였다. 또한 문헌과 임상적 경험을 통한 정보 역시 제공될 것이다.

키워드: 즉시 식립, 검토

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