Effect of diameter and length on stress distribution of the alveolar crest around immediate loading implants.

Ding X, Liao SH, Zhu XH, Zhang XH, Zhang L.


Abstract

BACKGROUND:

Many clinical observations have shown that immediate loading is indicated when the stabilization of the bone/implant is optimal and when the estimated loads are not excessively high. Nonetheless, more experimental studies are needed to consider the immediate loading protocol as a safe procedure. Mechanical analysis using the finite element (FE) method analysis has been employed by many authors to understand the biomechanical behavior around dental implants.

PURPOSE:

This study was to evaluate the effect of the diameter and length on the stress and strain distribution of the crestal bone around implants under immediate loading.

MATERIALS AND METHODS:

By an ad hoc automatic mesh generator, high-quality FE models of complete range mandible was constructed from computer tomography, with three Straumann (Straumann Institute, Waldenburg, Switzerland) implants of various sizes embedded in the anterior zone. The implant diameter ranged from 3.3 to 4.8 mm, and length ranged from 6 to 14 mm, resulting in seven designs. The implant-bone interface was simulated by nonlinear frictional contact algorithm. For each design, vertical and oblique loadings of 150 N were applied, respectively, to each implant, and stresses and strains in the surrounding cortical bone were evaluated.

RESULTS:

The biomechanics analysis provided results that the oblique loading would induce significantly higher interfacial stresses and strains than the vertical loading, while the intergroup stress difference significant levels was evaluated using t-tests method and the level of significance (.05) that was accepted for significance. Under both loadings, the maximal values were recorded in the 3.3 (diameter) x 10 (length) mm implant configuration, whose mean and peak values were both higher than that of others with significant statistical differences. The second maximal one is 4.1 x 6 mm configuration, and the minimal stresses were recorded in 4.8 x 10 mm configuration, whose strains were also near to lowest.

CONCLUSIONS:

Increasing the diameter and length of the implant decreased the stress and strain on the alveolar crest, and the stress and strain values notably increased under buccolingual loading.
as compared with vertical loading, but diameter had a more significant effect than length to relieve the crestal stress and strain concentration.

Implant-bone interface stress distribution in immediately loaded implants of different diameters: a three-dimensional finite element analysis.
Ding X, Zhu XH, Liao SH, Zhang XH, Chen H.

Abstract

PURPOSE:
To establish a 3D finite element model of a mandible with dental implants for immediate loading and to analyze stress distribution in bone around implants of different diameters.

MATERIALS AND METHODS:
Three mandible models, embedded with thread implants (ITI, Straumann, Switzerland) with diameters of 3.3, 4.1, and 4.8 mm, respectively, were developed using CT scanning and self-developed Universal Surgical Integration System software. The von Mises stress and strain of the implant-bone interface were calculated with the ANSYS software when implants were loaded with 150 N vertical or buccolingual forces.

RESULTS:
When the implants were loaded with vertical force, the von Mises stress concentrated on the mesial and distal surfaces of cortical bone around the neck of implants, with peak values of 25.0, 17.6 and 11.6 MPa for 3.3, 4.1, and 4.8 mm diameters, respectively, while the maximum strains (5854, 4903, 4344 muepsilon) were located on the buccal cancellous bone around the implant bottom and threads of implants. The stress and strain were significantly lower (p < 0.05) with the increased diameter of implant. When the implants were loaded with buccolingual force, the peak von Mises stress values occurred on the buccal surface of cortical bone around the implant neck, with values of 131.1, 78.7, and 68.1 MPa for 3.3, 4.1, and 4.8 mm diameters, respectively, while the maximum strains occurred on the buccal surface of cancellous bone adjacent to the implant neck, with peak values of 14,218, 12,706, and 11,504 microm, respectively. The stress of the 4.1-mm diameter implants was significantly lower (p < 0.05) than those of 3.3-mm diameter implants, but not statistically different from that of the 4.8 mm implant.

CONCLUSIONS:
With an increase of implant diameter, stress and strain on the implant-bone interfaces significantly decreased, especially when the diameter increased from 3.3 to 4.1 mm. It appears that dental implants of 10 mm in length for immediate loading should be at least 4.1 mm in diameter, and uniaxial loading to dental implants should be avoided or minimized.
Clinical, biomechanical and biological aspects of immediately loaded dental implants: a critical review of the literature.

Götz W, Gedrange T, Bourauel C, Hasan I.


Abstract

In recent years, the use of immediately loaded implants became more acceptable as a standard protocol for completely edentulous lower jaw and/or partially edentulous upper jaw cases, predominantly in the anterior region, after it was one of the cornerstones of the early protocols to avoid any occlusal loading of the implants for at least 3 months. This technique could potentially provide immediate function and aesthetics to the patient. This review aims to present the clinical indications of the immediately loaded protocol according to the individual cases and the corresponding risk factors and contraindications. The clinical, biomechanical and biological requirements concerning bone quality, occlusal loading and implant primary stability are discussed. Primary stability in immediate loading is determined rather by surgical than biological parameters. Peri-implant osteogenesis leading to secondary stability depends on the same biological factors than in unloaded implant healing. However, specific mechanical effects on the biology of immediate loading osseointegration are yet to be investigated.

Initial clinical efficacy of 3-mm implants immediately placed into function in conditions of limited spacing.

Reddy MS, O'Neal SJ, Haigh S, Aponte-Wesson R, Geurs NC.


Abstract

PURPOSE:

The objective of this study was to determine changes in interdental papillae, alveolar bone loss, esthetics, and initial healing survival when 1-piece narrow-diameter implants were immediately loaded in sites with limited tooth-to-tooth spacing.

MATERIALS AND METHODS:

One-piece titanium alloy implants with a maximum diameter of 3.0 mm and a resorbable blast surface texture on a square-thread form were evaluated. Digital photographs were made at each clinical visit to assess soft tissue healing. Interproximal soft tissue fill of the embrasure was assessed with a modified Jemt index. Standardized radiographs were made at baseline (implant placement) and at 6 and 12 months postsurgery. Radiographic bone height was measured from a consistent landmark on the implant. A 1-sided t test was used to determine statistical differences of bone height.

RESULTS:
Thirty-one implants were placed in 17 subjects. One implant had clinical mobility and was removed, for an overall survival rate of 96.7%. Mean bone height on the day of placement and restoration was 2.33 + 0.73 mm above the first thread. Mean bone height was 1.75 +/- 0.78 mm at 6 months postrestoration and 1.63 +/- 0.81 mm at 12 months postrestoration. There was a statistically significant loss of bone support over the initial 6 months (0.58 mm; P < .01), with no significant progression thereafter (0.12 mm; NS). Complete fill of papillae was found in 92% of maxillary lateral incisor sites and 60% of mandibular incisor sites.

CONCLUSION:
The use of 1-piece narrow-diameter immediately loaded implants appears to be an effective prosthetic treatment for areas of limited space.

Implant loading protocols for the partially edentulous esthetic zone.
Grütter L, Belser UC.

Abstract

PURPOSE:
The scientific evidence related to different or novel implant loading (primary objective) and directly associated implant placement (secondary objective) protocols developed for the anterior maxillae of partially edentulous patients was reviewed.

MATERIALS AND METHODS:
A comprehensive search of electronic databases and a hand search of six relevant journals was performed. The principal outcome variables were implant survival, implant success, and esthetic appearance. Concerning esthetic treatment outcomes, articles were specifically screened for the presence of objective evaluation parameters and patient satisfaction assessment.

RESULTS:
The analysis of the literature on immediately restored or conventionally loaded implants in the esthetic zone revealed an initial survival rate of 97.3% after 1 year (10 prospective cohort studies and one case series). For periods of 1 to 5 years, the survival rate was 96.7%. These survival rates are consistent with previous reports on more traditional loading modalities. However, for immediately placed implants with immediate restoration and occlusal loading, the survival rate dropped by approximately 10% (four studies). Success criteria such as stable crestal bone levels, soft tissue recession, and probing depth could not be evaluated on the basis of the available literature.

CONCLUSION:
There is a paucity of prospective cohort studies addressing patient-centered outcomes. No parameters specific to immediate loading protocols were available for evaluation. In order to validate or reject such implant protocols for use in the esthetically sensitive anterior maxilla,
long-term clinical trials should routinely include objective esthetic criteria that comprehensively embrace the pertinent elements of "pink and white esthetics" in the form of readily used indices.

 Immediate/early loading of dental implants. Clinical documentation and presentation of a treatment concept.


Ostman PO.

 Immediate loading of narrow-diameter implants with overdentures in severely atrophic mandibles.

Cho SC, Froum S, Tai CH, Cho YS, Elian N, Tarnow DP.


Abstract

Oral rehabilitation using two to four implants to support mandibular overdentures has been shown to have success rates of approximately 96% with implants placed in a one- or two-stage procedure. The purpose of this study is to evaluate 10 consecutive cases of immediately loaded, narrow-diameter implants (NDIs) as support for overdentures in severely atrophic mandibles, and report on implant/prosthetic survival rates and patient satisfaction. Overall implant and prosthetic survival rates were 94.1% and 100%, respectively.

 Mini-implants to reconstruct missing teeth in severe ridge deficiency and small interdental space: a 5-year case series.


Mazor Z, Steigmann M, Leshem R, Peleg M.

Abstract

Two of the major obstacles for dental implant placement to replace missing teeth are the lack of adequate bone width and interdental space. Overcoming these limitations requires bone augmentation procedures that transform the deficient ridge into a ridge that is capable of receiving conventional tooth-form implants. In the case of inadequate interdental space, orthodontic tooth movement is advocated before implantation. Using narrow-diameter mini-implants allows the clinician to overcome both of these obstacles without the need for additional grafting procedures or orthodontic tooth movement. The mini-implants are immediately loaded and restored so as to enable the patient to have satisfactory mastication
and aesthetic appearance. A 5-year follow up of 32 implants demonstrates the benefit of this treatment modality.

Immediate versus one-stage restoration of small-diameter implants for a single missing maxillary lateral incisor: a 3-year randomized clinical trial.
Degidi M, Nardi D, Piattelli A.
J Periodontol. 2009 Sep;80(9):1393-8.

Abstract

BACKGROUND:

The aim of this study was to compare the bone loss pattern and soft tissue healing of immediately versus one-stage loaded 3.0-mm-diameter implants in cases involving a single missing lateral maxillary incisor.

METHODS:

Sixty patients with a missing lateral incisor in the maxilla were randomized to one of the treatments: 30 patients in the immediate-restoration group and 30 patients in the one-stage group. All implants were placed in healed sites and had to be inserted with a torque >25 Ncm. The implants in the immediate-restoration group were fitted with a non-occluding temporary crown on the day of surgery. Both groups received a full occluding final crown 6 months after surgery. Mean marginal bone loss, probing depth, and bleeding on probing were assessed at 6-, 12-, 24-, and 36-month follow-up examinations by a masked examiner.

RESULTS:

Sixty 3.0-mm-diameter implants were placed between July 2003 and February 2006; 27 (45.0%) were in men, and 33 (55.0%) were in women. All implants osseointegrated and were clinically stable at the 6-month follow-up. No statistically significant differences were observed for bleeding or plaque index. No implant fractures occurred. At the 36-month follow-up, the accumulated mean marginal bone loss and probing depth were 0.85 +/- 0.71 mm and 1.91 +/- 0.59 mm, respectively, for the immediate-loading group (n = 30) and 0.75 +/- 0.63 mm and 2.27 +/- 0.81 mm, respectively, for the one-stage group (n = 30). There was no statistically significant difference (P >0.05) for the tested outcome measures between the two procedures.

CONCLUSIONS:

In the rehabilitation of a single missing lateral maxillary incisor, no statistically significant difference was assessed between immediately and one-stage restored small-diameter implants with regard to implant survival, mean marginal bone loss, and probing depth. Three-millimeter-diameter implants proved to be a predictable treatment option in our test and control groups if a strict clinical protocol was followed.
Interventions for replacing missing teeth: different times for loading dental implants.

Esposito M, Grusovin MG, Achille H, Coulthard P, Worthington HV.


Abstract

BACKGROUND:

To minimize the risk of implant failure, osseointegrated dental implants are conventionally kept load-free during the healing period. During healing removable prostheses are used, however many patients find these temporary prostheses rather uncomfortable and it would be beneficial if the healing period could be shortened without jeopardizing implant success. Nowadays immediately and early loaded implants are commonly used in mandibles (lower jaws) of good bone quality. It would be useful to know whether there is a difference in success rates between immediately or early loaded implants compared with conventionally loaded implants.

OBJECTIVES:

To evaluate the efficacy of (1) immediate (within 1 week), early (between 1 week and 2 months), and conventional (after 2 months) loading of osseointegrated implants, and of (2) immediate occlusal versus non-occlusal loading during the bone healing phase.

SEARCH STRATEGY:

The Cochrane Oral Health Group's Trials Register, CENTRAL, MEDLINE and EMBASE were searched. Handsearching included several dental journals. Authors of all identified trials, an Internet discussion group and 55 dental implant manufacturers were contacted to find unpublished randomised controlled trials (RCTs). The last electronic search was conducted on 4 June 2008.

SELECTION CRITERIA:

All RCTs of root-form osseointegrated dental implants, having a follow up of 4 months to 1 year, comparing the same implant type immediately, early and conventionally loaded or occlusally and non-occlusally loaded. Outcome measures were: prosthesis and implant failures and radiographic marginal bone level changes.

DATA COLLECTION AND ANALYSIS:

Data were independently extracted, in duplicate, by two review authors. Authors were contacted for details of randomisation and withdrawals and a quality assessment was carried out. The Cochrane Collaboration's statistical guidelines were followed.

MAIN RESULTS:

Thirty RCTs were identified and 22 trials including 976 participants in total were included. Twelve trials compared immediate versus conventional loading, three early versus conventional loading, six immediate versus early loading, and one occlusally versus non-
occlusally loaded implants. On a patient, rather than per implant basis, there were no statistically significant differences for any of the meta-analyses.

Authors’ Conclusions:

It is possible to successfully load dental implants immediately or early after their placement in selected patients, though not all clinicians may achieve optimal results. It is unclear whether it is beneficial to avoid occlusal contacts during the osseointegration phase. Trends suggest that immediately loaded implants fail more often than those conventionally loaded, but less commonly than those loaded early. If a clinician wishes to load the implants early, it might be wiser to load them immediately (within 1 week) rather than waiting for 1 or 2 months. A high degree of primary implant stability (high value of insertion torque) seems to be one of the prerequisites for a successful immediate/early loading procedure. More well designed RCTs are needed and should be reported according to the CONSORT guidelines (www.consort-statement.org/).

The immediate loading of dental implants.

Cooper LF, De Kok IJ, Rojas-Vizcaya F, Pungpapong P, Chang SH.


Source

Abstract

The aim of this article is to identify current opportunities for the immediate loading of endosseous dental implants. A biologic basis for the clinical parameters associated with success and failure of immediately loaded implants is presented, and select clinical situations where immediate loading is presently advocated will be illustrated. The wide-ranging applications of the immediate-loading concept for endosseous dental implants will be introduced; however, further experimental validation is necessary before incorporating all of these various expedited therapeutic approaches into practice.

Effect of immediate or delayed loading following immediate placement of implants with a modified surface.

Liñares A, Mardas N, Dard M, Donos N.


Abstract

Objective:

to evaluate the effect of the timing of loading on bone-to-implant contact (BIC) following immediate placement of implants with a hydrophilic sandblasted, large-grit and acid-etched surface (modSLA) into fresh extraction sockets in a minipig model.
MATERIAL AND METHODS:

Six minipigs were used in this study. In each hemi-mandible, two conical shape implants (TE, Straumann implants) with a hydrophilic surface (modSLA) were placed in fresh extraction sockets. In one side of the mandible (control), two implants were immediately placed in fresh extraction sockets. The implants were loaded after 4 weeks of healing. At the contralateral side (test), two implants were immediately placed and loaded. After 8 weeks of healing, the animals were sacrificed and histologically analysed.

RESULTS:

during the experimental period, no implants were lost and all of them presented to be osseointegrated. The percentage of BIC was similar in both groups: 66.1% and 65.1% for the control and test group, respectively. Furthermore, the distance from the shoulder of the implant to bone crest and the distance from the shoulder to the first BIC were similar in both groups.

CONCLUSION:

Immediate implant placement and loading showed similar BIC with immediate placement and delayed loading when implants with a modSLA surface were used. Both procedures showed similar buccal bone crest levels, which presented some resorption irrespective of the treatment modality.

**Implant-retained mandibular overdentures with immediate loading. A retrospective multicenter study on 226 consecutive cases.**

Chiapasco M, Gatti C, Rossi E, Haefliger W, Markwalder TH.


**Abstract**

A multicenter retrospective study has been conducted on 226 patients necessitating an implant-supported overdenture in the lower jaw. The patients were provided with 904 osseointegrated implants inserted in the interforaminal area of the mental symphisis (4 implants per patient). 4 titanium implant systems were used: TPS and ITI screw implants (Straumann Institute, Waldenburg, Switzerland); Ha-Ti screw implants (Mathys Dental Implants, Bettlach, Switzerland); NLS screw implants (Friatec, Mannheim, Germany). Immediately after implant placement, a U-shaped gold bar was fabricated and implants were immediately loaded with an implant-retained overdenture. Out of 226 patients treated, 194 were followed from a minimum of 2 years to a maximum of 13 years, with a mean follow-up of 6.4 years, whereas 32 patients dropped out during follow-up. The overall failure rate of implants was 3.1% (24/776 implants), whereas the failure rate of bars was 1.5% (3/194 bars). Results from this study showed that the success rate of immediately loaded implants is similar to that obtained in the case of delayed loading, after osseointegration has taken place. In contrast, this method shortens dental rehabilitation times with relevant satisfaction for patients.