Mechanical and technical risks in implant therapy.

Salvi GE, Brägger U.


Abstract

PURPOSE:

To systematically appraise the impact of mechanical/technical risk factors on implant-supported reconstructions.

MATERIAL AND METHODS:

A MEDLINE (PubMed) database search from 1966 to April 2008 was conducted. The search strategy was a combination of MeSH terms and the key words: design, dental implant(s), risk, prosthodontics, fixed prosthodontics, fixed partial denture(s), fixed dental prosthesis (FDP), fixed reconstruction(s), oral rehabilitation, bridge(s), removable partial denture(s), overdenture(s). Randomized controlled trials, controlled trials, and prospective and retrospective cohort studies with a mean follow-up of at least 4 years were included. The material evaluated in each study had to include cases with/without exposure to the risk factor.

RESULTS:

From 3,568 articles, 111 were selected for full text analysis. Of the 111 articles, 33 were included for data extraction after grouping the outcomes into 10 risk factors: type of retentive elements supporting overdentures, presence of cantilever extension(s), cemented versus screw-retained FDPs, angled/angulated abutments, bruxism, crown/implant ratio, length of the suprastructure, prosthetic materials, number of implants supporting an FDP, and history of mechanical/technical complications.

CONCLUSIONS:

The absence of a metal framework in overdentures, the presence of cantilever extension(s) > 15 mm and of bruxism, the length of the reconstruction, and a history of repeated complications were associated with increased mechanical/technical complications. The type of retention, the presence of angled abutments, the crown-implant ratio, and the number of implants supporting an FDP were not associated with increased mechanical/technical complications. None of the mechanical/technical risk factors had an impact on implant survival and success rates.
Evolution of the concept of angulated abutments in implant dentistry: 14-year clinical data.
Sethi A, Kaus T, Sochor P, Axmann-Krcmar D, Chanavaz M.

Abstract
This paper describes the evolution of the concept of selecting the abutment at first-stage surgery and presents clinical data accumulated over 14 years of the use of this concept with angulated abutments. The concept was developed for implants using internal and external hexed connections and has evolved in its use for implants using a Morse taper connection as a result of the considerable clinical advantages that this type of connection offers. A total of 3101 implants were restored using angled abutments ranging from 0 to 45 degrees and were observed over a period of up to 151 months. After an observation time of 120 months (10 years) after placement, the calculated 95% confidence interval of the mean survival estimation, according to Aalen et al, was 98.2% (+/- 0.7%). The magnitude of the angles did not influence the survival rate. The need to refine the implant position in terms of the depth to which it was placed and the angulation and rotational orientation, as well as the size and pivot point of the final abutment, were recognized as contributing to the harmonious emergence profile of the restoration. Good esthetic and functional outcomes were achieved by the use of conventional cement-retained restorations made possible by parallel and aligned abutments.

Retrospective evaluation of mandibular incisor replacement with narrow neck implants.
Cordaro L, Torsello F, Mirisola Di Torresanto V, Rossini C.

Abstract
The authors have retrospectively evaluated the clinical results of mandibular incisors replacement with narrow neck implants (NNI). Thirty-one patients treated consecutively for single or multiple lower incisor replacement with NNI with a mean follow-up of 23 months (range 18-42 months) were included in the study and were divided into three groups: single tooth, multiple unit restoration and restorations on adjacent implants. Survival and success rates and soft tissue parameters such as modified plaque index (mPI), peri-implant probing depth (PPD), bleeding on probing (BOP) and the papilla index were analyzed. Subjective evaluation was performed by patients and clinicians on visual analogue scales. The implants
and prostheses showed a survival rate of 100% and an overall success rate of 94%. The distribution of mPI outcomes showed better results for the single tooth group. BOP was present in four of eight implants (50%) in the adjacent implant group, in one out of 20 implants in the single tooth group (5%) and in one out of 16 implants in the multi unit group (6%). The adjacent implant group showed a statistically significant increase in PPD. The Papilla Index showed a better outcome distribution in single tooth and multi unit groups. Patients' evaluation of treatment outcome was satisfactory in all groups, even though the best esthetic and functional results were found in single tooth and multi unit groups. The professional evaluation showed good outcomes for the single tooth and multi unit groups and statistically significant poorer results in the adjacent implants group. With the limitations of this study, it may be concluded that the replacement of lower incisors with NNI leads to favorable functional and esthetic results in cases of single-tooth or multiple-unit replacement. Worse results are achieved if two adjacent mandibular incisors are replaced with adjacent implants.

Effect of abutment angulation on the strain on the bone around an implant in the anterior maxilla: a finite element study.
Saab XE, Griggs JA, Powers JM, Engelmeier RL.

Abstract
STATEMENT OF PROBLEM:
Angled abutments are often used to restore dental implants placed in the anterior maxilla due to esthetic or spatial needs. The effect of abutment angulation on bone strain is unknown.

PURPOSE:
The purpose of the current study was to measure and compare the strain distribution on the bone around an implant in the anterior maxilla using 2 different abutments by means of finite element analysis.

MATERIAL AND METHODS:
Two-dimensional finite element models were designed using software (ANSYS) for 2 situations: (1) an implant with a straight abutment in the anterior maxilla, and (2) an implant with an angled abutment in the anterior maxilla. The implant used was 4x13 mm (MicroThread). The maxillary bone was modeled as type 3 bone with a cortical layer thickness of 0.5 mm. Oblique loads of 178 N were applied on the cingulum area of both models. Seven consecutive iterations of mesh refinement were performed in each model to observe the convergence of the results.

RESULTS:
The greatest strain was found on the cancellous bone, adjacent to the 3 most apical microthreads on the palatal side of the implant where tensile forces were created. The same strain distribution was observed around both the straight and angled abutments. After several iterations, the results converged to a value for the maximum first principal strain on the bone.
of both models, which was independent of element size. Most of the deformation occurred in the cancellous bone and ranged between 1000 and 3500 microstrain. Small areas of cancellous bone experienced strain above the physiologic limit (4000 microstrain).

CONCLUSIONS:

The model predicted a 15% higher maximum bone strain for the straight abutment compared with the angled abutment. The results converged after several iterations of mesh refinement, which confirmed the lack of dependence of the maximum strain at the implant-bone interface on mesh density. Most of the strain produced on the cancellous and cortical bone was within the range that has been reported to increase bone mass and mineralization.

The use of angulated abutments in implant dentistry: five-year clinical results of an ongoing prospective study.
Sethi A, Kaus T, Sochor P.

Abstract

A total of 2,261 2-stage implants was placed in 467 patients in combination with angled abutments ranging from 0 to 45 degrees. These were observed over a period of up to 96 months, with a mean observation time of 28.8 months. Single and multiple teeth were replaced and restored using angled abutments. For patients who contributed multiple survival data, the data were considered dependent. Therefore, a mean survival estimation was performed. With a certainty of 95%, an estimated mean survival rate better than 98.6% after a 5-year observation period was calculated. The statistical comparison of 2 independent, randomized implant groups (with abutments angled between 0 and 15 degrees and between 20 and 45 degrees) by means of a log-rank test showed a probability of 0.84 (P value) that the survival functions are the same for both groups. Good esthetic and functional outcomes were observed.

The relationship of bone resorption around dental implants to abutment design: a preliminary 1-year clinical study.
Hasan I, Heinemann F, Bourauel C.

Abstract

The influence of abutment design on bone resorption around immediately loaded and osseointegrated implants used to support fixed partial prostheses was investigated in a 1-year study. One hundred ten implants were placed in 24 anterior partially edentulous maxillae. The probing depths of each implant were measured 6 and 12 months after abutment placement and analyzed statistically. Total probing depth was 1.75 ± 0.75 mm. There were significant differences between non- and submerged implants with angled abutments and between submerged implants with straight and angled abutments. No
significant differences were observed between non- and submerged implants with straight abutments and between nonsubmerged implants with straight and angled abutments. Bone resorption around dental implants is influenced by the abutment design and the associated implantation protocol. Int J Prosthodont 2011;24:457-459.

**Effects of implant diameter, insertion depth, and loading angle on stress/strain fields in implant/jawbone systems: finite element analysis.**

Qian L, Todo M, Matsushita Y, Koyano K.


**Abstract**

**PURPOSE:**

To investigate the interactions of implant diameter, insertion depth, and loading angle on stress/strain fields in a three-dimensional finite element implant/jawbone system and to determine the influence of the loading angle on stress/strain fields while varying the implant diameter and insertion depth.

**MATERIALS AND METHODS:**

Four finite element models were created, which corresponded to two implant diameters and two insertion depths. The jawbone was composed of cortical and cancellous bone and modeled as a linearly elastic medium; the implant had a detailed screw structure and was modeled as an elastic-plastic medium. Static loading was applied to the coronal surface of the implant with a maximum load of 200 N for all the models. Loading directions were varied, with buccolingually applied loading angles ranging from 0 to 85 degrees.

**RESULTS:**

Increases in the angle of force application caused not only increased maximum stress/strain values but worsened stress/strain distribution patterns in the bone and implant. The maximum stress in the bone always occurred at the upper edge of the cortical bone on the lingual side adjacent to the implant. The use of a larger-diameter implant or an increased insertion depth significantly reduced the maximum stress/strain values, improved the stress/strain distribution patterns and, in particular, decreased the stress/strain sensitivity to loading angle.

**CONCLUSIONS:**

A narrow-diameter implant, when inserted into jawbone with a shallow insertion depth and loaded with an oblique loading angle, is most unfavorable for stress distribution in both bone and implant. An optimized design of the neck region of an implant, in combination with a carefully controlled implant insertion depth that sets the threads of the implant neck well below the upper edge of the cortical bone, should be especially effective in improving the biomechanical environment for the maintenance of bone in implant/bone systems.
Clinical evaluation of small-diameter ITI implants: a prospective study.

Zinsli B, Sägesser T, Mericske E, Mericske-Stern R.


PURPOSE:

Dental implants with a reduced diameter are designed for specific clinical situations, such as placement of implants where bone width is narrow or between adjacent teeth that have only a narrow space between them. They are particularly useful when replacing small teeth such as lateral maxillary and mandibular incisors. The aim of the present study was the clinical evaluation of 2-part ITI implants (full-body screws with a 3.3-mm diameter).

MATERIALS AND METHODS:

One hundred forty-nine partially or completely edentulous patients received a total of 298 2-part ITI implants over a 10-year period. After a standard healing period (3 to 6 months), the implants were restored with fixed restorations such as single crowns or fixed partial or complete prostheses or overdentures. Complete prosthesis or overdenture in the edentulous jaw was the predominant type of restoration. All patients followed a strict maintenance program, with regular recalls at least once a year. The survival rate of the implants was analyzed, and prosthetic complications were assessed.

RESULTS:

Three implants were lost during the healing phase on account of peri-implant infection. Two implant body fractures with an osseous length of 8 mm were observed (one after 2 years of observation, the other after 6 years). Four implants exhibited transient peri-implant inflammation that was treated successfully by interceptive therapy. The cumulative 5-year survival rate of the implants was 98.7% (96.6% after 6 years). Prosthetic complications were mostly limited to loose occlusal screws and sore spots caused by the denture base.

DISCUSSION:

Within the limited observation period, failures of small-diameter implants were infrequent. Prosthetic complications were not dependent on the use of small-diameter implants.

CONCLUSION:

The use of 3.3-mm ITI implants appears to be predictable if clinical guidelines are followed and appropriate prosthetic restorations are provided. However, fatigue fracture may occur after a long period of function.
The influence of abutment angulation on micromotion level for immediately loaded dental implants: a 3-D finite element analysis.

Kao HC, Gung YW, Chung TF, Hsu ML.


Abstract

PURPOSE:

To investigate the micromotion between the implant and surrounding bone caused by the implementation of an angled abutment for an immediately loaded single dental implant located in the anterior maxilla.

MATERIALS AND METHODS:

A simplified half premaxillary bone model was fabricated. The dimension of the alveolar ridge was adopted from a dry human skull. Based on Brånemark protocol for Mk IV implants in type-3 bone, an immediate loading model was developed by press-fitting a 4-mm-diameter cylinder implant into a 3.15-mm osteotomy site in a numeric model. Material properties were assigned to the simulated model, and the model was meshed. A bite force of 89 N was applied to the tops of the 0-degree, 15-degree, and 25-degree angled abutments at a 120-degree angle to the abutment long axis. The micromotion between the bone-implant interfaces was calculated using ANSYS 9.0 software featuring a nonlinear contact algorithm.

RESULTS:

The micromotion values for 15-degree and 25-degree angled abutments were 119% and 134%, respectively, compared to the corresponding values for straight abutments. Compared to straight abutments, the 25-degree abutments resulted in increased maximum von Mises stresses to a level of 18%. Most of the stresses were concentrated within the cortical bone around the neck of the implants.

CONCLUSION:

Within the limits of the present finite element analysis study, abutment angulation up to 25 degrees can increase the stress in the peri-implant bone by 18% and the micromotion level by 30%.
Bone level changes at axial- and non-axial-positioned implants supporting fixed partial dentures. A 5-year retrospective longitudinal study.

Koutouzis T, Wennström JL.


Abstract

AIM:

The aim of this study was to retrospectively analyze the potential influence of implant inclination on marginal bone loss at freestanding, implant-supported, fixed partial dentures (FPDs) over a 5-year period of functional loading.

MATERIAL AND METHODS:

The material comprised 38 periodontally treated, partially dentate patients with a total of 42 free-standing FPDs supported by implants of the Astra Tech System. Mesio-distal inclination of the implants in relation to a vertical axis perpendicular to the occlusal plane was measured with a protractor on standardized photographs of the master cast. The two tail quartiles of the distribution of the implants with regard to the implant inclination were defined as axial-positioned (mean 2.4 degrees; range 0-4 degrees) and non-axial-positioned implants (mean 17.1 degrees; range 11-30 degrees), respectively. For FPDs supported by two implants, both the mesial-distal and buccal-lingual inter-implant inclination was measured. The primary outcome variable was change in peri-implant bone level from the time of FPD placement to the 5-year follow-up examination. Comparison between axial- and non-axial-positioned implants was performed by the use of a Mann-Whitney U-test. Spearman's correlation analysis was used to analyze relationships between inter-implant inclination (mesial-distal and buccal-lingual) and 5-year bone level change on the FPD level.

RESULTS:

The 5-year mean bone level change amounted to 0.4 mm (SD 0.97) for the axial and 0.5 mm (0.95) for non-axial-positioned implants (P>0.05). For the FPDs supported by two implants, the mean inter-implant inclination was 9.2 degrees (1-36 degrees) in the mesial-distal direction and 6.7 degrees (0-24 degrees) in the buccal-lingual direction. Correlation analysis revealed lack of statistically significant correlation between inter-implant inclination (mesial-distal and buccal-lingual) and 5-year bone level change (r=-0.19 and r=-0.32, respectively).

CONCLUSION:

The study failed to support the hypothesis that implant inclination has an effect on peri-implant bone loss.