

1. Clin Oral Implants Res. 2009 Sep;20 Suppl 4:32-47. PMID: 19663947 [PubMed - indexed for MEDLINE]

Title: Are ceramic implants a viable alternative to titanium implants? A systematic literature review.

Authors:

Andreiotelli M, Wenz HJ, Kohal RJ. Department of Prosthodontics, School of Dentistry, Albert-Ludwigs University, Freiburg, Germany.

AIM:

The aim of this systematic review was to screen the literature in order to locate animal and clinical data on bone-implant contact (BIC) and clinical survival/success that would help to answer the question 'Are ceramic implants a viable alternative to titanium implants?' MATERIAL AND METHODS: A literature search was performed in the following databases:

- (1) the Cochrane Oral Health Group's Trials Register,
- (2) the Cochrane Central Register of Controlled Trials (CENTRAL),
- (3) MEDLINE (Ovid), and
- (4) PubMed.

To evaluate biocompatibility, animal investigations were scrutinized regarding the amount of BIC and to assess implant longevity clinical data were evaluated.

Results: The PubMed search yielded 349 titles and the Cochrane/MEDLINE search yielded 881 titles. Based upon abstract screening and discarding duplicates from both searches, 100 full-text articles were obtained and subjected to additional evaluation. A further publication was included based on the manual search. The selection process resulted in the final sample of 25 studies. No (randomized) controlled clinical trials regarding the outcome of zirconia and alumina ceramic implants could be found. The systematic review identified histological animal studies showing similar BIC between alumina, zirconia and titanium. Clinical investigations using different alumina oral implants up to 10 years showed survival/success rates in the range of 23 to 98% for different indications. The included zirconia implant studies presented a survival rate from 84% after 21 months to 98% after 1 year.

Conclusions:

No difference was found in the rate of osseo-integration between the different implant materials in animal experiments. Only cohort investigations were located with questionable scientific value. Alumina implants did not perform satisfactorily and therefore, based on this review, are not a viable alternative to titanium implants. Currently, the scientific clinical data for ceramic implants in general and for zirconia implants in particular are not sufficient to recommend ceramic implants for routine clinical use. Zirconia, however, may have the potential to be a successful implant material, although this is as yet unsupported by clinical investigations.

2. Int J Prosthodont. 2008 Jan-Feb;21(1):27-36. PMID: 18350943 [PubMed - indexed for MEDLINE]

Title: Osseointegration and clinical success of zirconia dental implants: a systematic review.

Authors:

Wenz HJ, Bartsch J, Wolfart S, Kern M. Department of Prosthodontics, Propaedeutics and Dental Materials, School of Dentistry, Christian-Albrechts University, Kiel, Germany. hjwenz@proth.uni-kiel.de

Purpose:

Various ceramic implant systems made of yttria-stabilized tetragonal zirconia polycrystals (Y-TZP) have become commercially available in recent years. A systematic search of the literature was performed to assess the clinical success of dental Y-TZP implants and whether the osseointegration of Y-TZP is comparable to that of titanium, the standard implant material. MATERIALS AND METHODS: The internet database MEDPILOT was searched cumulatively for the keywords zircon* and dent* and implant as well as for zircon* and osseointegration. The last search was conducted on January 31st, 2007. Subsequently, the reference lists of the relevant publications were searched. Furthermore, a letter was sent to the 5 identified manufacturers of zirconia dental implants to ask for peer-reviewed publications. RESULTS: Ninety-six articles were found by the search strategy. No controlled clinical studies in humans regarding clinical outcomes or osseointegration could be identified. Clinical data were restricted to case studies and case series. Only 7 animal studies fulfilled the inclusion criteria. Osseointegration was evaluated at 4 weeks to 24 months after placement in different animal models and sites and under different loading conditions. The mean bone-implant contact percentage was above 60% in almost all experimental groups. In studies that used titanium implants as a control, Y-TZP implants were comparable to or even better than titanium implants. Surface modifications may further improve initial bone healing and resistance to removal torque.

Conclusions:

Y-TZP implants may have the potential to become an alternative to titanium implants but cannot currently be recommended for routine clinical use, as no long-term clinical data are available.

**3. Clin Implant Dent Relat Res. 2009 Jun;11(2):158-66. Epub 2008 Jul 24. PMID: 18657150
[PubMed - indexed for MEDLINE]**

Title:

Fracture strength of zirconia implants after artificial aging.

Authors:

Andreiotelli M, Kohal RJ. Department of Prosthodontics, School of Dentistry, Albert-Ludwigs University, Freiburg, Germany. marina.andreiotelli@uniklinik-freiburg.de

Background: Zirconia (ZrO₂) might be an alternative material to titanium (Ti) for dental implant fabrication. However, no data are available on the fracture strength of one-piece ZrO₂ oral implants. **PURPOSE:** The objective of this study was to evaluate the fracture strength of ZrO₂ implants after exposure to the artificial mouth. **MATERIALS AND METHODS:** One hundred twenty ZrO₂ and Ti implants were used. The Ti implants were divided into two control groups (A and B). ZrO₂ implants manufactured from yttria-stabilized tetragonal ZrO₂ polycrystal (Y-TZP) in group C, from Y-TZP dotted with alumina (Y-TZP-A) in group D, and from Y-TZP-A with a modified surface in groups E and F were used. In group F, the implant heads were prepared, and in group G, the implants were restored with ZrO₂ crowns. Each group included 16 samples with the exception of group D, which included 24 samples. A subgroup of each implant type (eight implants) was subjected to thermomechanical cycling in a chewing simulator prior to fracture testing. Test specimens were then loaded until a fracture occurred. **RESULTS:** Seven of the 120 samples failed in the chewing simulator. ZrO₂ implant fracture occurred at 725 to 850 N when the implants were not prepared, and at 539 to 607 N when prepared. The samples in group A fractured at the level of the abutment screw. All ZrO₂ implants fractured at the level of the Technovit resin (Heraeus Kulzer GmbH & Co., Wehrheim, Germany). No fracture of the ZrO₂ crowns in group G was observed.

Conclusion:

Mean fracture strength values obtained were all within the limits of clinical acceptance. However, implant preparation had a statistically significant negative influence on the implant fracture strength. Long-term clinical data are necessary before one-piece ZrO₂ implants can be recommended for daily practice.

4. Int J Oral Maxillofac Implants. 2010 Mar-Apr;25(2):336-44. PMID: 20369093 [PubMed - in process]

Title:

Five-year Success Rate of 831 Consecutively Placed Zirconia Dental Implants in Humans: A Comparison of Three Different Rough Surfaces.

Aurhors:

Oliva J, Oliva X, Oliva JD.

Purpose: The aim of this study was to evaluate the 5-year success rate of zirconia (ZrO₂) implants with three different kinds of surfaces. **Materials and Methods:** One-piece zirconia dental implants (CeraRoot) with three different roughened surfaces were designed and manufactured for this study: coated, uncoated, and acid-etched. Five different implant designs were manufactured. Standard or flapless surgical procedures were used for implant placement. Simultaneous bone augmentation or sinus elevation was performed when bone height or width was insufficient. Definitive all-ceramic restorations were placed 4 months after implant placement (8 months or more for implants when bone augmentation or sinus elevation was performed). The implants were followed up to 5 years (mean, 3.40 +/- 0.21). **Results:** In all, 831 implants were placed in 378 patients with a mean age of 48 years. The overall implant success rate after 5 years of follow-up was 95% (92.77% for uncoated implants, 93.57% for coated implants, and 97.60% for acid-etched implants). The success rate of the acid-etched surface group was significantly better than that of the other two.

Conclusion:

From this midterm investigation, it can be concluded that zirconia dental implants with roughened surfaces might be a viable alternative for tooth replacement. Further follow-up is needed to evaluate the long-term success rates of the implant surfaces studied.

5. **Int J Oral Maxillofac Surg. 2010 Feb 19. [Epub ahead of print] PMID: 20172693 [PubMed - as supplied by publisher] Copyright © 2010 International Association of Oral and Maxillofacial Surgeons.
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Title:

Comparison of zirconia and titanium implants after a short healing period. A pilot study in minipigs.

Authors:

Stadlinger B, Hennig M, Eckelt U, Kuhlisch E, Mai R. Department of Oral & Maxillofacial Surgery, Faculty of Medicine, University of Technology Dresden, Germany.

The aim of this animal study was to investigate and compare the osseointegration of zirconia and titanium dental implants. 14 one-piece zirconia implants and 7 titanium implants were inserted into the mandibles of 7 minipigs. The zirconia implants were alternately placed submerged and non-submerged. To enable submerged healing, the supraosseous part was removed, using a diamond saw. The titanium implants were all placed submerged. After a healing period of 4 weeks, a histological analysis of the soft and hard tissue and a histomorphometric analysis of the bone-implant contact (BIC) and relative peri-implant bone-volume density (rBVD; relation to bone-volume density of the host bone) was performed. Two zirconia implants were found to be loose. All other implants were available for evaluation. For submerged zirconia and titanium implants, the implant surface showed an intimate connection to the neighboring bone, with both types achieving a BIC of 53%. For the non-submerged zirconia implants, some crestal epithelial downgrowth could be detected, with a resultant BIC of 48%. Highest rBVD values were found for submerged zirconia (80%), followed by titanium (74%) and non-submerged zirconia (63%). The results suggest that unloaded zirconia and titanium implants osseointegrate comparably, within the healing period studied.

6. Int J Oral Maxillofac Implants. 2009 Jan-Feb;24(1):52-8. PMID: 19344025 [PubMed - indexed for MEDLINE]

Title:

Collagen fiber orientation around machined titanium and zirconia dental implant necks: an animal study.

Authors:

Tetè S, Mastrangelo F, Bianchi A, Zizzari V, Scarano A. Department of Oral Science, University G. d'Annunzio, Chieti-Pescara, Italy. tete@unich.it

Purpose: To evaluate in vivo collagen fiber behavior around two different dental implant necks placed in the mandibular bone of adult pigs. **Materials and methods:** Scanning electron microscopic (SEM) and profilometric analyses were performed on both types of implant necks to evaluate the different surface morphology. Ten dental implants with machined titanium necks and 20 implants with zirconia necks were inserted into the mandibles of five adult pigs. Three months later, the animals were sacrificed; samples from the peri-implant mucosa were obtained and prepared for histologic analysis. Evaluation of collagen fiber orientation in the connective tissue surrounding the implant necks was performed by polarized light microscopy. Inflammation in the peri-implant soft tissues was also measured via the Gingival Index. **Results:** ostoperative healing was uneventful; all implants, except for one of each type, were osseointegrated after 3 months. SEM and profilometric analyses confirmed that zirconia necks showed Ra, Rq, and Rz values that were lower than those seen around the titanium necks. Histologic observation indicated that collagen fiber orientation was similar for both types of implants. The majority of fibers showed a parallel or parallel-oblique orientation to the implant surface for all samples. Implants that were not osseointegrated, as determined by clinical evaluation, showed inflammatory infiltrate, whereas healthy connective tissue was found around all the other implant necks.

Conclusions:

Collagen fiber orientation was similar, regardless of implant material, demonstrating a predominantly parallel or parallel-oblique pattern. Moreover, zirconia, which is used as a transgingival collar on some implants, showed connective tissue adhesion that was similar to that seen on the machined titanium surface, but demonstrated limited plaque formation and may provide better esthetics.

7. Clin Oral Implants Res. 2009 Apr;20(4):333-9. PMID: 19298287 [PubMed - indexed for Medline]

Title:

Biomechanical and histological behavior of zirconia implants: an experiment in the rat.

Authors:

Kohal RJ, Wolkewitz M, Hinze M, Han JS, Bächle M, Butz F. Department of Prosthodontics, University Hospital Freiburg, School of Dentistry, Freiburg, Germany. ralf.kohal@uniklinik-freiburg.de

Objective: This study aimed at evaluating the integration of zirconia implants in a rat femur model. **Material and Methods:** Zirconia implants with two distinct surface topographies were compared with titanium implants with similar topographies. Titanium and zirconia implants were placed into the femurs of 42 male Sprague-Dawley rats. Four groups of implants were utilized: machined zirconia implants, zirconia implants with a rough surface, machined titanium implants, and titanium implants with an electrochemically roughened surface. After a healing period of 28 days, the load-bearing capacity between the bone and the implant surface was evaluated by a push-in test. Additionally, after a healing period of 14 and 28 days, respectively, bone tissue specimens containing the implants were processed and histologically analyzed. **Results:** The mean mineralized bone-to-implant contact showed the highest values after 14 and 28 days for the rough surfaces (titanium: 36%/45%; zirconia: 45%/59%). Also, the push-in test showed higher values for the textured implant surfaces, with no statistical significance between titanium (34 N) and zirconia (45.8 N).

Conclusions:

Within the limits of the animal investigation presented, it was concluded that all tested zirconia and titanium implant surfaces were biocompatible and osseointegrating. The presented surface modification of zirconia implants showed no difference regarding the histological and biomechanical results compared with an established electrochemically modified titanium implant surface.

8. Head Face Med. 2008 Dec 11;4:30. PMID: 19077228 [PubMed - indexed for Medline]

Title:

Osseointegration of zirconia implants compared with titanium: an in vivo study.

Authors:

Depprich R, Zipprich H, Ommerborn M, Naujoks C, Wiesmann HP, Kiattavorncharoen S, Lauer HC, Meyer U, Kübler NR, Handschel J.

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Background: Titanium and titanium alloys are widely used for fabrication of dental implants. Since the material composition and the surface topography of a biomaterial play a fundamental role in osseointegration, various chemical and physical surface modifications have been developed to improve osseous healing. Zirconia-based implants were introduced into dental implantology as an alternative to titanium implants. Zirconia seems to be a suitable implant material because of its tooth-like colour, its mechanical properties and its biocompatibility. As the osseointegration of zirconia implants has not been extensively investigated, the aim of this study was to compare the osseous healing of zirconia implants with titanium implants which have a roughened surface but otherwise similar implant geometries. **Methods:** Forty-eight zirconia and titanium implants were introduced into the tibia of 12 minipigs. After 1, 4 or 12 weeks, animals were sacrificed and specimens containing the implants were examined in terms of histological and ultrastructural techniques.

Results: Histological results showed direct bone contact on the zirconia and titanium surfaces. Bone implant contact as measured by histomorphometry was slightly better on titanium than on zirconia surfaces. However, a statistically significant difference between the two groups was not observed.

Conclusion:

The results demonstrated that zirconia implants with modified surfaces result in an osseointegration which is comparable with that of titanium implants.

9. Int J Periodontics Restorative Dent. 2008 Oct;28(5):479-87. PMID: 18990999 [PubMed - indexed for Medline]

Title:

Zirconia for teeth and implants: a case series.

Authors:

Kollar A, Huber S, Mericske E, Mericske-Stern R. Department of Prosthodontics, University of Bern, Bern, Switzerland.

This case series reports on the use of nonsilica-based high-strength full ceramics for different prosthetic indications. Fifty-two consecutive patients received tooth- or implant-supported zirconia reconstructions during a 2-year period. The observation period for reexamination was 12 to 30 months. The most frequent indications were single crowns and short-span fixed partial dentures. A few implant superstructures were screw-retained, whereas all remaining restorations were cemented on natural teeth or zirconia implant abutments. Clinical examination included biologic (probing depths, bleeding on probing) and esthetic (Papilla Index) parameters, as well as technical complications. No implant was lost or caused any problems, but two teeth were lost after horizontal fracture. Overall, the periodontal parameters were favorable. Fractures of frameworks or implant abutments were not observed. Abutment-screw loosening occurred once for one premolar single crown. Furthermore, five implant crowns in the posterior region exhibited chipping of the porcelain veneering material. With regard to esthetics, no reconstructions were considered unacceptable, but three crowns were remade shortly after delivery. In this short-term study, it was observed that biologic, esthetic, and mechanical properties of zirconia were favorable, and the material could be used in various prosthetic indications on teeth or implants.

10. Head Face Med. 2008 Nov 6;4:25. PMID: 18990214 [PubMed - indexed for Medline]

Title:

Osseointegration of zirconia implants: an SEM observation of the bone-implant interface.

Authors:

Depprich R, Zipprich H, Ommerborn M, Mahn E, Lammers L, Handschel J, Naujoks C, Wiesmann HP, Kübler NR, Meyer U. Department for Operative and Preventive Dentistry and Endodontics, Heinrich-Heine-University Duesseldorf, Germany. depprich@med.uni-duesseldorf.de

Background: The successful use of zirconia ceramics in orthopedic surgery led to a demand for dental zirconium-based implant systems. Because of its excellent biomechanical characteristics, biocompatibility, and bright tooth-like color, zirconia (zirconium dioxide, ZrO₂) has the potential to become a substitute for titanium as dental implant material. The present study aimed at investigating the osseointegration of zirconia implants with modified ablative surface at an ultrastructural level. **Methods:** A total of 24 zirconia implants with modified ablative surfaces and 24 titanium implants all of similar shape and surface structure were inserted into the tibia of 12 Göttinger minipigs. Block biopsies were harvested 1 week, 4 weeks or 12 weeks (four animals each) after surgery. Scanning electron microscopy (SEM) analysis was performed at the bone implant interface. **Results:** Remarkable bone attachment was already seen after 1 week which increased further to intimate bone contact after 4 weeks, observed on both zirconia and titanium implant surfaces. After 12 weeks, osseointegration without interposition of an interfacial layer was detected. At the ultrastructural level, there was no obvious difference between the osseointegration of zirconia implants with modified ablative surfaces and titanium implants with a similar surface topography.

Conclusion:

The results of this study indicate similar osseointegration of zirconia and titanium implants at the ultrastructural level.

**11. Clin Implant Dent Relat Res. 2009 Dec;11(4):323-9. Epub 2008 Sep 9. PMID: 18783418
[PubMed - indexed for Medline]**

Title:

Stability of prototype two-piece zirconia and titanium implants after artificial aging: an in vitro pilot study.

Authors:

Kohal RJ, Finke HC, Klaus G. Department of Prosthodontics, Albert-Ludwigs-University, Hugstetter Strasse 55; 79106 Freiburg, Germany. ralf.kohal@uniklinik-freiburg.de

Background: Zirconia oral implants are a new topic in implant dentistry. So far, no data are available on the biomechanical behavior of two-piece zirconia implants. Therefore, the purpose of this pilot investigation was to test in vitro the fracture strength of two-piece cylindrical zirconia implants after aging in a chewing simulator. **Materials and methods:** This laboratory in vitro investigation comprised three different treatment groups. Each group consisted of 16 specimens. In group 1, two-piece zirconia implants were restored with zirconia crowns (zirconia copings veneered with Triceram; Esprident, Ispringen, Germany), and in group 2 zirconia implants received Empress 2 single crowns (Ivoclar Vivadent AG, Schaan, Liechtenstein). The implants, including the abutments, in the two zirconia groups were identical. In group 3, similar titanium implants were reconstructed with porcelain-fused-to-metal crowns. Eight samples of each group were submitted to artificial aging with a long-term load test in the artificial mouth (chewing simulator). Subsequently, all not artificially aged samples and all artificially aged samples that survived the long-term loading of each group were submitted to a fracture strength test in a universal testing machine. For the pairwise comparisons in the different test groups with or without artificial loading and between the different groups at a given artificial loading condition, the Wilcoxon rank-sum test for independent samples was used. The significance level was set at 5%. **Results:** One sample of group 1 (veneer fracture), none of group 2, and six samples of group 3 (implant abutment screw fractures) failed while exposed to the artificial mouth. The values for the fracture strength after artificial loading with 1.2 million cycles for group 1 were between 45 and 377 N (mean: 275.7 N), in group 2 between 240 and 314 N (mean: 280.7 N), and in the titanium group between 45 and 582 N (mean: 165.7 N). The fracture strength results without artificial load for group 1 amounted to between 270 and 393 N (mean: 325.1 N), for group 2 between 235 and 321 N (mean: 281.8 N), and between 474 and 765 N (mean: 595.2 N) for the titanium group. The failure mode during the fracture testing in the zirconia implant groups was a fracture of the implant head and a bending/fracture of the abutment screw in the titanium group.

Conclusions:

Within the limits of this pilot investigation, the biomechanical stability of all tested prototype implant groups seems to be - compared with the possibly exerted occlusal forces - borderline for clinical use. A high number of failures occurred already during the artificial loading in the titanium group at the abutment screw level. The zirconia implant groups showed irreparable implant head fractures at relatively low fracture loads. Therefore, the clinical use of the presented prototype implants has to be questioned.

**12. J Biomed Mater Res B Appl Biomater. 2009 Feb;88(2):519-29.
PMID: 18561291 [PubMed - indexed for Medline] Copyright 2008 Wiley Periodicals, Inc.**

Title:

Zirconia: Established facts and perspectives for a biomaterial in dental implantology.

Authors:

Hisbergues M, Vendeville S, Vendeville P. Pasteur Institute of Lille, Laboratory of Lactic Acid Bacteria and Mucosal Immunology, Lille, France.

Currently, zirconia is widely used in biomedical area as a material for prosthetic devices because of its good mechanical and chemical properties. Largely employed in clinical area for total hip replacement, zirconia ceramics (ZrO₂) are becoming a prevalent biomaterial in dentistry and dental implantology. Although titanium is used in dental implantology currently, there is a trend to develop new ceramic-based implants as an alternative to monolithic titanium. This article reviews the evolution and development of zirconia through data published between 1963 and January 2008 in English language. Articles were identified via a MEDLINE search using the following keywords: zirconia, zirconia/biocompatibility, zirconia/osseointegration, zirconia/periosteointegration, zirconia/review, and zirconia/bacterial adhesion or colonization. This review of the literature aims at highlighting and discussing zirconia properties in biological systems for their future use in dental implantology. In conclusion, zirconia with its interesting microstructural properties has been confirmed to be a material of choice for the "new generation" of implants, thanks to its biocompatibility, osseointegration, tendency to reduce plaque accumulation, and interaction with soft tissues, which leads to periosteointegration. However, scientific studies are promptly needed to fulfill gaps like long-term clinical evaluations of "all zirconia implants," currently leading to propose an alternative use of "hybrid systems" (i.e., titanium screw with zirconia collar) and also bacterial colonization of zirconia. Moreover, there is a permanent need for consistent information about topography and chemistry of zirconia allowing easier cross-product comparisons of clinical devices.

**13. Int J Immunopathol Pharmacol. 2007 Jan-Mar;20(1 Suppl 1):9-12. PMID: 17897494
[PubMed - indexed for Medline]**

Title:

Biological considerations on the use of zirconia for dental devices.

Authors:

Manicone PF, Rossi Iommetti P, Raffaelli L, Paolantonio M, Rossi G, Berardi D, Perfetti G.
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Zirconium oxide, known as zirconia, is a ceramic material with optimal esthetical and mechanical properties. Zirconia stabilized with yttrium oxide has the best properties for medical uses. A stress on ZrO₂ surface creates a crystalline modification that opposes to propagation of cracks. Zirconia core for fixed partial dentures (FPD) on anterior and posterior teeth and on implants are now available. Clinical evaluations after 3 years report good percentage of success for zirconia fixed partial denture. Zirconia biocompatibility was studied in vivo and in vitro by orthopedic research; no adverse responses were reported on insertion of ZrO₂ samples in bone or muscle. In vitro experimentation showed absence of mutation and a good viability of cells cultured on this material.

14. Int J Oral Maxillofac Implants. 2008 Jan-Feb;23(1):65-74.

Title:

Evaluation of the cylinder implant thread height and width: a 3-dimensional finite element analysis.
PMID: 18416414 [PubMed - indexed for MEDLINE]

Authors:

Kong L, Hu K, Li D, Song Y, Yang J, Wu Z, Liu B. Department of Oral and Maxillofacial Surgery, School of Stomatology, Fourth Military Medical University, Xi'an, Shaanxi, China.

PURPOSE: To evaluate continuous and simultaneous variations of thread height and width for an experimental screw-type implant. **MATERIALS AND METHODS:** A finite element model of an implant with a V-shaped thread was created. The range of thread height was set at 0.20 to 0.60 mm, and the range of thread width was set at 0.10 to 0.40 mm. Forces of 100 N and 50 N were applied along the implant axis (AX) and an angle of 45 degrees in a buccolingual direction (45-degree BL), respectively. The maximum von Mises stresses in jawbone were evaluated, and the sensitivity of the stress in jawbone to the variables was also evaluated. **RESULTS:** Under AX load, the maximum von Mises stresses in cortical and cancellous bones increased by 4.3% and 63.0%, respectively, as thread parameters changed. Under 45-degree BL load, maximum von Mises stresses in cortical and cancellous bones increased by 19.3% and 118.0%, respectively. When thread height was from 0.34 to 0.50 mm and thread width was 0.18 to 0.30 mm, the tangent slope of the maximum von Mises stress response curve ranged from -1 to 1. The variation of the maximum von Mises stresses in jawbone was more sensitive to thread height than to thread width.

CONCLUSIONS: Stress in cancellous bone is more likely to be influenced by thread parameters than stress in cortical bone. A 45-degree BL force is more likely to be influenced by thread parameters than an axial force. A thread height of 0.34 to 0.50 mm and a thread width of 0.18 to 0.30 mm is optimal from a biomechanical point of view. In the design of a screw-type implant, thread height is more important than thread width for the reduction of stress within the bone.

Publication Types:

- Evaluation Studies

MeSH Terms:

- Alveolar Process/physiology
- Alveolar Process/surgery
- Biomechanics
- Bone Screws
- Computer Simulation
- Dental Implantation, Endosseous/methods*
- Dental Implants*
- Dental Prosthesis Design*
- Dental Stress Analysis/methods*
- Finite Element Analysis
- Humans
- Imaging, Three-Dimensional

- Osseointegration*/physiology
- Stress, Mechanical

Substances:

- Dental Implants

15. Clin Oral Implants Res. 2010 Mar;21(3):350-6. Epub 2010 Jan 13.

Osseointegration of one-piece zirconia implants compared with a titanium implant of identical design: a histomorphometric study in the dog.

Koch FP, Weng D, Krämer S, Biesterfeld S, Jahn-Eimermacher A, Wagner W.

Department of Oral and Maxillofacial Surgery, Faculty of Medicine, University of Mainz, Mainz, Germany.

Abstract

OBJECTIVE: The aim of this study was to evaluate osseointegration of one-piece zirconia vs. titanium implants depending on their insertion depth by histomorphometry.

MATERIAL AND METHODS: Four one-piece implants of identical geometry were inserted on each side of six mongrel dogs: (1) an uncoated zirconia implant, (2) a zirconia implant coated with a calcium-liberating titanium oxide coating, (3) a titanium implant and (4) an experimental implant made of a synthetic material (polyetheretherketone). In a split-mouth manner they were inserted in submerged and non-submerged gingival healing modes. After 4 months, dissected blocks were stained with toluidine blue in order to histologically assess the bone-to-implant contact (BIC) rates and the bone levels (BL) of the implants.

RESULTS: All 48 implants were osseointegrated clinically and histologically. Histomorphometrically, BL in the crestal implant part did not differ significantly with regard to material type or healing modality. The submerged coated zirconia implants tended to offer the most stable crestal BL. The histometric results reflected the different healing modes by establishing different BL. The median BIC of the apical implant part of the zirconia and titanium group amounted to 59.2% for uncoated zirconia, 58.3% for coated zirconia, 26.8% for the synthetic material and 41.2% for titanium implants.

CONCLUSIONS: Within the limits of this animal study, it is concluded that zirconia implants are capable of establishing close BIC rates similar to what is known from the osseointegration behaviour of titanium implants with the same surface modification and roughness.

PMID: 20074240 [PubMed - indexed for MEDLINE]

16. J Dent. 2008 Jul;36(7):513-9. Epub 2008 May 13.

Fracture resistance and failure patterns of endodontically treated mandibular molars with and without glass fiber post in combination with a zirconia-ceramic crown.

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Abstract

OBJECTIVE: The aim of this study was to investigate the influence of a fiber post on the fracture mechanics of zirconia crowns inserted over endodontically treated teeth with different extent of coronal damage.

METHODS: Endodontically treated human molars with three types of coronal damage received fiber posts before cementation of zirconia-veneered crowns. Controls received composite resin cores without fiber posts. The specimens were loaded to failure and fractographically examined using a scanning electron microscope (SEM).

RESULTS: Statistical analysis revealed that specimens with fiber posts demonstrated significantly higher failure loads and favorable fracture pattern compared to the controls. At fractographic analysis, specimens with fiber posts demonstrated delamination of the veneer ceramic from intact zirconia under structure. Meanwhile, the specimens that were restored without a fiber post demonstrated micro-cracking of the composite core build-up resulting in loss of the support under the zirconia crowns which was responsible for the initiation of radial crack and catastrophic damage.

CONCLUSIONS: Within the limitation of this study, the insertion of fiber post improved the support under zirconia crowns which resulted in higher fracture loads and favorable failure type compared to composite core build-up.

PMID: 18479800 [PubMed - indexed for MEDLINE]

17 . J Dent. 2009 Feb;37(2):115-21. Epub 2008 Dec 17.

Long-term survival of endodontically treated, maxillary anterior teeth restored with either tapered or parallel-sided glass-fiber posts and full-ceramic crown coverage.

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Abstract

OBJECTIVES: This retrospective study investigated the clinical effectiveness over up to 8 years of parallel-sided and of tapered glass-fiber posts, in combination with either hybrid composite or dual-cure composite resin core material, in endodontically treated, maxillary anterior teeth covered with full-ceramic crowns.

METHODS: The study population comprised 192 patients and 526 endodontically treated teeth, with various degrees of hard-tissue loss, restored by the post-and-core technique. Four groups were defined based on post shape and core build-up materials, and within each group post-and-core restorations were assigned randomly with respect to root morphology. Inclusion criteria were symptom-free endodontic therapy, root-canal treatment with a minimum apical seal of 4mm, application of rubber dam, need for post-and-core complex because of coronal tooth loss, and tooth with at least one residual coronal wall. Survival rate of the post-and-core restorations was determined using Kaplan-Meier statistical analysis.

RESULTS: The restorations were examined clinically and radiologically; mean observation period was 5.3 years. The overall survival rate of glass-fiber post-and-core restorations was 98.5%. The survival rate for parallel-sided posts was 98.6% and for tapered posts was 96.8%. Survival rates for core build-up materials were 100% for dual-cure composite and 96.8% for hybrid light-cure composite.

CONCLUSIONS: For both glass-fiber post designs and for both core build-up materials, clinical performance was satisfactory. Survival was higher for teeth retaining four and three coronal walls.

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18. Clin Oral Implants Res. 2009 Sep;20 Suppl 4:32-47.

Are ceramic implants a viable alternative to titanium implants? A systematic literature review.

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Abstract

AIM: The aim of this systematic review was to screen the literature in order to locate animal and clinical data on bone-implant contact (BIC) and clinical survival/success that would help to answer the question 'Are ceramic implants a viable alternative to titanium implants?'

MATERIAL AND METHODS: A literature search was performed in the following databases: (1) the Cochrane Oral Health Group's Trials Register, (2) the Cochrane Central Register of Controlled Trials (CENTRAL), (3) MEDLINE (Ovid), and (4) PubMed. To evaluate biocompatibility, animal investigations were scrutinized regarding the amount of BIC and to assess implant longevity clinical data were evaluated.

RESULTS: The PubMed search yielded 349 titles and the Cochrane/MEDLINE search yielded 881 titles. Based upon abstract screening and discarding duplicates from both searches, 100 full-text articles were obtained and subjected to additional evaluation. A further publication was included based on the manual search. The selection process resulted in the final sample of 25 studies. No (randomized) controlled clinical trials regarding the outcome of zirconia and alumina ceramic implants could be found. The systematic review identified histological animal studies showing similar BIC between alumina, zirconia and titanium. Clinical investigations using different alumina oral implants up to 10 years showed survival/success rates in the range of 23 to 98% for different indications. The included zirconia implant studies presented a survival rate from 84% after 21 months to 98% after 1 year.

CONCLUSIONS: No difference was found in the rate of osseointegration between the different implant materials in animal experiments. Only cohort investigations were located with questionable scientific value. Alumina implants did not perform satisfactorily and therefore, based on this review, are not a viable alternative to titanium implants. Currently, the scientific clinical data for ceramic implants in general and for zirconia implants in particular are not sufficient to recommend ceramic implants for routine clinical use. Zirconia, however, may have the potential to be a successful implant material, although this is as yet unsupported by clinical investigations.

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19. Dent Mater. 2010 Aug;26(8):807-20. Epub 2010 May 26.

Low temperature degradation -aging- of zirconia: A critical review of the relevant aspects in dentistry.

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Abstract

This review presents a critical survey of all experimental data about the low temperature degradation of zirconia (often referred to as "aging") due to the tetragonal-to-monoclinic transformation, which have been collected at temperatures of interest for dental application (room temperature to about 100 degrees C). It is shown that the main factors affecting the aging phenomenon are (i) the stabilizer type and content, (ii) the residual stress and (iii) the grain size. It is also shown that extrapolating the low temperature degradation rate from accelerated aging tests can lead to unacceptable conclusions about the lifetime of the zirconia-based components. Finally, based on the experimental evidence, a set of engineering guidelines for the use of zirconia in restorative and prosthetic dentistry is proposed.

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Low temperature degradation of a Y-TZP dental ceramic.

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Abstract

Bars of Y-TZP ceramic for dental restorations were subjected to hydrothermal degradation via in vitro exposure to water steam at 140°C for 7 days. X-ray diffraction, atomic force microscopy and scanning electron microscopy techniques were applied to observe and quantify the tetragonal-monoclinic (t-m) phase transformation associated with the process. Nanoindentation was used to assess the ceramic's mechanical properties before and after hydrothermal degradation. Texture associated with martensitic t-m transformation was observed at the grain surface. The t-m transformation followed nucleation-and-growth kinetics, with predominance of the nucleation process. The transformation occurred within a layer of 6µm below the surface. Mechanical properties deteriorated with hydrothermal degradation, resulting in a 30% reduction of Young's modulus and hardness. A strong correlation was found between the increasing monoclinic fraction and the decline in mechanical response. It was thus concluded that the emergence of the monoclinic phase and the associated microcracking were the most likely causes for the degradation of mechanical properties.

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