Clinical trials in zirconia: a systematic review.

Al-Amleh B, Lyons K, Swain M.


Department of Oral Rehabilitation, Faculty of Dentistry, University of Otago, Dunedin, New Zealand. alamleh@gmail.com

Abstract

Zirconia is unique in its polymorphic crystalline makeup, reported to be sensitive to manufacturing and handling processes, and there is debate about which processing method is least harmful to the final product. Currently, zirconia restorations are manufactured by either soft or hard-milling processes, with the manufacturer of each claiming advantages over the other. Chipping of the veneering porcelain is reported as a common problem and has been labelled as its main clinical setback. The objective of this systematic review is to report on the clinical success of zirconia-based restorations fabricated by both milling processes, in regard to framework fractures and veneering porcelain chipping. A comprehensive review of the literature was completed for in vivo trials on zirconia restorations in MEDLINE and PubMed between 1950 and 2009. A manual hand search of relevant dental journals was also completed. Seventeen clinical trials involving zirconia-based restorations were found, 13 were conducted on fixed partial dentures, two on single crowns and two on zirconia implant abutments, of which 11 were based on soft-milled zirconia and six on hard-milled zirconia. Chipping of the veneering porcelain was a common occurrence, and framework fracture was only observed in soft-milled zirconia. Based on the limited number of short-term in vivo studies, zirconia appears to be suitable for the fabrication of single crowns, and fixed partial dentures and implant abutments providing strict protocols during the manufacturing and delivery process are adhered to. Further long-term prospective studies are necessary to establish the best manufacturing process for zirconia-based restorations.

Recent advances in materials for all-ceramic restorations.

Griggs JA.


Abstract

The past 3 years of research on materials for all-ceramic veneers, inlays, onlays, single-unit crowns, and multi-unit restorations are reviewed in this article. The primary changes in the field were the proliferation of zirconia-based frameworks and computer-aided fabrication of prostheses, and a trend toward more clinically relevant in vitro test methods. This article includes an overview of ceramic fabrication methods, suggestions for critical assessment of
material property data, and a summary of clinical longevity for prostheses constructed of various materials.

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State of the art of zirconia for dental applications.
Denry I, Kelly JR.

Abstract
Zirconia has been recently introduced in prosthetic dentistry for the fabrication of crowns and fixed partial dentures, in combination with CAD/CAM techniques. This review encompasses the specific types of zirconia available in dentistry, together with their properties. The two main processing techniques, soft and hard machining, are assessed in the light of their possible clinical implications and consequences on the long-term performance of zirconia. An update on the status of clinical trials occurring worldwide is provided.

Five-year clinical results of zirconia frameworks for posterior fixed partial dentures.
Sailer I, Fehér A, Filser F, Gauckler LJ, Lüthy H, Hämmerle CH.

Abstract
PURPOSE: The aim of this prospective clinical cohort study was to determine the success rate of 3- to 5-unit zirconia frameworks for posterior fixed partial dentures (FPDs) after 5 years of clinical observation.

MATERIALS AND METHODS: Forty-five patients who needed at least 1 FPD to replace 1 to 3 posterior teeth were included in the study. Fifty-seven 3- to 5-unit FPDs with zirconia frameworks were cemented with 1 of 2 resin cements (Variolink or Panavia TC). The following parameters were evaluated at baseline, after 6 months, and 1 to 5 years after cementation at test (abutments) and control (contralateral) teeth: probing pocket depth, probing attachment level, Plaque Index, bleeding on probing, and tooth vitality. Intraoral radiographs of the FPDs were taken. Statistical analysis was performed using descriptive statistics, Kaplan-Meier survival analysis, and the McNemar test.

RESULTS: Twenty-seven patients with 33 zirconia FPDs were examined after a mean observation period of 53.4 +/- 13 months. Eleven patients with 17 FPDs were lost to follow-up. After the 3-year recall visit, 7 FPDs in 7 patients were replaced because they were not clinically acceptable due to biologic or technical complications. After 5 years of clinical observation, 12 FPDs in 12 patients had to be replaced. One 5-unit FPD fractured as a result
of trauma after 38 months. The success rate of the zirconia frameworks was 97.8%; however, the survival rate was 73.9% due to other complications. Secondary caries was found in 21.7% of the FPDs, and chipping of the veneering ceramic in 15.2%. There were no significant differences between the periodontal parameters of the test and control teeth.

CONCLUSIONS: Zirconia offers sufficient stability as a framework material for 3- and 4-unit posterior FPDs. The fit of the frameworks and veneering ceramics, however, should be improved.

Five-year clinical prospective evaluation of zirconia-based Denzir 3-unit FPDs.

Molin MK, Karlsson SL.


Abstract

PURPOSE: The aim of this prospective study was to evaluate the clinical performance of fully sintered hot isostatic pressed yttria-partially-stabilized zirconia (Denzir) 3-unit fixed partial dentures (FPDs).

MATERIALS AND METHODS: Nineteen 3-unit FPDs were placed in 18 patients. Ten FPDs were placed in the maxilla and 9 in the mandible. Two calibrated examiners evaluated the FPDs independently 1 week (baseline), 1 year, 3 years, and 5 years after placement using the California Dental Association quality evaluation system.

RESULTS: All FPDs were intact at the 5-year examination. One FPD lost retention after 12 months but remained intact; it was recemented and is still in function after 5 years. All FPDs were rated satisfactory over 5 years. No changes were seen in terms of color and anatomic form. The number of slightly rough or pitted occlusal surfaces increased approximately 30% over 5 years. Visible evidence of ditching along the margin increased over time, but only for those FPDs luted with zinc phosphate cement.

CONCLUSION: The 5-year results indicate that yttria-partially-stabilized zirconia 3-unit FPDs with anatomically designed frameworks are promising prosthetic alternatives, even in the premolar and molar regions. However, for all-ceramic FPDs with more units in function, further studies are necessary.

The clinical success of all-ceramic restorations.

Della Bona A, Kelly JR.

J Am Dent Assoc. 2008 Sep;139 Suppl:8S-13S.

Abstract

BACKGROUND: The authors conducted a comprehensive literature review to compile and compare clinical evidence for the treatment of teeth using all-ceramic restorations.
TYPES OF STUDIES REVIEWED: The authors searched the English-language peer-reviewed literature using MEDLINE and PubMed with a focus on research published between 1993 and 2008. They also conducted a hand search of relevant dental journals. They reviewed randomized controlled trials, nonrandomized controlled studies, longitudinal experimental clinical studies, longitudinal prospective studies and longitudinal retrospective studies.

RESULTS: Evidence suggests that for veneers, intracoronal restorations and complete-coverage restorations for single-rooted anterior teeth, clinicians may choose from any all-ceramic system on the basis of esthetic needs (many systems have had greater than 90 percent success at six years). Well-studied molar restorations include those made of alumina and, increasingly, zirconia and bonded lithium disilicate. Reasonable evidence has shown the effectiveness of anterior three-unit fixed partial dentures made of lithium disilicate, alumina and zirconia. For three-unit restorations involving a molar, expert consensus suggests that only zirconia-based systems are indicated.

CLINICAL IMPLICATIONS: Available evidence indicates the effectiveness of many all-ceramic systems for numerous clinical applications. Bonding has been shown to increase clinical success. Studies of zirconia prostheses indicate problems with porcelain cracking.

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Clinical evaluation of all-ceramic posterior three-unit FDPs made of In-Ceram Zirconia.

Eschbach S, Wolfart S, Bohlsen F, Kern M.

Abstract

This prospective study evaluated the clinical outcome of three-unit posterior fixed dental prostheses (FDPs) made of In-Ceram Zirconia. All 65 FDPs were inserted at the Department of Prosthodontics, School of Dentistry, Kiel, Germany, and cemented with glass-ionomer cement. Follow-ups were performed annually. During a mean observation time of 54.4 months, two FDPs failed (one technical and one biologic failure). Two FDPs debonded and the veneering ceramic fractured in four cases. Three abutment teeth needed endodontic treatment and two additional abutment teeth exhibited secondary caries. Results suggest that posterior three-unit all-ceramic FDPs made from In-Ceram Zirconia may be a viable prosthetic treatment option with an outcome comparable to metal-ceramic FDPs.
Prospective evaluation of zirconia posterior fixed partial dentures: four-year clinical results.

Roediger M, Gersdorff N, Huels A, Rinke S.


Abstract

PURPOSE: In this prospective clinical study, the performance of three- and four-unit fixed partial dentures (FPDs) with frameworks fabricated of yttria partially stabilized zirconia was determined after a mean observation period of 50 months. The study focused on the survival of the restoration (in situ criterion) and the success of the ceramic veneers (no defect).

MATERIALS AND METHODS: Seventy-five patients with a maximum of two missing teeth and an antagonistic dentition were treated at the Department of Prosthodontics, University of Goettigen, with 99 posterior FPDs. Fifty-one specimens (experimental group) were veneered with an experimental ceramic suitable for titanium and zirconia frameworks (thermal expansion coefficient [TEC]: 8.5 microm/m*K); 48 restorations (Ceram-S group) were veneered with a commercially available low-fusing ceramic optimized for zirconia frameworks (TEC: 9.5 microm/m*K). All restorations were luted with zinc-phosphate cement. Statistical analysis was performed according to the Kaplan-Meier method; time-dependent success rates of the different types of ceramic veneers were analyzed using the log-rank test.

RESULTS: Seven restorations were lost: 4 due to technical complications and 3 due to biologic complications. The overall survival rate after 48 months was 94% (Kaplan-Meier analysis). Twenty-three events required clinical intervention for restoration maintenance: 13 ceramic veneer chippings (polishing), 6 losses of retention (recementation), 3 caries lesions (filling therapy), and 1 loss of vitality (endodontic treatment). Between the two groups of veneering materials, no significant difference in the probability for success was determined (log-rank test, P=.81).

CONCLUSIONS: Within a mean observation period of 4 years, sufficient survival rates for zirconia-based posterior FPDs could be verified. The main complications included fracture of the ceramic veneering material and decementation, which occurred mainly in the mandible.

Randomized controlled clinical trial of zirconia-ceramic and metal-ceramic posterior fixed dental prostheses: a 3-year follow-up.

Sailer I, Grottnerb J, Kanelb S, Hammerle CH.


Abstract

PURPOSE: The aim of this study was to test whether posterior fixed dental prostheses (FDPs) with zirconia frameworks exhibit similar survival rates and technical and biologic outcomes as those with metal frameworks.

MATERIALS AND METHODS: Fifty-nine patients in need of 76 FDPs replacing one to three posterior teeth (molars and premolars) were included in the study. The three- to five-unit
FDPs were randomly assigned to 38 zirconia-ceramic and 38 metal-ceramic FDPs. At baseline, 6 months, and 1 to 3 years after cementation, the technical outcome of the reconstructions was examined using the United States Public Health Service (USPHS) criteria. The biologic outcome was analyzed at test (abutment) and control (contralateral) teeth by assessing: probing pocket depth (PPD), probing attachment level (PAL), plaque control record (PCR), bleeding on probing (BOP), and tooth vitality. Radiographs of the FDPs were made. Statistical analysis was performed by applying Kaplan-Meier, Pearson chi-square, Fisher exact, and Mann-Whitney U tests.

RESULTS: Fifty-three patients with 67 FDPs (36 zirconia-ceramic, 31 metal-ceramic) were examined after a mean observation period of 40.3 +/- 2.8 months. Six patients with 9 FDPs were lost to follow-up. The survival of both kinds of FDPs was 100%. No significant differences regarding the technical and biologic outcomes were found. Minor chipping of the veneering ceramic was found in 25% of the zirconia-ceramic and 19.4% of the metal-ceramic FDPs. Extended fracturing of the veneering ceramic occurred solely in zirconia-ceramic FDPs (C: 8.6%, D: 2.8% [USPHS criteria]). Few biologic complications were found. Both types of FDPs rendered the same mean values for the biologic parameters (mean PPD, PCR, and BOP for zirconia-ceramic FDPs = 2.4 +/- 0.3, 0.1 +/- 0.1, and 0.3 +/- 0.2, respectively; mean PPD, PCR, and BOP for metal-ceramic FDPs = 2.4 +/- 0.3, 0.1 +/- 0.1, and 0.3 +/- 0.2, respectively).

CONCLUSION: Zirconia-ceramic FDPs exhibited a similar survival rate to metal-ceramic FDPs at 3 years of function.