

SCIENTIFIC COMPENDIUM



cercon[®]
smart ceramics

Scientific Brochure Vol. IV

March 2011

DeguDent
A Dentsply Company

Current research on Cercon at a glance

Introduction	3
Prefabricated zirconium dioxide implant abutments for single-tooth replacement in the posterior region: evaluation of periimplant tissues and superstructures after 12 months of function.	4-5
Prospective evaluation of zirconia posterior fixed partial dentures: four-year clinical results.	6-7
Clinical evaluation of posterior all-ceramic FPDs (Cercon): a prospective clinical pilot study.	8-9
Four-year clinical results of fixed dental prostheses with zirconia substructures (Cercon): end abutments vs. cantilever design.	10-11
CAD/CAM Zirconia vs. slip-cast glass-infiltrated Alumina/Zirconia all-ceramic crowns: 2-year results of a randomized controlled clinical trial.	12-13
Prospective three-year study of zirconia-based posterior bridges	14-15
Randomized controlled clinical trial of zirconia-ceramic and metal-ceramic posterior fixed dental prostheses: a 3-year follow-up.	16-17
Clinical performance of extended zirconia frameworks for fixed dental prostheses: two-year results.	18-19
48 Month Clinical Evaluation of Cercon Zirconia All Ceramic Restorations	20-21
Technical complication „chipping“	22-23
Practice-based retrospective study on the complication rate of molar crowns	24-25
Recommendations for chipping prevention	26-27

Introduction

Over the last years, zirconium has become an indispensable component in the fabrication of all-ceramic crowns and fixed partial dentures. This decisive progress is due to the development of a practice-oriented processing of Yttrium-stabilized zirconium oxide in the dental lab. The advanced processing of zirconium oxide is closely connected to further developments in CAD/CAM technology. A constant improvement of both, the construction software and the milling device, allows an increasing precision and the detailed anatomic design of dental restorations in the lab. Moreover, new software options lead to new therapeutic indications as e.g. implant abutments for zirconium oxide restorations.

The Cercon Smart Ceramics system was launched more than 10 years ago and has in the meantime become a multi-modal CAD/CAM system. Today, our users can choose between various scanning systems and construction softwares (Cercon eye, 3Shape). At the same time, the milling technology for a lab-supported fabrication has been optimized by the introduction of a new high-performance milling unit (Cercon Brain Expert). Additionally, Compartis, DeguDent's central production, not only offers an alternative for the fabrication of CAD/CAM-based all-ceramic restorations, but it also allows the processing of CoCr alloys and titanium. Thus, CAD/CAM technology has become a key technology for a state-of-the-art and economically efficient production of dental restorations.

A constant close collaboration with renowned scientists and universities guarantees a consequent further development and diversification of indications for these innovative techniques.

Especially Cercon Smart Ceramics stands out for a consequent clinical evaluation strategy. Since the launch of this system, 14 international clinical studies with a total of more than 1,000 restorations have been conducted, in order to verify the reliability of Cercon restorations and to safeguard new therapeutic indications. A comprehensive clinical research moreover allows an early identification and analysis of technical complications, e.g. chipping. Thus, DeguDent was the first dental company to succeed in developing a scientifically substantiated prevention concept for the chipping of veneering ceramics on zirconium oxide restorations. Its central element is the modification of the cooling process by implementing a 6 minute long-term cooling. This process was scientifically evaluated in cooperation with the universities of Aachen and Heidelberg, its effectiveness was validated in a clinical study.

We are pleased to present this compilation of up-to-date surveys on relevant clinical research results with Cercon Smart Ceramics, published in 2009 and 2010. It hopefully provides useful information for your daily routine in practice and lab.

Prefabricated zirconium dioxide implant abutments for single-tooth replacement in the posterior region: evaluation of peri-implant tissues and superstructures after 12 months of function.

Clin Oral Implants Res. 2010 Aug; 21(8):857-65. Epub 2010 Apr 5.

Nothdurft F, Pospiech P.

Department of Prosthetic, Dentistry and Dental Materials Sciences, Saarland University, Saarbruecken, Germany.

Purpose:

In the present study, prefabricated abutments made of zirconium dioxide Y-TZP (tetragonal zirconia polycrystals) were inserted into the posterior region under controlled clinical conditions. The aim was to test whether abutments made of zirconium dioxide are suitable for this indication. Investigation parameters included reactions of peri-implant tissue and the structural integrity of the all-ceramic superstructures on the implants. Results after 12 months in function are reported in this article.



Implant-supported maxillary posterior Cercon single-tooth restoration

Illustration: Dr Sven Rinke, Hanau

Material and methods:

Forty implants of the XiVE S plus screw-type implants (DENTSPLY Friadent) were inserted into the posterior region of 24 patients. After the healing period, the implants were provided with all-ceramic abutments made of zirconium dioxide Y-TZP (FRIADENT CERCON Abutment; DENTSPLY Friadent). All-ceramic crowns (CERCON smart ceramics; DENTSPLY DeguDent) were used as superstructures and cemented using the conventional method. The following parameters were used to document the state of soft tissue: modified plaque index (mPI), sulcus fluid flow rate (SFFR, Periotron; Oraflow Inc), modified sulcus bleeding index (mSBI) and pocket depth (ST). Mesial and distal bone levels were determined on radiographs during the prosthetic treatment and at the 12-month recall. The Periotest (Medizin-technik Gulden) was used to determine implant stability.

Results:

All implants could be followed up after 12 months in function. In the presence of good oral hygiene (mPI: 0.5), the parameters SFFR (18) and mSBI (0.5) were indicative of stable and healthy soft tissue. ST was highest at the distal points of measurement (2.3 mm) and was generally at a low level. Compared with the baseline situation, proximal bone defects were reduced from -1.1 to -1 mm during the 12-month period of functioning. The mean Periost values at the 12-month recall were -1.9 in the maxilla and -3.8 in the mandible. Neither implant loss nor crown fractures occurred. Chipping of parts of the veneering ceramic was registered in four cases (10%).

Conclusion:

After 12 months of wear, no mechanical failure was registered in any of the all-ceramic abutments. On clinical investigation, the peri-implant hard and soft tissues were largely healthy and devoid of inflammation.

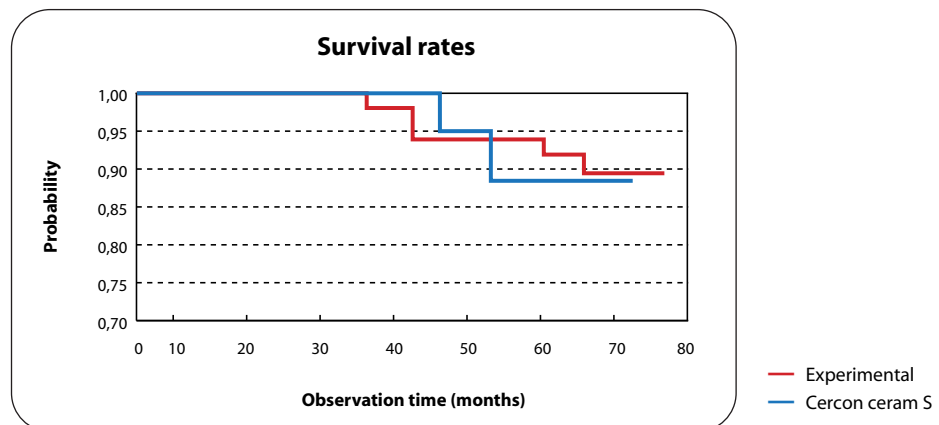
Prospective evaluation of zirconia posterior fixed partial dentures: four-year clinical results.

Int J Prosthodont. 2010 Mar-Apr; 23(2):141-8.

Roediger M, Gersdorff N, Huels A, Rinke S.
Department of Prosthodontics, Georg-August-University, Goettingen, Germany.
mroedig@gwdg.de

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).



Cercon bridge survival rates, Illustration: Dr M. Rödiger, University of Göttingen

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 Goettingen, 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, $P=.81$).



Case report: Preparation



Case report: Occlusal view of bridge in situ

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.



Case report: Lateral view of bridge in situ

Clinical evaluation of posterior all-ceramic FPDs (Cercon): a prospective clinical pilot study.

J Prosthodont Res. 2010 Apr; 54(2):102-5. Epub 2010 Feb 1.

Tsumita M, Kokubo Y, Ohkubo C, Sakurai S, Fukushima S.
Department of Fixed Prosthodontics, Tsurumi University, School of Dental Medicine, Yokohama,
Japan. tsumita-mitsuyoshi@tsurumi-u.ac.jp

Purpose:

This study prospectively evaluated the clinical performance of posterior zirconium-oxide-based all-ceramic fixed partial dentures (FPDs).



3-unit Cercon bridges
Illustration: Professor M. Tsumita, University of Yokohama,
Japan

Materials and methods:

Forty-two abutments of 21 Cercon FPDs were fitted in 20 patients at the Tsurumi University Dental Hospital from August 2005 to August 2006. The performance of these FPDs was evaluated using the California Dental Association (CDA) quality assessment system at baseline and at all follow-up examinations.

Results:

All FPDs were examined after a mean observation period of 28.1 (+/-3.4) months. During the observation period, no fracturing of FPDs was seen. All of the FPDs examined were rated as satisfactory with regard to all factors at the follow-up examinations based on the CDA quality assessment criteria.



4-unit Cercon base bridge framework

Conclusion:

Within the limitations of this short-term clinical study, no core framework fractures were seen. According to the CDA criteria, 100% of the FPDs were rated as satisfactory during this observation period.



Ceramic veneers made of e.g. Duceram® Kiss our proven and safe
Illustrations: Dr Sven Rinke, Hanau

	Satisfactory		Not acceptable	
	Excellent	Acceptable	Correction	Replacement
Marginal integrity				
Baseline	33.3	66.7	0	0
1 year	42.9	57.1	0	0
2 years	33.3	66.7	0	0
Color				
Baseline	100	0	0	0
1 year	95.2	4.8	0	0
Surface				
Baseline	100	0	0	0
1 year	81.0	19.0	0	0
2 years	100	0	0	0
Anatomic form				
Baseline	95.2	4.8	0	0
1 year	70.8	29.2	0	0
2 years	66.7	33.3	0	0

Four-year clinical results of fixed dental prostheses with zirconia substructures (Cercon): end abutments vs. cantilever design.

Eur J Oral Sci. 2009 Dec;117(6):741-9.

Wolfart S, Harder S, Eschbach S, Lehmann F, Kern M.
Department of Prosthodontics and Dental Materials, Medical Faculty, RWTH Aachen University, Aachen, Germany.

Purpose:

The purpose of this prospective study was to evaluate the clinical outcome of three- to four-unit posterior all-ceramic fixed dental prostheses (FDPs) made of yttria-stabilized tetragonal zirconia-polycrystal ceramic frameworks (CerconBase; Degudent).



Materials and methods:

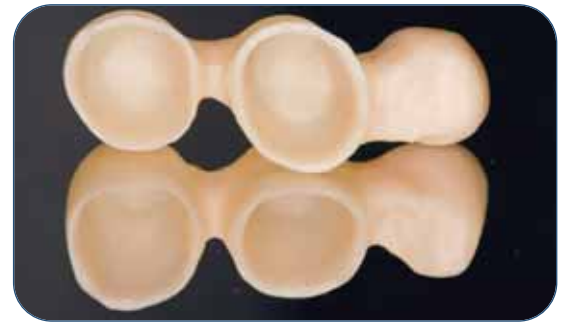
Fifty-eight restorations were placed in 48 patients. Twenty-four FDPs had an end abutment design (EAD) replacing 3 premolars and 21 molars. Thirty-four FDPs had a cantilever design (CD) replacing 11 premolars and 23 molars. The frameworks had a minimum proximal connector dimension of 3 x 3 mm. The fixed dental prostheses were cemented with glass-ionomer cement after air-abrading the inner crown surfaces.



Cercon bridges with cantilevered pontics for rehabilitation of the partially edentulous maxilla
Illustrations: Dr Sven Rinke, Hanau

Results:

Three FDPs were defined as drop-outs. The mean observation period was 48 +/- 7 months for the EAD (21 patients/24 FDPs) and 50 +/- 14 months for the CD (25 patients/31 FDPs). The 4-yr survival rate, according to the Kaplan-Meier analyses, was 96% for the EAD and 92% for the CD. The technical complication rate was 13% for the EAD and 12% for the CD, and the biological complication rate was 21% for the EAD and 15% for the CD. For none of the analyses were significant differences found between both groups.



Conclusions:

After 4 year the clinical outcome of three- to four-unit posterior FDPs with EAD and CD was promising.

CAD/CAM Zirconia vs. slip-cast glass-infiltrated Alumina/Zirconia all-ceramic crowns: 2-year results of a randomized controlled clinical trial.

J Appl Oral Sci. 2009 Jan-Feb;17(1):49-55.

Cehreli MC, Kökat AM, Akça K.

Section of Prosthodontics, CosmORAL Oral and Dental Health Polyclinics, Ankara, Turkey.

Purpose:

The aim of this randomized controlled clinical trial was to compare the early clinical outcome of slip-cast glass-infiltrated Alumina/Zirconia and CAD/CAM Zirconia all-ceramic crowns.



Posterior Cercon crowns

Illustration: Dr. M. Cehreli, CosmORAL Oral and Dental Health Polyclinic, Ankara, Turkey

Materials and methods:

A total of 30 InCeram Zirconia and Cercon Zirconia crowns were fabricated and cemented with a glass ionomer cement in 20 patients. At baseline, 6-month, 1-year, and 2-year recall appointments, Californian Dental Association (CDA) quality evaluation system was used to evaluate the prosthetic replacements, and plaque and gingival index scores were used to explore the periodontal outcome of the treatments.

Results:

No clinical sign of marginal discoloration, persistent pain and secondary caries was detected in any of the restorations. All InCeram Zirconia crowns survived during the 2-year period, although one nonvital tooth experienced root fracture coupled with the fracture of the veneering porcelain of the restoration. One Cercon Zirconia restoration fractured and was replaced. According to the CDA criteria, marginal integrity was rated excellent for InCeram Zirconia (73%) and Cercon Zirconia (80%) restorations, respectively. Slight color mismatch rate was higher for InCeram Zirconia restorations (66%) than Cercon Zirconia (26%) restorations. Plaque and gingival index scores were mostly zero and almost constant over time. Time-dependent changes in plaque and gingival index scores within and between groups were statistically similar ($p>0.05$).

Conclusions:

This clinical study demonstrates that single-tooth InCeram Zirconia and Cercon Zirconia crowns have comparable early clinical outcome, both seem as acceptable treatment modalities, and most importantly, all-ceramic alumina crowns strengthened by 25% zirconia can sufficiently withstand functional load in the posterior zone.

	Vital	Non-vital	Replacements*	Total
Maxillary premolar	3	3	5	6
Maxillary molar	4	5	6	9
Mandibular premolar	2	5	2	7
Mandibular molar	7	1	6	8

* Number of replacements for preexisting crowns

Prospective three-year study of zirconia-based posterior bridges

Clin Oral Investig. 2009 Dec; 13 (4):445-51. Epub 2009 Jan 24.

Department of Prosthodontics, Ludwig Maximilians University, Goethestr. 70, 80336 Munich, Germany.

Methods:

This clinical study evaluated posterior three-unit fixed dental prostheses (FDPs) made of zirconia substructures veneered with pressable glass-ceramic. Nineteen patients received 21 FDPs replacing either the second premolar, first molar, or second molar. The FDPs were cemented with glass ionomer.



Overpressed Cercon framework after pressing

Results:

Recall examinations were performed every 12 months. The mean service time of the FDP was 40 months. At 30 months, one maxillary FDP exhibited zirconia framework fracture at a thinned occlusal area of the abutment. Loss of retention led to the removal of one FDP after 38 months. The Kaplan-Meier survival probability was 90.5% after 40 months for all types of failures and 95.2% concerning framework fractures.



Cercon bridge with overpressed veneer
Illustration: PD Dr F. Beuer, University of Munich

Conclusions:

The overpressing technique appears to be reliable in terms of the veneering material. However, one framework fracture was observed in this study.

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

Int J Prosthodont. 2009 Nov-Dec; 22(6):553-60.

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

Clinic for Fixed and Removable Prosthodontics and Dental Material Science, Center for Dental and Oral Medicina, University of Zürich, Zürich, Switzerland.

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.



Cercon bridge restoration after seven years in situ
Illustrations: PD Dr I. Sailer, University of Zürich

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).



Metal-ceramic bridge restoration after seven years in situ
Illustrations: PD Dr I. Sailer, University of Zürich

Conclusion:

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

Clinical performance of extended zirconia frameworks for fixed dental prostheses: two-year results.

J Oral Rehabil. 2009 Aug; 36(8):610-5.Epub 2009 Jun 2.

Schmitter M, Mussotter K, Rammelsberg P, Stober T, Ohlmann B, Gabbert O.
Department of Prosthodontics, University of Heidelberg, Heidelberg, Germany.
Marc_Schmitter@med.uni-heidelberg.de

Purpose:

The purpose of this prospective cohort study was to assess the performance of tooth-supported, EXTENDED zirconia, fixed dental prostheses (FDPs).



Multi-span Cercon bridge
Illustration: Professor M. Schmitter, University of Heidelberg

Materials and methods:

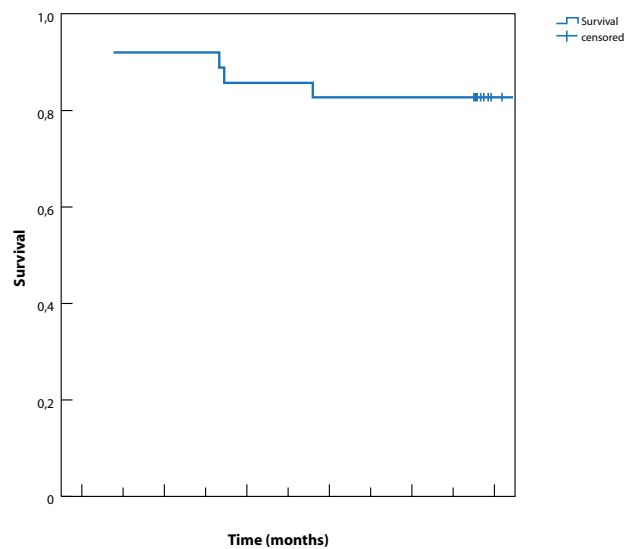
Thirty FDPs with span-lengths between 36 and 46 mm (mean: 40.33 mm), four to seven units and with connector dimensions of approximately 9 mm² were inserted (19 in the posterior region, 11 including anterior teeth) using glass-ionomer cement and assessed (aesthetic evaluation, failures, hypersensitivity/tooth vitality, secondary caries, pocket depth, decementation and chipping) at baseline and after 2 years. Differences between baseline and 2-year recall were analysed using the Wilcoxon signed-rank test for matched pairs.

Results:

There were five failures. One FDP revealed a core fracture at the base of the connector, probably caused by a damage induced during fabrication. Two FDPs had to be recemented, one abutment tooth had to be treated endodontically and one cohesive failure of the veneer was observed. There were no significant changes of pocket depth and hypersensitivity between baseline and 2-year recall.

Conclusion:

The aesthetics were rated as excellent by the patients at both baseline and recall. Two year clinical results of extended zirconia based FDPs with 9 mm² connectors are promising.



48 Month Clinical Evaluation of Cercon Zirconia All Ceramic Restorations

J Dent Res 89 (Spec. Iss C): Abstract No. 449

D. Barnes¹, J.C. Gingell¹, J. Rajaski¹, G. Kaplowitz¹, P. Warren¹, V. Sundar²
¹University of Maryland, Baltimore, MD/USA, ²Dentsply Company, York, PA/USA

Purpose:

The study examined all-ceramic Cercon zirconia restorations (DENTSPLY Prosthetics, Maryland, USA) cemented with the self-adhesive Dyract Cem Plus compomer cement (DENTSPLY Prosthetics).



Cercon base bridge after 48 months in situ
Illustration: Dr D. Barnes, University of Maryland,
Baltimore, MD

Methods:

A total of 55 patients received 78 anterior and posterior ceramic crowns and 23 all-ceramic bridges. The natural abutment teeth were conventionally prepared for ceramic restorations, and impressions were taken in a polyvinyl siloxane material. Restorations were cemented as per the manufacturers' recommendations, examined at baseline and followed up after 6, 12, 24 and 48 months on the basis of modified Ryge criteria.

Results:

With the exception of a handful of crowns that had to be written off as losses, both the single crowns and bridges showed only minor changes in terms of the parameters examined. One patient reported transient postoperative sensitivity, which required no treatment. The data support the view that the range of available shades is sufficient to achieve the desired aesthetic treatment result. A full 100% of the restorations were rated “alpha” for shade agreement with the Vita shade guide (Vita Zahnfabrik, Bad Säckingen). Overall, 99% of the 71 crowns followed and 100% of the 34 bridges were clinically acceptable after an observation period of 12 months. One crown failed due to an extensive fracture of the ceramic veneer. At the 24-month recall, three additional crowns were recorded as failures – one because of a framework fracture and two because of fractures of the ceramic veneer, where the veneering material had loosened from the zirconia framework. At the 48-month recall, five additional crowns were recorded as failures – two because of ceramic fractures during attempts to create endodontic access for a root filling, one because of a loss of retention and two because of ceramic fractures.



Conventionally cemented Cercon base crowns
Illustration: Dr Sven Rinke, Hanau

Schlussfolgerung:

All bridges were rated clinically acceptable at the 48-month recall. This study was supported by DENTSPLY Prosthetics.

Technical complication „chipping“

Die Zahnarztwoche 10/2009, 4 March 2009 (excerpt)

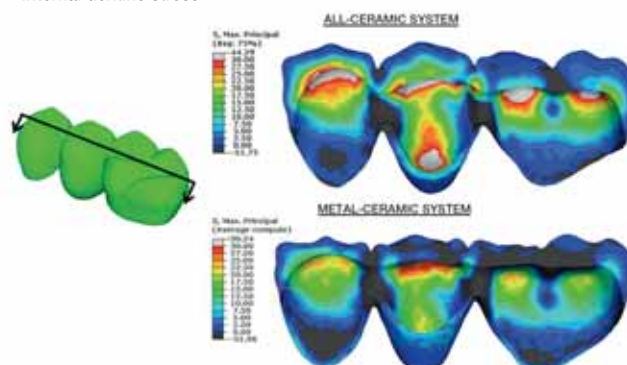
Schusser U., Vollmann M., Vökl L., Wiesner C.
DeguDent GmbH, Hanau

In the meantime, all clinical studies available on zirconium oxide restorations document a high stability of the structure with high survival rates over an observational period of up to 5 years. At the same time, the clinical studies showed an increased rate of technical complications, e.g. fractures of the veneering ceramics which mainly occurred in the molar region.

Zirconium oxide has a low coefficient of thermal expansion of approximately 9 to 10 ppm. This value is definitely different from that of the usual high-noble alloys which ranges between approximately 13 to 15 ppm. This difference in expansion becomes obvious during the cooling process after veneering: If the expansion properties of the structure do not match those of the veneering material, a high inner tension can build up which can lead to fissures and cracks in the veneering material. Therefore, a special veneering material is required. Moreover, zirconium-oxide has a significantly inferior thermal conductivity than metal, aluminous-oxide, and veneering materials. This can cause inhomogeneous heat conduction during the cooling process from sinter firing to a temperature below the transformation temperature (e.g. 600 °C).

The general problem of chipping was evaluated in a cooperation of the universities of Aachen and Heidelberg, the studies were based on a new approach with the Finite Element method. All temperature-related parameters were determined by measurements while also accounting for the viscoelastic properties of the veneering ceramics. Data for the cooling performance of both, the Cercon base/Cercon ceram kiss system as well as the metal-ceramic system DeguDent U/Duceram kiss were calculated. Initially, the all-ceramic structure produced a higher maximum tensile strength of the veneering ceramics on the outer surface. The calculated tensile strength which develops at the interface “structure/veneered part” supports these findings: Approximately 30 MPa were measured for the conventional cooling process of metal-ceramic restorations while this value was determined at 44 MPa for the zirconium-oxide all-ceramic structure. Compared to metal-ceramic structures, this increased tension can lead to a statistically earlier failure for zirconium-oxide restorations in extreme situations (e.g. thin walls of the structure, no minimized anatomic design of the zirconium-oxide structure and thus an increased layer thickness of the veneering ceramics, tangential preparation, or wrong bite). In short: The processing spectrum and margin of error are reduced; the processes described in the instructions for manufacturing have to be strictly adhered to. The faster the cooling process and the thicker the veneering layer, the more pronounced is this effect.

- Internal dentine stress

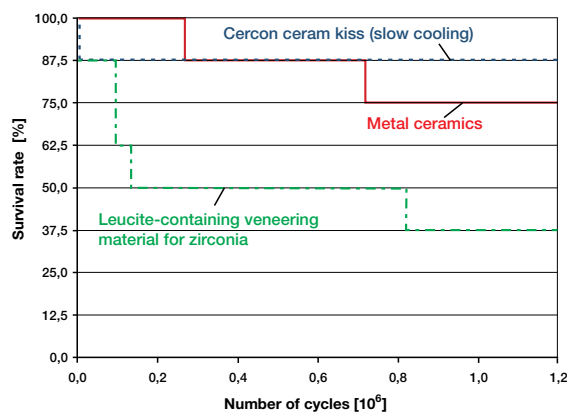


Internal tensions in the all-ceramic structure and the veneering layer originate from a too fast cooling of the crown after the veneering in the ceramic furnace. A decisive factor leading to chipping is a tensile strength in the core of the veneering. It is basically the same phenomenon that can be observed in safety glass – it cracks as soon as a fissure reaches the inner zone which is under tensile strength. Due to the low thermal conductivity of zirconium-oxide, this effect appears more often than in metal-ceramic restorations. Therefore, a prolonged cooling process of zirconium-oxide restorations is essential for their success.

Apart from the special veneering ceramics, the processing of zirconium-oxide restorations is more sensitive than the fabrication of metal-ceramic restorations. Further simulations dealt with the question of optimizing the production process and led to the following results:

- ✓ A modification of the firing temperature did not influence the maximum tensile strength in the veneering ceramic.
- ✓ A modification of the cooling rate did influence the maximum tensile strength significantly.

The reason for an increased chipping-rate did not depend on the type of veneering ceramics, indicating that this is a general characteristics of all-ceramic materials. Based on the simulations performed, a modification of the cooling rate seems to be an effective means to reduce tensile strength in the veneering material. The results of the simulation test were cross-checked in a more aggressive masticatory simulation study which was performed in cooperation with the University of Heidelberg. The range of the time in vivo was significantly prolonged. The accelerated life-cycle simulation was based on a theoretical in vivo period of 15 years – this value is normally determined to be 5 years for masticatory simulations. Due to the modified cooling process, the success rate of the all-ceramic system matched that of metal-ceramic restorations tested under identical conditions. Moreover, it could be proven that a modification of the veneering material by leucite-reinforcement did not lead to increased fracture stability. In a first clinical study, metal-ceramic molar crowns and zirconium-oxide-based molar crowns were evaluated:



Practice-based retrospective study on the complication rate of molar crowns

J Dent Res 89 (Spec. Iss C):Abstract No. 2111

S. Rinke, Evident Consulting GmbH, Hanau, M. Rödiger,
Georg-August-Universität Göttingen, A. Hüls, Georg-August-Universität Göttingen

Purpose:

Reviews of relevant literature assume that chipping of the veneering porcelain is a technical complication for zirconia restorations mainly in the molar area. This practice-based retrospective study evaluates the initial clinical performance of conventionally luted metal-ceramic and zirconia molar crowns fabricated with a prolonged cooling period of the veneering porcelain.



Metal-ceramic crown for tooth 26 after one year in situ



Cercon crowns for teeth 34-37 after 1.5 years in situ
Illustrations: Dr Sven Rinke, Hanau

Material and methods:

Forty-nine patients (30 women/19 men) were treated from 07/2008 until 07/2009 with either metal-ceramic crowns (group A: high noble alloy + low fusing porcelain) or zirconia crowns (group B: Cercon system, DeguDent). They participated in a clinical follow-up examination and were included in the study. All zirconia crowns were veneered with a modified porcelain firing cycle including a 6 minute cooling period. 90 restorations (72 vital abutments/18 non-vital abutments) were evaluated after a mean observational period of 338 days. Time-dependent crown survival (in-situ criteria) and success rates (event-free-restorations) were calculated according to Kaplan Meier and analyzed in relation to the crown fabrication technique (metal-ceramic vs. zirconia) using the log-rank test ($P < .05$).

Results:

No complete failures or loss of vitality were recorded in both groups, and 96.6% remained event-free. Two events were recorded in group A (1 loss of retention/1 minor ceramic chipping < 2 mm²). The third event occurred in group B (minor ceramic chipping < 2 mm²). All ceramic defects could be polished intraorally. Log-rank tests revealed non-significant differences in success rates (P=.876) of metal-ceramic and zirconia crowns fabricated with a modified porcelain firing.

Conclusion:

In the present study, the short-term success rates of metal-ceramic and zirconia molar crowns showed no significant difference. The modified firing of the zirconia porcelain seems to decrease the risk for early ceramic chipping in the molar area leading to technical complication rate comparable to metal-ceramic crowns.

Recommendations for chipping prevention

Based on the specified characteristics of brittle ceramics and zirconium-oxide and in consideration of the clinical experience gathered so far, recommendations for an appropriate processing of ceramics could be defined. For further information, please check www.ag-keramik.eu.

- ✓ If the manufacturing chain (manufacturer – lab – practice) adheres to the following criteria, ceramic fractures or chippings in the veneering material can be reduced:
- ✓ Observing the counter indications for all-ceramic materials: bruxism, parafunctions, missing anterior/canine guidance, deep bite, temporomandibular joint complaints, loosened teeth, insufficient oral hygiene, etc.
- ✓ Choice of faultless basic materials by certified manufacturers for both, the fabrication of the structure and the veneering process.
- ✓ Coordination of structure and veneering materials with regard to similar thermal expansion in order to avoid tensions during the fabrication process (recommendation: use one system only).
- ✓ Preparation suitable for the use of ceramics, i.e. consideration of the minimum layer thickness, axio-occlusal line angle must be rounded, rectangular preparation), and connector dimensions. An anatomic design of the crown cap or the FPD structure is recommended in order to achieve an even layer of the veneering material (practice).



- ✓ Shoulder or chamfer preparation, no shallow chamfers, tangential preparations, and tapers.
- ✓ Avoiding of extensive grinding of the structure and the inner lumen without water cooling (especially with coarse diamond grinders) or air-abrading the ceramic surfaces with a too high abrasion pressure or a too coarse blasting abrasive.
- ✓ No trimming or grinding on the basal aspect of connectors.
- ✓ Tension-release cooling (slow cooling process after sinter firing of the veneering ceramics), especially when using zirconium-oxide, in order to avoid internal tensions in the veneering ceramics (chipping risk).
- ✓ Try-in is recommended prior to veneering resp. glazing.
- ✓ Finish by polishing or by additional glazing in order to increase the survival time of the restoration in vivo.
- ✓ If possible, adhesive luting should be preferred over conventional cementation.
- ✓ Consideration of functional conditions in combination with repeated follow-up of the occlusion after insertion.

Fascination Prosthetics

28262/1103/GVD
Stand: 03/2011

