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Short communication

Outcome of posterior fixed dental prostheses made from veneered zirconia over an observation period of up to 13 years

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ABSTRACT

Objectives: It was the aim of this clinical study to evaluate the long-term outcome of 3- to 4-unit posterior all-ceramic fixed dental prostheses (FDPs) made from veneered zirconia ceramic.

Methods: Between June 2003 and February 2005, 48 patients received 58 restorations. Twenty-four FDPs had a fixed-to-fixed design (FF) and thirty-four FDPs had a cantilever design (CA). Frameworks were scanned and milled out of 3 mol% yttrium-oxide partially-stabilized zirconia ceramic (CerconBase30, Degudent) and were veneered with feldspathic ceramic (CerconCeramS, Degudent). All FDPs were cemented with glass-ionomer cement (Ketac-Cem, 3 MEspe) after air-abrading the inner crown surfaces.

Results: The mean observation period was 85.4 ± 54 (FF) and 91.7 ± 50 (CA) months, respectively. Ten cantilever FDPs and 5 fixed FDPs were lost due to biological problems of the abutment teeth. Two cantilever FDPs and 4 fixed-to-fixed FDPs were lost due to technical failures of the ceramic materials. The cumulative 13-year survival rate was 43.2% (FF) (CI: 22.8–66.2%) and 52.5% (CA) (CI: 32.5–71.8), respectively. In 13 cases, intraoral repair or polishing of the fractured feldspathic ceramic veneers was needed (7 in group FF, 6 in CA). Eight abutments of six restorations (4 in FF, 4 in CA) had to be treated endodontically and caries therapy was needed in 6 abutment teeth (4 in group FF, 2 in CA). The cumulative 13-year success rate was 29.5% (FF) (CI: 12.1–55.9%) and 22.5% (CA) (CI: 7.9–49.3%).

Conclusions: Within the limitations of the present investigation, posterior fixed dental prostheses made from veneered zirconia with either a fixed-to fixed or a cantilever design show comparable survival and success rates after 13 years of clinical observation.

Clinical Significance: FDPs made from veneered zirconia ceramic present high failure and complication rates, irrespective of the design (fixed-to-fixed or cantilevered).

1. Introduction

Over decades, metal-ceramic FDPs were considered the gold standard for replacing posterior missing teeth, when adjacent teeth were in need for crowns, with an excellent clinical performance and high survival and success rates [1]. However, due to the growing demand for metal-free restorations, all-ceramic FDPs became popular also for posterior dentition. Zirconia ceramic, as a high-strength all-ceramic material, exhibits clinically promising results [1]. Ten-year results of a randomized clinical trial on posterior veneered metal-ceramic and zirconia-ceramic FDPs demonstrated similar outcomes for the two treatment groups for the majority of outcome measurements [2]. However, in this study the drop-out rate was above 22% and the survival rate was slightly lower in the zirconia-ceramic group and the rate of framework fractures, decementations and major fractures of the veneering ceramic was significantly higher in the zirconia group compared to the metal-ceramic group. Little evidence is given on the clinical performance of cantilevered FDPs made from a veneered zirconia framework, but medium-term results over 3 to 4 years were acceptable [3,4]. Therefore, it was the aim of the present clinical investigation to evaluate the long-term outcome of 3-4-unit posterior all-ceramic FDPs made from 3 mol% yttrium-oxide partially-stabilized zirconia ceramic frameworks with either a fixed-to-fixed or a cantilevered design.

2. Materials and methods

The Institutional Review Board of the Medical Faculty of the University at Kiel approved the study design and all participants gave their informed written consent before inclusion in the study.

Patients in need for three- to four-unit posterior FDPs were screened

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Table 1
In- and exclusion criteria.

Inclusion criteria	Exclusion criteria
- Edentulous space equal to or smaller than the width of a molar (FF) - Edentulous space equal to the width of a premolar (CA) - No signs of active bone resorption - No peri-apical pathology - Good oral hygiene and low caries activity - Maximum abutment tooth mobility grade 1	- Probing pocket depth greater than 4 mm or vertical bone pockets around the abutment tooth - Extreme bruxism (self-reported bruxism with wear facets in posterior teeth exposing the dentin) - Conspicuous medical or psychological history

according to predefined in- and exclusion criteria (Table 1) and the final study population consisted of 48 patients, 24 women (mean age 55.7 years) and 24 men (mean age 54.3 years). Thirty-eight patients received 1 restoration and 10 patients received 2 restorations. Of these, 24 FDPs had a fixed-to-fixed design (FF-group) replacing 3 premolars and 21 molars (maxilla: 8, mandible: 16) and 34 FDPs had a cantilever design (CA-group) replacing 11 premolars and 23 molars (maxilla: 15, mandible: 19). All abutment teeth received a full-crown rounded shoulder preparation with a circular reduction of 0.8 mm and an occlusal reduction of at least 1.5 mm. The minimal proximal connector dimensions were 3 mm × 3 mm. Impressions were taken using a polyether material (Permadyne, 3 M Espe, Seefeld, Germany). All frameworks were scanned, milled and sintered out of 3 mol% yttrium-oxide partially-stabilized zirconia ceramic (Cercon Base30, Degudent, Hanau, Germany) after an anatomically designed wax-up, according to the manufacturer's recommendations. The minimum occlusal framework thickness was 0.5 mm and the minimum cervical framework thickness was 0.4 mm. In the FF-group, the shoulder area was covered with veneering material, so that the framework margin ended 1 mm before the preparation margin. However, due to higher stresses, the framework margin was extended to the preparation margin in the CA-group. Regarding veneering, the porcelain build-up technique (CerconCeramS, Degudent) was used for the FF-group and the overpressing technique (Cercon Ceram Express, Degudent) was used for the CA-group. The veneering material thickness ranged from 0.4 mm to 1.0 mm. The final restorations were checked intraorally regarding marginal fit, occlusion, and articulation. Adjustments were done under water-cooling with diamond burs with 30–40 µm grain size, if necessary. The occlusal surfaces were then polished with ceramic polishing instruments (Tanaka polishing wheels no. 10172-10174, Tanaka, Friedrichsdorf, Germany). All FDPs were cemented with glass-ionomer cement (Ketac Cem maxicap, 3 M Espe) after air-abrasion of the internal walls of the crowns with 50 µm Al_2O_3-particles and a pressure of 0.25 MPa for 10 s (Fig. 1a, b). All FDPs were inserted between July 2003 and February 2005. The detailed intervention and manufacturing process have already been described elsewhere [3].

Follow-up examinations were performed 6 and 12 months after insertion and then annually.

The following parameters were visually evaluated: framework fracture, chipping of the veneering material and decementation for technical complications; secondary caries, periodontal parameters (probing pocket depth, bleeding on probing, tooth mobility) and endodontic problems (endodontically treated, apicoectomy) for biological complications.

The cumulative success and survival rates were calculated according to Kaplan-Meier analysis (confidence intervals of 95%) using the analytical software Statistix 10 (Tallahassee, FL, USA). The Gehan-Wilcoxon test was used to evaluate significant differences between the two study groups. A COX-regression analysis was performed to reveal a possible influence of co-factors on the survival rate of the FDPs.

3. Results

The mean observation period was 85.4 ± 54 (FF) and 91.7 ± 50 (CA) months, respectively. After 13 years of observation, 7 patients were available in both treatment groups. Ten cantilever FDPs and 5 fixed FDPs were lost due to biological problems of the abutment teeth. Two cantilever FDPs and 4 fixed FDPs were lost due to technical failures of the ceramic materials. Hence, the cumulative 13-year survival rate for all FDPs was 47% (CI: 30.5–64.2%), with a cumulative survival rate of 43.2% (CI: 22.8–66.2%) in the FF-group and 52.5% (CI: 32.5–71.8) in the CA-group, respectively, with no significant differences between the two treatment groups (p = 0.38) (Fig. 2). The annual failure rate was 4.5% in both groups. It has to be remarked, that 3 FDPs failed in the FF-group within the last 3 years of observation. After 10 years, the cumulative survival rate was 70.3% (CI: 46.7–86.5%) in the FF-group and 66.2% (CI: 50.2–79.2%) for all FDPs. Table 2 shows the events over

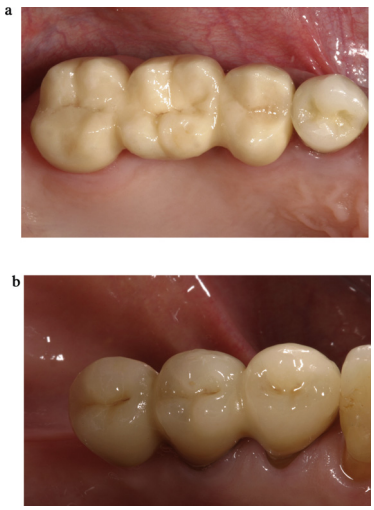

Fig. 1. a) FDP with a fixed-to-fixed design after insertion. b) FDP with a cantilever-design after insertion.

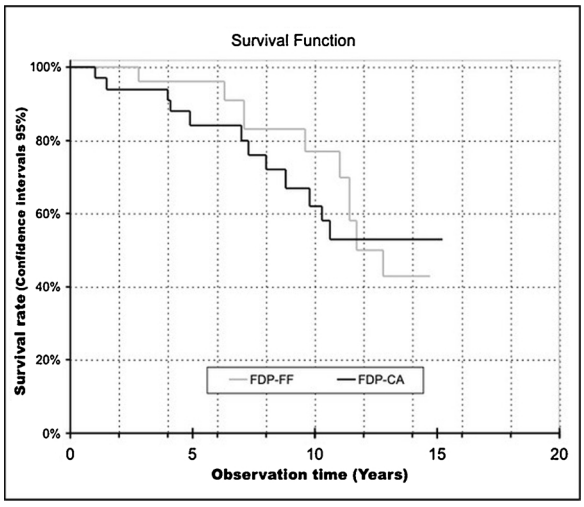

Fig. 2. Kaplan-Meier survival analysis.

Table 2
Events over time, divided up into the two treatment groups (CA = cantilever design, FF = fixed-to-fixed design).

Year	Event	Number of events (n)	
		CA-group	FF-group
0–5	Chipping	2	4
	Caries	1	1
	Endo	1	1
	Loss of FDP	4	4
6–10	Chipping	4	3
	Caries	0	1
	Endo	2	2
	Loss of FDP	6	1
> 10	Chipping	0	0
	Caries	1	2
	Endo	1	1
	Loss of FDP	2	4

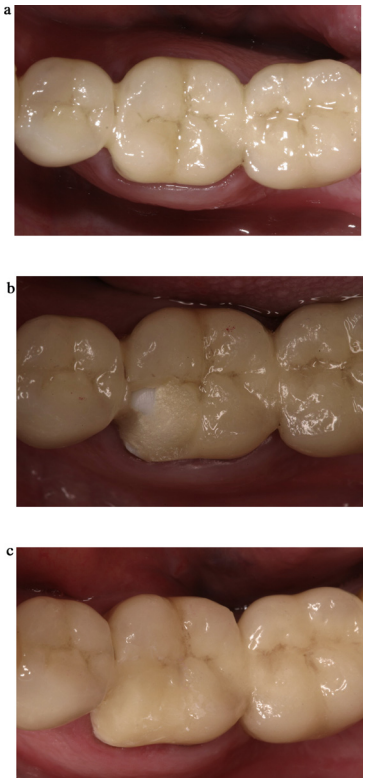

Fig. 3. a) Intact FDP after insertion. b) FDP after experiencing chipping. C) FDP after intraoral repair.

time for both treatment groups.

In 13 cases, intraoral repair or polishing of fractured feldspathic ceramic veneers was needed (7 in group FF, 6 in CA) (Fig. 3a–c). Eight abutments of six restorations (4 in FF, 4 in CA) had to be treated endodontically and caries therapy was needed in 6 abutment teeth (4 in group FF, 2 in CA). Twelve FDPs, 5 in the FF-group and 7 in the CA-group, were free of any complication. No framework fracture occurred during the observation period. Consequently, the estimated 13-year success rate was 29.4% (FF) (CI: 12.1–55.8%) and 22.5% (CA) (CI: 0.8–49.3%) with no significant differences between the two groups (p = 078).

Nineteen FDPs (11%) in 17 (8%) patients were considered a drop-out. In the CA-group, one patient with two restorations died 6 years after insertion. And one patient with one restoration died 2 years after insertion. All FDPs were free of complications at the last recall visit. One patient with one restoration died four years after insertion in the FF-group. The FDP was in place during the last recall visit, but an endodontic treatment had to be performed on one of the abutment teeth. The COX-regression analysis, regarding the influence of the location of the restoration (upper- or lower jaw) (p = 0.056) and the location of the replaced tooth (premolar or molar) (p = 0.571) revealed that both factors did not influence the survival rate of the FDP significantly.

4. Discussion

This clinical study was conducted to evaluate the long-term outcome of posterior fixed dental prostheses (FDPs) made from veneered yttrium-oxide partially-stabilized zirconia ceramic with either a fixed-to-fixed or a cantilever design.

After 13 years of observation, 14 FDPs, 7 in each group, were available for recall. Twenty-one restorations were lost due to technical or biological complications, resulting in 37 FDPs, which could have been available for the 13 years recall visit. Fourteen out of 37 sounds little, and the relatively small number of available restorations might be considered the weak part of this analysis. However, according to the authors' knowledge, this is the first clinical investigation on this topic over an observation period of 13 years and little evidence is given on the long-term outcome of veneered zirconia FDPs.

The overall survival rate for all FDPs irrespective of the design was 47% after 13 years and 66.2% after 10 years. These results are a lot lower than the reported estimated 10-year survival rates for FDPs according to a systematic literature review [5]. However, the 10-year survival rate corresponds well with the results of another clinical study on fixed dental prostheses with zirconia frameworks over an observation period of 10 years (67%) [6] but are a lot lower than the survival rates reported by Sailer et al. (91.3%) [2]. In the present investigation, 15 FDPs were lost due to biological problems. In the investigation by Sailer et al., only 3 FDPs had to be removed due to biological problems, but the authors also reported, that only one zircona-ceramic FDP was free of any biological complication. The present investigation might have been more restrictive, when considering a removal of an FDP because of biological and/or technical complications. Additionally, the drop-out rate in this investigation was with 22% nearly twice as high as the drop-out rate in the present investigation (11%).

In the present investigation, the total failure rate increased by 20% between 10 and 13 years of observation. This demonstrates, that real long-term data are extremely important for the final assessment of dental restorations.

Regarding technical complications, the chipping rate was 28.6% for all FDPs with 29.8% in the FF-group and 28.9% in the CA-group. It was significantly higher than the chipping rate reported for metal-ceramic FDPs [7]. It fits well into the results of Sax et al. with a chipping rate of 32% after 10 years [6] and was slightly lower than the results of Sailer et al., with a major chipping rate of 18.9% und a minor chipping rate of 54.8% [2]. A recently published prospective investigation of posterior FDPs made from the same material reported a 10-year ceramic veneer success rate of 61% and is also within the same range [8].

According to a systematic literature review, survival and success of cantilever FDPs are lower compared to conventional FDPs after 10 years of observation [5,9]. That was not the case in the present investigation. After 13 years observation, neither the survival rate nor the success rate regarding any complication (biological, technical) was statistically significant different between the two treatment groups (fixed-to-fixed design or cantilever design).

Patients with extreme bruxism (self-reported bruxism with wear facets in posterior teeth exposing the dentin) were excluded from participation in the study. However, the included patients were not differentiated regarding milder forms of bruxism or having no bruxism. Therefore unfortunately, we could not relate the occurring failure in any way to bruxism as risk factor, which must be considered a limitation of our study.

5. Conclusions

Within the limitations of the present investigation, posterior fixed dental prostheses made from veneered zirconia with either a fixed-to-fixed or a cantilever design show comparable survival and success rates after 13 years of clinical observation.

Conflict of interest

The authors declare that they have no conflict of interest.

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