Zirconia Posterior Fixed Partial Dentures: 5-Year Clinical Results of a Prospective Clinical Trial

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This study aimed to evaluate three- and four-unit posterior fixed partial dentures (FPDs) with zirconia frameworks after 5 years of function. Of the initial 30 subjects, 25 patients with 25 FPDs were examined after a mean follow-up period of 62.1 months. Five patients were not available for recall visits. Two FPDs failed before the 60-month evaluation because of framework fracture or delamination of the veneering ceramic after endodontic treatment. The 5-year survival rate was 92%. Based on these results, it can be suggested that zirconia frameworks have sufficient mechanical requirements for use in the stress-bearing posterior region. Major fracture of the ceramic veneer could be related to inadequate framework design or bruxism. *Int J Prosthodont 2012;25:585–589.*

In recent years, there have been promising results when zirconia frameworks are used as an alternative to metal-based fixed partial dentures (FPDs).¹ Nevertheless, long-term scientific evidence is still needed. The aim of the present study was to investigate the outcomes of all-ceramic FPDs with zirconia frameworks fabricated using the Lava system (3M ESPE) after an observation period of 5 years. The working hypotheses were that *(1)* no framework fractures would be observed but that *(2)* the ceramic veneers would show higher fracture rates than metalceramic restorations.

Materials and Methods

This prospective clinical investigation was conducted at the Department of Prosthodontics, Friedrich-Alexander University Erlangen-Nuremberg, Erlangen, Germany. Table 1 shows the inclusion and exclusion criteria. The clinical and technical procedures have been previously reported² but can be summarized briefly as follows:

- Preparation of abutment teeth, impression-taking, and fabrication of the master cast
- Scanning and design of an individually shaped framework
- Milling of frameworks from presintered, yttriastabilized zirconia blanks
- Veneering of the frameworks (Lava Ceram, 3M ESPE)
- Cementation of the FPDs using glass-ionomer cement (Ketac-Cem, 3M ESPE)

The surface, color, and marginal integrity were rated by two dentists independently at baseline and at annual follow-up visits according to the California Dental Association (CDA) criteria.³ Periodontal parameters and Plaque Index scores were also assessed.

Data analysis consisted of descriptive statistics, the Wilcoxon test, and the McNemar test. The overall classification of each restoration as a success (Romeo, Sierra) or failure (Tango, Victor) was determined by the worst single evaluation. Patients lost to follow-up were excluded.

Results

Of the initial 30 subjects, 25 patients (17 men, 8 women) with 25 FPDs were examined after a followup period of 62.1 months. Five patients were not available for recall visits (Table 2). Two FPDs had to be

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Table 1 Inclusion and Exclusion Criteria

Inclusion criteria	Exclusion criteria
Three- to four-unit posterior FPDs with end abutments	Compromised general health
Adequate occlusogingival height for a connector area of at least 9 \mbox{mm}^2	Severe occlusal wear or parafunctional activities
Vital or endodontically treated abutment teeth, with no apical periodontitis for the past 6 mo	Periodontal disease (probing depth \ge 5 mm, bleeding on probing, active bone resorption, grade 2 and 3 furcation involvement)
Good oral hygiene and no active caries lesions	Poor oral hygiene (> 25% marginal plaque, Sulcus Bleeding Index > 70%)

Table 2FPD Location, Number of Units, Service Time, Events, and Failures According to the CDA Rating at the
Last Follow-up

FPD	Location*			Sorvico		СПА
no.	MA	CA	DA	time (mo)	Event	rating
1	45	46	47	50	47: endodontic treatment; circular delamination of the veneering ceramic around the endodontic access cavity 10 mo later, FPD replacement	
2	45	46	47	72	Pronounced occlusal roughness, minor chipping	Т
3	23	24, 25	26	36	Lost to follow-up	
4	35	36	37	72	-	
5	15	16	17	72	Major chipping at the intermediate and distal abutment after 46 mo	V
6	45	46	47	24	Lost to follow-up	
7	45	46	47	60	-	
8	25	26, 27	28	72	Minor chipping	
9	25	26	27	54	Framework fracture after 54 mo, FPD replacement	V
10	44	45, 46	47	48	Lost to follow-up	
11	44	45, 46	47	60	-	
12	14	15, 16	17	60	Decementation, recementation	
13	45	46	47	60	-	
14	34	35, 36	37	60	-	
15	23	24, 25	26	12	Lost to follow-up	
16	35	36	37	60	-	
17	25	26	27	60	-	
18	35	36	37	60	Minor chipping	
19	25	26	27	60	Minor chipping	
20	25	26	27	60	-	
21	15	16	17	60	-	
22	45	46	47	60	-	
23	25	26	27	60	-	
24	35	36	37	60	_	
25	35	36, 37	38	24	Lost to follow-up	
26	25	26	27	60	_	
27	35	36	37	60	-	
28	35	36	37	60	37: loss of vitality, endodontic treatment	
29	45	46	47	60	-	
30	25	26	27	60	Major chipping at the intermediate and distal abutment after 36 mo	V

MA = mesial abutment; DA = distal abutment; CA = connecting abutment; V = Victor (irreparable); T = Tango (reparable).

*FDI tooth-numbering system.

Surface rating	Baseline	12 mo	24 mo	36 mo	48 mo	60 mo
Sufficient Excellent Acceptable	19 (63%) 11 (37%)	12 (41%) 17 (59%)	13 (48%) 14 (52%)	15 (56%) 11 (41%)	7 (27%) 17 (65%)	7 (32%) 13 (56%)
Insufficient Reparable Irreparable Total <i>P</i> *	0 (0%) 0 (0%) 30 (100%)	0 (0%) 0 (0%) 29 (100%) .10	0 (0%) 0 (0%) 27 (100%) .28	1 (4%) 0 (0%) 27 (100%) .41	1 (4%) 1 (4%) 26 (100%) .02	1(4%) 2 (8%) 23 (100%) .02

Table 3 Surface Quality According to CDA Criteria

*Compared to baseline.

	Excellent (%)	Acceptable (%)	Reparable (%)	Irreparable (%)	P *
Baseline	100	0	0	0	-
12 mo	100	0	0	0	-
24 mo	93	7	0	0	> .99
36 mo	91	9	0	0	> .99
48 mo	96	4	0	0	> .99
60 mo	96	0	4	0	> .99

Table 4 Marginal Integrity According to Modified CDA Criteria

*Compared to baseline.

replaced, resulting in an overall survival rate of 92%. Five restorations showed complications involving fractures of the veneering ceramic or core. The success rate of the core and ceramic veneer was 80%.

Roughened occlusal surfaces were detected in 56% of the restorations (Table 3). The marginal integrity was excellent (Table 4). There were no significant differences between test and control teeth after 60 months with respect to probing depths (mesial abutment tooth: P = .56; distal abutment tooth: P = .32) and the sulcus bleeding and gingival indices (.19 $\leq P \leq .99$).

Plaque assessments frequently revealed optimal scores at both abutment teeth, whereas control teeth were less likely to show optimal scores. The distal control tooth showed significantly more plaque after 12, 24, and 60 months (P = .03).

Discussion

The survival rate of posterior three- and four-unit zirconia-based FPDs was 92%, which is in accordance with an estimated 5-year survival rate of 94.3%.⁴

One FPD fractured at the coping wall close to the pontic (Figs 1a to 1c), possibly due to the stress transfer at this connecting point or to the thin and inconsistent framework thickness.⁵

Major chipping at one FPD may have been due to the patient's bruxism habit (Fig 2) or to an inadequate coping design (Fig 3). Minor chippings originated at a roughened occlusal surface (Fig 4), which is in accordance with Sailer et al,⁶ who found a correlation between the roughness of the veneering ceramic and chipping incidence.







Fig 1a Chipping of the veneering ceramic next to the fracture line at the distal molar retainer.

Fig 1b Core and veneering fracture in the connector area between the intermediate pontic and coping wall.

Fig 1c Scanning electron microscopy analysis of the fractured retainer area (coping thickness: approximately 370 to $950 \ \mu m$).



Fig 2 Major chipping of the ceramic veneer at the buccal aspect of the intermediate and distal abutments due to bruxism and occlusal attrition.

Conclusions

Within the limitations of the relatively small sample size, the following conclusions can be drawn:

- Zirconia frameworks for three- and four-unit posterior FPDs seem to have sufficient mechanical requirements for use in the stress-bearing posterior region.
- Major fracture of the ceramic veneer was related to inadequate framework design or bruxism.
- Minor chippings were found to originate at the roughened surface of the veneering ceramic.

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Fig 3a Multiple major chippings of the veneering ceramic at the intermediate and distal abutments.



Fig 3b Insufficient interocclusal space inhibited appropriate porcelain thickness for the distal molar retainer.



Fig 4a Scanning electron microscopy view of a slightly rough surface after 36 months.



Fig 4b Scanning electron microscopy view of the same abutment with minor chipping at the 60-month recall appointment; fracture of the veneering ceramic next to the roughened occlusal surface is evident.

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