Clinical Evaluation of Tooth-Supported Zirconia-Based Fixed Dental Prostheses: A Retrospective Cohort Study from the AIOP Clinical Research Group

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Purpose: The aim of this retrospective cohort study was to evaluate the clinical performance of tooth-supported zirconia-based fixed dental prostheses (FDPs) made by 15 members of the Italian Academy of Prosthetic Dentistry over a time period of up to 5 years. ***Materials and Methods:*** Ninety-eight patients were treated with a total of 137 zirconia-based FDPs in anterior and posterior regions using primarily chamfer or knife-edge tooth preparations. The cohort group with parafunctional habits was compared with patients without parafunctional habits according to the esthetic, functional, and biologic United States Public Health Service criteria modified by the FDI World Dental Federation. ***Results:*** The estimated cumulative survival of all restorations was 94.70% ± 1.25% standard error (SE), whereas the estimated cumulative success decreased to 89.78% ± 2.58 SE. Mechanical failures, including three zirconia framework fractures, two hairline cracks, nine chippings, and one delamination of the ceramic veneering, were recorded during the 1- to 5-year observation period. An odds ratio of 2.02 (95% confidence interval: 0.67 to 6.12) showed a moderate association between parafunction and failure. ***Conclusions:*** Zirconia-based tooth-supported FDPs showed promising clinical results over a period of up to 5 years. Technical complications were more commonly detected in patients with parafunctional habits. *Int J Prosthodont 2015;28:236–238. doi: 10.11607/ijp.4023*

Over the past decade, metal-free materials, and especially yttria-stabilized tetragonal zirconia polycrystals (Y-TZP), have facilitated the application of digital technologies in dentistry. Fixed dental prostheses (FDPs) made with zirconia-based restorations are alternatives to porcelain-fused-to-metal (MC) restorations due to their mechanical, esthetic, and biocompatible properties.[1] The deleterious property of crack propagation can be arrested through development of specific crystalline phase transformations with the possibility of new and extended clinical applications.[2] Short-term clinical studies indicate that Y-TZP–based FDPs may be used in anterior and posterior regions as a substitute for MC restorations.[3]

The aim of this study was to evaluate the 1- to 5-year clinical outcome of tooth-supported zirconia-based FDPs, performed in general dental practice, in an attempt to establish major risk factors that may contribute to restoration failure.

Materials and Methods

Ninety-eight patients (mean age: 54 years, range: 24 to 78 years) with 67 anterior and 70 posterior zirconia-based tooth-supported FDPs were recalled as described in a previous study by Monaco et al.[4] The 137 FDPs consisted of 505 units: 358 abutments and 147 pontics. One hundred twenty-eight abutments were on vital teeth, whereas 230 were on endodontically treated teeth and restored with composite resin (70), fiber post and composite resin (129), or metal post (31). Of the 98 patients, 60 showed no parafunctions, whereas 20, 15, and 3 showed light, moderate, and severe parafunctional habits, respectively. Two

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Fig 1 Small chipping of the ceramic veneering.

Fig 2 Fracture of the zirconia framework.

Table 1 Life Table Analysis of the Estimated Cumulative Survival (ECS) Rates with Standard Error (SE) of 137 Zirconia-Based Tooth-Supported FDPs

Time (y)	Anterior				Posterior				Total			
	n	Censored	Failed	ECS ± SE (%)	n	Censored	Failed	ECS ± SE (%)	n	Censored	Failed	ECS ± SE (%)
0–1	67	1	1	98.49 ± 1.48	70	2	0	100 ± 0	137	3	1	99.26 ± 0.72
1–2	44	0	0	98.49 ± 1.48	46	0	0	100 ± 0	90	0	0	99.26 ± 0.72
2–3	31	0	1	95.30 ± 2.07	28	0	0	100 ± 0	59	0	1	97.57 ± 1.02
3–4	18	0	1	90.00 ± 2.52	16	1	1	93.54 ± 1.41	34	1	1	93.25 ± 1.25
4–5	7	0	0	90.00 ± 2.52	8	0	0	93.54 ± 1.41	15	0	0	93.25 ± 1.25

FDPs = fixed dental prostheses.

Table 2 Life Table Analysis of the Estimated Cumulative Success (ECSs) Rates with Standard Error (SE) of 137 Zirconia-Based Tooth-Supported FDPs

Time (y)	Anterior				Posterior				Total			
	n	Censored	Failed	ECSs ± SE (%)	n	Censored	Failed	ECSs ± SE (%)	n	Censored	Failed	ECSs ± SE (%)
0–1	67	1	2	96.99 ± 2.07	70	2	2	97.10 ± 1.58	137	3	4	97.04 ± 1.43
1–2	44	0	0	96.99 ± 2.07	46	0	1	94.98 ± 2.42	90	0	1	95.95 ± 1.60
2–3	31	0	2	87.99 ± 2.89	28	0	3	84.80 ± 3.34	59	0	5	87.581 ± 2.22
3–4	18	0	2	78.20 ± 3.48	16	1	1	79.32 ± 3.58	34	1	3	79.94 ± 2.50
4–5	7	0	0	78.20 ± 3.48	8	0	1	69.40 ± 3.80	15	0	1	74.63 ± 2.58

FDPs = fixed dental prostheses.

hundred twelve abutments were treated with a knife-edge preparation, whereas 144 and 2 abutments were prepared with chamfer and shoulder finishing line designs, respectively.

Esthetic, functional, and biologic United States Public Health Service parameters modified by the FDI World Dental Federation study design were collected, and each parameter was ranked in four subgroups. Estimated cumulative survival (ECS) was defined as the FDP remaining in situ with scores of 1 to 3 for esthetic, functional, and biologic parameters, whereas it was considered a failure when the FDPs reached a score of 4. A fracture of ceramic veneering, marginal discrepancy, postoperative sensitivity, FDP decementation, and secondary caries with a score of 3 and 4 were considered terminal events for estimated cumulative success analysis. Life table analyses were generated using SPSS version 21 statistical software (IBM). The odds ratios of the subgroups of patients with parafunctions also were calculated.

Results

The ECS of tooth-supported zirconia-based FDPs (± standard errors) from 1 to 5 years was 94.70% ± 1.25%, whereas the estimated cumulative success rate (ECSs) decreased to 89.78% ± 2.58% (Figs 1 and 2). Tables 1 to 3 describe the life table analysis and the results, respectively. The odds ratio for all restorations was 2.02 (95% confidence interval: 0.67 to 6.12) with a moderate association between parafunction and failure.

Discussion

The reduction of more than 7% from ECS to ECSs was primarily due to mechanical failures. The framework fractures could be due to insufficient connector size. In all three cases, the failures were recorded in anterior regions in combination with parafunctional habits, where high forces were acting on a relatively small connector area. Most of the 13 fractures of ceramic

Table 3 Clinical Parameters and Complications of 137 FDPs in Terms of Esthetic, Functional, and Biologic Properties Following USPHS Parameters

Parameters			FDP (natural tooth) Anterior no.	Posterior no.	Total
Esthetic properties					
Surface luster	1	Surface luster comparable to enamel	62	59	121
	2	Slightly dull, not noticeable if covered with film of saliva	5	9	14
	3	Dull, cannot be masked by saliva film	0	2	2
	4	Rough surface, unacceptable plaque retentive surface	0	0	0
Functional properties					
Framework fracture	1	No	64	70	134
	4	Yes	3	0	3
Fracture of ceramic veneering	1	No	63	61	124
	2	Yes, hairline crack/small chipping (grade 1: polishable)	1	2	3
	3	Yes, chipping (grade 2: repairable)	3	6	9
	4	Yes, severe chipping/delamination (grade 3: replacement)	0	1	1
Marginal discrepancy (related to the FDP)	1	Not detectable	66	68	134
	2	Detectable but not requiring repair	1	2	3
	3	Requiring repair	0	0	0
	4	Not repairable	0	0	0
FDPs de-cementation	1	No	65	70	135
	2	Yes (reluted without marginal modification)	2	0	2
	3	Yes (reluted but requiring marginal modification)	0	0	0
	4	Not able to be reluted	0	0	0
Patient's view	1	Entirely satisfied	61	60	121
	2	Satisfied	4	10	14
	3	Minor criticism of esthetics; no adverse effect	2	0	2
	4	Completely dissatisfied and/or adverse effect, including pain	0	0	0
Biologic properties					
Postoperative sensitivity; tooth vitality (related to the FDPs)	1	No hypersensitivity; normal vitality	66	67	133
	2	Yes, low hypersensitivity for a limited period of time; normal vitality	1	2	3
	3	Yes, premature/intense or in response to the stimulus	0	1	1
	4	Yes, very intense; need for endodontic treatment	0	0	0
Secondary caries (related to the FDPs)	1	No primary or secondary caries	67	70	137
	2	Yes, very small and localized	0	0	0
	3	Yes, large area of demineralization, caries with cavitation, erosion, or abrasion under the margin of the crown	0	0	0
	4	Yes, deep secondary caries or exposed dentin, not repairable	0	0	0

FDPs = fixed dental prostheses; USPHS = United States Public Health Service; 1 = clinically excellent/very good; 2 = clinically good; 3 = clinically sufficient/satisfactory; 4 = clinically unsatisfactory.

veneering detected during the observation period were located in the posterior regions and almost all when a specific type of zirconia brand (Ceramill ZI, Amann Girrbach) was combined with a specific layering ceramic (GC Initial zr-FS, GC). Several factors such as framework design, mismatch of the thermal expansion coefficients between zirconia and the veneering ceramic, heat treatment, or the thermal conductivity of the Y-TZP can generate residual stresses that induce chipping or fracture.[5] No correlation was found between mechanical failures and type of occlusion, vitality of the abutment, antagonist tooth, or with the finishing line of the tooth preparation.

Conclusions

The short- to medium-term follow-up results of tooth-supported zirconia-based FDPs are promising. Mechanical complications were limited primarily to patients with parafunctional habits, although the degree of bruxism or clenching is a difficult clinical parameter to identify and quantify.

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