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CLINICAL RESEARCH

Five-year clinical performance of monolithic and partially veneered zirconia fixed partial dentures

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ABSTRACT

Statement of problem. The introduction of high-strength zirconia has provided a tooth-colored alternative to metal-ceramics. However, complications such as ceramic chipping have been associated with veneered zirconia. Modifications to zirconia and prosthesis design, such as the omission of occlusal veneering or the avoidance of veneering ceramics through a monolithic design, have been developed to improve clinical outcomes, but clinical data on these developments are limited.

Purpose. The purpose of this study was to generate 5-year prognostic data on the survival, success, and ceramic-related complications of tooth-supported monolithic and partially veneered zirconia fixed partial dentures (FPDs) fabricated from translucent 3 mol% yttria-stabilized tetragonal zirconia polycrystal (Cercon ht; DeguDent GmbH).

Material and methods. A total of 52 participants were enrolled in this observational study and received 68 FPDs (34 monolithic and 34 partially veneered) with 88 pontics. Of these, 58 FPDs were located in the posterior region, 4 in the anterior region, and 6 spanned the canine. The restorations were delivered between November 2011 and June 2016 and were clinically evaluated at fixed intervals. Data were collected until December 2022. The mean observation period of the restorations was 6.0 ±3.0 years (range 0.1 to 10.2); 6.5 ±3.0 years (range 0.6 to 10.2) for monolithic and 5.5 ±2.9 years (range 0.1 to 9.7) for partially veneered FPDs. Kaplan–Meier survival analysis and log-rank tests were performed (α=.05).

Results. A total of 16 FPDs (8 monolithic and 8 partially veneered) failed during the observation period, with biological complications being the most common cause of failure. The cumulative 5-year failure-free survival rates were 89.4% for monolithic and 81.9% for partially veneered (P=.640). The 5-year intervention-free survival rates were 83.7% for monolithic and 68.9% for partially veneered (P=.395). The 5-year ceramic defect-free survival rate was 100% for monolithic and 86.4% for partially veneered (P=.036).

Conclusions. Tooth-supported zirconia monolithic and partially veneered FPDs demonstrated comparable survival and success rates over a 5-year period. However, ceramic complications occurred exclusively in partially veneered FPDs. These findings suggest that monolithic FPDs may offer an advantage in terms of ceramic defect-free survival. (J Prosthet Dent xxxx;xxx:xxx-xxx)

The introduction of high-strength zirconia ceramics has provided a tooth-colored alternative to metal-ceramic materials. Yttria-stabilized tetragonal zirconia polycrystal (Y-TZP) has been reported to have high fracture toughness and biocompatibility and can be used with low minimum layer thickness for fixed dental restorations.[1] It can be processed using cost-effective computer-aided design and computer-aided manufacturing (CAD-CAM) milling and additive manufacturing.[2,3] However, the esthetics of the initial zirconia products were unsatisfactory because of their opacity, and veneering with translucent ceramic was required.[4] The veneer predisposed the restorations to chipping and other ceramic-related complications.[5] The translucency of zirconia has since been improved by modifying the alumina content in

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Clinical Implications

Monolithic zirconia FPDs have better ceramic defect-free survival compared with partially veneered FPDs. In load-bearing situations, clinicians should favor monolithic designs because of their durability and resistance to technical problems. These findings align with those of previous research, reinforcing existing evidence on the advantages of monolithic zirconia. However, this study provides additional medium-term clinical data supporting their reliability in clinical practice.

combination with an increased sintering temperature or by increasing the yttria content, the latter at the cost of reduced fracture strength.[6]

Studies examining zirconia fixed partial dentures (FPDs) have primarily focused on completely veneered designs and have shown variable outcomes.[7–10] Reported 10-year failure rates ranged from 8.7% to 33.8%, and almost all studies reported high rates of ceramic veneer chipping,[7–16] especially in single crowns where chipping ranked among the 3 most common complications.[17] Implant-supported restorations appear to be particularly critical.[9,13] For long-span FPDs on implants, the FPD-related chipping rate was reported to be 71% after 3 years.[18] The high chipping rate has been investigated and attributed to mismatched thermal expansion coefficients,[19–21] thin core layers,[22] and material weaknesses.[23]

Zirconia has continued to be developed for broader clinical use.[24] Monolithic and partially veneered designs have helped reduce the complications seen in fully veneered restorations.[25–27] The introduction of multilayer blocks containing different zirconia formulations has produced monolithic designs with adequate esthetics, including translucency and/or color gradients.[28,29] However, in these modifications the favorable effect of phase transformation is reduced.[24,30,31]

Monolithic zirconia has been investigated as a tooth-colored alternative to partially veneered or unveneered metal alloys for both tooth- or implant-supported single crowns and FPDs.[26,27,32–36] Monolithic zirconia FPDs with a minimum layer thickness of 0.5 to 0.6 mm have demonstrated high fracture loads after thermomechanical aging.[37] Clinical studies have confirmed that the risk of ceramic chipping can be significantly reduced using monolithic or partially veneered zirconia FPDs, while still achieving high patient satisfaction in terms of esthetics, even in the anterior region.[26,38]

Clinical studies have shown promising short-term results for these restorations,[26,39–45] but few have extended beyond a 3-year follow-up.[27,46,47] As ceramic defects may result from age-related microcrack growth, longer follow-ups are needed, particularly in load-bearing areas.[48–51] Therefore, this study aimed to assess and compare the medium-term (5-year) prognosis of monolithic and partially veneered zirconia FPDs. The null hypothesis was that no significant differences in the prognostic outcome would be found between the 2 designs.

MATERIAL AND METHODS

This observational study included patients provided with one or more monolithic or partially veneered FPDs fabricated from translucent 3 mol% Y-TZP (3Y-TZP) at the Department of Prosthodontics, University of Heidelberg, Germany. Participants were clinically evaluated at fixed intervals as part of an ongoing longitudinal study on the performance of zirconia-based single crowns and FPDs. The study had been approved by the local ethics committee and was conducted in accordance with the principles of the Declaration of Helsinki. All participants were informed about the purpose of the study and provided written consent for data collection, analysis, and pseudonymized publication.

Participants were treated by dentists with a minimum of 2 years of experience in prosthodontics by following a standardized protocol. In this observational study, restorations were included if fabricated from a specific 3Y-TZP ceramic (Cercon ht; DeguDent GmbH) and placed between November 2011 and June 2016. Abutment teeth had to be either vital or adequately endodontically treated and periodontally stable. Caries and existing restorations were removed before foundation restorations with a dual-polymerizing composite resin (Rebilda DC; VOCO GmbH) and a 2-bottle etch-and-rinse adhesive (Optibond FL; Kerr Corp) were placed. A conical glass-fiber post, or a cylindrical titanium screw when indicated, or a cast post-and-core build-up for 4-wall defects was used for endodontically treated teeth.

Occlusal reduction of the abutment teeth ensured a minimum layer thickness of 0.6 mm for both restoration designs. Axial wall thickness was ≥0.5 mm for monolithic and ≥1.3 mm for veneered surfaces. The abutments were prepared with a chamfer margin of at least 0.5 mm and a total angle of convergence of 6 degrees (Figs. 1 and 2).

Impressions were made with a polyether material (Impregum Penta H DuoSoft/Garant L Duo Soft; 3M Deutschland GmbH) in a single-step, double-mix impression technique, poured in Type IV gypsum (GC Fujirock EP Classic; GC Corp), and digitized with a laboratory scanner (D800; 3Shape A/S). The restorations were designed (3Shape DentalDesigner; 3Shape A/S) either monolithically or with a labial veneering window in the esthetic zone (maxillary anteriors and first and second

Figure 1. Representative participant with foundation restoration and prepared anterior abutment teeth.

Figure 2. Representative participant with foundation restoration and prepared posterior abutment teeth.

Figure 3. Representative participant with luted partially veneered anterior fixed partial denture.

Figure 4. Representative participant with luted monolithic posterior fixed partial denture.

premolars, mandibular anteriors and first premolars). All load-bearing areas (static and dynamic occlusal contact areas) of partially veneered FPDs were designed to be monolithic. Minimum connector dimensions were 7 mm^2 (3-unit) and 9 mm^2 (4-unit) in the anterior region and 9 mm^2 (3-unit) and 12 mm^2 (4-unit) in the posterior region. All restorations were milled from presintered, precolored 3Y-TZP blanks (Cercon ht light/medium/white; DeguDent GmbH) using CAM equipment (Cercon brain XPERT/Cercon brain CAM Pro; DeguDent GmbH) and individually shaded by infiltration in the presintered state (Color Liquid Prettau; Zirkonzahn GmbH). Final sintering was performed according to the manufacturer's instructions at 1500 °C (Cercon heat plus; DeguDent GmbH). Partially veneered FPDs were hand-veneered (Cercon Ceram Kiss; DeguDent GmbH), and all restorations were then stained and glazed (Cercon stain/glaze; DeguDent GmbH).

During the intraoral evaluation (Figs. 3 and 4), adjustments were made as needed using water-cooled diamond instruments (ZR 8863, ZR 8379; Gebr. Brasseler GmbH & Co KG) and polished with ceramic-specific polishers (set no. 4637.000; Gebr. Brasseler GmbH & Co KG). Either a conventional glass ionomer cement (Ketac Cem; 3M Deutschland GmbH), a self-adhesive cement (RelyX Unicem; 3M Deutschland GmbH, or Panavia SA; Kuraray Europe GmbH), or, for 1 FPD, an interim cement (RelyX Temp NE; 3M Deutschland GmbH) was used to lute the restorations. Interim cement was used at the participant's request for a 1-week shade evaluation. Two removal attempts failed, and further efforts were avoided to prevent damage to the restoration or abutments. Occlusal corrections, if required after insertion, were polished appropriately.

Standardized report forms were used at baseline (placement day or within 7 days), after 6 months, and annually thereafter. Baseline forms included sociodemographic data, abutment and restoration characteristics, and early complications. Follow-up forms documented biological events (such as secondary caries, fractures, periodontal issues, or endodontic issues) and technical events (such as decementation, chipping, fractures, or cracks). Unlisted complications were recorded in a free-text field. Both the participant and the examiner rated the esthetics of the restoration without blinding on a scale of 0 to 10 (0=very poor, 10=excellent).

Data were analyzed with a statistical software program (IBM SPSS Statistics, v27; IBM Corp) based on follow-up examinations completed by December 2022. Descriptive statistics summarized participant sex and age, FPD design distribution (monolithic or partially veneered), FPD characteristics, and esthetic ratings. The 5-year survival rate (restoration in situ, no renewal or removal for other reasons of the restoration required, no abutment tooth extraction needed), intervention-free survival (success), and ceramic defect-free survival were calculated using the Kaplan–Meier method including 95% confidence interval (CI) and compared by log-rank test (α=.05). To account for potential clustering of multiple FPDs within individual participants, shared frailty models based on gamma-distributed random effects were applied in all time-to-event analyses using a software program (R version 4.4; The R Project for Statistical Computing) and the "frailtypack" package. As an exploratory study, *P* values were interpreted descriptively.

RESULTS

The study population included 57 participants (27, 47.4% men; 30, 52.6% women) with a mean age of 61.1 years (standard deviation [SD] 11.8, range 21.8 to 88.0). A total of 73 FPDs were delivered: 37 monolithic (50.7%) and 36 partially veneered (49.3%). Five participants (8.7%; 4 men, 1 woman) were excluded as dropouts because of missed follow-up visits (4 noncompliant, 1 deceased), resulting in the exclusion of 5 (6.8%) FPDs (3 monolithic, 2 partially veneered). The final analysis included 52 participants (23, 44.2% men; 29, 55.8% women; mean age 61.4 years, SD 11.8, range 21.8 to 88.0) with 68 FPDs (34 monolithic, 34 partially veneered). Among these, 40 participants (76.9%) received 1 FPD, 8 (15.4%) received 2, and 4 (7.7%) received 3. Five participants (7.4%) received both designs.

The mean observation period was 6.0 years (SD 3.0, range 0.1 to 10.2) with 6.5 years (SD 3.0, range 0.6 to 10.2) for monolithic and 5.5 years (SD 2.9, range 0.1 to 9.7) for partially veneered FPDs. Table 1 lists the sociodemographic and baseline characteristics.

A total of 16 (23.5%) FPDs (8 monolithic and 8 partially veneered) failed during the observation period (Table 2). Biologic complications (fractures, secondary caries, periodontal disease, endodontic problems) were the most common reason for loss, affecting 11 (16.2%) FPDs. Loss due to technical failure was documented for 5 (7.4%) restorations (Table 2).

A total of 40 complications requiring clinical intervention were reported in 27 FPDs (Table 3). These complications affected 14 monolithic (22 complications) and 13 partially veneered FPDs (18 complications). Most of the observed complications (30/40, 75%) were biological in nature, primarily caused by endodontic problems, secondary caries, abutment tooth fractures, and progression of periodontal disease (Table 3). Four ceramic defects occurred in partially veneered FPDs: 1 framework fracture (2.9%) and 3 veneer chippings (8.8%) (Fig. 5). The remaining 6 complications were decementations, noted in 4 (11.8%) monolithic and 2 (5.9%) partially veneered FPDs.

The cumulative 5-year failure-free survival rate was 89.4% (95% CI: 78.0% to 100%) for monolithic and 81.9% (95% CI: 67.2% to 96.6%) for partially veneered FPDs. The log-rank test indicated that this difference was not statistically significant (*P*=.640) (Fig. 6). The 5-year intervention-free survival (success) rates were 83.7% (95% CI: 70.6% to 96.8%) for monolithic and 68.9% (95% CI: 51.3% to 86.5%) for partially veneered FPDs (*P*=.395) (Fig. 7). No ceramic defects occurred in monolithic FPDs, resulting in 100% ceramic defect-free survival. The 5-year ceramic defect-free survival rate was 86.4% (95% CI: 73.9% to 98.9%) for partially veneered FPDs (*P*=.036) (Fig. 8). Median survival was not reported because no group reached the 50% survival threshold.

A shared frailty model based on a gamma distribution was applied to assess subject-level clustering. The resulting frailty parameter estimates were close to 0 (*P*=.117 for failure-free survival, *P*=.257 for intervention-free survival and *P*=.498 for ceramic defect-free survival). Because of the negligible effect of clustering, the main survival analyses were conducted without accounting for frailty.

Esthetic ratings by clinicians and participants remained high throughout the observation period, with mean values ranging from 8.5 (SD 1.26) for monolithic to 9.48 (SD 0.71) for partially veneered FPDs (Table 4). However, no statistical tests were performed to assess significant changes over time.

DISCUSSION

This study examined the longitudinal clinical performance of tooth-supported monolithic and partially veneered zirconia FPDs over a period of up to 10 years. The cumulative 5-year survival rates were 89.4% for monolithic and 81.9% for partially veneered FPDs, with no statistically significant difference, consistent with recent meta-analyses,[12,13,52] indicating no difference in the prognostic outcomes between these design groups. Therefore, the null hypothesis that no significant differences in the prognostic outcome would be found

Table 1. Baseline characteristics of fixed partial dentures in different design groups

Characteristic	Details	FPD Design	
		Monolithic (n=34)[a]	Partially Veneered (n=34)[a]
Restored arch, n (%)	Maxilla	8 (23.5)	25 (73.5)
	Mandible	26 (76.5)	9 (26.5)
Location, n (%)	Anterior	0 (0)	4 (11.8)
	Canine-spanning	0 (0)	6 (17.6)
	Posterior	34 (100.0)	24 (70.6)
Units, n (%)	3	32 (94.1)	18 (52.9)
	4	1 (2.9)	8 (23.5)
	5	1 (2.9)	4 (11.8)
	6	0 (0)	1 (2.9)
	7	0 (0)	3 (8.8)
Abutment teeth, n (%)	2	33 (97.1)	25 (73.5)
	3	1 (2.9)	5 (14.7)
	4	0 (0)	4 (11.8)
Replaced teeth, n (%)	1	32 (94.1)	19 (55.9)
	2	2 (5.9)	12 (35.3)
	3	0 (0)	3 (8.8)
% of veneered units, mean ±SD		0	73.0 ±29.2
Endodontically treated abutment teeth, n (%)	0	25 (73.5)	17 (50)
	1	7 (20.6)	11 (32.4)
	2	2 (5.9)	4 (11.8)
	3	0 (0)	2 (5.9)
% of endodontically treated abutment teeth, mean ±SD		15.7 ±29.0	30.2 ±35.6
Endodontic post, n (%)	No	33 (97.1)	25 (73.5)
	Conical fiber-reinforced composite post	0 (0)	2 (5.9)
	Cylindrical titanium screw	0 (0)	6 (17.6)
	Conical fiber-reinforced composite post + cylindrical titanium screw	1 (2.9)[b]	0 (0)
	Cast post-and-core	0 (0)	1 (2.9)
Support of antagonistic teeth or prostheses, n (%)	No antagonists	1 (2.9)	0 (0)
	Periodontal	30 (88.2)	31 (91.2)
	Combined periodontal-gingival	3 (8.8)	2 (5.9)
	Implant	0 (0)	1 (2.9)
Cement type, n (%)	Conventional	28 (82.4)	23 (67.6)
	Self-adhesive	3 (8.8)	11 (32.4)
	Provisional	3 (8.8)	0 (0)
Chairside occlusal adjustment / subsequent treatment, n (%)	No / none	11 (32.4)	10 (29.4)
	Yes / polished	19 (55.9)	19 (55.9)
	Yes / glazed	4 (11.8)	5 (14.7)

FPD, fixed partial denture; SD, standard deviation.

[a] Several participants received more than one restoration.

[b] 3-unit FPD with titanium screw in one abutment tooth and glass-fiber post in other.

between the 2 designs was not rejected. The observed survival rates were lower than those reported in a previous 3-year study (96.7% for monolithic, 93.8% for partially veneered).[26] A 2023 review found a 99.6% survival rate for monolithic implant-supported FPDs after 1 to 5 years, with only 1 failure in 644 prostheses.[35] A 2022 systematic review examined tooth-supported monolithic crowns for up to 2 years and found significant heterogeneity between studies and a survival range of 91% to 100%.[52] Notably, the lowest survival rate was associated with the longest study period and the largest sample size,[52] highlighting the need for sufficient observation periods and sample sizes to avoid an overestimation of success rates. The survival rates in the present study were also lower than those for metal-ceramic FPDs, in contrast with findings by Limones et al,[53] who reported no significant difference between zirconia and metal-ceramic restorations. As survival

Table 2. Causes of failures in fixed partial dentures during observation period

Causes of Failures	FPD Design			
	Monolithic (n=34)		Partially Veneered (n=34)	
	n	(%)	n	(%)
No failure	26	76.5	26	76.5
Abutment tooth fracture	3	8.8	3	8.8
Unilateral decementation	2	5.9	2	5.9
Secondary caries	1	2.9	1	2.9
Abutment tooth extraction due to progression of periodontal disease	1	2.9	1	2.9
Abutment tooth extraction due to secondary endodontic problems (combined endodontic-periodontic lesion of endodontically treated abutment tooth)	1	2.9	0	0
Framework fracture	0	0	1	2.9

FPD, fixed partial denture.

Table 3. Biological and technical complications in fixed partial dentures

Complications			FPD Design			
			Monolithic (n=34)		Partially Veneered (n=34)	
			n	(%)	n	(%)
Biological	Secondary caries	No	29	85.3	30	88.2
		Yes	5	14.7	4	11.8
	Abutment tooth fracture	No	30	88.2	31	91.2
		Yes	4	11.8	3	8.8
	Endodontic problems	No	27	79.4	30	88.2
		Yes, primary[a]	5	14.7	3	8.8
		Yes, secondary[b]	2	5.9	1	2.9
	Progression of periodontal disease	No	32	94.1	33	97.1
		Yes	2	5.9	1	2.9
Technical	Decementation (total or partial/unilateral)	No	30	88.2	32	94.1
		Yes	4	11.8	2	5.9
	Cracking or chipping of ceramic veneer	No	34	100.0	31	91.2
		Yes	0	0	3	8.8
	Framework fracture	No	34	100.0	33	97.1
		Yes	0	0	1	2.9

FPD, fixed partial denture.
[a] Abutment tooth in need of initial endodontic treatment because of symptomatic irreversible pulpitis.
[b] Endodontically treated abutment tooth with recurrent apical infection requiring endodontic retreatment, endodontic surgery (root tip resection), or extraction.

Figure 5. Clinical complication after 2.99 years with chipped edge of ceramic veneer of partially veneered fixed partial denture.

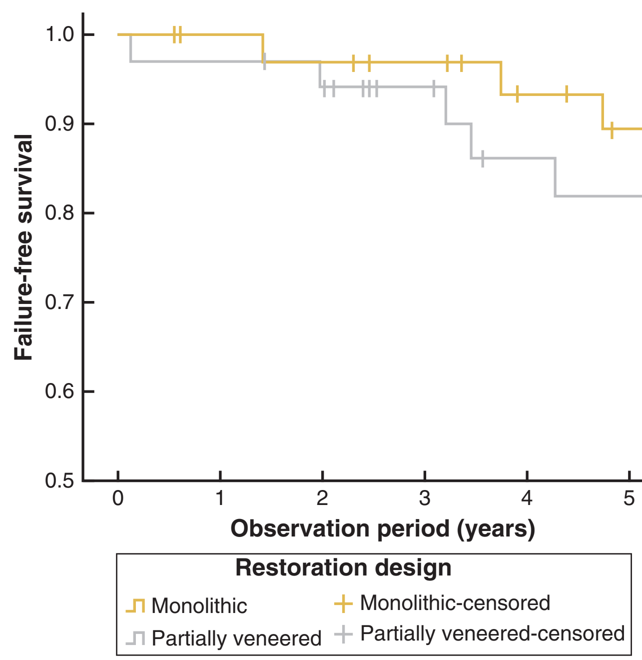

Figure 6. Kaplan–Meier failure-free survival for restorations in different design groups (log-rank test, *P*=.640).

analyses assume evenly distributed failures, short-term data may lead to inflated estimates. Evidence suggests most failures in ceramic FPDs occur between years 5 and 10,[49–51] underscoring the need for long-term studies and meta-analyses to improve prognostic accuracy.

The present study also compared complication rates requiring clinical intervention between monolithic and partially veneered zirconia FPDs. The 5-year success rates were 83.7% for monolithic and 68.9% for partially veneered FPDs. Most complications were biological rather than technical, with secondary caries and endodontic treatment being most frequent, consistent with a previous review.[17] Biological failures occurred equally in both groups, with abutment fractures as the primary cause. Although not statistically significant, the slightly lower success rates in the PV group may be related to a higher proportion of long-span FPDs and non-vital abutments, both of which are known risk factors for technical and biological complications.[14,17,52]

Only a few technical complications were observed, with decementation and chipping being the most frequent, in agreement with previous meta-analyses on posterior zirconia crowns[15] and FPDs.[14,15] A 2022 meta-analysis reported a 4-fold higher risk of chipping compared with decementation in veneered posterior zirconia restorations,[15] which was not observed in the present study. Meta-analyses reported no overall difference in technical complication rates between veneered and monolithic designs,[13,36,53] though ceramic fractures occur more frequently in veneered designs.[13,14] Chipping remains a common technical challenge for

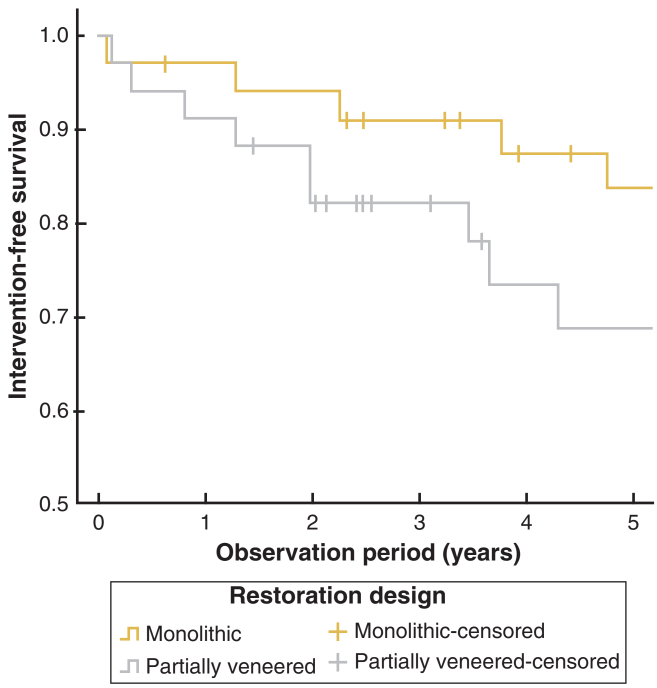

Figure 7. Kaplan–Meier intervention-free survival for restorations in different design groups (log-rank test, *P*=.395).

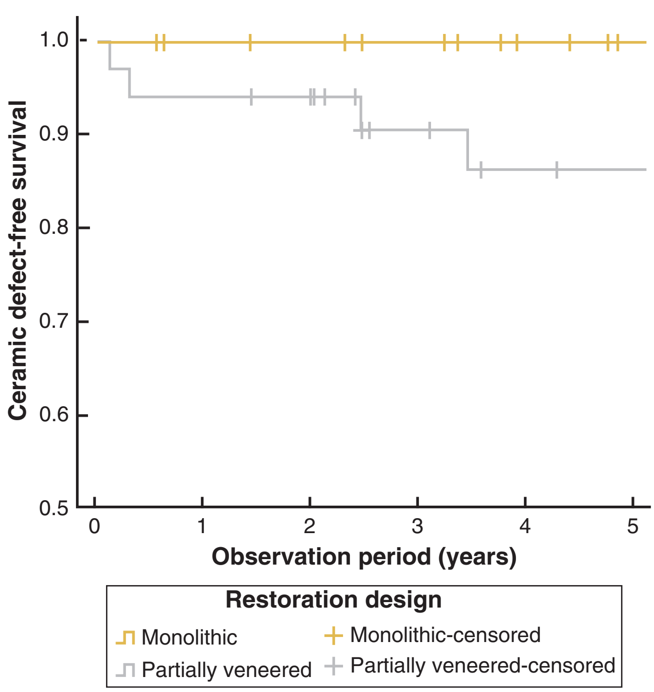

Figure 8. Kaplan–Meier ceramic defect-free survival for restorations in different design groups (log-rank test, *P*=.036).

veneered restorations.[13–16,52,53] Monolithic and partially veneered designs aim to reduce this risk by avoiding the material interface inherent in veneering, thereby lowering complication rates, aftercare costs, and improving long-term outcomes. Veneering did not significantly affect the survival of FPDs in the present study. Ceramic defects were rare, with only 1 framework fracture and 3 chipped prostheses, all in the partially veneered FPD group. Although various veneering techniques have been tested in vitro,[54] no significant difference in reliability was found between the hand-layered method used here and the pressed veneering method.[54]

Chipping occurred only in partially veneered FPDs, affecting 8.8% of restorations, resulting in a ceramic defect-free survival rate of 86.4%. This was lower than previously reported rates, including 20.4% after 5 years for posterior partially veneered FPDs[14] and 71% after 3 years for fully veneered long-span FPDs.[18] In the present study, all ceramic complications occurred within the first 3 years and exclusively in anterior FPDs, affecting incisal edges not fully covered by the zirconia framework and subject to dynamic contacts during protrusive movements. Although the 5-year intervention-free survival rate of partially veneered FPDs (68.9%; 95% CI: 51.3% to 86.5%) was lower than that of monolithic FPDs (83.7%; 95% CI: 70.6% to 96.8%), the clinical relevance of this difference remains unclear. Most interventions were related to biological complications, which are multifactorial and not solely dependent on the prosthetic design, while the absence of ceramic chipping in monolithic FPDs suggests a practical advantage. Taken together, these findings show that monolithic and partially veneered designs can significantly reduce the risk of ceramic defects, particularly the monolithic design, which showed no chipping.

The participants received prostheses fabricated from a 3Y-TZP with a flexural strength of 1200 MPa. Variants with increased translucency, resulting from higher yttrium content and reduced alumina,[28,29] show lower flexural strength by reducing phase transformation potential.[31] Therefore, the results are not directly applicable to zirconia materials with different compositions.

Esthetic scores were high in both the anterior and posterior regions, suggesting that monolithic and partially veneered FPDs met patient and clinician expectations, consistent with previous studies.[26,27] Ratings were collected during clinical follow-up examinations without blinding, which may have influenced the subjective evaluation.

Limitations of the study included the small sample size that may limit the generalizability of the results. Furthermore, variations in FPD length and location could have influenced outcomes, with most monolithic restorations being 3-unit (n=32; 94.1%) and with longer spans being more frequent in the partially veneered group (n=16; 47.1%). Opposing dentition and occlusal loading were not standardized, which may have allowed for individual differences in occlusal forces and may have influenced the incidence of technical complications. As an

Table 4. Esthetic ratings of restorations on numeric scale from 0 (very poor) to 10 (excellent) by dentists and participants at baseline and last follow-up

Variable	Assessor	FPD Design	Baseline		Last Follow-up*	
			Mean	SD	Mean	SD
Esthetics	Dentist	Monolithic	8.50	1.26	9.00	1.10
		Partially veneered	8.65	1.15	9.15	0.83
	Participant	Monolithic	9.26	1.31	9.38	0.85
		Partially veneered	9.35	1.07	9.48	0.71

*single partially veneered FPD for which dentist and participant vote not available at last follow-up.

FPD, fixed partial denture; SD, standard deviation.

observational study, confounding factors such as oral hygiene habits and functional loading could not be controlled, which might have affected the results.

To strengthen the evidence in this field, future studies should address these aspects in more detail. Investigations with larger cohorts and controlled study designs would help improve the validity of the findings. Prospective randomized clinical trials that consider standardized occlusal conditions and extend follow-up periods are needed to confirm the long-term performance of monolithic and partially veneered zirconia restorations. Further research should explore how different zirconia compositions and veneering techniques affect clinical outcomes.

CONCLUSIONS

Based on the findings of this clinical study, the following conclusions were drawn:

1. Tooth-supported monolithic and partially veneered FPDs exhibited comparable survival and success rates over a 5-year period.
2. The most notable difference was the absence of ceramic defects in monolithic FPDs, whereas partially veneered FPDs showed a low but notable rate of chipping.

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Christos Labis: Investigation, Data Curation, Writing – original draft, Writing – review and editing. **Rebecca Handermann:** Investigation, Data curation, Writing – original draft, Writing – review and editing. **Peter Rammelsberg:** Resources, Writing – review and editing, Investigation. **Wolfgang Bömicke:** Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Visualization, Supervision. **Christos Labis** and **Rebecca Handermann** contributed equally to the work and are considered co-first authors.

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