Prospective Clinical Split-Mouth Study of Pressed and CAD/CAM All-Ceramic Partial-Coverage Restorations: 7-Year Results

Petra C. Guess, Dr Med Dent, PhD[a]/Christian F. Selz, Dr Med Dent[b]/Yann-Niclas Steinhart, Dr Med Dent[b]/Susanne Stampf, Dr Rer Nat[c]/Joerg R. Strub, DMD, Dr hc PhD[d]

The aim of this prospective clinical split-mouth study was to investigate the long-term performance of pressed and computer-aided design/computer-assisted manufacture (CAD/CAM) all-ceramic partial-coverage restorations (PCRs). Twenty-five patients were restored with 40 lithium disilicate pressed PCRs (IPS e.max-Press, Ivoclar Vivadent) and 40 leucite-reinforced glass-ceramic CAD/CAM PCRs (ProCAD, Ivoclar Vivadent). All restorations were placed in vital first or second molars. The 7-year Kaplan-Meier survival rate was 100% for pressed PCRs and 97% for CAD/CAM PCRs. Both systems showed significant deterioration over time in all modified United States Public Health Service criteria. Increased surface roughness and impaired color match were significantly more prevalent with pressed PCRs. Based on the 7-year data, both all-ceramic systems can be considered reliable treatment options for posterior PCRs. *Int J Prosthodont 2013;26:21–25. doi: 10.11607/ijp.3043*

All-ceramic partial-coverage restorations (PCRs) are increasingly used in restorative dentistry due to the growing demand for minimally invasive, biocompatible, and tooth-colored restorations. The short- and medium-term results of adhesively luted all-ceramic restorations involving the entire occlusal tooth surface are promising, but long-term data are still lacking.[1] The purpose of this study was to compare the long-term behavior of pressed and computer-aided design/computer-assisted manufacture (CAD/CAM) all-ceramic PCRs over 7 years.

Materials and Methods

This randomized controlled trial comprised 25 patients (11 women, 14 men) who required two to four PCRs. The clinical investigation was approved by the local ethics committee (registration no. 277/01) and followed a split-mouth study design. Eighty vital first and second molars with extended Class II caries lesions were restored with 40 pressed PCRs (IPS e.max Press, Ivoclar Vivadent) and 40 CAD/CAM-fabricated all-ceramic PCRs (ProCAD, Ivoclar Vivadent; Cerec 3 InLab, Sirona). Patients with removable prostheses in the opposing arch, poor oral hygiene (pocket depths greater > 3 mm; Papillary Bleeding Index > 35%), or pronounced parafunction (eg, bruxism) were excluded. All patients provided informed consent for all study procedures. The preparation design included reduction of the entire occlusal surface (2 mm) with a butt joint margin for the nonbearing cusps and a rounded shoulder finishing line for the bearing cusps. Full-arch impressions (Permadyne, 3M ESPE) were taken, and the PCRs were adhesively cemented with a hybrid composite resin material (Tetric/Syntac Classic, Ivoclar Vivadent). The restorations were examined for postoperative hypersensitivity and fractures and evaluated according to the modified United States Public Health Service (USPHS) criteria (Table 1) at baseline and annually for 7 years. The Kaplan-Meier survival rate accounting for absolute failures (inacceptable fractures, secondary caries, and endodontic complications) and success rate for relative failures (acceptable minimal cohesive fractures and Charlie ratings in any of the USPHS criteria) were calculated. The success rates of the pressed and CAD/CAM restorations were compared by calibrating the confidence intervals (CIs). A random-intercept logistic regression model was calculated for each outcome of the USPHS criteria (PROC/GLIMMIX, SAS).

[a]*Associate Professor, Department of Prosthodontics, School of Dentistry, Albert-Ludwigs-University Freiburg, Freiburg, Germany.*
[b]*Assistant Professor, Department of Prosthodontics, School of Dentistry, Albert-Ludwigs-University Freiburg, Freiburg, Germany.*
[c]*Research Assistant, University Medical Center, Albert-Ludwigs-University Freiburg, Freiburg, Germany.*
[d] *Professor and Chair, Department of Prosthodontics, School of Dentistry, Albert-Ludwigs-University Freiburg, Freiburg, Germany.*

Correspondence to: *Dr Petra C. Guess, Department of Prosthodontics, School of Dentistry, Albert-Ludwigs-University Freiburg, Hugstetter Strasse 55, 79106 Freiburg, Germany. Fax: 49 (0)761 270 49 250. Email: petra.guess@uniklinik-freiburg.de*

Table 1 USPHS Criteria for Classification of Partial-Coverage Restorations

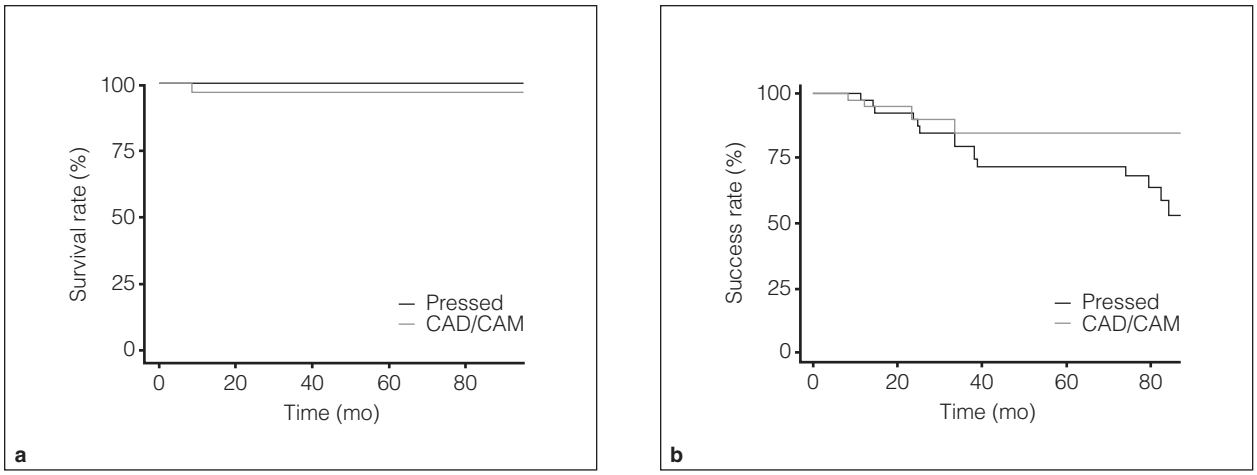
Criteria	Rating	Characteristics
Secondary caries	Alfa	No evidence of caries contiguous with the margin of the restoration.
	Bravo	Caries evident contiguous with the margin of the restoration.
Marginal adaptation	Alfa	No visible evidence of crevice along margin; no catch or penetration of explorer.
	Bravo	Visible evidence of crevice and/or catch of explorer; no penetration of explorer.
	Charlie	Visible evidence of crevice; penetration of explorer.
Marginal discoloration	Alfa	No discoloration on the margin between the restoration and tooth structure.
	Bravo	Superficial discoloration on the margin between the restoration and tooth structure; does not penetrate in pulpal direction.
	Charlie	Discoloration has penetrated along the margin of the restorative material in pulpal direction.
Surface roughness	Alfa	Visual fine polished glossy surface; no palpable roughness.
	Bravo	Slight, visible, and palpable roughness.
	Charlie	Coarse, visible, and palpable roughness; unglazed surface.
Color match	Alfa	No mismatch in color, shade, and/or translucency between restoration and adjacent tooth.
	Bravo	Mismatch between restoration and tooth structure within the normal range of color, shade, and/or translucency (< 1 shade off; VITA shade guide).
	Charlie	Mismatch between restoration and tooth structure outside the normal range of color, shade, and/or translucency (> 1 shade off; VITA shade guide).
Anatomical form	Alfa	The restoration is continuous with tooth anatomy.
	Bravo	The restoration is not continuous with tooth anatomy. The restoration is slightly under- or overcontoured.
	Charlie	The restoration is not continuous with tooth anatomy. Restoration material is missing; a surface concavity is ascertainable.

Table 2 Distribution of Ceramic Fractures

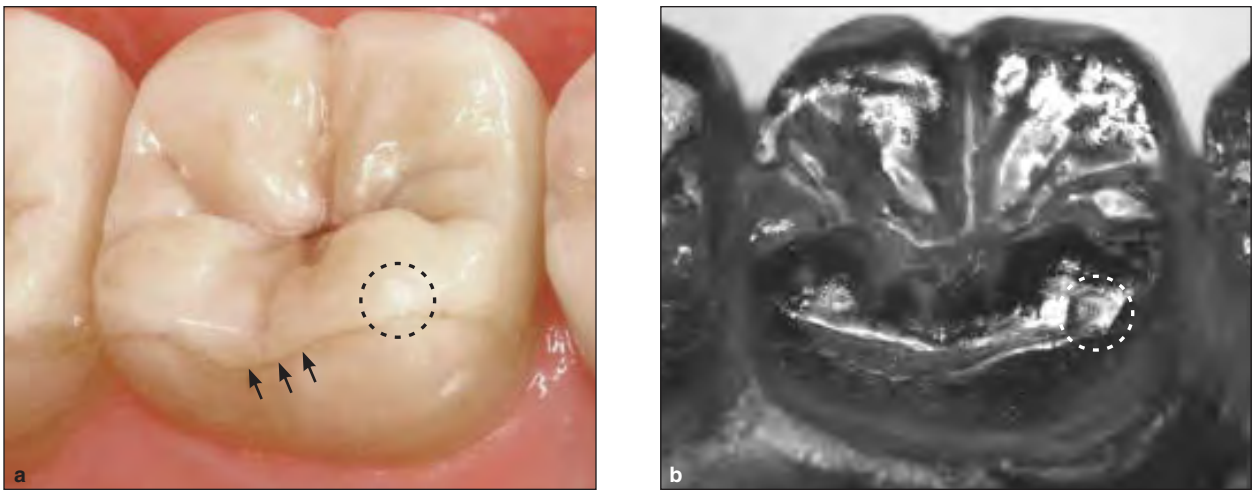
	Restoration	
	Pressed	CAD/CAM
Minor cohesive fractures (clinically acceptable)	1 at mesiolingual occlusal margin (25 mo) 1 at mesiobuccal occlusal margin (38 mo) 1 at distobuccal occlusal margin (68 mo)	1 at distolingual occlusal margin (12 mo) 1 at distobuccal occlusal margin (60 mo) –
Bulk fractures (clinically unacceptable)	–	1 at lingual-occlusal cusp (9 mo)

Results

Eleven of the 25 patients were lost during the 7-year follow-up for reasons unrelated to the dental treatment. The 7-year Kaplan-Meier survival rate was 100% for the pressed PCRs and 97% for the CAD/CAM PCRs (one fracture of one restoration) (Table 2, Fig 1a). No secondary caries, endodontic complications, or postoperative complaints were observed. Minimal cohesive ceramic fractures (Figs 2a and 2b) were noted in 5 patients, but all affected restorations remained in situ (Table 2). The estimated 7-year Kaplan-Meier success rate (Fig 1b) was 0.84 (CI: 0.70–0.98) for the pressed PCRs and 0.58 for the CAD/CAM PCRs (CI: 0.38–0.78). Statistical comparison of the success rates showed overlapping of the CIs. The difference was not significant ($P = .05$). Both fabrication techniques revealed significantly decreasing Alfa ratings for all USPHS criteria over time (baseline to 7 years) ($P < .0001$), especially regarding the marginal adaptation and discoloration criteria. Increased surface roughness ($P < .0001$) and decreasing color match ($P < .0014$) were significantly more prevalent over time for pressed restorations than for CAD/CAM restorations (Table 3).



Figs 1a and 1b Kaplan-Meier **(a)** survival and **(b)** success rates according to material and time.



Figs 2a and 2b **(a)** Clinical view of a mandibular pressed PCR after a service time of 25 months. **(b)** Optical microscopic view of an epoxy replica of the pressed restoration after 70 months. Minimal ceramic cohesive fracture (chipping) is indicated by dotted circles; marginal discoloration is indicated by arrows.

Discussion

After an observation period of 7 years, the pressed and CAD/CAM PCRs showed high survival rates of 100% and 97%, respectively. To the authors` knowledge, no study has investigated the long-term clinical performance of differently fabricated all-ceramic PCRs in a split-mouth design. Therefore, this study can only be compared to trials of IPS Empress (81% survival after 7 years[2]) and Vita Mark II partial crowns (88.8% survival after 5.5 years[3]). The lower failure rate of the present study can be attributed to the improved flexural strength of the pressed system (400 MPa) and the homogeneity of the CAD/CAM material. The success rates of both materials were comparable over time. The minor ceramic cohesive fractures at the occlusal margins for both all-ceramic systems did not result in clinical problems during the observation period.

Time-dependent changes regarding the marginal adaption and marginal discoloration can be correlated with wear of the luting composite and marginal deterioration of the luting space. These degradation processes have been extensively addressed in the dental literature and have been described for both CAD/CAM-fabricated and conventionally fabricated

Table 3 Modified USPHS Criteria (%) Over the Observation Period

	Baseline (25 patients)		12 mo (22 patients)		24 mo (22 patients)		36 mo (23 patients)		50 mo (12 patients)	
USPHS criteria	PC (n = 40)	IP (n = 40)	PC (n = 33)	IP (n = 34)	PC (n = 33)	IP (n = 34)	PC (n = 35)	IP (n = 36)	PC (n = 19)	IP (n = 19)
Secondary caries										
Alfa	100	100	100	100	100	100	100	100	100	100
Bravo	–	–	–	–	–	–	–	–	–	–
Marginal adaptation										
Alfa	92.5	95.0	84.9	88.2	81.8	85.3	72.9	78.9	63.2	78.9
Bravo	7.5	5.0	15.1	11.8	18.2	14.7	27.1	15.8	36.8	21.1
Charlie	–	–	–	–	–	–	–	5.3	–	–
Marginal discoloration										
Alfa	100	100	84.9	76.5	57.6	55.8	54.1	60.5	57.9	63.2
Bravo	–	–	15.1	23.5	42.4	41.2	45.9	36.9	42.1	36.8
Charlie	–	–	–	–	–	3.0	–	2.6	–	–
Surface roughness										
Alfa	100	100	48.5	11.7	30.3	3.0	32.4	7.9	36.9	15.8
Bravo	–	–	51.5	79.4	63.6	88.2	56.8	71.1	52.6	73.7
Charlie	–	–	–	8.9	6.1	8.8	10.8	21	10.5	10.5
Color match										
Alfa	95.0	92.5	42.4	20.5	39.4	11.8	48.6	15.8	52.6	10.5
Bravo	5.0	7.5	57.6	79.5	60.6	88.2	51.4	84.2	47.4	89.5
Charlie	–	–	–	–	–	–	–	–	–	–
Anatomical form										
Alfa	77.5	97.5	78.8	94.1	69.7	85.3	67.6	78.9	78.9	89.5
Bravo	22.5	2.5	21.2	5.9	30.3	14.7	32.4	21.1	21.1	10.5
Charlie	–	–	–	–	–	–	–	–	–	–

PC = ProCAD (CAD/CAM restorations); IP = IPS e.max Press (pressed restorations).

all-ceramic PCRs.[3,4] The marginal impairments observed in the present study did not require clinical intervention or replacement of the affected restorations. Further, no incidence of secondary caries was observed.

The present results were achieved using an earlier version of the Cerec software and hardware. The currently available Biogeneric software and advanced milling device Cerec MCXL offer improved occlusal morphology and restoration fit. Surface roughness and color match were subject to significant changes over time, especially for pressed restorations. Slightly rough or pitted surfaces as well as color changes were also observed in a study of IPS Empress onlays[5] and could be the result of occlusal contact wear and chemical degradation of the glazing material. Due to the posterior location of the restorations, these time-dependent degradation processes were not of concern clinically and were only observed by the examiners.

The loss of patients to recall represents one limitation of this prospective longitudinal study; however, similar investigations have reported losses to the same extent.[4,5]

Conclusions

Pressed and CAD/CAM-fabricated all-ceramic partial-coverage restorations showed favorable survival rates after 7 years and can be recommended for the restoration of extended lesions in posterior teeth. Fatigue-resistant adhesive cementation as well as all-ceramic glazing materials should be investigated in future research.

	61 mo (12 patients)		71 mo (11 patients)		84 mo (14 patients)	
	PC (n = 20)	IP (n = 19)	PC (n = 16)	IP (n = 16)	PC (n = 24)	IP (n = 24)
	100	100	100	100	100	100
	–	–	–	–	–	–
	70.0	84.2	56.3	75.0	54.2	58.3
	30.0	15.8	43.7	25.0	45.8	37.5
	–	–	–	–	–	4.2
	40.0	57.9	62.5	56.3	45.8	45.8
	60.0	42.1	37.5	43.7	54.2	54.2
	–	–	–	–	–	–
	30.0	15.8	31.3	12.5	16.7	8.3
	50.0	57.9	56.2	68.8	75.0	79.2
	20.0	26.3	12.5	18.7	8.3	12.5
	50.0	26.3	43.8	12.5	37.5	12.5
	50.0	73.7	56.2	87.5	62.5	87.5
	–	–	–	–	–	–
	75.0	94.7	62.5	93.8	66.7	83.3
	25.0	5.3	37.5	6.2	33.3	16.7
	–	–	–	–	–	–

Acknowledgment

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Literature Abstract

Oral health and cancer, cardiovascular, and respiratory mortality of Japanese

This study investigated the association between oral health and cardiovascular diseases, cancer, and respiratory mortality for elderly Japanese subjects. In 2003, participants of the Aichi Gerontological Evaluation Study (AGES) Project were sent self-administered questionnaires, of which 4,425 respondents were used for data analysis. Oral health was categorized into three groups: 20 or more teeth, 19 or fewer teeth and eat everything, and 19 or fewer teeth with eating difficulty. Other data collected for analysis included sex, age, Body Mass Index, self-rated health, present illness, exercise, smoking history, alcohol consumption, education attainment, and equivalent income. After a mean follow-up of 4.28 years, 410 participants had died (159 from cancer, 108 from cardiovascular diseases, and 58 from respiratory disease). Multivariate adjusted Cox proportional hazard models demonstrated a 1.83- and 1.85-times greater hazard ratio for cardiovascular disease mortality and respiratory disease mortality, respectively, in respondents with 19 or fewer teeth and with eating difficulty when compared with respondents with 20 or more teeth. As for cancer mortality, there was no significant association. The authors concluded that oral health status can be used to predict cardiovascular and respiratory disease mortality but not cancer mortality in elderly Japanese subjects.

Aida J, Kondo K, Yamamoto T, et al. *J Dent Res* 2011;90:1129–1135. **References:** 34. **Reprints:** Asst Professor Jun Aida , Department of International and Community Oral Health, Tohoku University Graduate School of Dentistry, Sendai, Japan. Email: j-aida@umin.ac.jp—*Sapphire Gan, Singapore*