Clinical Long-Term Evaluation and Failure Characteristics of 1,335 All-Ceramic Restorations

Ulrike S. Beier, MSc, DMD[a]/Ines Kapferer, MSc, DMD[a]/Herbert Dumfahrt, MD, DMD, PhD[b]

Purpose: The aim of this clinical retrospective study was to evaluate the clinical quality, estimated survival rate, and failure analysis of different all-ceramic restorations in a long-term analysis of up to 20 years. ***Materials and Methods:*** Different all-ceramic restorations (crowns [n = 470], veneers [n = 318], onlays [n = 213], and inlays [n = 334]) were placed in 302 patients (120 men, 182 women) between 1987 and 2009 at Medical University Innsbruck, Innsbruck, Austria. Clinical examination was performed during patients' regularly scheduled maintenance appointments. Esthetic match, porcelain surface, marginal discoloration, and integrity were evaluated following modified California Dental Association/Ryge criteria. Number of restoration failures and reasons for failure were recorded. The study population included 106 (35.1%) individuals diagnosed with bruxism. The success rate was determined using Kaplan-Meier survival analysis. ***Results:*** The mean observation time was 102 ± 60 months. Ninety-five failures were recorded. The main reason for failure was fracture of the ceramic (33.68%). The estimated survival rate was 97.3% after 5 years, 93.5% at 10 years, and 78.5% at 20 years. Nonvital teeth showed a significantly higher risk of failure ($P < .0001$). There was a 2.3-times greater risk of failure associated with existing parafunction (bruxism, $P = .0045$). Cementation using Variolink showed significantly fewer failures than Optec Cement ($P = .0217$) and Dual Cement ($P = .0099$). No significant differences were found for type of restoration and distribution in the mouth. ***Conclusion:*** All-ceramic restorations offer a predictable and successful restoration with an estimated survival probability of 93.5% over 10 years. Significantly increased failure rates are associated with bruxism, nonvital teeth, and specific cementation agents. *Int J Prosthodont 2012;25:70–78.*

The demand for high-quality esthetic restorations in prosthetic dentistry resulted in the development of all-ceramic materials used for individual veneers, crowns, onlays, and inlays.[1] In addition to esthetic considerations when selecting a restorative material, patients have questioned the use of amalgam and nonprecious alloy filler materials.[2] All-ceramic restorations are esthetically optimal to mimic the translucency and structure of natural teeth. In addition to a pleasing appearance, these materials are biocompatible; possess chemical resistance, wear characteristics, and coefficients of thermal expansion similar to that of enamel; and have low thermal conductivity and radiopacity.[1,3] Furthermore, they demonstrate diminished plaque accumulation.[4,5] However, inherent brittleness, crack propagation, low tensile strength, and the potential to abrade the opposing dentition are mentioned as mechanical shortcomings of these materials[6–9] and influence the success of all-ceramic restorations.[10,11] Bulk fracture and loss of restoration have been reported as the main reasons for failure in short-term evaluations of all-ceramic inlays and onlays[12] and partial and complete all-ceramic prostheses.[13] Many authors state that fractures are the most frequent cause for clinical failure of all-ceramic restorations.[14,15]

Today, all-ceramic restoration materials can be divided into three main categories[16,17]: predominantly glass-based ceramics, particle-filled glass-ceramics, and completely polycrystalline ceramics (no glass). In the present study, only glass-ceramics were evaluated.

The purpose of this clinical retrospective study was to evaluate the clinical quality, success rate, and estimated survival rate of silicate glass-ceramic restorations in both dental arches over a 20-year period.

[a]*Assistant Professor, Clinical Department of Restorative and Prosthetic Dentistry, Innsbruck Medical University, Innsbruck, Austria.*
[b]*Professor, Clinical Department of Restorative and Prosthetic Dentistry, Innsbruck Medical University, Innsbruck, Austria.*

Correspondence to: *Dr Ulrike Stephanie Beier, Clinical Department of Restorative and Prosthetic Dentistry, Innsbruck Medical University, MZA, Anichstrasse 35, A-6020 Innsbruck, Austria. Fax: +43-512-504-27157. Email: ulrike.beier@i-med.ac.at*

Additionally, the restoration-specific failure rate was evaluated to characterize both patient-specific and restoration-specific variables to identify those that predict ceramic restoration failure. This portion of the study describes the clinical outcome, estimated survival rate, and failure rate of all-ceramic restorations. Further reports will focus on the long-term performance, clinical quality, success rates, and estimated survival rates of veneer restorations, as well as on the clinical performance of different types of porcelain restorations in posterior teeth.

Materials and Methods

Three hundred two patients (120 men, 182 women) were examined during their regularly scheduled maintenance appointments in the Department of Restorative and Prosthetic Dentistry, Innsbruck Medical University, Innsbruck, Austria, over a 4-month period from March to July 2010. All patients were informed of the purpose of the all-ceramic restoration study, and permission was obtained. No patients were excluded.

Ceramic-specific and patient-specific variables were recorded before clinical examination. Ceramic-specific data included the type of restoration, ceramic material, type of bonding and cementation, distribution in the dental arch, and observation time since insertion of the restoration. The data concerning the distribution in the mouth were categorized into three regions of the oral cavity: anterior (canine to canine), premolar, and molar regions. Every ceramic restoration was additionally documented in a specific database. If there was a former reported failure of the ceramic restoration in the patient chart or the specific database, the restoration failure was included in the sample. Patient-specific data concerned sex, age, tooth sensitivity, smoking, and bruxism habits. The presence or absence of bruxism was determined by either patient self-reporting or clinical signs of occlusal wear patterns on a patient's teeth that were consistent with a bruxism habit. The observation of tooth wear or spots on restorations was performed on a tooth-by-tooth basis in relation to the patient's age and coarseness of diet. Patients' self-reported satisfaction with their all-ceramic restorations was measured using a categoric scale consisting of the following four responses: excellent, good, medium, or none.

The sample consisted of 1,335 silicate ceramic restorations placed between November 1987 and December 2009 at the Department of Restorative and Prosthetic Dentistry, Innsbruck Medical University, including ceramic restorations placed on anterior and posterior teeth. As preliminary treatment, all patients took part in the dental hygiene program at the clinic. Prior to preparation, all teeth had to be free of active periodontal inflammation with probing depths less than 3 mm and no bleeding on probing. The clinical treatment was carried out by two experienced dental clinicians at the Department of Prosthodontic and Restorative Dentistry to achieve the best clinical results. The clinical procedure used was similar. Radiographic examinations and tooth sensitivity evaluations were performed for diagnosis and treatment planning. Additionally, axiographic recordings (Axiograph II, SAM) were made for diagnosis and to adjust the horizontal condylar inclination and the Bennett angle of the articulator two-dimensionally. In cases where the included teeth were part of a full-mouth rehabilitation, lateral cephalographs were produced. The actual and ideal lower facial heights were calculated to determine the vertical dimension.

All preparations were performed according to accepted universal guidelines for tooth preparations.[18] Impressions were made using a single-step double-phase impression technique.[19] Silver-plated master casts were produced from the silicone impressions and mounted in a semiadjustable articulator (SAM II, SAM).[20] The mandibular casts were mounted in centric relation. The intended occlusal scheme for all-ceramic restorations was an anterior-guided protrusive and canine-guided laterotrusive movement. The restorations were fabricated following the manufacturers' recommendations in the dental laboratory of the department. After cementation and finishing under 2.5× magnification, the occlusion was checked carefully and, if indicated, adjusted as necessary using canine-guided dynamic occlusion.[21–23]

Most of the patients evaluated in the study regularly attended the recall sessions offered by the dental clinic in the years before (approximately 80%).

Clinical Evaluation

The clinical examination of the restorations was performed by two dentists after careful calibration. One of the dentists had inserted most of the restorations, and the other had not placed any of the restorations. Disagreements in ratings between both examiners were resolved by consensus.

Esthetic match, porcelain surface, marginal discoloration, and integrity were carefully examined for every restoration following modified California Dental Association (CDA)/Ryge criteria.[24,25] If the evaluation parameters were rated Alpha or Bravo, the ceramic restoration was rated acceptable and successful; Charlie and Delta ratings were determined as unacceptable and classified as failures (Table 1).

Table 1 Clinical Rating of Restorations (Modified CDA/Ryge Criteria)[24,25]

Parameter	Rating*	Restoration
Esthetic match		
	Alpha	No mismatch in color, shade, or translucency between restoration and adjacent tooth
	Bravo	Mismatch between restoration and tooth structure within the normal range of tooth color, shade, or translucency
	Charlie	Esthetically displeasing color, shade, or translucency
Porcelain surface		
	Alpha	Smooth surface (shiny after air drying)
	Bravo	Dull surface or chipping of porcelain that does not impair esthetics or function and does not expose tooth structure
	Charlie	Chipping of porcelain impairing esthetics and function or exposing tooth structure; intraporcelain fissures detectable with the explorer
Marginal discoloration		
	Alpha	No discoloration of the margin
	Bravo	Superficial discoloration not penetrating in a pulpal direction
	Charlie	Discoloration penetrating in a pulpal direction
Marginal integrity		
	Alpha	No visible evidence of crevice along the margin; no catch or penetration of the explorer
	Bravo	Visible evidence of crevice or catch along the margin of the explorer; no penetration of the explorer
	Charlie	Visible evidence of crevice and penetration of the explorer
	Delta	Restoration is mobile, fractured, or missing

*Alpha and Bravo = restoration is acceptable/successful; Charlie and Delta = restoration is not acceptable and must be replaced.

Examination of the margin quality and recurrent caries was done using an explorer (no. 3 CH, Hu-Friedy) and visual inspection with 2.5× magnification. The Papilla Bleeding Index (PBI) according to Saxer and Mühlemann was additionally used for evaluating patients' oral hygiene.[26]

Absolute and relative failures were recorded in this analysis. An absolute failure was defined when the restoration presented an irreparable problem and had to be removed and substituted with a new dental restoration. A relative failure was a ceramic restoration that allowed correction with a finishing procedure and polishing. Failures were defined as fractures of the ceramic with exposed dentin, fractures of the tooth, unacceptable marginal adaptation, caries, cracks in the ceramic, chipping, being esthetically irreparable (color or too short), producing hypersensitivity, debonding, or in need of a new restoration after endodontic treatment. Data concerning failures of the ceramic restoration before the evaluation in 2010 were additionally collected from the patients' charts or the ceramic database.

Statistical Analyses

Data were tabulated using Excel 2003 (Microsoft Office Excel 2003, Microsoft). The statistical analysis was performed using SAS 9.2 software (SAS Institute).

Survival time was defined as the period of time starting from the successful fitting of the restoration and ending when the restoration presented with an irreparable problem. Kaplan-Meier methodology was used for the calculation of the survival probabilities in this study. This nonparametric statistical technique takes into account censored observations resulting from incomplete follow-up.[27] The Cox proportional hazards model was used to study the influence of various risk factors for all ceramic failures. Since many patients had more than one ceramic restoration, robust standard errors were computed using the methods of Lin and Wei.[28] Because of the small number of events, only univariate models are presented.

Associations with binomial outcomes were assessed using logistic regression incorporating generalized estimating equations.[29] This process estimated a correlation between observations from the same patient. The level of significance was established at $P \leq .05$.

Results

The mean observation time was 102 ± 60 months for the 1,335 ceramic restorations. The mean age of patients at the time of cementation was 46.51 ± 13.14 years. The distribution of restored teeth is presented in Fig 1. The frequency distribution of the type of all-ceramic restoration related to bonding system and type of cement used is presented in Table 2.

During the clinical examination undertaken between March and July 2010, 95 all-ceramic restorations were rated as failures. The Kaplan-Meier survival analysis of all 1,335 all-ceramic restorations with 95 failures evaluated is shown in Fig 2. The estimated survival rate was 97.3% after 5 years, 95.6% at 8 years, 93.5% at 10 years, 85.8% at 15 years, and 78.5% at

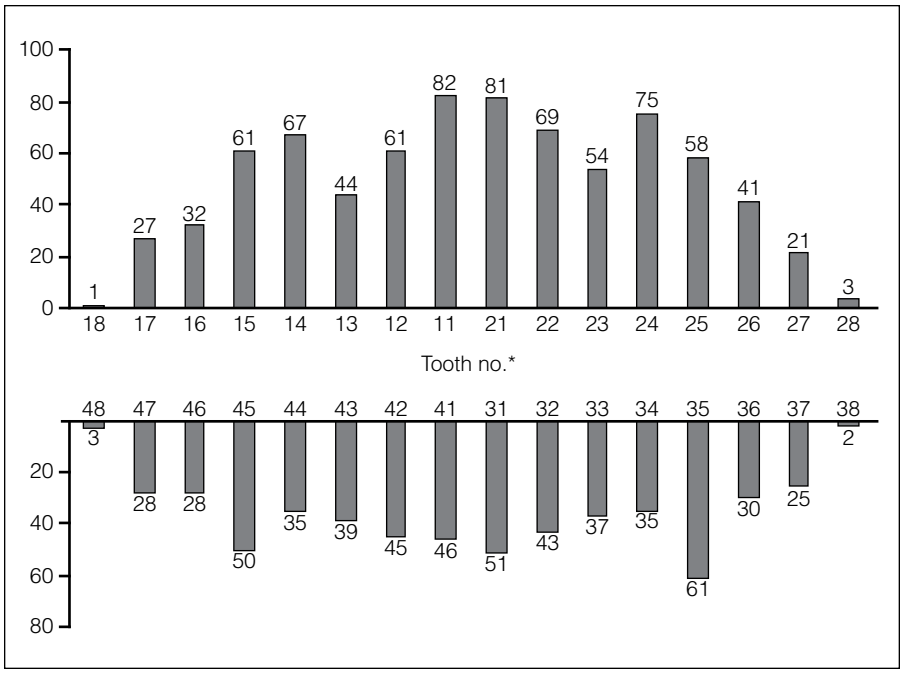

Fig 1 Distribution of all-ceramic restorations (n = 1,335). *FDI tooth-numbering system.

Table 2 Frequency Distribution of Bonding System and Type of Cement Used Related to Type of Ceramic Restoration*

	Bonding						Cement								
	No dentin bonding		Syntac Classic		Optibond FI		Optec Cement		Dual Cement		3M Cement		Variolink high-viscosity		
Type of restoration	n	%	n	%	n	%	n	%	n	%	n	%	n	%	Total
Veneer	38	2.9	38	2.9	242	18.1	44	3.3	14	1.1	5	0.4	255	19.1	318
Crown	46	3.5	64	4.8	360	27.0	20	1.5	31	2.3	29	2.2	390	29.2	470
Onlay	2	0.2	10	0.8	201	15.1	0	0.0	1	0.1	1	0.1	211	15.8	213
Inlay	71	5.4	10	0.7	253	18.9	6	0.6	59	4.6	5	0.4	264	19.9	334
Total	157	11.8	122	9.1	1,056	79.1	70	5.2	105	7.9	40	3.0	1,120	83.9	1,335

*Syntac Classic, Ivoclar Vivadent; Optibond FI, Kerr; Optec Cement, Jeneric/Pentron; Dual Cement, Ivoclar Vivadent; 3M Cement, 3M ESPE; Variolink high-viscosity, Ivoclar Vivadent.

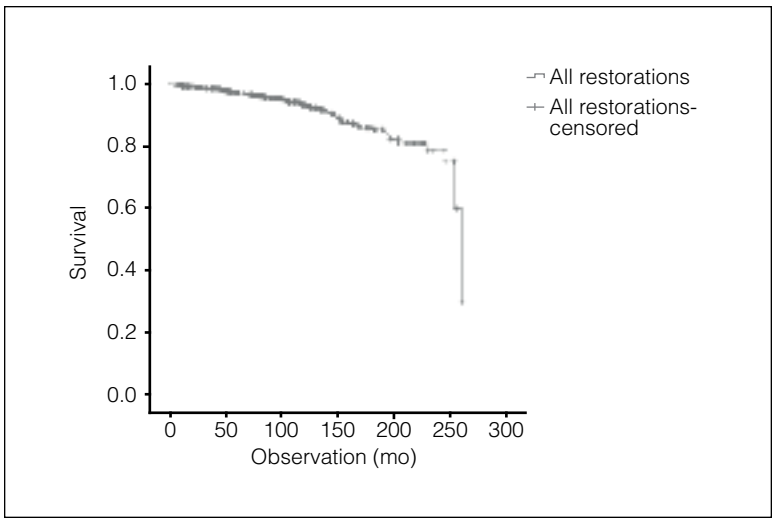

Fig 2 Overall estimated survival rate for ceramic restorations.

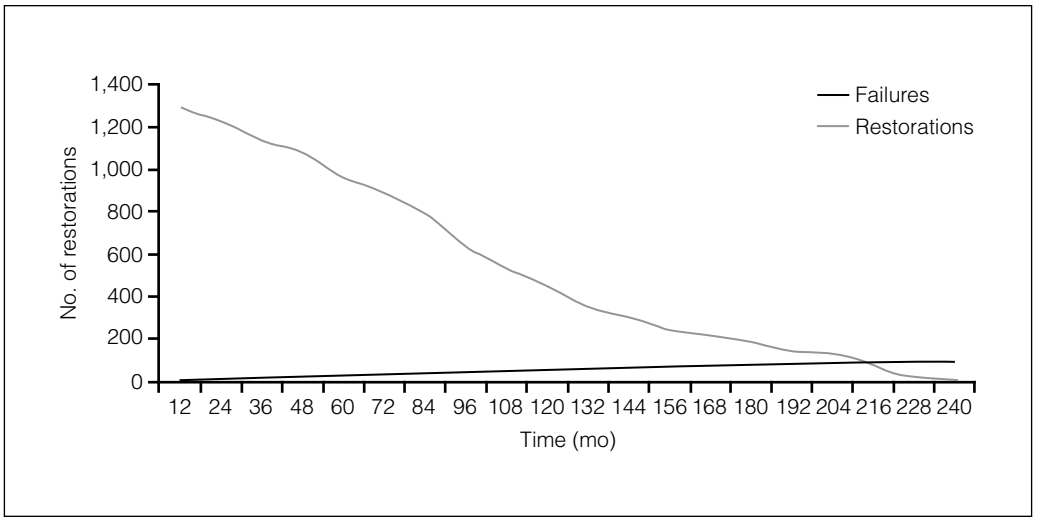

Fig 3 Number of failures and remaining restorations according to observation time.

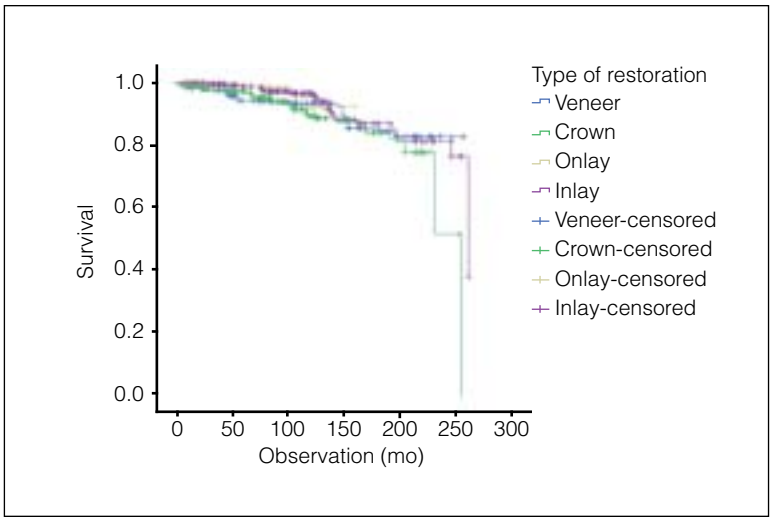

Fig 4 Estimated survival rate for different restoration types. No significant differences were found between restoration types.

20 years. Figure 3 demonstrates the number of remaining restorations and the number of failed restorations during the observation period. Nearly half of the failures occurred in the first 8 years (n = 47). After 10 years, 451 restorations were in service; 184 remained after 15 years, and 24 restorations were in service after 20 years. Additionally, Fig 4 gives an overview of the estimated survival rates of the different restoration types in this study.

All together during this period, 1,266 restorations were examined clinically. The results of the clinical evaluation of all-ceramic restorations using modified Ryge criteria are presented in Table 3. The entire study population contained 1,335 all-ceramic restorations because 69 failures occurred before the evaluation in 2010. The patient-specific and ceramic-specific data were taken from patients' charts. Data concerning types of failures and PBI were present, but not clinical data using modified Ryge criteria. For this reason, only 1,266 clinical evaluations are presented in Table 3 with the results of the CDA/Ryge classification. After clinical evaluation, 26 restorations (2.05%) were rated not acceptable and unsatisfactory. The unsatisfactory ratings were judged for the categories esthetic match (n = 2), porcelain surface (n = 17), marginal discoloration (n = 5), and marginal integrity (n = 2). All 26 were rated Charlie; no Delta ratings were found. The defined categories were rated as follows: esthetic match, Alpha (84.4%) and Bravo (15.4%); porcelain surface, Alpha (75.8%) and Bravo (22.8%); marginal

Table 3 Clinical Evaluation of All Veneers Using Modified Ryge Criteria[24,25]

	Alpha		Bravo		Charlie		Delta	
Parameters	n	%	n	%	n	%	n	%
Esthetic match	1,069	84.4	195	15.4	2	0.1	0	0.0
Porcelain surface	960	75.8	289	22.8	17	1.3	0	0.0
Marginal discoloration								
Buccal	988	78.0	278	22.0	0	0.0	0	0.0
Mesial	958	75.7	305	24.1	3	0.2	0	0.0
Distal	1,046	82.6	216	17.1	4	0.3	0	0.0
Lingual	983	77.6	281	22.2	2	0.2	0	0.0
Mean	993.8	78.4	270.0	21.4	2.3	0.6	0	0.0
Marginal integrity								
Buccal	1,075	84.9	191	15.1	0	0.0	0	0.0
Mesial	1,152	91.0	112	8.8	2	0.2	0	0.0
Distal	1,159	91.5	105	8.3	2	0.2	0	0.0
Lingual	1,063	84.0	201	15.8	2	0.2	0	0.0
Mean	1,112.3	87.9	152.3	12.8	1.5	0.2	0	0.0

Table 4 Overview of Failure Characteristics

	Veneer		Crown		Onlay		Inlay		Total	
	n	%	n	%	n	%	n	%	n	%
Ceramic factors										
Fracture of the ceramic	13	13.7	12	12.6	1	1.1	6	6.3	32	33.7
Crack in the ceramic	8	8.4	12	12.6	0	0.0	3	3.2	23	24.2
Chipping	3	3.2	1	1.1	1	1.1	0	0.0	5	5.3
Caries	1	1.1	5	5.3	1	1.1	7	6.8	14	14.7
New restoration after endodontic treatment	1	1.1	2	2.1	1	1.1	2	2.1	6	6.3
Fracture of tooth	0	0.0	3	3.2	0	0.0	1	1.1	4	4.2
Debonding	3	3.2	0	0.0	0	0.0	0	0.0	3	3.2
Marginal integrity	0	0.0	1	1.1	0	0.0	2	2.1	3	3.2
Esthetic (color or too short)	0	0.0	2	2.1	0	0.0	1	1.1	3	3.2
Hypersensitivity	0	0.0	1	1.1	1	1.1	0	0.0	2	2.1
Total	29	30.5	39	41.1	5	5.3	22	23.2	95	100.0

discoloration, Alpha (78.4%) and Bravo (21.4%); and marginal integrity, Alpha (87.85%) and Bravo (12.75%).

Papillary bleeding after cautious probing of the sulcus was present in 369 (27.64%) restored teeth. No statistical dependence of PBI was found for the type of restoration and cement used for insertion.

In summary, 95 restoration failures (absolute: 78.95%, relative: 21.05%) were recorded. The overview of the failure characteristics for the different types of restorations is presented in Table 4. The most frequent reason for failure was fracture of the ceramic (33.68%). The second most frequent reason for failure was cracks in the ceramic (n = 23, 24.21%). Secondary caries was the reason for failure in 14 cases (14.74%). Comparing the type of restoration and all-ceramic material as a predictor for failure, no significant differences were found. Significantly higher failure rates were observed for nonvital teeth ($P < .0001$), patients with parafunction (bruxism, $P = .0045$), and regarding luting agents; cementation using Variolink showed significantly fewer failures than Optec Cement ($P = .0217$) and Dual Cement ($P = .0099$).

Nearly half of the restorations were placed in the anterior region (n = 652, 48.8%), while 442 (33.1%) were in premolars and 241 (18.1%) were in molars. Of the 95 failures, 11 (11.6%) occurred in molars, 19 (20%) in premolars, and 65 (68.4%) in the anterior region. In the molar group, 33 crowns were placed and 2 failures occurred (fracture of the ceramic in a mandibular right second molar and new restoration

Table 5 Univariate Cox Models for All Restoration Failures

Parameter	Hazard ratio (95% confidence interval)	*P*
Nonvital (vs vital)	0.2066 (0.1218–0.3503)	< .0001*
Bruxism-yes (vs no)	2.3052 (1.2959–4.1006)	.0045*
Optec Cement (vs Variolink)	4.5695 (1.2489–16.7190)	.0217**
Dual Cement (vs Variolink)	3.8728 (1.3848–10.8309)	.0099*
Veneer (vs inlay)	1.3254 (0.5678–3.0937)	.5148
Crown (vs inlay)	1.6473 (0.7993–3.3953)	.1761
Onlay (vs inlay)	0.7281 (0.2465–2.1510)	.5659
Veneer (vs crown)	0.8046 (0.3717–1.7416)	.5811
Veneer (vs onlay)	1.8203 (0.5616–5.8998)	.3181
Crown (vs onlay)	2.2624 (0.8311–6.1590)	.1101
Molar (vs anterior)	0.6355 (0.3105–1.3005)	.2147
Premolar (vs anterior)	0.5209 (0.2451–1.1074)	.0901
Molar (vs premolar)	1.2199 (0.5275–2.8211)	.6421

*$P < .01$; **$P < .05$.

as a result of hypersensitivity in a mandibular right first molar). No significant differences were found for the different regions of the oral cavity (anterior, premolar, or molar) (Table 5).

In the study population, 106 patients reported a bruxing habit or were diagnosed as bruxers. The hazard ratio for bruxism was 2.31 ($P = .0045$).

Seventy-two (5.39%) abutment teeth were nonvital and had endodontic therapy before ceramic treatment, and 34 (2.54%) had root canal treatment after cementation. The nonvital abutment teeth showed a significantly higher failure risk with a hazard ratio of 0.21 ($P < .0001$) (Table 5). No significant differences were found for the risk of failure with endodontic treatment before or after ceramic restoration ($P = .92$).

Of the four responses (excellent, good, medium, or none) given to the self-rating of patient satisfaction, no "medium" or "none" responses were noted. Fifty-seven patients (4.1%) rated their satisfaction as good, and 1,280 patients (95.9%) rated their satisfaction as excellent. All of the patients, even those who had ceramic failures, regarded the all-ceramic restorations as an ideal type of dental restoration and would bear the time and costs of the all-ceramic procedure again.

Discussion

This retrospective clinical investigation evaluated the clinical quality, success rate, and estimated survival rate of 1,335 silicate ceramic restorations in both dental arches over a 10-year period, with 451 restorations observed over 10 years, 84 restorations observed over 15 years, and 24 restorations observed over 20 years of service (see Fig 3). Additionally, the restoration-specific failure rate was evaluated to characterize both patient-specific and restoration-specific variables to determine those that might significantly predict all-ceramic failures. After a mean observation period of 102 ± 60 months, 95 failures occurred.

The most frequent reason for failure in this study was fracture of the ceramic (33.68%). Regarding the literature on the different types of restorations (crowns, veneers, onlays, and inlays), bulk fractures have been reported as the main reasons of failure in short-term evaluations.[9,12–15] The results of this study concur with the former findings in the literature. Comparing the type of restoration as a predictor for failure, no significant differences were found (see Fig 4). Additionally, for the different regions in the oral cavity, again no significant differences were found (Table 5). Other, albeit few, long-term studies evaluating different types of glass-ceramic restorations[11,30–32] do not agree with the present results. Fradeani and Redemagni[11] showed that posterior all-ceramic crowns are associated with a higher risk of fracture (survival rate: 84.4%) than anterior crowns (survival rate: 98.9%). Malament and Socransky showed in their over 20-year survival analysis of Dicor glass-ceramic restorations that restorations on molars have a 3.37-times higher risk of failure.[32] In the literature, it seems that fracture rates in general appear to be lower for anterior crowns than for molar crowns.[10,16,33] However, the present study does not focus on all-ceramic crowns in the posterior regions of the oral cavity; only 33 crowns were placed on molars in this study, representing only 7% of all crown restorations. Furthermore, in this molar crown group, only 2 failures occurred: one was a fracture of the ceramic of a mandibular right second molar after 141 months of service, and a mandibular right first molar had to be replaced because of hypersensitivity after 6 months. From the authors' point of view, because of the higher occlusal forces present in molar teeth, the dentist has to be especially careful of ceramic material selection depending on indication, the extent of the defect, and the patient. This includes preparation guidelines and parafunctional habits of the patient. As the high failure rate in the bruxism group shows, occlusal forces are one of the main reasons

for fracture. Therefore, meticulous occusal adjustment has to be performed to avoid premature and balanced contacts. Additionally, the strictly obtained canine-guided occlusal concept, as performed for all patients in this study, will reduce occlusal forces during jaw movement as well as the risk of failure. In this evaluation, significantly higher failure rates were observed for nonvital teeth ($P < .0001$), with a hazard ratio of 0.21 (Table 5). No significant differences were found for the risk of failure of the ceramic with endodontic treatment before or after ceramic treatment ($P = .92$). However, before treatment, if there is any doubt concerning the vitality of the tooth, the clinician must consider that ceramic preparations increase the likelihood of eventual pulpal death,[34] and endodontic access cavities through a ceramic restoration can become difficult and more extensive.[35]

Additionally, higher failure rates were observed in patients with parafunction (bruxism, $P = .0045$) and for the different luting agents. In general, for all restoration types, the determined risk was 2.3 times higher for failure in bruxing patients than in patients without a bruxing habit. Patients should be informed about the higher failure risk, and after placing ceramic restorations, they should be provided with hard acrylic resin occlusal guards to protect the definitive restorations during bruxing episodes. To check compliance and to motivate the patients, they should bring their guards to control appointments.

Cementation using the high-viscosity Variolink cement showed significantly fewer failures than the low-viscosity Optec Cement ($P = .0217$) and Dual Cement ($P = .0099$), suggesting that when used with the appropriate cements, all-ceramic restorations have desirable longevity and predictability.

To the best of the authors' knowledge, no study has been published with up to 20 years of follow-up on different types of glass-ceramic restorations. The estimated survival rates for the different types of restorations will be presented in future reports and compared to the current literature.

The present retrospective study has some limitations to be recognized: This study depends on available data, which may not include the full extent of clinical relevance; a prospective and randomized controlled clinical study has more power. Nevertheless, this study clearly demonstrates the significantly higher risk of failure for nonvital teeth and patients with a bruxing habit. The clinical outcome is absolutely predictable and highly successful in this long-term evaluation. At Innsbruck Medical University, approximately 80% of patients with custom-made restorations attend regularly offered recall sessions. Additionally, all-ceramic preparations were performed under university conditions by only two experienced dentists and on patients who were free of active gingival and periodontal inflammation prior to ceramic treatment. A more compromised oral environment with premature occlusal contacts may have produced different results. The observed risk factors (parafunction and nonvital abutment teeth) need to be confirmed in studies with more rigorous design.

Nevertheless, this study presents an up to 20-year analysis with good clinical outcome results for crown, veneer, onlay, and inlay glass-ceramic restorations with estimated survival rates of 93.5% at 10 years, 85.8% at 15 years, and 78.5% at 20 years.

Conclusion

This study evaluated 1,335 different all-ceramic restorations placed in 302 patients. Crowns (n = 470), veneers (n = 318), onlays (n = 213), and inlays (n = 334) were examined during patients' regularly scheduled maintenance appointments. The mean observation time was 102 months. Within the limitations of this study, the following conclusions can be drawn:

- All-ceramic restorations offer a predictable and highly successful restoration.
- The estimated survival probability was 93.5% at 10 years, 85.8% at 15 years, and 78.5% at 20 years.
- The main reason for failure was fracture of the ceramic.
- Increased failure rates were associated with parafunction (bruxism) and nonvital abutment teeth.
- Cementation using Variolink showed significantly fewer failures than Optec Cement and Dual Cement.
- No significant differences were found for the risk of failure of the different types of restorations and regions in the oral cavity.

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Literature Abstract

Analysis of primary risk factors for oral cancer from select US states with increasing rates

This study examined the primary risk factors for oral cancer (smoking prevalence and tobacco use) among US states that had a short-term increase in oral cancer incidence and mortality. Recent trends in oral cancer morbidity and mortality in the United States were obtained from the National Cancer Institute's Surveillance, Epidemiology, and End Results (NCI-SEER) database and the Centers for Disease Control and Prevention's Behavioral Risk Factor Surveillance System (CDC-BRFSS). Previous state-specific tobacco use and tobacco-related policies were obtained from the Initial Outcomes Index (IOI, 1992 to 1993) and the Strength of Tobacco Control Index (SoTC, 1999 to 2000). The NCI-SEER data revealed an increase in oral cancer in specific states and was not regional, with Nevada being the state with the greatest increase in oral cancer. The observed increases were among white males and not among females or minorities as thought previously. The CDC-BRFSS data showed that these states with increases in oral cancer also had relatively higher percentages of smokers both currently and historically. The IOI and SoTC indexes indicated that smoking prevalence in these areas might be influenced by many factors. Some of these factors include cigarette pricing, taxes, and home or workplace smoking bans. The data analyzed demonstrate that there is a recent and significant reversal in prevalence of smoking. Decline in oral cancer incidence and mortality may be expected. Results from this study provided evidence on how health prevention efforts may be targeted at specific states with increases in oral cancer prevalence and toward white males.

Bunnell A, Pettit N, Reddout N, et al. *Tob Induc Dis* 2010;8:5. **References:** 43. **Reprints:** Karl Kingsley, Department of Biomedical Sciences, School of Dental Medicine, University of Nevada, Las Vegas, NV, USA. Email: karl.kingsley@unlv.edu—*Simon Ng, Singapore*