Clinical Long-Term Results of VITA In-Ceram Classic Crowns and Fixed Partial Dentures: A Systematic Literature Review

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Purpose: VITA In-Ceram Classic is a system designed to fabricate all-ceramic crowns and fixed partial dentures (FPDs) with a glass-infiltrated aluminum oxide core material. This systematic literature review gives an overview of the clinical performance of the VITA In-Ceram Classic Alumina, Spinell, and Zirconia restorations. ***Materials and Methods:*** Based on a systematic literature review, an evidence-based selection and assessment of clinical studies of VITA In-Ceram Classic ceramics was carried out. ***Results:*** A total of 299 publications were found, 21 of which met the inclusion criteria. Only a few meaningful studies of In-Ceram Alumina FPDs and In-Ceram Zirconia crowns and FPDs were found. The 5-year survival rate of In-Ceram Alumina crowns and In-Ceram Spinell crowns ranged from 91.7% to 100% and is similar to the survival rate of conventional metal-ceramic crowns. The 5-year survival rate of single-retainer In-Ceram Alumina resin-bonded FPDs (RBFPDs) was 92.3%, which is higher than that of 2-retainer RBFPDs. ***Conclusion:*** In-Ceram Classic Alumina can be recommended for anterior and posterior crowns as well as for anterior single-retainer RBFPDs. Further studies should be initiated to evaluate in detail the clinical performance of In-Ceram Classic Alumina FPDs. In-Ceram Classic Spinell can be recommended for anterior crowns, especially if highly esthetic results are requested. For In-Ceram Classic Zirconia crowns or FPDs no statement can be made presently because of insufficient data. *Int J Prosthodont 2006;19:355–363.*

All-ceramic crowns and fixed partial dentures (FPDs) have some advantages over metal-ceramic systems. They are advantageous from the esthetic point of view because there is no dark metal framework to be covered, which can lead to exposed metal margins or dark coloring in the marginal areas. Moreover, they are superior with respect to corrosion, galvanism, and biocompatibility.[1] However, all-ceramic systems may differ considerably in translucency and thus in esthetics.[2,3] Depending on the quantity, size, and chemical properties of the crystals within the ceramic matrix, light is more or less scattered and reflected, causing the ceramic to look more opaque or translucent. But there are also disadvantages. In the past, many all-ceramic systems failed because of insufficient physical loadability. There were increased fracture rates, especially in the case of conventional cementation.[4] The VITA In-Ceram System (VITA Zahnfabrik) was designed for the fabrication of all-ceramic crowns and 3-unit FPDs and can be cemented conventionally.

VITA In-Ceram Alumina was introduced to the market in 1989. It was developed by the French dentist and material scientist Michael Sadoun in the 1980s and was the first all-ceramic crown and FPD system available in Europe.[5] It is based on the principle of glass infiltration of porously sintered aluminum oxide ceramics and in the beginning was a further development of the classic slip cast technique. Aluminum oxide powder is mixed with a special liquid in an ultrasonic bath and applied as a slip onto a special plaster die. The restoration already has its final, precision-fit inner contour and is porously sintered at more than 1,100°C. The aluminum oxide particles fuse at the points of contact without any shrinkage. At this stage, the framework can

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Table 1 Manufacturer Information Regarding the Indications and Flexural Strengths of the Different VITA In-Ceram Types

Type	Indication	Flexural strength
VITA In-Ceram Classic		
Alumina	Crowns for the anterior and posterior regions Three-unit FPDs for the anterior region	500 MPa
Spinell	Crowns for the anterior region	400 MPa
Zirconia	Crowns for the posterior region Three-unit FPDs for the posterior region	600 MPa
VITA In-Ceram 2000		
AL Cubes	Crowns for the anterior and posterior regions Three-unit FPDs for the anterior region Telescopic crowns	500 MPa
YZ Cubes	Crowns and FPDs for the anterior and posterior regions	900 MPa

easily be further processed. A special glass is infiltrated, giving the restoration its characteristic color, translucency, and high final strength. It can then be veneered with VM 7 (VITA Zahnfabrik). Since 1993, it has been possible to fabricate crown and FPD frameworks from industrially prefabricated blocks using various machine grinding methods (CAD/CAM, copy milling, etc). Also in 1993, In-Ceram Spinell was introduced. This is a metal-free oxide ceramic based on a magnesium-aluminum mixed oxide, with an improved, dentin-like translucency.[6] In 1999, In-Ceram Zirconia was introduced. This is an aluminum oxide ceramic reinforced with zirconium oxide particles. Recently, the densely sintered aluminum and zirconium oxide ceramic blocks In-Ceram 2000 AL Cubes and In-Ceram 2000 YZ Cubes (VITA Zahnfabrik) became available. Both are processed exclusively using CAD/CAM technology. There is no need for glass infiltration. For a better distinction, the glass-infiltrated oxide ceramics In-Ceram Alumina, Spinell, and Zirconia have recently been grouped under the brand name VITA In-Ceram Classic, and the densely sintered ceramic blocks AL and YZ Cubes have been grouped as VITA In-Ceram 2000. Flexural strength and crack toughness differ among the various In-Ceram types.[7] They also cover a wide range of indications (Table 1). In addition to the classic crown and FPD technology, In-Ceram may be used for endocrowns,[8] posts and cores,[9] telescopic crowns,[10,11] veneers,[12] inlay-retained FPDs,[13] resin-bonded FPDs (RBFPDs),[14] and implant abutments.[15] However, except for RBFPDs, this article does not address these additional uses.

The aim of this article is to present a systematic overview of the clinical performance of the different In-Ceram Classic types, in accordance with the guidelines of evidence-based dentistry. Crowns and FPDs placed in anterior and posterior arches were considered.

Materials and Methods

A structured literature review was performed for articles published between January 1988 and January 2006. The Internet database PubMed (www.ncbi.nlm.nih.gov/entrez) was used to search for the keywords *In-Ceram* and *InCeram*. A manual search was performed in significant English- and German-language dental journals (*European Journal of Prosthodontics and Restorative Dentistry, International Journal of Periodontics & Restorative Dentistry, International Journal of Prosthodontics, Journal of Prosthodontics, Quintessence International, Deutsche Zahnärztliche Zeitschrift, Die Quintessenz, Schweizer Monatsschrift für Zahnmedizin und Zahnärztliche Mitteilungen*). For this manual search, the titles and the subject indices of these journals were searched for the terms *Alumina*, *Spinell*, *Zirconia*, *(all-) ceramic* (*Voll-Keramik* in German), *dental porcelain*, *esthetic* (*Ästhetik* in German) and *CAD/CAM*, and the corresponding publications were checked for these keywords. All publications found were entered in the literature program EndNote (ISI ResearchSoft). For further evaluation, the following inclusion criteria were defined: only publications dealing with the clinical use of crowns, FPDs, and RBFPDs made of In-Ceram Alumina, Spinell, and/or Zirconia were included. Studies of endocrowns[8] were not considered. Publications had to reach evidence level III or higher, according to the guidelines of the Unites States Agency for Health Care Policy and Research[16] (Table 2). Studies were judged to be controlled studies (level IIa and higher) when they investigated the "gold standard" as a control group—in this case, metal-ceramic crowns and/or FPDs. The reference lists of all publications included were checked for further relevant articles. If data from the same restorations of one study had been published in different

Table 2 Classification of Evidence-Based Studies[16]

Classification level	Evidence type
Ia	Evidence obtained from a meta-analysis of randomized controlled studies
Ib	Evidence obtained from at least 1 randomized controlled study
IIa	Evidence obtained from at least 1 well-designed controlled study without randomization
IIb	Evidence obtained from at least 1 other type of well-designed quasi-experimental study
III	Evidence obtained from well-designed nonexperimental descriptive studies, such as comparative studies, correlation studies, and case-control studies
IV	Evidence obtained from expert committee reports or opinions and/or clinical experience of respected authorities

Table 3 VITA In-Ceram Classic Alumina Crowns

Mean observation time (y)/ publication	Classification level[16]	No.		Fabrication method	Observation time (mo)			Survival rate*
		Anterior	Posterior		Mean	Min	Max	
Less than 3								
Pröbster[17]	IIb	21	40	Slip cast	20.8	4	35	100.0% 100.0%[a]
Pang[18]	IIb	35	–	Slip cast	NI	2.5	21	91.5%[†]
Pröbster[19]	IIb	28	68	Slip cast	24.4	1.3	55.9	100.0% 100.0%[b]
Groten et al[20]	IIb	58		Celay	31.8	2	100	86.5%[‡]
Three or more								
Hüls[21]	IIb	228	107	Slip cast + celay	NI	NI	72	99.1% 97.3%[c]
Scotti et al[22]	IIb	25	38	Slip cast	37.6	24	44	98.4%
Pröbster[23]	IIb	46	89	Slip cast	40	1.3	92.9	98.5% 97.2%[d]
Haselton et al[24]	IIb	58	22	Slip cast	NI	NI	NI	100.0%[e] 95.5%[f]
McLaren and White[25]	IIb	223		Slip cast	36	36	36	96.0%
Scherrer et al[26]	IIb	45	23	Slip cast	NI	NI	NI	92.0%[g]
Segal[27]	IIb	177	369	Slip cast	33.4	12	72	99.1%
Bindl and Mörmann[28]	IIb	–	24	CAM	40.6	14	58	91.7% 92.0%[g]

NI = not indicated; CAM = computer-aided manufacture.
*Cumulative survival rate (Kaplan-Meier) after: a: 30 months; b: 56 months; c: 3 years; d: 6 years; e: 4 years (concerning core fractures); f: 4 years (concerning secondary caries); g: 5 years.
[†]All failures caused by external traumas.
[‡]No failures caused by core fractures.

journals or covered different study periods, only the most significant publication was considered. The publications were sorted by restoration type (VITA In-Ceram Classic Alumina crowns, Alumina FPDs, Alumina RBFPDs, Spinell crowns, Zirconia crowns, and Zirconia FPDs) and are presented in Tables 3 to 7, which show classification level; number of restorations; fabrication method; mean, minimum, and maximum observation time; and survival rate. In addition, the studies in each table were divided into mean observation periods of less than 3 years or 3 years or more. The classified studies were descriptively analyzed. It was not considered whether the survival rates referred to real observation periods or to statistical estimations (cumulative survival rates according to the Kaplan-Meier method[37]). Furthermore, the data available for every restoration from the relevant articles (restoration type, restoration area [anterior or posterior tooth area, maxilla or mandible], cementation type, fabrication method [slip cast or milling technique], observation period, failure/survival, time and type of failure) were compiled in an Excel table to give a statistical survey of the survival probability of each In-Ceram Classic type based on different parameters (in the manner of a meta-analysis).

Table 4 VITA In-Ceram Classic Spinell Crowns

Mean observation time (y)/ publication	Classification level[16]	No.		Fabrication method	Observation time (mo)			Survival rate
		Anterior	Posterior		Mean	Min	Max	
Three or more								
Bindl and Mörmann[28]	IIb	–	19	CAM	36.3	28	56	100.0% 100.0%*
Fradeani et al[29]	IIb	40	–	Slip cast	50	22	60	97.5% 97.5%*
Groten et al[20]	IIb	25	2	Celay	38	10	80	100.0%
Bindl and Mörmann[30]	IIb	18	–	CAM	44.9	33	57	94.5% 91.7%*

CAM = compuer-aided manufacture.
*Cumulative survival rate (Kaplan-Meier) after 5 years.

Results

Altogether, 299 publications were found, 219 by electronic search, 69 by manual search in German-language journals, and 11 by manual search in English-language journals. Twenty-one met the inclusion criteria. The included publications were clinical investigations of In-Ceram restorations and thus had an experimental character. Since there were no controlled studies according to the definition in Table 2, all were classified as level IIb. The study design of the publications included was inhomogeneous (inclusion criteria, failure criteria, restoration area, etc), and almost none of them supplied the required data on the individual restorations. Therefore, a statistically sound meta-analysis of the survival probability of the various In-Ceram Classic types could not be made. Therefore, the 21 included studies were analyzed only descriptively.

In-Ceram Alumina Crowns

In 12 relevant publications, a total of 1,724 In-Ceram Alumina crowns were observed over a minimum period of 1.3 months[19] up to a maximum period of 100[20] months (Table 3). The mean observation time ranged between 20.8[17] and 40.6[28] months. Survival rates were between 86.5%[20] and 100%.[17,19,24] The cumulative survival rates according to the Kaplan-Meier method[37] were 100% after 4 years (concerning core fractures),[24] 92% after 5 years,[26,28] and 97.2% after 6 years.[23] Because of the relatively high number of investigated crowns, the results obtained by McLaren and White[25] (3-year survival rate of 96% of 233 investigated crowns) and by Segal[27] (survival rate of 99.1% of 546 investigated crowns for an average follow-up period of 33.4 months) are also worth mentioning. Failures were caused by core fractures, fractures of the veneering material (chipping), secondary caries, tooth or root fractures, and loss of retention. When evaluating these data, it must be taken into account that in most publications, only those restorations that had to be removed were considered failures. The relatively low survival rate of 86.5% for a mean observation period of 31.8 months reported in the study by Groten et al[20] was a result of bad fit and postcementation complaints for 3 crowns and tooth fractures beneath 2 crowns, but not of framework fractures or other exclusively material-specific failures. In a study by Pang,[18] the survival rate of 91.5% for a maximum observation time of only 21 months was solely owing to external traumas.

A clear difference in the survival rates of anterior and posterior crowns was found in only one study. Scherrer et al[26] reported fractures of 2% of 45 anterior crowns and 13% of 23 posterior crowns within a 5-year period. However, the relatively low number of investigated crowns reduces the significance of this result. McLaren and White[25] found a slightly higher failure rate for posterior crowns. They reported 3-year survival rates of 98% for In-Ceram Alumina anterior crowns and 94% for posterior crowns. However, in a study of 546 crowns, Segal[27] reported a (marginally) higher survival rate of posterior crowns compared to anterior crowns (99.2% to 98.9%). Three authors[17,19,24] investigated a few crowns on implants. There were no failures.

In-Ceram Spinell Crowns

In 4 relevant publications, a total of 104 In-Ceram Spinell crowns (83 anterior and 21 posterior) were observed for a minimum period of 10 months[20] up to a maximum period of 80[20] months (Table 4). The mean observation time ranged between 36.3[28] and 50[29] months. Survival rates were between 94.5%[30] and 100%.[20,28] Cumulative survival rates after 5 years according to the Kaplan-Meier method[37] were 91.7%,[30] 97.5%,[29] and 100%.[28] The few failures reported were caused exclusively by core fractures. Fradeani et al[289] stressed the high translucency of In-Ceram Spinell crowns, which provides very good esthetic results.

Table 5 VITA In-Ceram Classic Alumina FPDs

Mean observation time (y)/ publication	Classification level[16]	No.		Fabrication method	Observation time (mo)			Survival rate*
		Anterior	Posterior		Mean	Min	Max	
Less than 3								
Sorensen et al[31]	IIb	9	25	Slip cast	5.4	1	18	100.0%
Pröbster[17]	IIb	7	8	Slip cast	16.3	2	35	86.7% 93.3%[a]
Pang[18]	IIb	7	–	Slip cast	NI	4.5	21	100.0%
Groten et al[20]	IIb	5		Celay	20	3	49	20.0% 60.0%[†]
Three or more								
Sorensen et al[32]	IIb	21	40	Slip cast	36	36	36	88.5% 82.5%[‡] 100.0%[§]
Vult von Steyern et al[33]	IIb	–	20	Slip cast	60	60	60	90.0%
Olsson et al[34]	IIb	16[#]	26[¨]	Slip cast	76	2	110	88.0%[¶] 93.0%[b] 83.0%[c]

NI = not indicated.
*Cumulative survival rate: a: (Kaplan-Meier) after 1 year; b: (life table analysis) after 5 years; c: (life table analysis) after 10 years.
[†]Only if fracture considered as failure.
[‡]Posterior FPDs.
[§]Anterior FPDs.
[¶]93% if external trauma not considered as failure.
[#]8 cantilever.
[¨]19 cantilever.

In-Ceram Zirconia Crowns

No studies of In-Ceram Zirconia crowns conforming to the inclusion criteria of this systematic review were found.

In-Ceram Alumina FPDs

In 7 relevant publications, a total of 184 In-Ceram Alumina FPDs were observed for a minimum period of 1 month[31] up to a maximum period of 110[34] months (Table 5). The mean observation time varied between 5.4 months[31] and 76[34] months. Survival rates were between 20%[19] and 100%.[18,31] Groten et al[20] reported in their clinical observation of only 5 FPDs a survival rate of 20% for a mean follow-up time of 20 months. Two of these 5 FPDs fractured in the same patient (bruxism). One failure was caused by loss of retention and 1 FPD had to be remade because of postcementation complaints. If only framework fractures are considered as failures, the survival rate was 60%. In another study, Sorensen et al[32] observed 7 fractures in 61 FPDs. The 3-year survival rate was 88.5% (100% for anterior FPDs and 82.5% for posterior FPDs). Fracture always occurred in the connector area in the early stages of the study. The authors attributed this phenomenon to technical problems during the sophisticated fabrication procedure of FPD frameworks using the slip cast technique. They recommended that In-Ceram Alumina FPDs be used in the anterior region. A similar evaluation was made by Vult von Steyern et al,[33] who reported a survival rate of 90% for 20 posterior FPDs after 5 years. They recommended with reservations the use of In-Ceram Alumina FPDs in the posterior region and stressed the necessity of a correct shoulder preparation with sufficient removal of tooth substance, sufficient dimensions of the connector, a flawless ceramic surface, and a skilled dental technician who meticulously follows the manufacturer's instructions. They also recommended that clinicians coat the framework with glaze only and refrain from use of veneerings in the basal FPD pontic area to avoid critical strain. Olsson et al[34] investigated 42 In-Ceram Alumina FPDs, 27 of which were fashioned as cantilever FPDs. The cumulative survival rates of 93% after 5 years and 83% after 10 years were calculated by a life table analysis according to Norman.[38] Two fractures occurred in 16 anterior FPDs, and 3 in 26 posterior FPDs. Two of the 3 fractured posterior FPDs were cantilever FPDs. The failure rate was about the same in the anterior and posterior regions. Both failures in the anterior region were caused by trauma.

In-Ceram Zirconia FPDs

Only 2 publications met the inclusion criteria. The authors of these publications investigated a total of 27 In-Ceram Zirconia FPDs for a minimum period of 6 months[20] up to a maximum period of 41[20] months (Table 6). The mean observation period was given in only 1 of the 2 publications (29 months[20]). The survival rate was 89%. Suarez et al[35] reported a cumulative survival rate of 94.5% for 18 FPDs after 3 years. The only failure was caused by a root fracture of an endodontically treated tooth. Groten et al[20] reported 1 fracture in 9 FPDs.

Table 6 VITA In-Ceram Classic Zirconia FPDs

Mean observation time (y)/ publication	Classification level[16]	No.		Fabrication method	Observation time (mo)			Survival rate
		Anterior	Posterior		Mean	Min	Max	
Less than 3								
Groten et al[20]	IIb	1	8	Celay	29	6	41	89.0%
Three or more								
Suarez et al[35]	IIb	–	18	NI	NI	12	36	94.5%* 94.5%*,†

NI = not indicated.
*One failure due to root fracture of an endodontically treated tooth (no FPD fracture).
†Cumulative survival rate (Kaplan-Meier) after 3 years.

Table 7 VITA In-Ceram Classic RBFPDs

Mean observation time (y)/ publication	Classification level[16]	No. of retainers		Fabrication method	Observation time (mo)			Survival rate
		1	2		Mean	Min	Max	
Less than 3								
Pospiech et al[36]*	IIb	–	35§ 9¶	Slip cast	24	NI	NI	79.6% 74.3%§ 100.0%¶
Three or more								
Kern[14]	IIb	21	–	Slip cast	51.7	25	86	95.2% 92.3%†
		–	16		75.8	3	146	75.0% 62.5%‡ 73.9%† 67.3%†,‡

NI = not indicated.
*RBFPDs with different box or groove abutments (without retainers).
†Cumulative survival rate (Kaplan-Meier) after 5 years.
‡Survival rate if fracture of only 1 retainer (FPD still in service) is also considered as failure.
§Anterior FPDs
¶Posterior FPDs

In-Ceram Alumina RBFPDs

Two relevant articles about In-Ceram Alumina RBFPDs were found in the literature (Table 7). In a study by Pospiech et al,[36] 44 RBFPDs without classic retainers were investigated (box and groove abutments). The survival rate was 79.6% (74.3% for anterior FPDs and 100% for posterior FPDs) over a mean observation time of 24 months. A recent study by Kern[14] is the latest in a series of long-term studies by this author. The study compared different designs of In-Ceram Alumina RBFPDs. In one group the pontic was adhesively fixed between 2 supporting teeth by 2 retainers. In the second group the pontic was fixed to 1 supporting tooth by a single retainer, as a kind of adhesive extension. In this group, 21 FPDs were observed between 25 and 86 months (median: 51.7 months). The cumulative survival rate according to the Kaplan-Meier method[37] was 92.3% after 5 years. In the other group, 16 FPDs with 2 retainers were observed for 3 to 146 months (median: 75.8 months). The cumulative survival rate was 67.3% after 5 years. The failures were partly because of the fracture of one of the retainers. However, these FPDs were still functioning as single-retainer RBFPDs. If these cases are not considered failures, the cumulative survival rate was 73.9% after 5 years.

Discussion

There are many promising publications on the different VITA In-Ceram types, but only a few meet evidence-based criteria. Overall, studies with a high number of cases and an effective observation period of more than 5 years are missing. Therefore, it is difficult to make a comparison between the studies mentioned in this review and the results of conventional crowns and FPDs acting as the gold standard. The possibilities of evaluating the studies (eg, by meta-analysis) are greatly limited by their different fabrication methods, locations, cementation methods (conventional or adhesive), inclusion and failure criteria, and statistical methods.

In-Ceram Alumina Crowns

Of all VITA In-Ceram Classic types, the most data are available about Alumina crowns. However, the maximum effective observation period was 40.6 months, and the 4- to 6-year survival probabilities were calculated by cumulative extrapolations using the Kaplan-Meier method.[37] However, the results of the included studies of In-Ceram Alumina crowns are promising. The different manufacturing processes for the frameworks of In-Ceram Alumina crowns (slip cast technique, copy milling, CAM) apparently do not influence the clinical performance. The survival rates of In-Ceram Alumina crowns and of metal-ceramic crowns were similar according to Kerschbaum,[39] who reported that the long-term survival rate of metal-ceramic crowns was 95% after a service time of 5 years. However, further studies must be initiated to evaluate the clinical performance of In-Ceram Alumina crowns after 10, 15, or 20 years, and to clarify whether a lower survival rate must be presumed for the posterior region compared to the anterior region. Presently, a comparison with other all-ceramic crown systems, which, like In-Ceram, can be conventionally cemented, can only be made with Procera AllCeram (Nobel Biocare). Significant studies covering similar time periods are available. The survival rates of Procera AllCeram crowns are between 93.8% and 98.4% after 5 years.[40–43] These data are comparable to those of In-Ceram Alumina crowns.

In-Ceram Spinell Crowns

In the publications identified, the observation periods were relatively short and the number of examined crowns was comparatively low. The factor of coincidence cannot be excluded with any certainty. On the basis of the few available studies, it can be assumed that the clinical performance of In-Ceram Spinell crowns is about as good as that of In-Ceram Alumina crowns. Because of the high translucency of the material,[2,3] crowns of excellent esthetic quality can be fabricated.[29] Whether the survival rates of In-Ceram Spinell anterior and posterior crowns differ or whether the different fabrication methods influence longevity of the crowns cannot be answered on the basis of the available studies. Since a reduced flexural strength and crack toughness of In-Ceram Spinell were found in laboratory studies,[7] and in accordance with the manufacturer's recommendations, its use in the posterior region cannot be recommended.

In-Ceram Alumina FPDs

Only a few data are available on In-Ceram Alumina FPDs. The relatively poor results obtained by Groten et al[20] are based on the clinical observation of only 5 FPDs, 2 of which failed as a result of bruxism, and are therefore of limited relevance. In the study by Olsson et al,[34] 2 failures in the anterior region were a result of trauma. If these misleading events are not taken into consideration, the 5-year survival rates of In-Ceram Alumina anterior FPDs are similar to those of metal-ceramic FPDs as stated by Kerschbaum.[39] Whether they can achieve the very good long-term results reported by Creugers et al[44] and Scurria et al[45] in their meta-analyses for metal-ceramic FPDs after a service time of 15 years (survival rates of 74% and 75%) remains to be seen. Their use in the posterior region cannot be recommended without reservations. In several studies, it is stressed that the fabrication process of In-Ceram Alumina FPDs, at least the slip cast technique, is very sophisticated, and mistakes made during this process may lead to a failure.[32,33] No statement can be made about the possible influence of the different fabrication methods for the frameworks of In-Ceram Alumina FPDs on the clinical performance based on available studies. Other all-ceramic FPD systems, which can also be conventionally cemented, have not yet been studied over similar time periods with significant results.

In-Ceram Alumina RBFPDs

The study by Kern[14] is especially interesting because of the long observation period and the data about the correct fashioning of all-ceramic RBFPDs. In-Ceram Alumina RBFPDs unilaterally fixed to a neighboring tooth by 1 wing showed a lower fracture rate than FPDs fixed to both neighboring teeth by 2 wings on the mesial and the distal side of the pontic. However, even if 1 wing of a 2-retainer RBFPD fractures, the FPD is often still serviceable for several years as a single-retainer FPD. The cumulative 5-year survival rate of 92.3% for the group of single-retainer RBFPDs does not quite match the rate published for metal-ceramic FPDs.[39] Since the tooth structure is better preserved in single-retainer resin-bonded restorations (In-Ceram Alumina) they should be preferred to the conventional fixed partial dentures. Particularly, these RBFPDs can be recommended in the case of caries-free neighboring teeth or if an implant restoration is not wanted or (yet) possible as a minimally invasive alternative in the anterior region with good esthetic results. Possible contraindications are bruxism and deep bite (CAVE: minimum thickness of the frame). Kern and Strub[46] reported that conventional RBFPDs with a metal framework fail more frequently, as a result of insufficient bonding to the metal, and are thus more suitable as long-term provisional appliances. The clinical performance of all-ceramic RBFPDs with a framework made of densely sintered zirconium oxide ceramics, such as YZ Cubes, can not be evaluated at present.

Conclusions

On the basis of the available data, only an initial assessment of the clinical performance of VITA In-Ceram Classic can be made. In-Ceram Classic Alumina crowns seem to be an alternative to conventional metal-ceramic crowns and full cast crowns and can be used in both the anterior and posterior regions. In-Ceram Spinell crowns are especially well suited for anterior restorations because of their high esthetic quality. Since there are only a few data available on In-Ceram Alumina FPDs for the intended indication area (anterior FPDs), they cannot be recommended for clinical use on a large scale without reservations. The positive results obtained in the publications mentioned above must be substantiated by further studies. Single-retainer In-Ceram Classic Alumina RBFPDs can be recommended for certain indications. In this systematic review, no statement can be made about the clinical performance of In-Ceram Classic Zirconia crowns or FPDs. To evaluate in detail the clinical performance of VITA In-Ceram Classic, well-planned, randomized controlled longitudinal studies (follow-up of 5 years or more) of all In-Ceram types must be performed.

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Literature Abstract

Dental implant failure rates and associated risk factors

The purpose of this retrospective cohort analysis of dental implants was to test the hypothesis that coexisting conditions lead to increased rates of implant failures. A total of 1,140 patients treated with a total of 4,680 implants by a single surgeon, from January 1982 to 2003, were included in this study. Failure was defined as any condition that led to removal of the implant, both short and long term. Risk factors abstracted from the patients record included: gender, age, location, smoking history, coexisting medical conditions (insulin and non-insulin dependent diabetes, hypertension and coronary artery disease, asthema, steroid therapy, history of chemotherapy or head and neck radiation therapy, and treatment (or lack of treatment) with post-menopausal hormones replacement therapy (PMHRT). Univariate and multivariate logistic regression analyses were performed to evaluate the relationship between baseline characteristics and the occurrence of implant failure. A stepwise logistic regression was performed using the significant variables location, sex, age, smoking, hypertension, coronary artery disease, asthma, diabetes, chemotherapy, head and neck radiation therapy, PMHRT, and no PMHRT. Older patients (60 to 79) compared to younger patients (< 40) have a significantly higher risk of implant failure (RR = 2.24, $P < .05$). Smoking (RR = 1.56), diabetes (RR = 2.75), head and neck radiation (RR = 2.73), and PMHRT (RR = 2.55) were correlated with a significant increase in failure rates. Implant failure was 8.16% in the maxilla compared with 4.93% in the mandible (RR = 1.79, $P < .001$).

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