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All-Ceramic Implant-Supported Single Crowns (SCs) and Fixed Dental Prostheses (FDPs): How Good Are They?

The introduction of CAD/CAM technology to dentistry facilitated the use of new materials suited for this technique, including all-ceramic materials in the prosthetic restoration of missing teeth with dental implants. In turn, these materials have become increasingly popular among dentists and dental technicians. CAD/CAM fabrication of prosthetic restorations can now be performed with high precision using ceramic blocks, making it possible to manufacture metal-free prosthetic restorations from reinforced glass-ceramics and zirconia.

After the introduction of these materials, several studies reported nonoptimal properties when used as implant-supported prosthetic restorations either as single crowns (SCs) or fixed dental prostheses (FDPs). Zirconia used for multiple-unit restorations was considered too opaque and did not fulfill the esthetic criteria for these restorations, which reduced the level of success in the clinic. The process of veneering with monolithic zirconia was therefore introduced to successfully improve the esthetics of these restorations, which made it possible to produce monolithic zirconia-based FDPs with acceptable esthetics. However, clinicians experienced chipping and fractures in the veneered-zirconia FDPs. In fact, several clinical studies¹⁻⁶ reported that about 50% of the veneered-zirconia FDPs could experience fracture over a 5-year period.

Newer generations of zirconia materials with improved translucency and different shades have been introduced to overcome this esthetic problem and reduce the need for veneering. These new and esthetically improved materials have unfortunately also reduced mechanical strength and fracture resistance. Therefore,

it is of interest to evaluate if these new all-ceramic materials with improved esthetics also have sufficient mechanical properties to function as long-term FDPs in the clinic.

Tischler et al¹ studied the survival outcome and technical complications for up to 4 years in a retrospective clinical study of complete-arch fixed implant-supported prostheses (CAFIPs). Of the 49 prostheses followed, only one zirconia fracture was recorded, yielding a cumulative survival rate (CSR) of 99.4% for the prostheses. The authors reported technical complications related to debonding of titanium cylinders (one case) and prosthesis screw fracture (two cases). There were, however, no reports of chipping of the veneered gingival porcelain. The authors concluded that there are high survival rates and minimal technical complications when using one-piece zirconia CAFIPs with veneered gingival porcelain.

In another retrospective study performed in a single center, Saponaro et al² evaluated the prevalence of prosthetic complications with monolithic or microveneered single-unit, multiunit, and complete-arch zirconia prostheses supported with Ti-base abutments. In this study, 94 patients were included and received a total of 153 prostheses, 108 microveneered and 45 monolithic, with an average observation period of 6 years. The authors reported that 33 prostheses in 29 patients experienced at least one complication. The complications were related to the design and length of the prosthetic construction; the single-unit prostheses had a lower probability of complications than multiunit prostheses. The complication most frequently observed was fracture of the veneering material (6%), followed

by prosthetic screw loosening (5%). Frequency of chipping was related to veneering, and regardless of the prosthetic design, monolithic zirconia prostheses had significantly lower probability of chipping than the microveneered prostheses. The authors did not observe any difference in the probability of chipping between microveneered single-unit, multiunit, and complete-arch zirconia prostheses.

Zhang et al³ investigated the clinical performance of screw-retained, ceramic-veneered, monolithic zirconia partial implant-supported FDPs over a 5- and 10-year period. They evaluated factors influencing treatment failure and complications in 171 patients that received 208 prostheses. Of the 208 prostheses, 62 had technical complications. Among them, the monolithic zirconia accounted only for 9 cases. The authors concluded that in contrast to the buccal-ceramic-veneered or monolithic zirconia type, full-coverage ceramic-veneered zirconia had a significantly greater chance of chipping.

Lemos et al⁴ evaluated the clinical performance of monolithic ceramic implant-supported crowns and fixed partial dentures (FPDs) with a focus on survival and prosthetic complication rates in a systematic review with meta-analysis. The 28 studies included represented a total of 1,298 monolithic ceramic implant-supported restorations (1116 SCs and 182 FPDs) in 1,193 patients. The studies had a median observation time of 24 months. In this meta-analysis, the authors reported proportion of failures and prosthetic complication rates of 2% for crowns. No difference was observed between monolithic zirconia and lithium disilicate crowns. Only monolithic zirconia was evaluated in the FPD group, and one failure was reported which gave a 0% proportion of failure and a complication rate of 4%. The most common complications reported for both types of restorations were screw loosening, debonding, and minor chipping. The authors concluded that the use of monolithic ceramic implant-supported crowns that are independent of ceramic material and monolithic zirconia implant-supported FPDs have low prosthetic complications and should be considered an effective and safe treatment option.

A systematic review by Pjetursson et al⁵ evaluated the influence of the prosthetic material and prosthetic design on the clinical outcomes of implant-supported multiunit FDPs (iFDPs) in the posterior area. The review focused on iFDPs with a pontic or splinted crown. The 32 included studies had at least 12 months of observation. In this systematic review, the meta-analysis of the included studies indicated estimated 3-year survival rates of 98.3% for porcelain-fused-to-metal (PFM) iFDPs, 97.5% for veneered zirconia (Zr) iFDPs with pontic, 98.9% for monolithic or microveneered-zirconia iFDPs

with pontic, and 97.0% for lithium disilicate iFDPs with pontics. No statistically significant differences in survival rates were found among the different material combinations. Veneered restorations showed significantly higher ceramic fracture and chipping rates compared with monolithic restorations.

In a systematic review, Kim et al⁶ investigated survival rates of implant-supported monolithic zirconia crowns and FPDs. Overall, 14 studies reporting on 644 implant-supported monolithic zirconia restorations were included. Of these 644 restorations, 391 were SCs and 253 were FPDs. The studies reported on at least 5-year observation periods. Of the 644 implant-supported monolithic zirconia restorations, one failure was reported. The CSRs computed for a 5-year interval were 100% for SCs and 99.60% for FPDs, which led the authors to conclude that monolithic zirconia has an excellent clinical performance in the short term.

The studies referred to in this review demonstrate that full-ceramic prosthetic restorations for SCs and FPDs are high quality and have a satisfactory survival rate comparable to PFM. However, a major limitation of the observed performance of the prosthetic restorations was that all studies on this subject referred to short-term observations. There is a need for information on the long-term performance of these restorations, and further follow-up of the ongoing studies will present the needed results in the future.

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Tischler M, Patch C, Bidra, AS. Rehabilitation of edentulous jaws with zirconia complete-arch fixed implant-supported prostheses: An up to 4-year retrospective clinical study. *J Prosthet Dent* 2018;120:204–209.

Limited data are available on the clinical outcomes of patients with edentulism treated with zirconia complete-arch fixed implant-supported prostheses (CAFIPs). The primary purpose of this retrospective clinical study was to study the failure rate of dental implants as well as the fracture rate of zirconia CAFIPs. The secondary purpose was to study the survival outcomes of patients with edentulism treated with zirconia CAFIPs as well as the rate of technical complications. This retrospective clinical study from a private practice included 128 patients rehabilitated between January 1, 2013, and December 31, 2016, with 1,072 implants supporting 191 zirconia CAFIPs for single-jaw as well as double-jaw rehabilitations. All zirconia prostheses were a 1-piece design and were veneered with feldspathic porcelain only at the gingival region and therefore considered as predominantly monolithic. Additionally, all prostheses were bonded to the implant manufacturer's titanium cylinders that provided an intimate contact with the implants. The primary outcome measures were implant failure rate and prosthesis fracture rate. The secondary outcome measures were prosthodontic treatment survival rate and the incidence of technical complications with respect to monolithic zirconia CAFIPs. The cumulative survival rate (CSR) for implants and prostheses was calculated after a life-table survival analysis. Of the analyzed samples over a 4-year period, at least 288 implants and 49 prostheses had a minimum of 4 years of follow-up. A total of 18 implant failures were noted (13 in maxilla and 5 in mandible), yielding a CSR of 97.6% for implants. One fracture of the zirconia prosthesis was recorded, yielding a CSR of 99.4% for the prostheses over the 4-year period. Another three prostheses required remaking because the supporting implants failed, and one prosthesis was remade because the lack of passive fit resulted in a CSR of 96.8% for the prosthodontic treatment itself. During the 4-year period, one zirconia prosthesis had a technical complication related to the debonding of titanium cylinders, and two prostheses had fractured screws; both complications were resolved successfully. No zirconia prostheses had chipping of the veneered gingival porcelain. Findings from this study showed that the prosthodontic treatment of edentulous patients with a one-piece CAFIP with veneered porcelain restricted to the gingival region had high survival rates for implants and prostheses. Minimal technical complications were reported related to this type of treatment for edentulous jaws and no chipping of the veneered gingival porcelain were encountered. Because of their excellent survival rates and minimal technical complications, CAFIPs made of zirconia offer a favorable treatment option for the rehabilitation of patients with edentulism.

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Saponaro PC, Karasan D, Donmez MB, Johnston WM, Yilmaz B. Prosthetic complications with monolithic or micro-veneered implant-supported zirconia single-unit, multiple-unit, and complete-arch prostheses on titanium base abutments: A single center retrospective study with mean follow-up period of 72.35 months. *Clin Implant Dent Relat Res* 2023;25:99–106.

The influence of prosthetic design on prosthetic complications when monolithic or microveneered zirconia prostheses are supported with titanium base (Ti-base) abutments is not well known. The purpose of this single-center retrospective study was to assess the prevalence of prosthetic complications with monolithic or microveneered single-unit, multiunit, and complete-arch zirconia prostheses supported with Ti-base abutments (implant level or multiunit abutment level). This study retrospectively evaluated the electronic health record (EHR) of participants who received either monolithic or microveneered implant-supported (single-unit, multiunit, and/or complete-arch) prostheses supported by Ti-base or zirconia/Ti-base hybrid abutments delivered between the years 2010 and 2021. Data were analyzed by using logistic regression and the Exact Mantel-Haenszel chi-square test ($\alpha = .05$) to assess the clinical performance of prostheses and complications including crown decementation, feldspathic porcelain chipping, prosthesis fracture, zirconia/Ti-base hybrid abutment decementation, abutment screw loosening, screw fracture, abutment fracture, implant loss, and prosthesis remake. The study included 94 participants (50 female, 44 male) with a mean age of 59.5 years (range: 24–101 years of age). The retrospective EHR evaluation yielded 82 single-unit, 51 multiunit, and 20 complete-arch prostheses on 325 implants. Among 153 prostheses delivered, 108 were microveneered (47 single-unit, 41 multiunit, and 20 complete-arch prostheses) and 45 were monolithic. The average duration was 72.35 months (6.02 years) with a follow-up period of 5 to 132 months. From the time of placement to the time of EHR review, of the 153 prostheses, 78.43% did not exhibit any prosthetic complication. However, 33 prostheses (21.57%) from 29 participants (30.85%) had at least one prosthetic complication. Only four patients (4.25%) experienced two or more prosthetic complications. Prosthetic design affected the probability of having a complication ($P = .005$); complete-arch prostheses had a higher probability ($P \leq .028$). Single-unit prostheses had a lower probability of complications than multiunit prostheses ($P = .005$). The most commonly observed complication was the fracture of veneering material (5.88%) followed by prosthetic screw loosening (4.57%) and decementation between the zirconia and the Ti-base abutments (2.61%). Microveneered complete-arch prostheses had a higher probability of chipping than not ($P < .001$), and other microveneered prosthetic designs had a similar probability of chipping with complete-arch prostheses ($P \geq .082$). In fact, the frequency of chipping was affected by veneering ($P < .001$). Monolithic prostheses had a lower probability of chipping than microveneered prostheses, regardless of the prosthetic design ($P < .001$). Notably, the frequency of prosthetic complications varied depending on prosthetic

design. Complete-arch prostheses had the highest probability of complications, while the single-unit prostheses had the lowest. In addition, microveneered prostheses had a higher probability of chipping than monolithic prostheses. Note that the probability of chipping was similar for microveneered single-unit, multiunit, and complete-arch zirconia prostheses.

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Zhang Y, Luo J, Di P, Chen B, Li J, Yu Z, Ye Lin. Screw-retained ceramic veneered/monolithic zirconia partial implant-supported fixed dental prostheses: A 5 to 10-year retrospective study on survival and complications. J Prosthodont 2024;33:221–230.

An assessment of the clinical performance of screw-retained, ceramic-veneered, monolithic zirconia partial implant-supported fixed dental prostheses (ISFDP) over 5 and 10 years was performed to evaluate the implant- and prosthesis-related factors influencing treatment failure and complications. Partially edentulous patients treated with screw-retained all-ceramic ISFDPs, 2 to 4 prosthetic units, and a documented follow-up of at least 5 years after implant loading were included in this retrospective study. The outcomes analyzed included implant/prosthesis failure and biologic/technical complications. Possible risk factors were identified using the mixed effects Cox regression analysis. A screened sample of 171 participants with 208 prostheses (95% of the restorations were splinted crowns without a pontic) supported by 451 dental implants were enrolled in this study. The mean follow-up duration after prosthesis delivery was 82.4 ± 17.2 months. By the end of the follow-up period, 431 (95.57%) of the 451 implants remained functional at the implant level. At the prosthesis level, 185 (88.94%) of the 208 partial ISFDPs remained functional. Biologic complications were observed in 67 implants (14.86%), and technical complications were observed in 62 ISFDPs (29.81%). The analysis revealed only emergence profiles (over-contoured) as a significant risk factor for implant failure ($P < .001$) and biologic complications ($P < .001$). Full-coverage ceramic-veneered zirconia prostheses had a significantly greater chance of chipping ($P < .001$) compared with buccal-ceramic-veneered or monolithic zirconia prostheses. Screw-retained ceramic-veneered monolithic partial ISFDPs have a favorable long-term survival rate. However, an overcontoured emergence profile is a significant risk factor associated with implant failure and biologic complications. Buccal-ceramic-veneered and monolithic zirconia partial ISFDPs lower the initial prevalence of chipping compared with a full-coverage veneered design.

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Lemos CAA, Verri FR, Gomes JMdl, Santiago Junior JF, Miyashita E, Mendonça G, Pellizzer EP. Survival and prosthetic complications of monolithic ceramic implant-supported single crowns and fixed partial dentures: A systematic review with meta-analysis. J Prosthet Dent 2022;S0022-3913(22)00736–3.

Monolithic ceramic implant-supported restorations have been used to rehabilitate partially edentulous patients. However, knowledge of the survival and prosthetic complications of single crowns (SCs) and fixed partial dentures (FPDs) is limited. The purpose of this systematic review with meta-analysis was to evaluate the clinical performance of monolithic ceramic implant-supported SCs and FPDs in terms of the survival and prosthetic complication rates. The systematic review was registered on the prospective register of systematic reviews (PROSPERO) (CRD42017078568). Overall, five electronic databases were independently searched by two authors for articles published before May 2022. In addition, a hand search was performed in the non-peer-reviewed literature, specific journals, and reference lists of included articles. A single-arm meta-analysis was performed by using the R program. The risk of bias and quality were assessed using the Cochrane risk of bias tools and the Newcastle–Ottawa scale. Overall, 28 studies were included in the quantitative synthesis. A total of 1,298 monolithic ceramic implant-supported restorations (1,116 SCs and 182 FPDs) were evaluated in 1,193 participants, with a median observation time of 24 months (range: 12–72 months). Meta-analysis indicated that the proportion of failures and prosthetic complication rates were 2% (95% confidence interval [CI]: 1% to 4%) for SCs. No difference was observed for monolithic zirconia and lithium disilicate SCs. In the FPDs, only monolithic zirconia was considered, with one failure reported, totaling the proportion of failure at 0% (0% – 1%) and complication rates at 4% (0% – 12%). The most complications reported for both types of restorations were screw loosening, debonding, and minor chipping, which were considered repairable. The included studies showed a low risk of bias and good quality. The use of monolithic ceramic implant-supported SCs (independent of ceramic material) and monolithic zirconia implant-supported FPDs should be considered an effective and safe treatment option because of favorable short-term survival rates and low prosthetic complications. However, additional well-conducted studies with a longer-term follow-up and direct comparison between veneered restorations are recommended to reassess clinical performance. The results of this systematic review indicate short-term evidence supporting the use of monolithic ceramic implant-supported SCs and FPDs for the rehabilitation of partially edentulous patients.

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Pjetursson BE, Sailer I, Merino-Higuera E, Spies BC, Burkhardt F, Karasan D. Systematic review evaluating the influence of the prosthetic material and prosthetic design on the clinical outcomes of implant-supported multi-unit fixed dental prosthesis in the posterior area. *Clin Oral Implants Res* 2023;34(suppl 26):86–103.

The objectives of the study were to assess the survival, failure, and technical complication rates of implant-supported fixed dental prosthesis (iFDPs) with pontic or splinted crown (iSpC) designs in the posterior area; the study also compared the influence of prosthetic materials and prosthetic design on the outcomes. Electronic and manual searches were performed to identify randomized, prospective, and retrospective clinical trials with a follow-up time of at least 12 months evaluating the clinical outcomes of posterior iFDPs with pontic or iSpCs. Survival and complication rates were analyzed using robust Poisson's regression models. Overall, 32 studies reporting on 42 study arms were included in the systematic review. The meta-analysis of the included studies indicated estimated 3-year survival rates of 98.3% (95% CI: 95.6% to 99.3%) for porcelain-fused-to-metal (PFM) iFDPs, 97.5% (95% CI: 95.5% to 98.7%) for veneered zirconia (Zr) iFDPs with pontic, 98.9% (95% CI: 96.8% to 99.6%) for monolithic or microveneered zirconia iFDPs with pontic, and 97.0% (95% CI: 84.8% to 99.9%) for lithium disilicate iFDPs with pontics. The survival rates for different material combinations showed no statistically significant differences. Veneered restorations overall showed significantly ($P < .01$) higher rates of ceramic fracture and chipping compared with monolithic restorations. Furthermore, there was no significant difference in survival rates (98.3% [95% CI: 95.6% to 99.3%] vs 99.1% [95% CI: 97.6% to 99.7%]) and overall complication rates between PFM iFDPs with pontic and PFM iSpCs. Based on the data identified by this systematic review, PFM, veneered Zr, and monolithic Zr iFDPs with pontic and iSpCs showed similarly high short-term survival rates in the posterior area. Additionally, veneered restorations exhibit ceramic chipping more often than monolithic restorations, as they had the highest fracture rate reported for veneered Zr iFDPs.

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Kim W, Li XC, Bidra AS. Clinical outcomes of implant-supported monolithic zirconia crowns and fixed partial dentures: A systematic review. *J Prosthodont* 2023;32:102–107.

The purpose of this study was to determine the survival rates of implant-supported monolithic zirconia crowns and fixed partial dentures (FPDs). An electronic search for articles in the English language literature published from January 1, 2001, to September 17, 2021, was performed using PubMed, Scopus, and Central search engines. After applying predetermined inclusion and exclusion criteria, the definitive list of selected articles was used for calculating the interval survival rate (ISR) and cumulative survival rate (CSR). Restoration failure in this study was defined as the fracture or compromise of any part of the ceramic restoration that required the removal or remake of the implant-supported restoration. The electronic search resulted in 457 titles. The systematic application of inclusion and exclusion criteria resulted in 14 clinical studies that addressed the clinical outcomes of implant-supported monolithic zirconia crowns and FPDs. Of these, three were randomized controlled trials, five were prospective studies, and six were retrospective studies. Follow-up periods ranged from 1 to 5 years. Of the 644 implant-supported monolithic zirconia restorations computed in this systematic review, there was only one reported failure of the monolithic zirconia restorative material over a follow-up period of up to 5 years (CSR of 99.84%). At the maximum follow-up interval of 5 years, the CSR for monolithic zirconia single crowns was 100% and the CSR for monolithic zirconia fixed partial dentures was 99.60%. Implant-supported monolithic zirconia single crowns and fixed partial dentures have excellent short-term (< 5 years) survival rates, but the evidence for medium-term survival (> 5 years) and beyond is lacking.

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