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The Implant-Supported Fixed Complete Dental Prosthesis

The implant-supported fixed complete dental prosthesis (IFCDP) has become one of the fastest-growing treatment modalities in recent years. Gallardo et al, in their introduction, raised an important observation that none of the published systematic reviews included studies directly comparing the different protocols in the rehabilitation of completely edentulous arches with IFCDPs; they showed a high implant survival rate of 95% to 100%, with cautions to interpret the results presented specifically in clinical studies. They recommended that future clinical trials should evaluate both the influence of time of loading and patient outcomes with clear clinical outcomes from healed ridges and extraction sockets to avoid bias in result interpretation.

As described in a 10-year follow-up retrospective evaluation study by Chrcanovic et al, the IFCDP survival rate was 87.1% due primarily to the supporting implant failure attributed to bruxism, along with the following risk factors: the prosthesis being in men, maxillae, and natural opposing dentition leading to an increase in mechanical and prosthetic failures.

The IFCDP method of fixation (ie, screw- vs cement-retained) can have a higher biologic impact on marginal bone loss, especially in cemented prostheses, according to Gaddale et al. The meta-analysis study attributed results to the irretrievability of the cemented IFCDP, while more mechanical complications were noted in screw-retained IFCDPs, drawing the conversation to the materials used, for example, zirconia vs titanium IFCDP frameworks. In addition, regarding the materials used as the framework on biomechanical outcomes, in a study by Tiossi et al, the findings correlated the strains and the number of implants used relative to the kind of material used, focusing on the maxilla. The authors concluded that zirconia frameworks transferred more strains if loaded on six implants vs titanium frameworks, which transferred less strain, while if four implants were used, it resulted in both zirconia and titanium frameworks exhibiting similar strains.

Using acrylic IFCDPs such as polyetheretherketone (PEEK), the prosthesis can have a better shock-absorbing advantage. Nobre et al investigated the All-on-4 treatment concept with PEEK, with 100% implant survival after 3 years, in a total of 37 patients with 2 patients lost due to different reasons; the complications documented in this study were mainly material failures, such as fracture of acrylic resin crowns, prosthetic and screw loosening, and abutment wearing, with a patient satisfaction rate of 90%.

The weight of the IFCDP can also have a direct proportional relationship with the strain generated around the osseointegrated implants. Tribst et al studied that relationship in maxillae with a range of four to eight implants. In Table 2 of their article, they indicated that the acrylic IFCDPs such as the PEEK material and the titanium framework with acrylic teeth, with a weight ranging from 10 to 15 g, had the least strain, with favorable strain on eight implants. The heavier the IFCDP is, such as in zirconia and cast cobalt-chromium frameworks coated with ceramic veneers, the more strain is generated around the implants.

The length of the implants used to support an IFCDP was studied in a short-term multicenter randomized clinical trial by Guida et al. The protocol was based on five implants in the mandible with 6-mm implant length vs 11 mm; there was no statistical difference between the two groups. These results were only after 3 years and will need to be investigated as a 10-years-plus, long-term study.

Long-term studies have started to unfold a more clear understanding of the IFCDP treatment, as indicated in a 10-year follow-up study by Tartaglia et al. Multiple factors were identified relative to prosthesis failure, including the following: men having a 78% survival rate vs 94% for women, zirconia demonstrating a slightly better survival vs all resin, noting that the prosthesis failure rate was more evident at the 3-year mark, and more complications increasing over time, especially after 6 years. A 12-year follow-up by Papaspyridakos et al had a cumulative 85.5% of prostheses free of major complications, with a recommendation to use a night guard to help decrease the IFCDP complications.

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Gallardo YNR, Rodrigues da Silva-Olivio I, Gonzaga L, Sesma N, Martin W. A systematic review of clinical outcomes on patients rehabilitated with complete-arch fixed implant-supported prostheses according to the time of loading. J Prosthodont 2019;28:958–968.

The purpose was to perform a systematic review on studies assessing clinical outcomes in patients rehabilitated with complete-arch fixed implant-supported prostheses according to the time of loading. Data from patient and clinical outcomes, implant failure, success rate, survival rate, biologic complications, technical complications, mechanical complications, and marginal bone loss were included in this review. The search was performed on the PubMed, Scopus, and Cochrane databases. The Cochrane Collaboration tool was used to assess the risk of bias of randomized controlled studies, and an adapted version of the Newcastle-Ottawa scale was used for observational studies. All data were tabulated according to the time of loading: *(1)* immediate restoration/loading, *(2)* early loading, and *(3)* conventional loading. From a total of 4,027 studies identified, 6 were randomized controlled trials, 5 prospective observational studies, and 5 retrospective observational studies. In total, 5,954 implants, 1,294 patients, and 1,305 full-arch fixed implant-supported prostheses were included in this review. There was a wide heterogeneity among clinical studies regarding the study design and treatment procedures. Thus, pooled estimates were not performed in order to avoid potential biases. The methodologic assessment by the Modified Newcastle-Ottawa scale showed a moderate quality of observational studies. Regarding the randomized controlled trial studies, all of them presented at least one element of bias according to the Cochrane Collaboration tool for assessing risk of bias. There is evidence of high implant survival/success rates (95% to 100%) for both of the loading protocols (immediate restoration/loading, early loading, and conventional loading). However, careful attention must be taken by the clinician when interpreting the results reported in clinical studies. Future studies should be performed using a standardized methodology in order to determine the true predictability regarding immediate, early, and conventional loading protocols.

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Chrcanovic BR, Kisch J, Larsson C. Retrospective evaluation of implant-supported full-arch fixed dental prostheses after a mean follow-up of 10 years. Clin Oral Implants Res 2020;31:634–645.

The purpose of this study was to assess the outcomes of implant-supported full-arch fixed dental prostheses (ISFAFDPs) and the supporting implants. This retrospective study included patients treated with ISFAFDPs at one specialist clinic. Implant/prosthesis failure and complications were the outcomes analyzed. Survival analysis methods were used. A total of 709 patients with 869 ISFAFDPs (4,797 implants) were included, with a mean ± SD follow-up of 10.7 ± 7.2 years. A total of 353 implants and 62 prostheses failed. Estimated cumulative survival rates were as follows: 93.3% (95% CI: 91.3, 95.3) after 10 years and 87.1% (95% CI: 83.4, 90.8) after 20 years. Implants placed in bruxers, smokers, and the maxilla had a lower survival than implants placed in nonbruxers, nonsmokers, and the mandible, respectively. A total of 415 ISFAFDPs (47.8%) presented technical complications, of which 67 (7.7%) presented only occurrences of loss/fracture of implant access hole sealing. Bruxism was a factor to exert a higher risk of screw loosening (HR = 3.302; also in younger patients), screw fracture (HR = 4.956), ceramic chipping/fracture (HR = 5.685), and loss/fracture of acrylic teeth (HR = 2.125; with this last complication also having higher risk in men, in maxillae, and when the opposing arch presented natural dentition or fixed prostheses). Patients with bruxism had a statistically significantly higher risk of prosthesis failure than nonbruxers (HR = 3.276). ISFAFDPs presented a good long-term prognosis. Failure of several supporting implants was the main reason for failure. The results of the present study strongly suggest that bruxism is an important contributor to implant and prosthesis failure, as well as to an increased prevalence of technical complications in ISFAFDPs.

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Gaddale R, Mishra SK, Chowdhary R. Complications of screw- and cement-retained implant-supported full-arch restorations: A systematic review and meta-analysis. Int J Oral Implantol (Berl) 2020;13:11–40.

The purpose of this study was to assess the technical and biologic complications of screw- or cement-retained implant-supported full-arch dental prostheses. An electronic search was conducted on Medline/PubMed and Cochrane databases in February 2019, irrespective of time restrictions, using MeSH terms. All studies were first reviewed by abstract and subsequently by full-text reading. A further hand search was performed to identify related references. Articles only related to cement-retained and/or screw-retained reconstructions in full-arch fixed dental prostheses (FDPs) were included. The initial literature search resulted in 3,670 papers; 3,478 articles remained after removing duplicate articles, and 3,439 articles were further excluded by the reviewers after the abstract screening, which resulted in a selection of 39 studies. Twelve studies were further excluded due to not fulfilling the inclusion criteria. Hand searching resulted in two additional papers

being included, and finally, 29 articles were included in this review. Screw-retained full-arch fixed dental prostheses have fewer complications than cemented reconstructions. Biologic complications such as marginal bone loss > 2 mm occurred more frequently in cemented reconstructions, and technical complications such as screw-loosening and screw fracture occurred more in screw-retained reconstructions. Clinical outcomes were influenced by both fixations in different ways. The screw-retained restorations were more easily retrievable than cemented ones; therefore, technical and eventually biologic complications could be treated more easily. For this reason, and for their higher biologic compatibility, these reconstructions are preferable.
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Tiossi R, Gomes EA, Lapria Faria AC, Silveira Rodrigues RC, Ribeiro RF. Biomechanical behavior of titanium and zirconia frameworks for implant-supported full-arch fixed dental prosthesis. Clin Implant Dent Relat Res 2017;19:860–866.
The biomechanical behaviors of implant-supported titanium and zirconia full-arch fixed dental prosthesis (FAFDP) frameworks require further investigation. Strains transferred by implant-supported titanium (Ti) and zirconia (Zr) FAFDP frameworks were analyzed. Maxillary 14-unit FAFDPs supported by 6 implants and 12-unit FAFDPs supported by 4 implants were tested. One-piece frameworks were fabricated by CAD/CAM. Four groups were divided (n = 3 each): G1, Ti-6 implants; G2, Zr-6 implants; G3, Ti-4 implants; G4, Zr-4 implants. A 250-N single-point load was applied on the second premolar. A three-dimensional digital image correlation system recorded framework and maxilla model surface deformation. The following strains (μS) averaged over the length of the second premolar were calculated: frameworks, G1 (321.82 ± 111.29), G2 (638.87 ± 108.64), G3 (377.77 ± 28.64), G4 (434.18 ± 132.21); model surface, G1 (473.99 ± 48.69), G2 (653.93 ± 45.26), G3 (1,082.50 ± 71.14), G4 (1,218.26 ± 230.37). Zirconia frameworks supported by six implants (G2) presented higher surface strains ($P < .05$). FAFDPs with titanium frameworks transferred significantly lower strains to the supporting maxilla when six implants were used (G1; $P < .05$). Both framework materials transferred similar strains when supported by four implants (G3 and G4; $P > .05$). Zirconia frameworks supported by six implants showed higher strains. FAFDPs supported by six implants transferred less strain to the supporting maxilla, irrespective of framework material.
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de Araújo Nobre M, Guedes CM, Almeida R, Silva A, Sereno N. Hybrid polyetheretherketone (PEEK)-acrylic resin prostheses and the All-on-4 concept: A full-arch implant-supported fixed solution with 3 years of follow-up. J Clin Med 2020;9:2187.
The aim of this 3-year prospective study was to examine the outcome of a solution for full-arch rehabilitation through a fixed implant-supported hybrid prosthesis (polyetheretherketone [PEEK]-acrylic resin) used in conjunction with the All-on-4 treatment concept. Thirty-seven patients (29 women, 8 men), with an age range of 38 to 78 years (average: 59.8 years) were rehabilitated with 49 full-arch implant-supported prostheses (12 maxillary rehabilitations, 13 mandibular rehabilitations, and 12 bimaxillary rehabilitations). The primary outcome measure was prosthetic survival. Secondary outcome measures were marginal bone loss, plaque and bleeding scores, veneer adhesion issues, biologic complications, mechanical complications, and the patients' subjective evaluation. There were two patients (maxillary rehabilitations) lost to follow-up, while one patient withdrew (maxillary rehabilitation). One patient with bimaxillary rehabilitation fractured the mandibular PEEK framework, rendering a 98% prosthetic survival rate. Implant survival was 100%. Average (SD) marginal bone loss at 3 years was 0.40 mm (0.73 mm). Veneer adhesion was the only technical complication (n = 8 patients), resolved for all patients. Nine patients (n = 11 prostheses) experienced mechanical complications (all resolved): fracture of acrylic resin crowns (n = 3 patients), prosthetic and abutment screw loosening (n = 4 patients and 3 patients, respectively), and abutment wear (n = 1 patient). One patient experienced a biologic complication (peri-implant pathology), resolved through nonsurgical therapy. A 90% satisfaction rate was registered for the patients' subjective evaluation. Based on the results, the 3-year outcome suggests the proposed rehabilitation solution as a legitimate treatment option, providing a potential shock-absorbing alternative that could benefit the implant biologic outcome.
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Tribst JPM, Dal Piva AMO, Borges ALS, Rodrigues VA, Bottino MA, Kleverlaan CJ. Does the prosthesis weight matter? 3D finite element analysis of a fixed implant-supported prosthesis at different weights and implant numbers. J Adv Prosthodont 2020;12:67–74.
This study evaluated the influence of prosthesis weight and number of implants on the bone tissue microstrain. Fifteen fixed full-arch implant-supported prosthesis designs were created using modeling software with different numbers of implants (4, 6, or 8) and prosthesis weights (10, 15, 20, 40, or 60 g). Each solid was imported to the computer-aided engineering software, and tetrahedral elements formed the mesh. The material properties were assigned to each solid with isotropic and homogenous behavior. The friction coefficient was set as 0.3 between all the metallic interfaces, 0.65 for the cortical bone-implant interface, and 0.77 for the cancellous bone-implant interface. The standard earth gravity was defined along the z-axis, and the bone was fixed. The resulting equivalent strain was assumed as failure criteria. The prosthesis weight was related to the bone strain. The more implants placed, the less the amount of strain generated in the bone. The most critical situation was the use of a 60-g prosthesis supported by four implants with the largest calculated magnitude of 39.9 mm/mm, thereby suggesting that there was

no group able to induce bone remodeling simply due to the prosthesis weight. Heavier prostheses under the effect of gravity force are related to more strain being generated around the implants. Placing more implants to support the prosthesis enables attenuating the effects observed in the bone. The simulated prostheses were not able to generate harmful values of peri-implant bone strain.
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Guida L, Annunziata M, Esposito U, Sirignano M, Torrisi P, Cecchinato D. 6-mm-short and 11-mm-long implants compared in the full-arch rehabilitation of the edentulous mandible: A 3-year multicenter randomized controlled trial. Clin Oral Implants Res 2020;31:64–73.
The aim of this multicenter parallel-group randomized controlled trial is to compare 6-mm-short with 11-mm-long implants in the rehabilitation of the totally edentulous mandible in a completely comparable clinical situation, from anatomical, surgical, and prosthetic point of views. Thirty patients were selected from three study centers to receive a fixed full-arch mandibular rehabilitation supported by five interforamina implants. Patients were randomly allocated, at the time of surgery, half to the test group (6-mm-long implants) and half to the control group (11-mm-long implants). No bone augmentation procedure was performed. After 3 months, a screw-retained full-arch prosthesis with distal cantilevers was positioned (baseline). Peri-implant marginal bone level change (MBLc), implant and prosthesis survival rate, and biologic/technical complications were evaluated after 1 and 3 years. Thirty subjects (150 implants) were evaluated after 1 year and 28 (140 implants) after 3 years. No implant or prosthesis loss occurred. No significant intergroup difference for biologic/technical complications was registered. No statistically significant ($P > .025$) intragroup or intergroup difference in the mean MBLc values was registered. The mean MBLc was 0.01 ± 0.19 mm and –0.04 ± 0.21 mm at 1 year, and –0.10 ± 0.24 mm and 0.02 ± 0.25 mm at 3 years (test and control groups, respectively). Six-mm short implants may be a reliable option when used in the rehabilitation of totally edentulous mandibles. These results need to be confirmed by longer follow-up data from well-designed randomized controlled clinical trials.
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Tartaglia GM, Farronato M, Sforza C, Bidra AS. Implant-supported immediately loaded complete arch rehabilitations with a mean follow-up of 10 years: A prospective clinical study. J Prosthodont 2019;28:951–957.
The purpose of this study was to evaluate the complication-free and failure-free survival rates of porcelain-fused-to-zirconia (PFZ) and all-resin complete-arch fixed implant-supported prostheses over a mean follow-up of 10 years. Subjects with either all-resin or PFZ complete-arch fixed implant-supported prostheses on four or six implants were followed prospectively for 10 years. Cumulative survival rates of prostheses without any catastrophic mechanical complications (resolved without replacing the prosthesis) and free of prosthesis failure (requiring the replacement or removal of the prosthesis) were calculated using life table analysis for an up-to-10-year period. Additional descriptive variables for various prosthesis events were recorded, such as sex, smoking, and drinking status of subjects. A total of 36 subjects with a total of 68 prostheses (53 all-resin and 15 PFZ) were available for evaluation, with a mean follow-up of 10 years (SD: 1.47; range: 8 to 13 years). The study registered an overall 90% prostheses survival rate: 78% for men and 94% for women; 91% for PFZ and 87% for all-resin; and a 31% complication-free prosthesis survival rate—13% for men and 38% for women; 29% for PFZ and 31% for all-resin at 10 years. A slight decrease in survival rate was identified in the first 3 years since the initial treatment (from 100% to 93%). The number of complications increased with time, especially 6 years after the initial treatment. Despite the number of reparable mechanical complications, the results confirmed the long-lasting features of both PFZ and all-resin complete-arch fixed implant-supported prostheses over a 10-year period. There was, however, an increased number of mechanical complications after 6 years, which may entail additional treatment cost for patients.
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Papaspyridakos P, Bordin T, Kim YJ, et al. Technical complications and prosthesis survival rates with implant-supported fixed complete dental prostheses: A retrospective study with 1- to 12-year follow-up. J Prosthodont 2020;29:3–11.
The purpose of this study was to report the rate of technical complications and prosthesis survival in a cohort of edentulous patients treated with implant-supported fixed complete dental prostheses (IFCDPs) after a mean observation period of at least 1 year. The single-visit examination included clinical and radiographic assessment, occlusal analysis, photographs, and questionnaire assessing patient satisfaction in a cohort of 52 patients rehabilitated with 71 IFCDPs (supported by 457 implants). The IFCDPs were assessed for technical complications, number of implants and cantilever extension, retention type, and prosthetic material type. Comparison was made between ceramic IFCDPs (group 1) and metal-resin IFCDPs (group 2). Kaplan-Meier survival curve analysis was carried out for assessment of prosthesis survival and was done for both groups 1 and 2 separately. The Cox proportional hazard model was used for survival analysis, adjusting for a number of potential confounders, to evaluate the association between prosthesis survival and several risk factors, such as type of opposing occlusion, nightguard use, and presence of bruxism. Responses to patient satisfaction questions were compared with Fisher exact test. Out of 71 edentulous arches (52 patients) restored with IFCDPs, 6 IFCDPs failed, yielding a cumulative prosthesis survival rate of 91.6% after a mean observation period of 5.2 years (range: 1 to 12 years) after definitive prosthesis insertion.

Three IFCDPs were lost due to implant failures after 5.8 to 11 years of functional loading. Additionally, three metal-resin IFCDPs failed due to technical complications. Minor complications were the most frequent complications observed, namely, wear of the prosthetic material (9.8% annual rate) being the most common, followed by de-cementation of cement-retained IFCDPs (2.9%), and loss of the screw access filling material of the screw-retained IFCDPs (2.7%). The most frequently observed major complication was fracture of the prosthetic material (1.9% annual rate), followed by fracture of occlusal screw (0.3%), and fracture of framework (0.3%). The annual rate of wear of prosthetic material was 7.3% for porcelain IFCDPs (n = 19/55) and 19.4% for metal-resin IFCDPs (n = 13/16), yielding a statistically significant difference between the two groups (P = .01). After a mean exposure time of 5.2 years, 91.6% prosthesis survival rates were achieved (65 out of 71 IFCDPs). The most frequent minor technical complication was wear of the prosthetic material with an estimated 5-year rate of 49.0%, while the most frequent major complication was fracture of the prosthetic material with estimated 5-year dental unit–based rate of 9.5%. The cumulative rates for "prosthesis free of minor complications" at 5 and 10 years were 60.5% (95% CI: 47.2% to 71.3%) and 8.9% (95% CI: 2.9% to 18.0%), respectively. The cumulative rates for "prosthesis free of major technical complications" at 5 and 10 years were 85.5% (95% CI: 73.0% to 92.5%) and 30.1% (95% CI: 12.0% to 50.6%), respectively. Presence of bruxism and absence of a nightguard were associated with increased risk for chipping of the prosthetic material of the IFCDPs.

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