

Fixed Dental Prostheses: A Systematic Review of the Survival and Complication Rates

Entela Fuga¹, Gafur Shtino²

¹Dental Clinic Studio, Tirana – Albania

²Faculty of Dental Medicine - Tirana - Albania

Abstract: *The aim of the study was to assess the 5-year survival rate and number of technical, biologic, and esthetic complications involving implant abutments. Electronic (Medline) and hand searches were performed to assess studies on metal and ceramic implant abutments. Relevant data from a previous review were included. Failure and complication rates were analyzed, and estimates of 3-year survival proportions were calculated from the relationship between event rate and survival function. The search yielded 1,558 titles and 274 abstracts. Twenty-four studies were selected for data. Survival rates of metal-ceramic FDPs were higher than those reported for other types of all-ceramic FDPs.*

Keywords: fixed dental prostheses, metal-ceramic, bridges

1. Introduction

Socio-economic factors, better prophylaxis and oral hygiene regimens with patients included in regular recall programs have led to an increased number of teeth and to a shift from fully to more partially edentulous patients over the past decades (1). This resulted in more single and multiple tooth gaps that can be restored with fixed tooth- or implant-supported reconstructions. In order to support the decision-making process for either one option, evidence based clinical data are needed reporting on survival and complication rates for both types of reconstructions. Whereas for implant-supported reconstructions, systematic reviews provide very recent evidence comparing metal- and all-ceramic reconstructions (2), a systematic pooling of newer clinical data on tooth-supported reconstructions is limited to all-ceramic reconstructions (3). Traditionally, metal-based reconstructions for fixed dental prostheses (FDPs) were considered as the gold standard (4). Alloys, mainly gold-based, were fully or partially veneered with feldspathic ceramics. The evolution in material science led to the introduction of new framework materials (ceramics) and partially a change in clinical concepts (e.g. monolithic rather than veneered framework materials) (5,6). Ceramics as part of reconstructive materials fulfill the need for esthetics. Today, partially edentulous individuals represent the main group of patients requiring treatment in daily dental practice. Therefore, oral implants are the predominant treatment modality for the rehabilitation of these patients. Using implants, fixed partial dentures can be applied in situations where removable dentures would previously have been necessary. In addition, more treatment options that preserve the tooth structure are possible by replacing missing single teeth with dental implants. Since most of the patients provided with oral implants are between 40 and 50 years of age, promising long-term survival rates for implants and prostheses are expected both by the clinician and the patient to ensure the longevity of the prosthesis (7). The definition “long-term” has been specified as a follow-up of at least 5 years. (8). Thus, survival rates and the incidence of biologic, technical, and esthetic events should be based on mean observation periods of at least 5 years. Several years

ago, hierarchies of evidence were developed as aid for the interpretation and evaluation of research findings. As evidence, systematic reviews were ranked to be excellent in terms of effectiveness, appropriateness, and feasibility. An evidence level of “excellent” equates with the strongest scientific basis for clinical practice along with the least risk of error (9). Consequently, systematic reviews are an optimal tool for the development of practice guidelines and clinical recommendations. The aim was to systematically review the existing dental literature on the survival rates of metal and ceramic abutments supporting single implant crowns with a mean observation period of at least 3 years. In addition, the occurrence of negative biologic, technical, and esthetic events was evaluated for metal and ceramic abutments

2. Material and Methods

The PICO (population, intervention, comparison, outcome) question was stated as follows: For single-tooth implant prostheses in anterior and posterior locations, are there differences in survival/performance based on technical, biologic, and esthetic outcomes as influenced by material and design? Search Strategy: The present systematic review was performed as an update of a previously published systematic review with the same objectives. A Medline (PubMed) search was performed for clinical studies published in dental journals from year 2010 up to year 2017. Survival was defined as the abutment/implant prosthesis remaining in situ for the observation period with or without modifications. Technical complications included abutment fracture, abutment screw fracture, abutment screw loosening, misfit at the implant-abutment junction (gap), fracture of the implant prosthesis, chipping of the veneering ceramic, and loosening of the implant prosthesis. The analysis of biologic complications encompassed bone loss of more than 2 mm, soft tissue recession, and general soft tissue complications. The analysis of the esthetic complications included soft tissue discoloration and other esthetic problems.

3. Results and Discussion

The mean age of all patients was 41 years, ranging from 14 to 78 years. For metal-ceramic FDPs, studies provided data on 1796 FDPs after a mean follow-up time of 7.0 years. Out of these, 145 FDPs were reported to be lost. The annual failure rate was estimated at 1.15% (95% C.I.: 0.72 – 1.84%) (Fig. 2), translating into a 5-year survival rate for metalceramic FDPs of 94.4% (95 % C.I.: 91.2% - 96.5%). Investigating formally the relative failure rates of different types of FDPs, using metal-ceramic FDPs as reference, all-ceramic FDPs showed higher annual failure rates. Moreover, for glass-infiltrated alumina FDPs this difference reached statistical significance ($p=0.05$)

Technical Complications: Technical complications Material complications: framework fracture, ceramic chipping or ceramic fracture. From 2640 FDPs that were evaluated, 72 were known to be lost due to framework fractures. The overall annual failure rate was 0.45%, translating into a 5-year failure rate of 2.2%. For different types of FDPs, the annual failure rates of framework fractures ranged from 0.12% to 2.76%. Investigating the relative complication rates of different types of FDPs, using metal-ceramic FDPs as reference, significantly more glass-infiltrated alumina FDPs and reinforced glass ceramic FDPs were lost due to framework fractures ($p<0.001$). Compared to the other ceramics, densely sintered zirconia exhibited the highest stability as framework material with an estimated 5-year failure rate of 1.9%. The incidence, however, of fractures of the ceramic veneering that needed repair or replacement was highest for densely sintered zirconia FDPs with an annual complication rate of 3.14%, translating into a 5-year complication rate of 14.5%. This difference reached statistical significance ($p=0.02$).

Ceramic chipping was the most frequent technical complication reported, but the difference in ceramic chipping between different types of FDPs did not reach statistical significance.

Loss of retention: Loss of retention or fracture of the luting cement was analyzed in 25 studies reporting on 1702 FDPs. The overall annual complication rate was 0.64%, translating into a 5-year failure rate of 3.1%

Marginal discoloration: Marginal discoloration or the occurrence of marginal gaps was evaluated in 9 studies reporting on 253 FDPs. The overall annual complication rate was 3.91%, translating into a 5-year complication rate of 17.7%

Biologic and Esthetic Complications: The overall annual complication rate was 0.29%, translating into a 5-year complication rate of 1.4%. For different types of FDPs the annual rate of secondary caries ranged from 0.11% to 0.65%. Investigating the relative complication rates of different types of FDPs, using metal-ceramic FDPs as reference, densely sintered zirconia FDPs experienced significantly higher rate of secondary caries ($p=0.001$)

Abutment tooth fracture: The overall annual failure rate was 0.17%, translating into a 5-year failure rate of 0.9%. For

different types of FDPs the annual failure rates due to abutment tooth fractures ranged from 0.09% to 0.21%. The difference between different types of FDPs did not reach statistical significance.

Periodontal disease: The overall annual failure rate was 0.23%, translating into a 5-year failure rate of 1.2%. Investigating the relative complication rates of different types of FDPs, using metalceramic FDPs as reference, significantly more glass-infiltrated alumina FDPs and reinforced glass ceramic FDPs were lost due to recurrent periodontal diseases ($p<0.001$ & 0.009). There is a lack of classification for the report of biologic complications. Consequently, negative events were reported in a non-standardized way and comparison of the studies was impeded. There was a trend for a higher incidence of biologic complications with ceramic abutments (11.4%) compared to metal ceramic abutments (8.2%), but without statistical significance. Systematic reviews have been used extensively in medicine for the last two decades to summarize the cumulative information on the optimal treatment for clinically relevant questions and to support the clinicians in the decision-making process for different treatment options. This research method has slowly found its way into dental research. Systematic reviews have mainly been used to analyze and summarize results from randomized controlled clinical trials (RCTs) (10). In the absence of RCTs with adequate statistical power to compare head-to-head metalceramic and all-ceramic fixed dental prosthesis (FDPs) prospective and retrospective cohort studies and case series with stringent inclusion criteria were included in this systematic review in order to summarize the available information about survival and complication rates of metalceramic and all-ceramic FDPs after a observation period of at least 3 years. Even with follow-up periods of at least 3 years, some clinicians may argue that such a period is still too short to obtain reliable information on survival and complication rates of fixed reconstructions. Due to the fact that the use of all-ceramic FDPs is relatively recent, a mean follow-up period of 3 years or more was a necessary compromise. Survival was defined as FDP remaining in situ with or without modifications and success was defined as the FDPs remaining in situ free of all complications over the entire observation period.

From the Forrest plots of study specific failure rates, it is evident that these vary widely among the various studies. This may be attributable to the patient cohort observed, the design and extent of the FDPs, the maintenance care provided and the experience and clinical set-up of the clinicians. After an observation period of 3 years, the lowest failure rate were observed for metal-ceramic FDPs (5.6%) compared with a failure rates of 9.6% for densely sintered zirconia ceramic FDPs, 10.9% for reinforced glass ceramic FDPs and 13.8% for glass-infiltrated alumina FDPs. Due to the different composition of different ceramic materials it was decided not to pull, different types of all-ceramic FDPs, into one group in the meta-analysis as was done in the previous review on the same topic. Four of the included studies randomized the patients according to material utilized.

Three of them reported more failure of all-ceramic FDPs compared with metal-ceramic FDPs (11-13). The last one reported no failures in either group (14). In this review stringent study inclusion criteria were used. Only studies with a clinical follow-up examination of at least 3 years were included to avoid the potential inaccuracies in event description in studies that based their analysis on patient self-reports.

4. Conclusion

Metal-ceramic FDPs had lower failure rates than all-ceramic FDPs after a mean observation period of at least 3 years. There is a large heterogeneity among the studies concerning the evaluation of the esthetics, due to a lack of standardization.

References

- [1] Walton TR. Making sense of complication reporting associated with fixed dental prostheses. *Int J Prosthodont* 2014;27:114–8.
- [2] Passia N, Stampf S, Strub JR. Five-year results of a prospective randomised controlled clinical trial of posterior computer-aided design-computer-aided manufacturing ZrSiO₄-ceramic crowns. *J Oral Rehabil* 2013;40: 609–17.
- [3] Cehreli MC, Kokat AM, Ozpay C, Karasoy D, Akca K. A randomized controlled clinical trial of feldspathic versus glass-infiltrated alumina all-ceramic crowns: a 3-year follow-up. *Int J Prosthodont* 2011;24:77–84.
- [4] Naumann M, Ernst J, Reich S, Weisshaupt P, Beuer F. Galvano- vs. metal-ceramic crowns: up to 5-year results of a randomised split-mouth study. *Clin Oral Investig* 2011;15:657–60.
- [5] Sax C, Hammerle CH, Sailer I. 10-year clinical outcomes of fixed dental prostheses with zirconia frameworks. *Int J Comput Dent* 2011;14:183–202.
- [6] Sailer I, Gottnerb J, Kanelb S, Hammerle CH. Randomized controlled clinical trial of zirconia-ceramic and metal-ceramic posterior fixed dental prostheses: a 3-year follow-up. *Int J Prosthodont* 2009;22:553–60.
- [7] Schley JS, Heussen N, Reich S, Fischer J, Haselhuhn K, Wolfart S. Survival probability of zirconia-based fixed dental prostheses up to 5 yr: a systematic review of the literature. *Eur J Oral Sci* 2010;118:443–50.
- [8] Heintze SD, Rousson V. Survival of zirconia- and metal-supported fixed dental prostheses: a systematic review. *Int J Prosthodont* 2010;23:493–502.
- [9] Gherlone E, Mandelli F, Cappare P, Pantaleo G, Traini T, Ferrini F. A 3 years retrospective study of survival for zirconia-based single crowns fabricated from intraoral digital impressions. *J Dent* 2014;49(9):1151–5.
- [10] Koenig V, Vanheusden AJ, Le Goff SO, Mainjot AK. Clinical risk factors related to failures with zirconia-based restorations: an up to 9-year retrospective study. *J Dent* 2013;41:1164–74.
- [11] Reitemeier B, Hansel K, Kastner C, Weber A, Walter MH. A prospective 10-year study of metal ceramic single crowns and fixed dental prosthesis retainers in private practice settings. *The Journal of prosthetic dentistry*. 2013;109:149-55.
- [12] Pjetursson BE, Sailer I, Makarov NA, Zwahlen M, Thoma DS. All-ceramic or metal-ceramic tooth-supported fixed dental prostheses (FDPs)? A systematic review of the survival and complication rates. Part II: multiple-unit FDPs. *Dent Mater*. 2015;31(6):624-39.
- [13] Sailer I, Makarov NA, Thoma DS, Zwahlen M, Pjetursson BE. All-ceramic or metal-ceramic tooth-supported fixed dental prostheses (FDPs)? A systematic review of the survival and complication rates. Part I: single crowns (SCs). *Dent Mater*. 2015;31(6):603-23.