Retrospective Comparison of Semipermanent and Permanent Cementation of Implant-Supported Single Crowns and FDPs with Regard to the Incidence of Survival and Complications

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ABSTRACT

Purpose: To retrospectively compare the fixation modalities semipermanent and permanent for all cemented single crowns and Fixed Dental Prostheses (FDPs) placed at the Department of Prosthodontics in the years 2002 to 2010 with regard to the incidence of survival and complications.

Materials and Methods: Two hundred forty-one patients (48.5% male, mean age 57.3 years) received 166 FDPs and 232 single crowns. A total of 50.6% of the FDPs and 54.7% of the single crowns were fixed using semipermanent cements. Aside from fixation, age, gender, type, location, and material of the suprastructures were assessed as possible factors affecting complications, namely de-cementation, chipping, framework, or abutment fracture.

Results: During an observation period of up to 6.6 years (mean 2.24 years; standard deviation 1.38), the survival rates were 96.4% and 100% for FDPs (semipermanent/permanent cementation), and 98.4% and 92.4% for single crowns (semipermanent/permanent). The success rates achieved, counting every complication, for the FDPs were 61.9% and 70.7% (semipermanent/permanent) and for single crowns were 75.6% and 77.1% (semipermanent/permanent). The cement used had a significant effect on loss of retention of the FDPs ($p = .006$), but no significant effect on the retention of the single crowns. Cementation procedure exhibited no significant impact on chipping for both FDPs and single crowns. The frequency of framework or abutment fractures was too low for further statistical analyses.

Conclusion: Both semipermanent and permanent cementation of FDPs and single crowns resulted in high survival rates. Within the limitations of the study design, because of the amount of chairside aftercare required, implant-borne FDPs could be recommended for permanent cementation.

KEY WORDS: cementation, complications, implants, permanent, semipermanent, survival

For partially edentulous jaws reconstructed by use of dental implants, treatment can entail use of single crowns,[1] conventional implant-borne Fixed Dental Prostheses (FDPs),[2,3] implant-borne splinted crowns with cantilever,[4,5] or combined tooth–implant-borne FDPs.[6,7] In recent years two methods of fixing FDPs on implants have become established. Screw-retained suprastructures are preferred by some authors[8,9] because of the advantage of avoiding the cement gap at bone level and the repairability after chipping of the veneer

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material. Disadvantages include possible complications, for example, fracture of the fixing screws, the need for screw retightening, and the aesthetic outcome for the occlusal areas. Cementation of single crowns and FDPs is the other common treatment option.[10,11] Semipermanent and permanent cements are both used. Semipermanent cementation may enable removal of the single crown or FDP for retightening of the abutment screws and repair of veneer fractures without the need to replace the total suprastructure. Loss of retention, chipping of the veneer material, and abutment screw loosening seem to be the most common complications associated with cement-retained, implant-supported fixed dentures.[12] In a review, Pjetursson and colleagues[13] analyzed 21 studies of 1,123 patients with 1,336 conventional FDPs on 3,578 implants. Despite high survival of the FDPs, biological and technical complications were frequent. Only 61.3% of the patients were free from any complications after 5 years. Two studies in this review, both performed by Brägger and colleagues,[6,14] reported loss of retention. For 33 patients with 40 FDPs on 84 implants, the cumulative incidence of de-cementation in the first study was 2.9% (three units) after 5 years.[6] In the second study of 29 patients receiving 33 FDPs on 69 implants, of which 25 FDPs were cemented, loss of retention occurred for four units (16%) during an observation period of 10 years.[14] In a review in 2004 Lang and colleagues[15] reported that 5- and 10-year survival of combined tooth–implant-supported FDPs were 94.1% and 77.8%, respectively. Although these authors did not discuss technical complications in detail, loss of retention was also reported to be a common complication. Implant-borne cantilever FDPs are rarely described in the literature. Aglietta and colleagues,[16] in a review, examined five studies of 155 FDPs with cantilevers and calculated cumulative survival as 94.3% (5 years) and 88.9% (10 years). Veneer fracture and screw loosening were the most common complications, but loss of retention also occurred.

In another review, Jung and colleagues[17] examined the survival and complication rates of 1,530 implant-borne single crowns. Loss of retention was reported in six studies and was named to be the second most common complication with a cumulative incidence of 5.5% after 5 years.

In recent years, although the main focus in the description of complications for implant-retained fixed suprastructures has been on chipping of the veneer material, fractures, or loosening of the abutment screws, loss of retention seems to be a common complication with implant-supported single crowns and FDPs. Detailed information about the dependence of the frequency of complications on the cement used and about subsequent aftercare is, to the knowledge of the authors, not available in the literature. In addition, possible correlation between de-cementation and the occurrence of other complications has not yet been investigated.

The purpose of this retrospective study was, therefore, to compare semipermanent and permanent cementation of all cemented single crowns and FDPs fabricated at the Department of Prosthodontics in the years 2002 to 2010 with regard to the suprastructure survival and incidence of prosthodontic complications.

The null hypothesis was that there would be no difference between the incidence of loss of retention and complications for FDPs and single crowns fixed with semipermanent cement and those fixed by permanent cementation.

MATERIALS AND METHODS

All patients consulting the Department of Prosthodontics, University of Heidelberg, between June 2002 and January 2010 in need of prosthetic treatment, including implant insertion, and who fulfilled the inclusion criteria, were included in the study. The inclusion criteria were: presence of a tooth gap to be restored by implant placement, receiving both implants and single crown or FDP at the Department of Prosthodontics, attending at least one follow-up examination after fixing the suprastructure, and signing the informed consent form for documentation. The exclusion criteria were: rejection of participation in the study or receiving the implant or the suprastructure outside the Department of Prosthodontics. The number of such patients was not documented explicitly, however. A total of eight patients who did not attend follow-ups after fixing of the suprastructure were also excluded from this analysis. Prospectively documented material was analyzed retrospectively. Data were compiled by use of a data-extraction sheet. The prospective study, which documented all implants and suprastructures placed and fabricated at the Department of Prosthodontics, was approved by the ethics committee of the University of Heidelberg (27/2005). Before signing the informed consent form, patients were informed in detail about the procedures used.

Observation started at implant placement. The fixed suprastructures were placed after healing for 3–9 months. Two hundred forty-one patients (48.5% male, mean age at the time of implant insertion 57.3 years, standard deviation (SD) 12.3) with 533 implants received 166 FDPs and 232 single crowns.

Survival, incidence of chipping, and related aspects have already been published for the 232 single crowns.[18] To enable easier comparison with the FDPs, some of these results are included, again, in the "Results" section of this paper and are indicated with "*".

Of the FDPs studied, 91 were all-implant-supported, 27 were implant-supported cantilever, and 48 were combined tooth-implant-supported. Of the implant-supported FDPs 83.5% were fabricated with a metal framework whereas the others were all-ceramic. A metal framework was used for 92.6% of the implant-supported cantilever FDPs and 81.3% of the combined tooth–implant-supported FDPs. Of the single crowns* 77.2% were metal–ceramic. Of the suprastructures, 161 were fixed in the posterior region of the maxilla and 44 in the anterior region. A total of 193 suprastructures were fixed in the mandible – 187 in the posterior region and 6 in the anterior region.

Semipermanent cements (Dycal®, DENTSPLY DeTrey GmbH, Konstanz, Germany; TempBond™, Multident Dental GmbH, Hanover, Germany) and permanent cements (Harvard®, Harvard Dental International GmbH, Hoppegarten, Germany; Ketac™ Cem, 3M ESPE GmbH, Neuss, Germany; RelyX™ Unicem, ESPE GmbH, Germany) were used in accordance with the manufacturers' recommendations. The luting cement used, was selected by the dentist solely on the basis of the patients' wishes, no randomization was performed. Semipermanent cements were used to fix 50.6% of all FDPs; of these, 62.6% were implant-supported, 44.4% were cantilever, and 31.3% were combined tooth–implant-supported. Of the single crowns, 54.7%* were fixed by semipermanent cementation.

Every dentist maintained baseline documentation, including prosthetic procedure, suprastructure material, and cement used. Follow-ups were scheduled after 6 and 12 months, and then at 1-year intervals. Patients were requested to consult the clinic immediately on recognition of any complication, to enable recording of the approximate failure time. Any intervention for maintenance of the single crowns or FDPs was counted as a complication. Occurrence of complications, for example, loss of retention, fracture of the veneer, or loosening of abutment screws, and the measures used to correct these, were documented separately on standard forms. Depending on the type of complication, single crowns or FDPs were repaired chairside or by the dental technician. If repair was impossible the suprastructure was remade.

All data were analyzed by use of SPSS 17.0 (SPSS Inc., Chicago, IL, USA). Kaplan–Meier curves were plotted to compare the survival of the FDPs and the single crowns and to compare implant survival for both groups. Because a patient could have received more than one single crown or FDP, and complications may not have been independent of the factor "patient", non-time-dependent general estimation equation models (GEE; binary logistic, with loss of retention yes/no and chipping yes/no as target variables) were produced with age, gender, type of suprastructure (single crown/implant-borne FDP/cantilever FDP/tooth–implant-borne FDP), suprastructure material (all-ceramic/metal–ceramic), type of cementation (semipermanent/permanent), and location of the restoration (anterior/posterior and maxilla/mandible) as independent factors/covariates. The probability level for statistical significance was set at alpha < 0.05. Because of the explorative nature of the study, no correction was made for the local level of alpha.

RESULTS

During the implant observation period of up to 6.9 years (mean 2.95 years; SD 1.39) three implants with clinical signs of periimplantitis were lost in three patients (one single crown*, two FDPs), resulting in implant survival of 99.6% for the single crowns* and 99.3% for all FDPs (Figure 1).

During the suprastructure observation period of up to 6.6 years (mean 2.24 years; SD 1.38), two FDPs were lost because of implant failure, and one FDP had to be remade because of major chipping. All three FDPs were fixed with semipermanent cement, resulting in cumulative FDP survival rates of 96.4% (semipermanent) and 100% (permanent cementation). Eight single crowns* had to be remade because of major chipping (one semipermanent/seven permanent cementation), one was lost because of implant failure (permanent cementation), and one crown was lost because the patient had swallowed it after fracture of the luting cement (semipermanent cementation), so cumulative survival rates

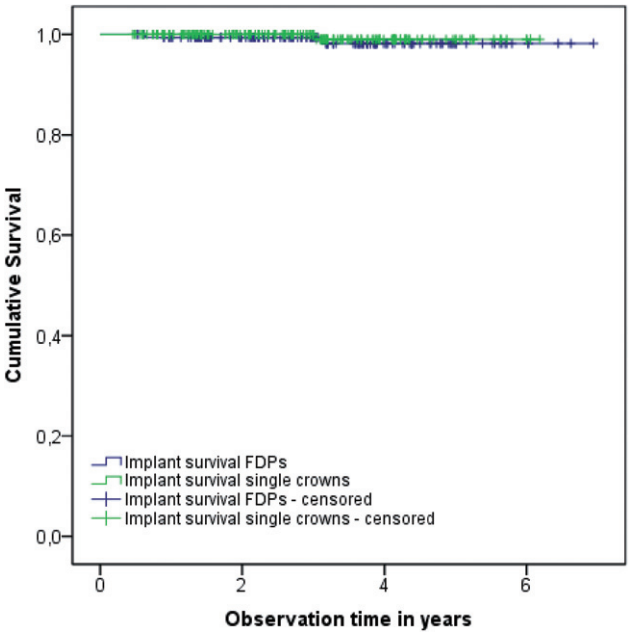

Figure 1 Kaplan–Meier survival curves for the implant groups "FDPs" and "single crowns*," starting at implant placement. FDP = Fixed Dental Prostheses.

were 98.4% and 92.4% (semipermanent/permanent) (Figure 2).

Loss of retention occurred on 35 FDPs (21.1%) and 27 single crowns* (11.6%). Further complications were fractures of the veneer material (total 17.5% of the FDPs and 12.9% of the single crowns*) and abutment fractures (2 FDPs, total 1.2%). No framework fractures occurred. Frequency of factors affecting the incidence of loss of retention of FDPs and single crowns, stratified for the groups "fixed with semipermanent/permanent cementation" are listed in Table 1. The success rates achieved, counting every complication, for the FDPs were 61.9% and 70.7% (semipermanent/permanent) and for the implant-borne single crowns* were 75.6% and 77.1%, respectively, after up to 6.6 years.

The cement used had a significant effect on loss of retention of FDPs (Table 2), but no effect on loss of retention of single crowns (Table 3). By use of the GEE model, non-time-dependent risk of loss of retention for FDPs was estimated to be 3.5 times higher in the semipermanent cementation group than in the permanent cementation group (lower bound of 95% confidence interval (CI): 1.4; $p = .006$; see Table 2). The occurrence of the complication "chipping of the veneer material" was not affected by cementation, and the other factors type of FDP, material of suprastructure, location, jaw, age, and gender also had no effect (GEE model not depicted). The incidence of framework or abutment fractures was too low to perform further analysis.

DISCUSSION

The study hypothesis had to be rejected for the FDPs. The incidence of fracture of the luting cement when semipermanent material was used was significantly greater than that for permanent cements ($p = .006$), with a 3.5 times greater risk of loss of retention (lower bound 95% CI: 1.4). FDPs fixed with semipermanent cement did not, however, suffer more from other complications, for example, chipping of the veneer material or fracture of the abutment. Although abutment fractures occurred for FDPs fixed with semipermanent cement only, the incidence of this complication was too low for further analyses. The study hypothesis for the single crowns could be confirmed, a difference between the incidence of de-cementation and complications for single crowns fixed with semipermanent cement and those fixed by permanent cementation was not found.

The results of this study agree with literature results to a limited extent only, not least because detailed information about fixing procedures are not given in the

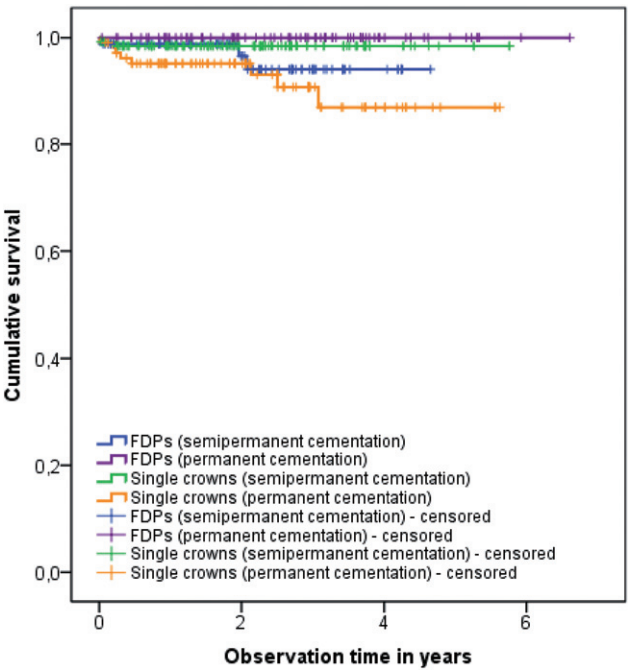

Figure 2 Kaplan–Meier survival curves for the restoration groups "FDPs (semipermanent cementation)," "FDPs (permanent cementation)," "single crowns* (semipermanent cementation)," and "single crowns* (permanent cementation)." FDP = Fixed Dental Prostheses.

TABLE 1 Frequency of Factors Affecting Incidence of the Complications "Loss of Retention" of FDPs and Single Crowns* Stratified for the Groups "Semipermanent/Permanent Cementing"

Event	Loss of Retention of FDPs		Loss of Retention of Single Crowns*	
Factor	Semipermanent cementing	Permanent cementing	Semipermanent cementing	Permanent cementing
Age	62.2 years (SD 8.0)	60.2 years (SD 9.1)	55.1 years (SD 13.2)	56.9 years (SD 13.4)
Gender				
Male	10 (33.3%)	6 (13.9%)	9 (13.0%)	6 (11.8%)
Female	16 (29.6%)	3 (7.7%)	8 (13.8%)	4 (7.4%)
Type of FDP				
Implant/implant	21 (36.8%)	1 (6.1%)	–	–
Implant cantilever	4 (33.3%)	6 (40.0%)	–	–
Tooth/implant	1 (6.7%)	2 (2.9%)	–	–
Material				
Metal–ceramic	24 (35.3%)	8 (11.1%)	16 (14.3%)	7 (10.5%)
All-ceramic	2 (12.5%)	1 (10.0%)	1 (6.7%)	3 (7.9%)
Location				
Anterior	7 (41.2%)	1 (14.3%)	3 (18.75%)	1 (10.0%)
Posterior	19 (28.4%)	8 (10.6%)	14 (12.6%)	9 (9.5%)
Jaw				
Maxilla	13 (27.1%)	7 (15.6%)	7 (12.1%)	5 (9.3%)
Mandible	13 (36.1%)	2 (5.4%)	10 (14.5%)	5 (9.8%)

One patient could have received more than one FDP or single crown.
FDP = Fixed Dental Prostheses; SD = standard deviation.

literature. Pjetursson and colleagues[13] reported 61.3% success of implant-borne FDPs after a 5-year observation period. Loss of retention occurred for 5.7% of the FDPs. The incidence of de-cementation for solely implant-supported FDPs in this study (24.2%) was markedly higher. One reason could be the choice of luting cement; only 2.9% of the FDPs fixed with permanent cement suffered loss of retention.

Romeo and colleagues,[19] in a prospective study, examined implant-borne cantilever FDPs in partially edentulous arches. After a 7-year observation FDP success was 98%. The results of this study differ. Our results were more similar to those of Kreissl and colleagues,[20] who reported that the incidence of complications after 5 years was highest in the cantilever FDPs group (68.6% success), or to those of Zurdo and colleagues,[21] who found, in a review, that a 5-year survival of cantilever FDPs without any complication varied between 66.7% and 79.2%. In this study loss of retention was recorded for 10 of the cantilever FDPs (37%), four of which had been fixed with semipermanent cement.

Lang and colleagues,[15] in another review, found survival was lower for combined tooth–implant-borne FDPs (94.1% after 5 years and 77.8% after 10 years) than for solely implant-supported FDPs (95% and 86.7%). Loss of retention occurred for 6.2% during the 5-year observation period. With incidence of complications of 6.3% for loss of retention, the results of this study are comparable.

Regarding the single crowns no difference between the de-cementation rates of semipermanent and permanent fixation was found in this retrospective analysis. The results are difficult to compare with the literature, because data are missing to the knowledge of the authors. Vigolo and Givano[22] within a 5-year retrospective study examined 52 single-tooth mini-implants. All crowns were fixed using semipermanent cementation and loss of retention occurred on 13.5%. Palmer and colleagues,[23] within another prospective study on 15 implant-borne single crowns, reported on loss of retention of 6.7% after 5 years of observation. Chaar and colleagues,[12] in a review about the prosthetic outcome of cement-retained suprastructures, found 11 short-term and nine long-term studies reporting on cemented single crowns. Semipermanent and permanent cements were both used. The authors conclude that cementation is an effective option to fix single crowns, but guidelines about cement or cementation procedures are missing.

TABLE 2 General Estimation Equation (GEE) Model for the Dependent Variable: "Incidence of Loss of Retention of FDP"

			95% Wald Confidence Interval	
Factor	Exp (B)	Significance	Minimum	Maximum
Age	1.019	0.397	0.975	1.065
Gender				
Male	1.133	0.775	0.480	2.676
Female	1	–	–	–
Type of FDP				
Tooth/implant	0.307	0.081	0.081	1.155
Cantilever	2.348	0.152	0.730	7.552
Implant/implant	1	–	–	–
Material				
Metal–ceramic	2.020	0.297	0.539	7.574
All-ceramic	1	–	–	–
Luting cement				
Semipermanent	3.495	0.006	1.423	8.585
Permanent	1	–	–	–
Location				
Anterior	1.488	0.492	0.479	4.624
Posterior	1	–	–	–
Jaw				
Maxilla	0.792	0.570	0.355	1.769
Mandible	1	–	–	–

FDP = Fixed Dental Prostheses.

In this study, only suprastructures without intervention were counted as successful. These results are based on retrospective analysis of documentation forms and patient charts. Suprastructure material and type, and the luting cement used, were selected by the dentist solely on the basis of the patients' wishes; this resulted in groups of different sizes, but all dentists treated the same kinds of subject. Although this does not guarantee generalizability, it seems adequate for assessment of the incidence of loss of retention in this study.

When comparing the occurrence of complications and subsequent aftercare for implant-borne FDPs, fixing with semipermanent cement does not seem to have advantages. Abutment fractures occurred for 1.2% of FDPs only, and 5.4% of the FDPs had to be repaired by a dental technician or replaced, solely because of major chipping. All other complications could be repaired chairside by polishing the surface of the veneer material, re-cementation, or tightening the abutment screws; of these, re-cementation was the most common. However, in this study setting the luting cement used had no effect on retention of single crowns. In all probability loss of retention does not only depend on the luting cement used. The size, form, and surface of the abutments could also affect the incidence of clinical complications. Despite this, the mechanisms of de-cementation of implant-supported suprastructures have not yet been completely investigated, and further prospective and randomized clinical studies are needed.

CONCLUSION

Semipermanent and permanent cementation of FDPs and single crowns both resulted in high survival rates. However, semipermanent cementation of the FDPs revealed significantly greater incidence of de-cementation and more chairside aftercare than permanent cementation. For the single crowns this could not be proven. For both, single crowns and FDPs, the other complications investigated, namely framework or abutment fractures and chipping, were not affected by the cementation procedure. Within the limitations of the study design, and taking into consideration the extent of

TABLE 3 General Estimation Equation (GEE) Model for the Dependent Variable: "Incidence of Loss of Retention of Single Crowns"

			95% Wald Confidence Interval	
Factor	Exp (B)	Significance	Minimum	Maximum
Age	0.990	0.550	0.957	1.024
Gender				
Male	1.278	0.701	0.365	4.470
Female	1	–	–	–
Material				
Metal–ceramic	1.849	0.337	0.527	6.482
All-ceramic	1	–	–	–
Luting cement				
Semipermanent	1.225	0.716	0.410	3.661
Permanent	1	–	–	–
Location				
Anterior	1.791	0.395	0.468	6.856
Posterior	1	–	–	–
Jaw				
Maxilla	0.755	0.504	0.331	1.723
Mandible	1	–	–	–

chairside aftercare, implant-borne FDPs could be recommended to be fixed by permanent cementation.

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