# Medium- and Long-Term Survival Rates of Implant-Supported Single and Partial Restorations at a Maximum Follow-up of 12 Years: A Retrospective Study

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***Purpose:*** To present medium- and long-term biologic outcomes of implant-supported single-tooth restorations and fixed partial dentures and to analyze their correlations with prosthesis and patient characteristics. ***Materials and Methods:*** The records of patients treated with implant-supported fixed restorations between 2004 and 2019 reporting the presence or absence of peri-implantitis and/or implant failure were analyzed. The cumulative survival rate (%) over time was calculated, as well as the cumulative prevalence of units free of peri-implantitis. ***Results:*** A total of 344 implants in 112 patients were included, with a mean follow-up period of 5.3 ± 4.0 years after loading. The cumulative survival rates for implants supporting single crowns and fixed partial dentures were 98.11% and 100% after 5 years, respectively, and 97.43% and 98.96% after 10 years, with an overall survival rate of 91.69% after 12 years. At the patient level, the implant survival rates were 95.42%, 92.73%, and 85.31% at 5, 10, and 12 years, respectively. The cumulative rate of implants free from peri-implantitis was 87.46% at the implant level and 72.39% at the patient level. Implant and prosthesis characteristics did not affect the long-term occurrence of implant failure or peri-implantitis. The development of peri-implantitis was statistically correlated with patient smoking habits, but not with history of periodontitis or with diabetes mellitus. ***Conclusion:*** Implants supporting single crowns and fixed partial dentures showed relatively high medium- and long-term survival rates that were not influenced by the implant or prosthesis characteristics, including the retention method. As for patient characteristics, only smoking was correlated with the occurrence of peri-implantitis. *Int J Prosthodont 2021;34:183–191. doi: 10.11607/ijp.6883*

Dental implants are widely used to support dental prostheses in order to provide a solution for partial and complete edentulism. It is well known that edentulism is correlated with a significant impairment in patients' quality of life (QoL) by limiting masticatory and phonetic functions and, in some cases, affecting esthetic appearance, with consequent effects on social life.[1–3] Moreover, complete edentulism has been found to be correlated with a higher risk for poor nutrition and typically presents concurrently with other diseases.[4,5] Patients' QoL could improve significantly even when resolving partial edentulism with a fixed implant-supported partial prosthesis.[1]

Fixed implant-supported prostheses can be used to replace one single tooth, several teeth (ie, fixed dental prostheses [FDPs]), or up to all the teeth in one arch (ie, full-arch

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implant-supported rehabilitations [FAISRs]). The application of FAISRs to treat complete edentulism was described by a number of well-designed longitudinal studies aiming at evaluating clinical outcomes with a medium- or long-term follow-up (5 years or more).[6–14] In such studies, the cumulative implant survival rate over a follow-up period of 10 to 20 years ranged from 96.11%[8] to 98.9%,[7] while the prosthesis cumulative survival rate varied from 97.1%[10] and 93% (for implant-supported overdentures[14]) to 100%[10,11] after at least a 5-year follow-up.

Implant-supported single-tooth restorations and FDPs can prevent the application of removable prostheses or they can allow the preservation of the healthy tooth structure of adjacent teeth, with favorable long-term outcomes. A review published in 2012 analyzed a maximum of 3,223 implant-supported single crowns after a follow-up period of 5 and 10 years and estimated implant survival and single-crown survival rates of 97.2% and 96.3%, respectively, after 5 years, and 95.2% and 89.4% after 10 years.[15] As for FDPs, an extensive review by Pjetursson et al[16] reported an estimated implant survival rate of 95.6% and 93.1% over a 5-year and a 10-year follow-up period, respectively. The estimated FDP survival rates were 95.4% and 80.1% at 5 and 10 years, respectively, while the success rate was 66.4% after 5 years.

With regard to retention methods, many studies have found that these parameters might not significantly affect medium- and long-term outcomes, also highlighting that the choice between screw-retained and cement-retained implant-supported prostheses often depends on technical feasibility.[17–19] Conversely, other studies found that cement-retained prostheses show a higher rate of biologic complications,[20] largely because the presence of excess cement has been reported to be an important risk factor for the development of inflammatory peri-implant diseases.[21]

Peri-implantitis is a pathologic condition of the peri-implant tissues characterized by inflammation of the peri-implant mucosa and progressive marginal bone loss.[22] Peri-implantitis was found to be correlated with the presence of plaque (namely poor oral hygiene)[22,23] and a history of periodontitis.[22,24,25] The effect of other risk factors (systemic diseases and conditions and smoking status) remains controversial.[22] The reported prevalence of peri-implantitis varies largely because of the different definitions of peri-implantitis adopted in published studies and the actual lack of cutoff points for the considered clinical and radiographic parameters.[26] However, data about the occurrence of peri-implantitis in single-tooth implants and FDPs are poor; hence, there is a need for studies addressing this topic.

The aim of the present retrospective study was to analyze the medium- and long-term survival rates of implants used for single-tooth replacement and FDPs, as well as the occurrence of peri-implantitis at the implant and patient levels. Their correlations with prosthesis and patient characteristics were also investigated.

## MATERIALS AND METHODS

The protocol for this retrospective study was approved by the Institutional Review Board of the IRCCS Istituto Ortopedico Galeazzi, Milan, Italy. Using only retrospective anonymized data, this study was a nonintervention clinical trial without the need for local review board approval according to the European guidelines for Good Clinical Practice (CPMP/ICH/135/95). All phases of the study were carried out in accordance with the principles of the Helsinki Declaration for Research on Human Subjects.[27] The manuscript was prepared according to the instructions included in the STROBE (Strengthening the Reporting of Observational studies in Epidemiology) guidelines for reporting observational studies.[28]

The clinical records of all subjects treated with implant-supported fixed restorations between January 1, 2004, and January 1, 2019, in the implantology department of the Dental Clinic of the IRCCS Istituto Ortopedico Galeazzi were screened for inclusion. The inclusion criteria were as follows: *(1)* subjects who were 18 years or older at the time of intervention; *(2)* subjects who provided their informed consent for the intervention and for the use of their data in an anonymous form for research purposes; and *(3)* subjects treated with single-tooth replacement or FDPs. Patients who received maxillary sinus floor augmentation or any type of vertical bone regeneration at the same time as implant placement were excluded. The surgical interventions were all performed by trained operators with more than 3 years of experience in implant dentistry.

### Outcomes

The primary outcome was the implant-level cumulative survival rate (CSR%) over time. The secondary outcomes included: *(1)* patient- and implant-level cumulative prevalence of peri-implantitis–free units; *(2)* estimation of how prosthesis characteristics could have influenced survival curves and the occurrence of peri-implantitis; and *(3)* estimation of how patient characteristics (eg, gender, age, smoking status, periodontal status, diabetes mellitus) could have influenced survival curves and the occurrence of peri-implantitis.

The definition of implant survival/failure was based on parameters applied by previous studies.[8,12,13,29,30] In particular, implant survival was based on whether the implant was still in situ, stable, and supporting a functional prosthesis, while implant failure identified an implant that was removed or spontaneously lost due to failed osseointegration.

The diagnosis of peri-implantitis was based on the following criteria proposed by Berglundh et al in 2018[31]:

*(1)* signs of inflammation of peri-implant tissues (bleeding and/or suppuration on gentle probing); *(2)* presence of radiographic bone loss beyond crestal bone level changes due to initial bone remodeling, or, in the absence of periapical radiographs 1 year after surgical intervention, presence of bone level located ≥ 3 mm apical to the most coronal portion of the intraosseous portion of the implant; and *(3)* presence of increased probing depth as compared to previous observations.

All periapical radiographs were taken with the paralleling technique and long spacer cone using phosphor-plate digital images (0.16 to 0.20 seconds of exposure, 65 kV, 4 mA). The quality of images was assessed by the selection criteria for dental radiography of the Faculty of General Dental Practice (UK). Two previously calibrated operators (A.A. and S.C.) independently evaluated periapical radiographs for assessing the presence of marginal bone loss.

### Statistical Methods

The statistical analysis was performed by one operator (S.C.) using a dedicated software (SPSS version 22, IBM).

The normality of the distribution of variables was tested using Shapiro-Wilk test.

With regard to descriptive statistics, for continuous variables, mean values and relative SDs and ranges were provided. For categorical variables, frequencies were calculated and reported.

Survival tables and Kaplan-Meier analysis curves were calculated for survival analysis, considering the occurrence of implant failure and the diagnosis of peri-implantitis as events. The time of such events or the time of the last visit were used as censoring time. Log rank, Breslow, and Tarone-Ware tests were applied to compare different types of restorations, the presence of multiple implants, maxillary vs mandibular restorations, and screwed vs cemented prostheses for Kaplan-Meier estimates. Cox regression analysis was used in order to evaluate the influence of covariates (periodontal status, smoking status, bone grafting) on survival curves.

For all analyses, the level of significance was set at $P < .05$.

## RESULTS

A total of 344 implants in 112 patients (mean of 3.1 implants per patient) were included in the evaluation. The mean age of the subjects was 57.3 ± 13.7 years (range: 21 to 80 years), and the mean follow-up period was 5.3 ± 4.0 years (range: 1.1 to 14.8 years). The clinical charts of 12 patients (28 implants) treated in the same period were not considered because they did not provide the information needed for the study (missing information about smoking status [n = 2]; missing periodontal chart or periodontal examination [n = 2]; missing information about implant characteristics [n = 8]). Among the included patients, 22.9% were smokers at the time of implant placement, 54.3% had a history of treated periodontitis, and 7% had a diagnosis of diabetes mellitus. Distribution of implant placement is shown in Fig 1. All implants had a moderately rough surface (Brånemark System Mk IV TiUnite and NobelSpeedy Groovy, Nobel Biocare).

The mean implant length was 10.8 ± 2.1 mm (range 6 to 15 mm); 28.8% of implants were 10 mm long, 28.2% of them were 13 mm long, and 10.2% were 8 mm long. Implant diameter ranged from 3.2 to 5.0 mm.

With regard to the type of restoration, 41.0% (n = 141) of implants supported single-tooth restorations. Among these, 27.0% (n = 38) were screwed restorations, and 73% (n = 103) were cemented. Twenty-six restorations were in the anterior area between the two canines (mandible [n = 8]), 38 were in the premolar area (mandible [n = 15]), and 77 were in the molar area (mandible [n = 57]). Among FDPs, 35.5% of implants (n = 72) supported screwed restorations, and 64.5% (n = 131) supported cemented ones. Twenty-seven implants supporting one FDP were placed in the anterior area (11 in the mandible), 71 in the premolar area (40 in mandible), and 105 in the molar area (51 in the mandible). At the implant level, the 5-year CSR% considering implant failure was 98.11% (95% CI: 97.13% to 99.09%; n = 166); 94.81% (95% CI: 89.60% to 100.2%) for single crowns and 100% for FDPs. The 10-year CSR% was 97.43% (95% CI: 96.24% to 98.62%; n = 76); 94.81% (95% CI: 89.60% to 100.2%) for single crowns and 98.96% (95% CI: 96.92% to 101.00%) for FDPs. The 12-year CSR% was 91.69% (95% CI: 85.03% to 98.35%; n = 43).

At the patient level, the 5-year CSR% for the same outcome was 95.42% (95% CI: 89.97% to 100.87%; n = 45), the 10-year CSR% was 92.73% (95% CI: 85.30% to 100.16%; n = 17), and the 12-year CSR% was 85.31% (95% CI: 69.79% to 100.83%; n = 11). Survival tables considering the occurrence of peri-implantitis as the event of examination at both the implant and patient levels are presented in Tables 1 and 2, respectively. Considering the Kaplan-Meier estimation, no differences between single-tooth restorations and FPDs were found for either outcome (implant failure or occurrence of peri-implantitis; Figs 2 and 3). Furthermore, no difference between screwed and cemented restorations were found for either outcome (Figs 4 and 5). Patient-level Kaplan-Meier curves for occurrence of peri-implantitis are presented in Fig 6. The implant-level prevalence of peri-implantitis was 2.3% and 8.3% after 5 and 10 years, respectively, and the patient-level prevalence of peri-implantitis was 3.0% and 14.3% after 5 and 10 years, respectively. Regarding single-tooth restorations, there was a small but significant difference between mandibular and maxillary restorations in terms of implant failure, favoring mandibular restorations ($P = .037$,

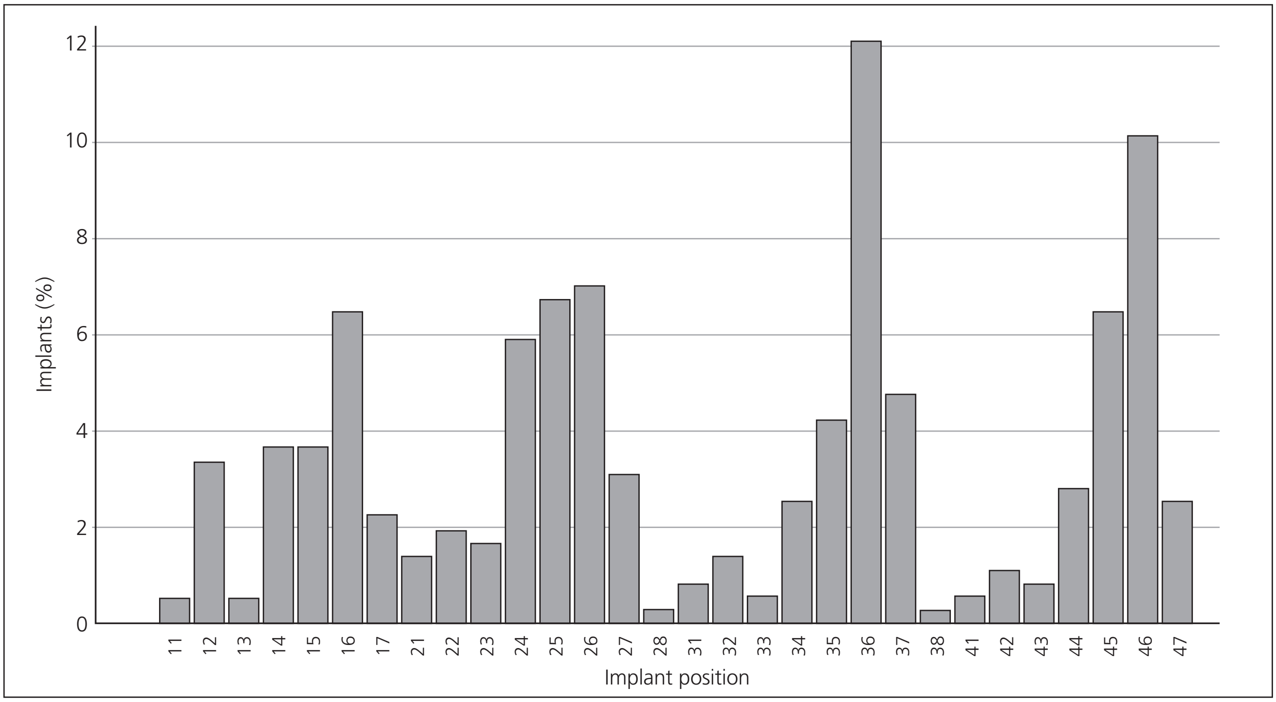


**Fig 1** Diagram showing implant distribution according to FDI tooth numbering system.

*P* = .043, *P* = .038 depending on the method used for calculation). No other differences were found between mandibular and maxillary restorations (see Appendices 1 to 4 in the online version of this article at www.quintpub.com/journals).

The regression analysis revealed that implant length, implant diameter, implant manufacturer and type, prosthesis type, number of implants, and fixation method did not affect the occurrence of implant failure or peri-implantitis over time. Performance of a bone grafting procedure showed no correlation with the occurrence of peri-implantitis (odds ratio [OR] = 1.926, 95% CI: 0.989 to 3.749, *P* = .054) but seemed to affect the occurrence of implant failure (OR = 6.206, 95% CI: 2.047 to 18.817, *P* = .001). At the patient level, it was found that smoking was correlated with the development of peri-implantitis (OR = 2.954, 95% CI: 1.228 to 7.104, *P* = .016), while history of periodontitis and diabetes mellitus appeared not to be statistically correlated.

## DISCUSSION

The present retrospective study found that the occurrence of peri-implantitis affected a relevant proportion of subjects and of implants over a medium- to long-term period (up to 12 years from prosthetic loading). Remarkably, no correlation was suggested between the type of prosthesis (single-tooth or FDPs) and the survival rate in relation to the occurrence of implant failures and development of peri-implantitis. In the same way, the fixation method of the prosthesis (screw-retained or cemented) did not appear to significantly affect the outcome of implant treatment. Finally, the regression analysis found that smoking was independently correlated with the development of peri-implantitis, determining an increase in risk of approximately 3 times.

The generalizability of the present results should be carefully considered after the evaluation of the limitations that are listed below and discussed. First, the retrospective nature of the study has intrinsic and obvious limitations in evaluating comparative results between types of prostheses and fixation methods; prospective randomized controlled clinical trials are, in fact, the ideal studies to comparatively evaluate one treatment vs another. Furthermore, an observational investigation could be biased by the effect of uncontrolled confounding factors; ie, associations could be suggested (eg, smoking and peri-implantitis) that do not necessarily have a causal relationship.[33] The heterogeneity of the cohort that was under investigation must be taken into account while evaluating the effect of confounding factors that were uncontrolled, such as other systemic conditions, frequency of recall visits, and level of oral hygiene. Furthermore, this point could have influenced the survival analysis, since the time points were not uniform. However, it can be assumed that the characteristics of the sample could be representative of the general population, since it was decided to include a wide range of subjects and similar inclusion/exclusion criteria as adopted by other studies were followed.[8,12,34] Moreover, the sample of implants

**Table 1** Implant-Level Life Table Analysis

| | | | | | 95% CI | |
|---|---|---|---|---|---|---|
| Interval (y) | Implants | Censored | Events[a] | CSR% | Lower | Upper |
| 0–1 | 344 | 39 | 0 | 100.00 | 100.00 | 100.00 |
| 1–2 | 305 | 44 | 1 | 99.65 | 98.96 | 100.34 |
| 2–3 | 260 | 66 | 1 | 99.21 | 98.11 | 100.31 |
| 3–4 | 193 | 28 | 0 | 99.21 | 98.11 | 100.31 |
| 4–5 | 165 | 11 | 5 | 96.10 | 93.22 | 98.98 |
| 5–6 | 149 | 21 | 0 | 96.10 | 93.22 | 98.98 |
| 6–7 | 128 | 22 | 0 | 96.10 | 93.22 | 98.98 |
| 7–8 | 106 | 9 | 2 | 94.20 | 90.36 | 98.04 |
| 8–9 | 95 | 23 | 2 | 91.95 | 87.09 | 96.81 |
| 9–10 | 70 | 17 | 3 | 87.46 | 80.68 | 94.24 |
| 10–11 | 50 | 5 | 4 | 80.10 | 70.81 | 89.39 |
| 11–12 | 41 | 15 | 0 | 80.10 | 70.81 | 89.39 |
| 12–13 | 26 | 22 | 4 | 58.74 | 39.57 | 77.91 |

CSR% = cumulative survival rate %. [a]Occurrence of peri-implantitis.

**Table 2** Patient-Level Life Table Analysis

| | | | | | 95% CI | |
|---|---|---|---|---|---|---|
| Interval (y) | Patients | Censored | Events[a] | CSR% | Lower | Upper |
| 0–1 | 112 | 22 | 0 | 100.00 | 100.00 | 100.00 |
| 1–2 | 90 | 21 | 1 | 98.70 | 96.25 | 101.15 |
| 2–3 | 68 | 15 | 1 | 97.11 | 93.13 | 101.09 |
| 3–4 | 52 | 8 | 0 | 97.11 | 93.13 | 101.09 |
| 4–5 | 44 | 7 | 0 | 97.11 | 93.13 | 101.09 |
| 5–6 | 37 | 4 | 0 | 97.11 | 93.13 | 101.09 |
| 6–7 | 33 | 5 | 0 | 97.11 | 93.13 | 101.09 |
| 7–8 | 28 | 3 | 0 | 97.11 | 93.13 | 101.09 |
| 8–9 | 25 | 5 | 2 | 88.48 | 76.50 | 100.46 |
| 9–10 | 18 | 3 | 3 | 72.39 | 53.22 | 91.56 |
| 10–11 | 12 | 1 | 1 | 66.10 | 45.01 | 87.19 |
| 11–12 | 10 | 5 | 0 | 66.10 | 45.01 | 87.19 |
| 12–13 | 5 | 4 | 1 | 44.06 | 6.09 | 82.03 |

CSR% = cumulative survival rate %. [a]Occurrence of peri-implantitis..

examined were similar (all with moderately rough surfaces), but not identical. Furthermore, no evaluation was made of how the operators' experience could have influenced the outcomes of the treatment, but it can be considered that their experience was substantially homogenous. It should be noted that the data were collected from patients treated within a highly qualified environment and by clinicians with at least 3 years of experience in implant surgery. As such, generalizability of the results in a less qualified environment should be taken with caution. Finally, the limited sample size (18 patients and 70 implants at the 10-year follow-up) available for analysis in longer follow-up periods should be considered a significant limitation that prevents robust conclusions from being made for such follow-ups.

The results of the present study agree with the existing scientific literature exploring similar outcomes.

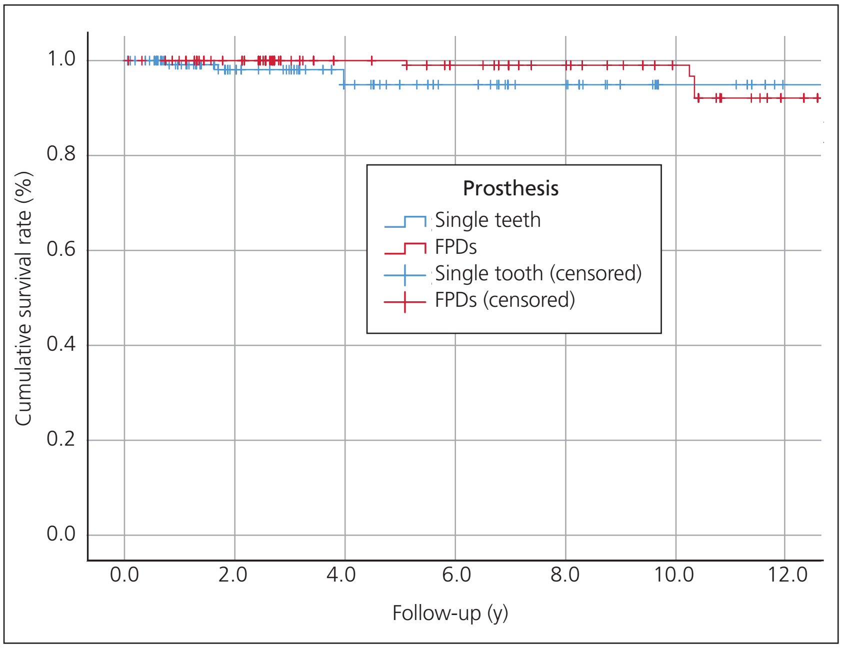


**Fig 2** Kaplan-Meier survival analysis (implant level) for single-tooth restorations and fixed partial dentures (FPDs).

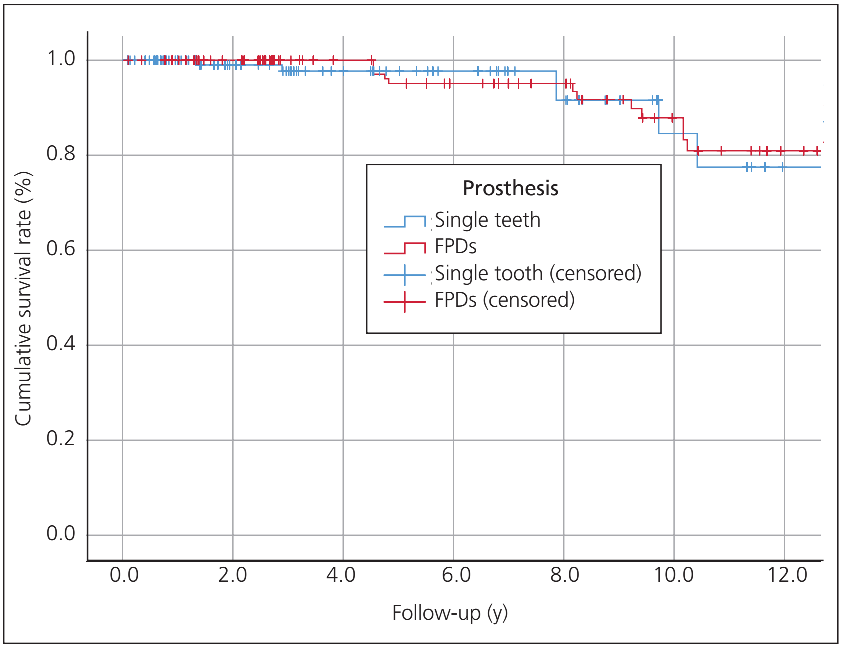


**Fig 3** Kaplan-Meier analysis of implant-level occurrence of peri-implantitis for single-tooth restorations and FPDs.

Implant survival is described as the presence of an implant in function and without specific symptoms. The CSR% of implants in both single-tooth restorations and FDPs was very close to the CSR% that was reported in a previous research paper by the same authors[8] with a protocol very similar to the one used in the present study. The authors examined a cohort of 77 subjects treated with FAISRs and followed up for a mean of 8.0 years. The reported CSR% after 10 years was 96.11%, which is in line with what was found in the present study. Jung et al published a systematic review of the literature on single-tooth restorations with a mean follow-up of 5 years.[15] They included a total of 46 papers, mainly reporting retrospective studies with substantial heterogeneity in terms of implants used, population characteristics, and type of prosthetic restoration. The 5-year implant CSR% was 97.2% (result of the meta-analysis on 14,715 implants), which dropped slightly to 95.2% after 10 years. Such results were substantially comparable to what was found in the cohort examined in the present study.

Another systematic review of the literature and meta-analysis explored the outcomes of FDPs over a follow-up period of at least 5 years.[16] The authors found that the implant CSR% was 95.6% and 93.1% at 5 years and 10 years, respectively. The aforementioned results (derived from one meta-analysis) were substantially different from the present outcomes. Interestingly, when Pjetursson et al[16] considered only studies about rough/moderately rough implants in their review, the results appeared more similar, thus supporting the evidence that implant surface could affect the implant CSR% over time. It should be highlighted that the success rate of implant restorations was not evaluated in the present study and is instead represented by the survival of the implant in conjunction with optimal hard and soft tissue integration of the prosthetic rehabilitation.[35,36] For this reason, the study reported only partial data about ISR reliability over time, reporting just the occurrence of implant failure and of peri-implantitis.

In the present study, a diagnostic pattern for peri-implantitis was adopted that was in accordance with a recently published consensus statement on the same topic.[31] Peri-implantitis appeared to be a highly prevalent disease in the examined cohort, with 87.46% (95% CI: 80.68% to 94.24%) of implants and 72.39% (95% CI: 53.22% to 91.56%) of subjects not affected at the 10-year follow-up (cumulative data). A substantial decrease in CSR% was observed between the 9- and 10-year follow-up periods, but the limited sample size did not allow for further speculation on this difference. These outcomes were comparable to the study published by the present author group in 2019; the difference concerning patient-level data was due to the fact that the patient/implant ratio was lower in the present study compared to the previously published study about FAISRs on four implants ("all-on-four").[8] If the data are read in light of the existing literature, no substantial differences from what is reported in other studies with similar follow-up periods are found.[26,37–39] Moreover, the comparison of implant-level and patient-level outcomes did not reveal any significant issue, since failures and peri-implantitis appeared evenly distributed among the participants.

Remarkably and unexpectedly, no correlation between periodontal status and the occurrence of peri-implantitis was found in the present study. This finding seems in disagreement with what is reported in the scientific literature,[40,41] but is coherent with what was found by the present authors' research group.[8] Considering that the validity of such a result could be affected by the limitations of the study, it can be hypothesized that an accurate and complete periodontal treatment protocol before implant placement and the presence of a supportive periodontal regime could have limited the effect of periodontal status on implant-related adverse events. Moreover, it should be considered that it was not possible to precisely determine the severity and extension of periodontitis because of the potential heterogeneity in diagnostic parameters and in classification schemes adopted. In fact, this assumption appears to find partial support from the systematic review published by Ferreira et al in 2018 reporting that the association between periodontitis and peri-implantitis was not found in cohort retrospective investigations.[42]

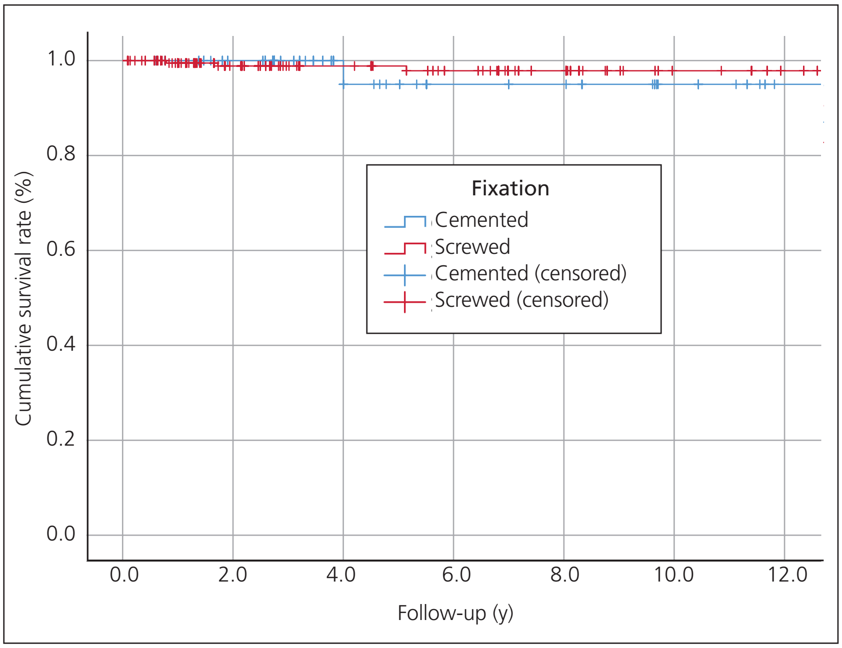


**Fig 4** Kaplan-Meier survival analysis (implant level) for screw- and cement-retained prostheses.

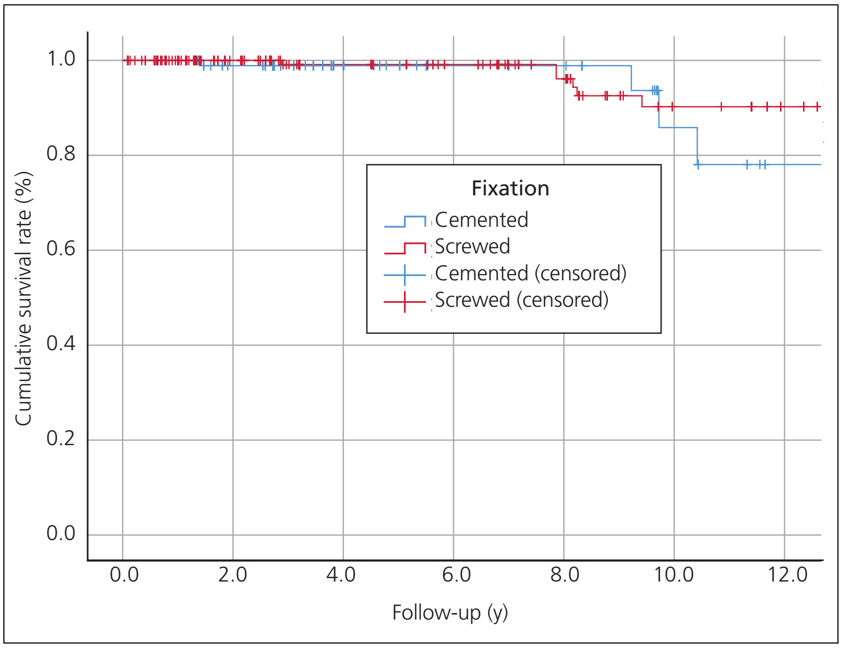


**Fig 5** Kaplan-Meier analysis of implant-level occurrence of peri-implantitis for screw- and cement-retained prostheses.

The present analysis revealed a positive correlation between smoking and the development of peri-implantitis. The effect of smoking on peri-implant disease is still controversial.[22,38] The difficulties in determining the exact number of cigarettes (ie, exposure) in retrospective investigations based strictly on patient-reported information should be considered, and thus, the external validity of the correlation found should be considered with caution.

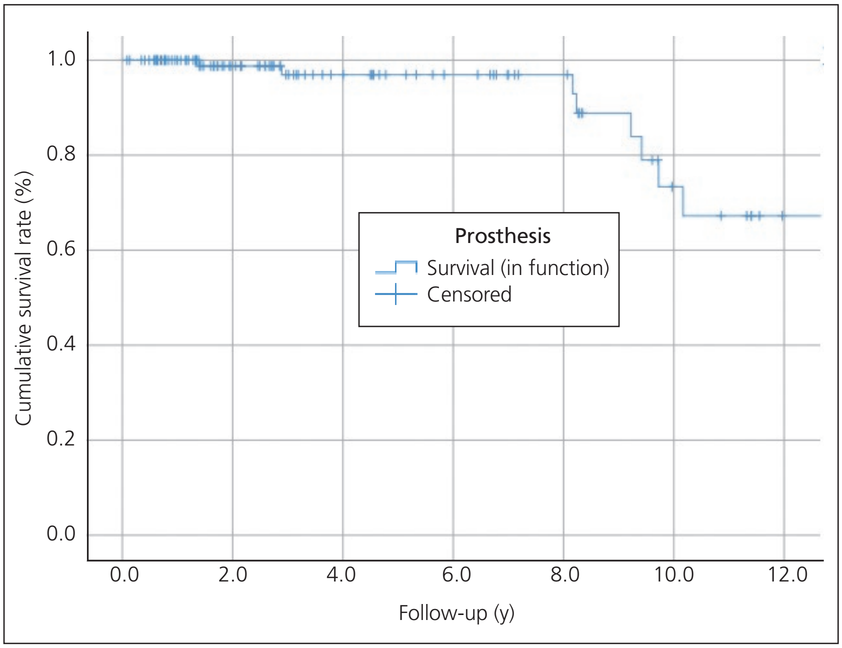


**Fig 6** Kaplan-Meier analysis of patient-level occurrence of peri-implantitis.

The present analysis suggested a correlation between bone grafting procedures and the occurrence of implant failure, but this finding seems to disagree with previous studies.[43–45] It can be hypothesized that such a correlation could be the result of the effect of inadequate bone volume at the time of placement instead of the grafting procedure itself, as it was demonstrated that inadequate bone volume could be one cause of implant failure.[46] However, the heterogeneity of the bone grafting procedures performed and the lack of information about the size (height, width) of bone defects (when present) should lead such a result to be considered with caution.

The present study allowed the comparison of clinical outcomes of single-tooth restorations and FDPs in relation to the method of fixation (screwed or cement-retained). The analysis performed did not find any correlation between fixation method and survival or peri-implantitis prevalence. Although the effect of potential limitations in this study design should be considered, this result is in line with a number of studies that found no difference in clinical outcomes between cemented and screw-retained restorations.[20,47,48] On the contrary, other authors found overall superior results for cement-retained prostheses mainly because they are described to be less prone to technical complications than screwed ones.[49] However, as highlighted in other papers, the accurate removal of cement appears to be crucial since it was correlated with the development of peri-implant inflammatory diseases.[50]

## CONCLUSIONS

Considering the limitations described, it can be concluded that: *(1)* single-tooth restorations and FDPs demonstrated relatively high survival rates at up to 12 years from prosthetic loading without any significant difference between the two prosthesis types; *(2)* the survival analysis revealed a rate of implants/patients affected by peri-implantitis that is substantially coherent with the data available in the scientific literature, with this rate being 87.46% (95% CI: 80.68% to 94.24%) at the implant level and 72.39% (95% CI: 53.22% to 91.56%) at the patient level after 10 years; *(3)* smoking, but not history of periodontitis, was correlated with the occurrence of peri-implantitis; and *(4)* no differences in clinical outcomes between screw-retained and cemented restorations were suggested.

More long-term prospective studies with a larger cohort of patients/implants are advised for better understanding of the differences between treatment types and prosthetic restorations, while long-term retrospective investigations should be considered valid for investigating the prevalence of peri-implant diseases over time. Future studies should also take into account the impact of different implant-related (eg, implant surface, malposition) and patient-related factors (eg, medications, oral hygiene) on the examined outcomes.

## ACKNOWLEDGMENTS

The authors report no conflicts of interest.

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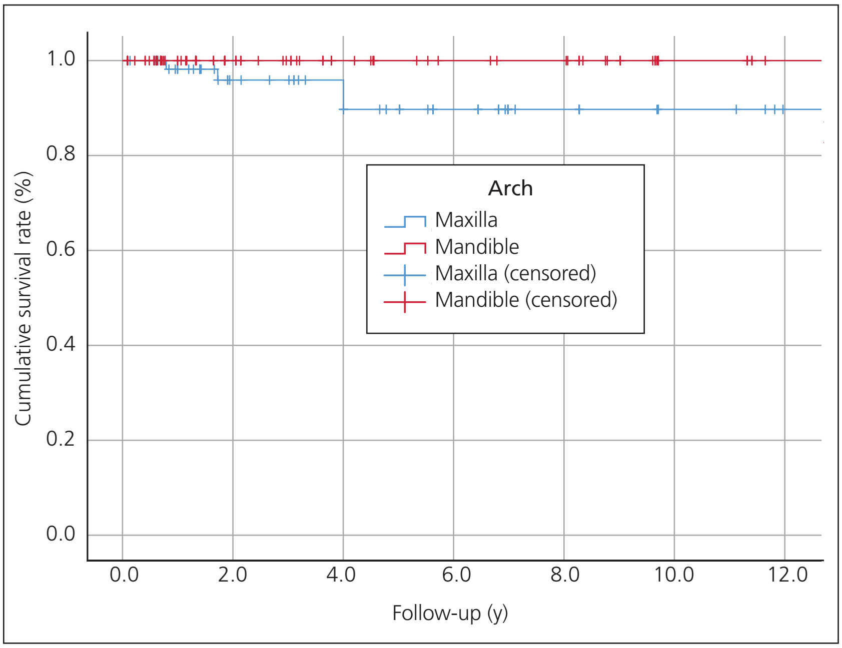
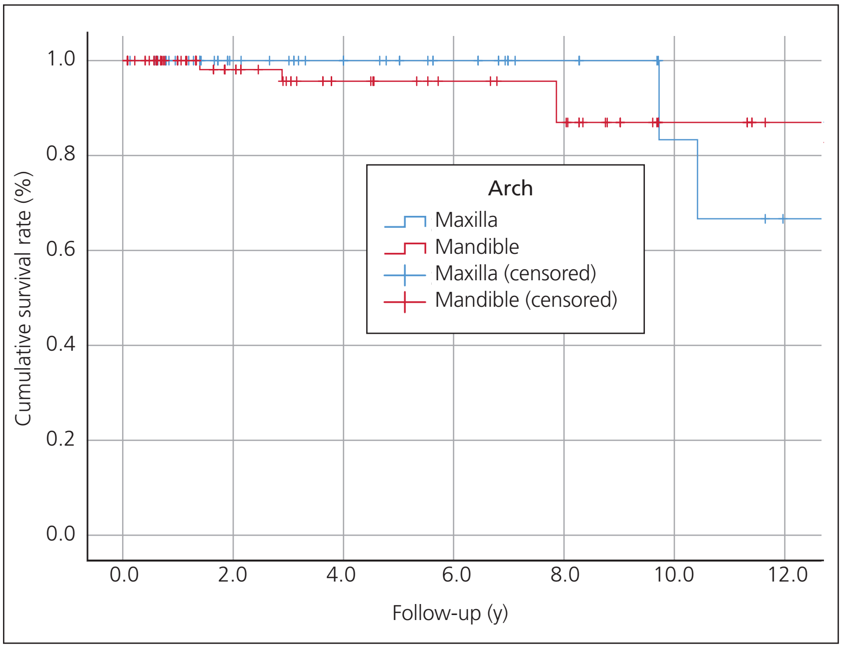
## APPENDIX 1



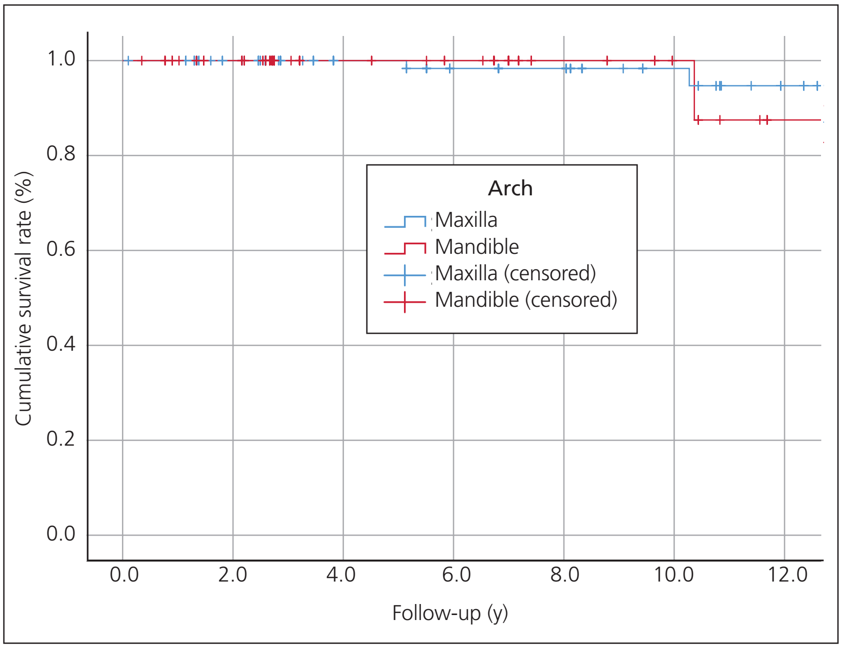

**Appendix 1** Kaplan-Meier survival analysis (implant level) for single-tooth restorations comparing maxillary and mandibular restorations.

## APPENDIX 2



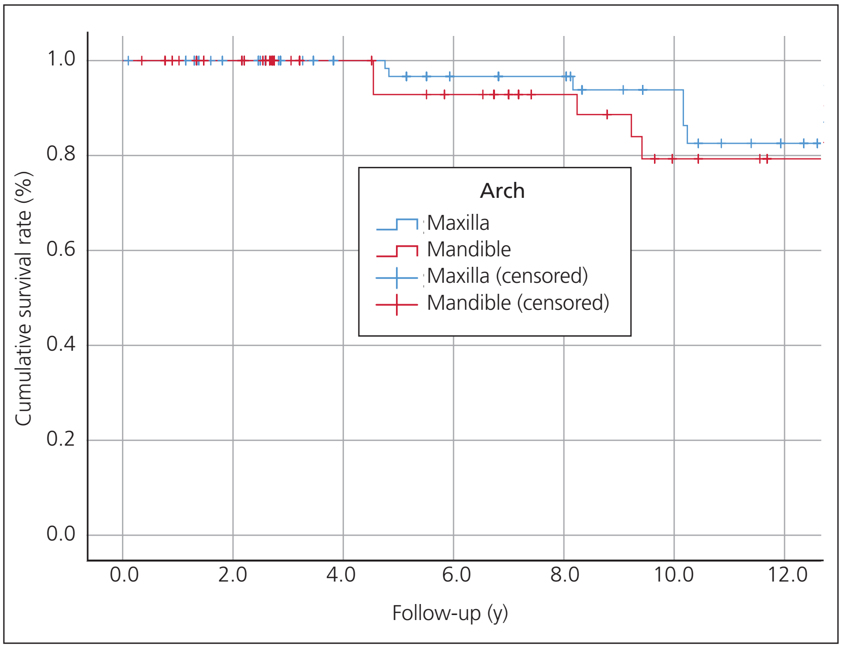

**Appendix 2** Kaplan-Meier analysis of implant-level occurrence of peri-implantitis for single tooth-restorations comparing maxillary and mandibular restorations.

## APPENDIX 3




**Appendix 3** Kaplan-Meier survival analysis (implant level) for fixed partial dentures (FDPs) comparing maxillary and mandibular restorations.

## APPENDIX 4




**Appendix 4** Kaplan-Meier analysis of implant-level occurrence of peri-implantitis for FDPs comparing maxillary and mandibular restorations.