Ten years follow-up retrospective study on implant survival rates and prevalence of peri-implantitis in implant-supported full-arch rehabilitations

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Abstract

Objectives: The aim of the present paper was to present medium- and long-term data on implant survival and on the prevalence of peri-implantitis in a cohort of patients treated with full-arch rehabilitations.

Materials and methods: Clinical records of all patients treated with immediately loaded full-arch rehabilitation in the Dental Clinic of the IRCCS Istituto Ortopedico Galeazzi in Milan, Italy, supported by moderately rough implants were retrospec- tively examined to calculate survival curves for implant loss and for the occurrence of peri-implantitis (both at implant- and at patient level). Regression methods were used to evaluate the correlation between the presence of periodontitis and smoking habits with the outcomes.

Results: A total of 384 implants placed in 77 patients (96 rehabilitations) were evalu- ated for a mean period of 8.0 years (range 1.0–13.7 years) from loading. After 10 years, the cumulative survival rate was 96.11% (95% CI: 99.17%–93.05%; 84 im- plants) while the cumulative rate of implants free from peri-implantitis was 86.92% (95% CI: 82.14%, 91.71%; 60.69% [95% CI: 44.19%, 77.19%] at patient level). The cumulative proportion of implants without peri-implantitis after 10 years was signifi- cantly higher in mandible (89.76%, 95% CI: 84.49%, 95.03%) than in maxilla (81.71%, 95% CI: 71.91%, 91.51%; $p = 0.028$). No correlation was found between periodontal and smoking status and outcomes.

Conclusions: The study reported high 10-year implant survival rate for full-arch reha- bilitations since implant loss was relatively rare. Peri-implantitis was relatively fre- quent in the examined population although the number of subjects available for 10-year evaluation was limited.

KEYWORDS

dental implants, dental prosthesis, peri-implantitis, retrospective study

1 | INTRODUCTION

Since Brånemark described for first the osseointegration process in the 1960s (Branemark et al., 1969), the use of titanium implants to support dental prosthesis in edentulous sites has been widely

described and validated by a number of evidence−based scientific papers. In particular, several longitudinal studies, with a follow−up of 5 years or more, investigated the outcomes of the treatment of completely edentulous patients by the use of full−arch implant− supported rehabilitations (FAISRs; Attard & Zarb, 2004; Ekelund, Lindquist, Carlsson, & Jemt, 2003; Jemt, 2017a, 2017b; Jemt & Stenport, 2011; Jemt, Stenport, & Friberg, 2011; Lindquist, Carlsson, & Jemt, 1996; Papaspyridakos et al., 2018; Papaspyridakos, Mokti et al., 2014; Rohlin et al., 2012). Some of the studies with longer follow−up referred to subjects treated with turned/machined im− plants that demonstrated a cumulative survival rate of more than 90% in mandibles and more than 80% in maxilla, with a follow−up of 5 years or more (Albrektsson, Zarb, Worthington, & Eriksson, 1986; Jimbo & Albrektsson, 2015; Lindquist, Carlsson, & Jemt, 1997). One recently published long−term retrospective study on machined im− plants reported a cumulative survival rate % (CSR%) of 88.3% for implants with turned design after more than 20 years of follow−up (Chrcanovic, Kisch, Albrektsson, & Wennerberg, 2018). Moreover, Papaspyridakos et al. (2018) reported a CSR% of 98.7% on 457 moderately rough implants supporting full−arch rehabilitations after a mean period of 5.2 years from loading (range 1–12 years; Papaspyridakos et al., 2018). Implants with rough surfaces, that are manufactured through several industrial procedures, were proposed more recently than machined ones and were described to be more capable to establish a long−standing osseointegration, with favorable clinical outcomes (De Bruyn et al., 2017). Indeed, implant surface treatments (roughness) were described to favor the host reaction during peri−implant bone remodeling (Coelho et al., 2010), to affect collagen fiber orientation during the healing phase (Schroeder, van der Zypen, Stich, & Sutter, 1981) and to increase the wettability of the surface itself by blood and biological fluids (Gittens et al., 2014; Rupp et al., 2014). The surface roughness could improve clinical per− formances in more demanding conditions such as poor bone density, immediate implant placement, and immediate prosthetic loading (De Bruyn et al., 2017). In one recent systematic review of the literature, Doornewaard et al. (2017) evaluated long−term effects of surface characteristics on crestal bone loss. The results, retrieved from 87 clinical reports, found, after 5 years or more from loading, an implant survival rate of 97.3% for the total material and 98.4% for implants with moderately rough surface that showed the best performances (Doornewaard et al., 2017).

Peri−implantitis has to be considered the main biological cause of implant failure, leading to progressive bone resorption around den− tal implants, and, in the end, to mobility or to the need for implant removal (Heitz−Mayfield, Needleman, Salvi, & Pjetursson, 2014). The prevalence of peri−implantitis, even considering the heterogeneity due to the definitions of the disease, was relatively high in the popu− lation ranging from 1% to 47% as reported by one systematic review by Derks and Tomasi (2015) and from 1.1% to 85% (implant level) as found in one recent review (Dreyer et al., 2018). The same authors revealed an adjusted prevalence of peri−implantitis of 38.4% after 10 years from loading (Dreyer et al., 2018). From the epidemiological point of view, inadequate plaque control and history of periodontitis are recognized as risk factors for peri−implantitis, while the scientific evidence regarding diabetes and smoking is still inconclusive and controversial (Schwarz, Derks, Monje, & Wang, 2018).

The aim of the present paper was to present retrospective data on implant survival and on the prevalence of peri−implantitis in a cohort of patients treated with FAISR supported by moderately rough implants.

2 | MATERIAL AND METHODS

The protocol of the study was approved before the beginning of the selection process by the Institutional Review Board of the IRCCS Istituto Ortopedico Galeazzi in Milan, Italy, in 2018. All the phases of the study were performed in accordance to the Declaration of Helsinki (World Medical, 2013).

The clinical records of all subjects treated with FAISRs between January 1, 2004, and December 31, 2017 in the Dental Clinic of the IRCCS Istituto Ortopedico Galeazzi in Milan, Italy, were screened. To be included, records

must belong to: (a) patients who are 18 years old or older at the time of intervention; (b) patients who received a maxillary or mandibular FAISR supported by a combination of two tilted and two upright rough or moderately rough dental implants, either immediately after extraction or in healed bone; (c) patients who received a provisional prosthesis within 48 hr from surgical in− tervention; (d) patients who gave their written informed consent for using their clinical records for research purposes; and (e) patients with complete clinical and radiographic records, with at least one radiograph per year for each implant.

2.1 | Outcomes

The primary outcome was to evaluate the implant level cumulative implant survival rate % (CSR%) for the examined cohort. The sec− ondary outcomes were as follows: (a) implant level cumulative preva− lence of peri−implantitis; (b) patient level cumulative prevalence of peri−implantitis; and (c) 5−year prevalence of peri−implantitis (implant level and patient level).

The following parameters were recorded: (a) gender; (b) age at the time of surgery; (c) location of the FAISR (maxilla or mandible); (d) date of surgery; (e) date of prosthesis placement; (f) date of the last visit; (g) date of diagnosis of peri−implantitis; (h) date of implant loss/ removal; (i) smoking status (non−smoker, former smoker, smoker); and (j) history of periodontitis (diagnosis of periodontitis before im− plant placement).

Implant survival was defined as implant in situ, stable, supporting a functional prosthesis (Heitz−Mayfield et al., 2014; Papaspyridakos et al., 2018; Papaspyridakos, Chen, Chuang, & Weber, 2014; Papaspyridakos, Mokti et al., 2014). An implant was considered failed when it was extracted by one operator due to loss of osse− ointegration or when it was spontaneously lost (Heitz−Mayfield et al., 2014; Papaspyridakos et al., 2018).

The criteria to define the presence of peri−implantitis were the evidence of bleeding/suppuration (signs of inflammatory reaction) and a concomitant bone resorption process of 2 mm or more, evaluated comparing the baseline and follow−up radio− graphs (Heitz−Mayfield et al., 2014; Papaspyridakos et al., 2018). Probing depth > 5 mm was not used in our study as criteria for defining peri−implantitis since this parameter was not available for all implants because the prosthesis was not removed in any visit to allow such measurement.

2.2 | Statistical analysis

Descriptive statistics was provided by means of mean values and standard deviations for continuous variables. Frequencies of cat− egorical values were reported as percentages.

The statistical analysis was performed by one operator (SC) using a dedicated software (IBM SPSS Statistics version 22, IBM, Armonk, NY, USA). Survival analysis was performed using life tables in order to calculate 10−year CSR% and Kaplan–Meier analysis to compare maxillary and mandibular restorations, using implant loss and diag− nosis of peri−implantitis as events. The time of event or the time of the last follow−up visits for implants/subjects free of events were considered as time for censoring in life tables and for Kaplan–Meier analysis. Log−rank method served to evaluate if differences between mandibular and maxillary restorations existed for Kaplan–Meier es− timates. Both implant and patient were used as the unit of analysis. Cox Regression analysis served to estimate the effects of covariates (smoking status, periodontal status) on survival curves. The CSR% was calculated with 95% confidence interval which was computed from the standard errors.

The level of significance was set $p = 0.05$.

The guidelines for strengthening the reporting of observational study in epidemiology (STROBE; Gallo et al., 2011) were followed.

3 | RESULTS

Data from the clinical records of a total of 96 FAISRs each supported by four implants in 77 patients (58.4% females and 41.6% males, mean age 68.2 ± 12.5 years), accounting for a total of 384 dental implants, were included. Nineteen patients (24.7%) were smokers (7.4 cigarettes a day on average, range 2–15), while 31 (40.3%) had an history of periodontitis. The follow−up time was up to 13.7 years (mean 8.0 years, range 1.0–

13.7 years) from placement of the provi‒ sional restoration. With regard to the location, 52.1% of the FAISR were placed in mandible and 47.9% in maxilla. All implants were at least 11.5 mm‒long with moderately rough surface and external con‒ nection (Brånemark System Mk IV TiUnite®, NobelSpeedy Groovy®, Nobel Biocare AB, Zurich, Switzerland). The CSR% was 96.11% (95% CI: 93.05%, 99.17%) after 10 years (84 implants; Table 1). The cumu‒ lative proportion of implants free from peri‒implantitis was 86.92% (95% CI: 82.14%, 91.71%; 60.69 [95% CI: 44.19%, 77.19%] at pa‒ tient level; Tables 2 and 3). Figures 1 and 2 show the survival analysis comparing implant survival in mandibular and maxillary restorations, respectively, patient‒based and implant‒based, showing no differ‒ ences between the two jaws. Figures 3 and 4 show the survival analysis comparing implants free from peri‒implantitis in mandibu‒ lar and maxillary restorations, respectively, patient‒based and im‒ plant‒based, showing a statistically significant difference between the maxillary and mandibular restorations for implant level outcome. After 5 years, the prevalence of peri‒implantitis was 4.6% implant level and 12.7% patient level; most of implants affected were in mandibular restorations (61.5%) and 46.1% were tilted implants. Neither smoking status (HR=0.704; 95% CI: 0.078, 6.380, $p = 0.755$) nor periodontitis (HR=2.170; 95% CI: 0.358, 13.141, $p = 0.399$) re‒ sulted to be significant risk factors for implant loss; moreover, none (Smoking HR=0.501; 95% CI: 0.146, 1.722, $p = 0.272$; Periodontitis HR=1.214; 95% CI: 0.497, 2.966, $p = 0.671$) of them could resulted to be a significant risk factor for peri‒implantitis (Table 4).

4 | DISCUSSION

The present retrospective study demonstrated that the CSR% of implants supporting full‒arch rehabilitations was approximately 96% after 10 years from prosthetic loading, since implant failure could be considered a relatively rare occurrence. However, data on oc‒ currence of peri‒implant infectious disease (described by survival analysis) showed that, after 10 years of prosthetic loading, 86.92% (95% CI: 82.14%, 91.71%) of implants and 60.69% (95% CI: 44.19%, 77.19%) of patients were free from peri‒implantitis. Data about longer follow‒up outcomes have to be considered less reliable since they were based on a low number of subjects.

The validity of the results should be weighted after consider‒ ing the limitations of the study. Firstly, the retrospective design of the study and the limited sample size could have influenced the level of quality of data. In fact, 10‒year data were based on a

small proportion of patient, and the outcomes showed a wide con‒ fidence interval range; these aspects limited the external validity of the results referred to 10‒year timeframe. Then, in the present paper we decided to evaluate a cohort of patients treated with im‒ mediately loaded FAISRs, and thus, the results could not be gener‒ alized to other types of implant‒supported restorations. Moreover, we presented no data about the effect of plaque accumulation, and of hygienic parameters in general on the explored outcomes. In addition, we presented no data about the regularity of atten‒ dance to the recall program and about the influence of the pres‒ ence of systemic diseases and parafunctional habits (e.g., bruxism) on the evaluated outcomes. The main strengths of the present study include the homogeneity of the restorations considered (FAISRs), the long‒term follow‒up, and the possibility to have data about periodontal status before implant placement for most of the subjects included.

In the present study, we used time‒to‒event analysis, both at implant and patient level, to evaluate the proportion of implants survived and the proportion of implants free from peri‒implantitis. One recent paper published by Chrcanovic et al. (2018) reported the results of their retrospective investigation on 1,045 machined implants (227 patients) followed for more than 20 years. The CSR% after 10 years from loading was 89.8% and most of the failures oc‒ curred in the first 1–2 years. We can observe that the results were

lower than those observed in the present study and the difference could be due to the surface characteristics of the implants used, and this observation was corroborated by scientific evidence (De Bruyn et al., 2017). Another retrospective study on 457 moderately rough dental implants supporting 71 FAISRs placed in 52 patients explored the cumulative survival rate over a period of 12 years from loading (Papaspyridakos et al., 2018). The authors reported a CSR% of 95.93% after 9 years and 83.14% after 10 years reporting that one third of the total failures (2 out of 6) occurred between 9 and 10 years. Such results appeared coherent with those obtained by our group (96.11% [95% CI: 93.05%, 99.17%] after 10 years), prob‒ ably because of the similarities between treatment protocol. If we compare the results of the study with those presented in one sys‒ tematic review of the literature published in 2014 (Papaspyridakos, Mokti et al., 2014), we found that the two studies included with

10−year follow−up showed a CSR% that ranged from 96.7% in 17 patients (Ortorp & Jemt, 2012) to 99.5% in 42 patients (Rasmusson, Roos, & Bystedt, 2005). The results were comparable with those presented in our investigation.

One recently published consensus statement suggested to make a diagnosis of peri−implantitis in presence of bleeding and/ or suppuration on gentle probing, in presence of increased prob− ing depth as compared to previous examinations and when eval− uating the presence of bone loss beyond crestal bone changes resulting from initial bone remodeling (Berglundh et al., 2018). In the present study, we considered the presence of peri−implantitis when we detected evidence of bleeding/suppuration (evidence of inflammatory reaction) and a concomitant bone resorption process of 2 mm or more, as it was done in other similar stud− ies (Heitz−Mayfield et al., 2014; Papaspyridakos et al., 2018). The present study reported the data about peri−implantitis both im− plant−based and patient−based following the recommendation of the paper published by Sanz, Chapple, and Working Group 4 of the (2012).

One systematic review of the literature published in 2018 by Dreyer and coworkers included 57 studies that provided epide− miological data about the prevalence of peri−implantitis (Dreyer et al., 2018). At implant level, the prevalence was reported to be extremely variable. Considering only studies with 10 years of fol− low−up, the reviewers found a prevalence of 16% in one study on 96 subjects (10.9 years of follow−up; Daubert, Weinstein, Bordin, Leroux, & Flemming, 2015), of 4.0% in 100 subjects from a private practice (10 years; Cecchinato, Parpaiola, & Lindhe, 2014), and of 38.4% in 103 subjects (more than 10 years; Marrone, Lasserre, Bercy, & Brecx, 2013). The heterogeneity among the studies lim− its the possibility to compare the results from the present study with those reported in the systematic review. One previously published systematic review of the literature found a prevalence of peri−implantitis of 9.6% at the implant level and of 18.8% at patient level (Atieh, Alsabeeha, Faggion, & Duncan, 2013). One study on a large cohort of subjects (2,277 implants in 588 pa− tients) reported data on prevalence of severe peri−implantitis (de− fined with the same parameters used here; Derks et al., 2016). The authors found, at the 9−year examination, an implant level prevalence of peri− implantitis of 8.0%. The results were compa− rable to those found in the present study, considering that we evaluated a cohort of subjects treated with four implants; this can have increased the patient level prevalence as compared to studies about subjects treated with less implants. The relatively high rate of implants affected by peri−implantitis (subject−level) was due also to the fact that each subject received four implants, thus causing an increased subject−level prevalence; indeed, such proportion is strictly related to the mean number of implants placed per subject.

With regard to factors affecting the outcomes we explored, in− terestingly, we found no significant correlation between smoking and periodontal status on implant loss and on the occurrence of peri−implantitis. These results appeared in disagreement to those presented in previously published systematic review of the litera− ture (Sgolastra, Petrucci, Severino, Gatto, & Monaco, 2015a, 2015b; Sousa et al., 2016). As for periodontitis, our results were comparable to those presented in some papers included in the review published by Sgolastra on implant loss (Sgolastra, Petrucci, Severino, Gatto, & Monaco, 2015a) but different from the study that accounted for the majority of cases considered in the meta−analysis (Levin, Ofec, Grossmann, & Anner, 2011). In literature, smoking was correlated to higher rates of implant loss and higher prevalence of peri−implantitis in few studies but literature failed to demonstrate that smoking is a risk factor for peri−implantitis (Dreyer et al., 2018; Schwarz et al., 2018). In our investigation, we did not find a statistical correlation between smoking and implant loss/peri−implantitis; we can hypoth− esize that the difficulties in evaluating retrospectively the number of cigarettes realistically smoked by the patients during the entire period of the investigation could have limited the possibility to ex− plore such link. Moreover, in the present study, no data about the cleanability of the prosthesis (that was related also to the character− istics of the prosthesis itself; Abi Nader et al., 2015) were presented even though insufficient oral hygiene should be considered a risk factor for peri−implantitis (Schwarz et al., 2018). Finally, other factors related to surgical procedure (immediate implants, grafting proce− dures, bone stiffness) were not statistically evaluated in relation to the outcomes.

5 | CONCLUSIONS

Considering the limitations of this retrospective investigation, we can conclude that:

• The CSR% of immediately loaded FAISRs was 96.11% (95% CI: 93.05%, 99.17%) after 10 years of loading. A total of eight implant failures were recorded;

• The cumulative proportion of implants free from peri−implan− titis after 10 years of loading was 86.92% (95% CI: 82.14%, 91.71%), while the cumulative proportion of subjects free from peri−implantitis was 60.69% (95% CI: 52.66%, 80.38%) after 10 years;

• A significant difference was found between maxillary and man− dibular FAISR for the survival curves of implants free from peri−implantitis;

• We found no statistically significant correlation between the smoking and periodontal status and the explored outcomes.

• Further research, also with a retrospective design, on wider sam− ples can help to understand better the effects of patient−related risk factors on the development of peri−implant diseases and on implant survival in general. Moreover, it would be important that future research would take in account also implant success and the parameters to define an implant successful.

CONFLICT OF INTEREST

Authors declare they were free from any conflict of interest in per− forming the study.

AUTHOR CONTRIBUTIONS

LF and SC conceived the idea; LF approved the study protocol; NC and SC collected the data; SC performed statistical analysis and drafted the manuscript with support of ST; LF and ST revised the manuscript; LF, SC and ST interpreted the data.

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