



ORIGINAL ARTICLE

Clinical sequelae and patients' perception of dental implant removal: A cross-sectional study

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Abstract

Background: A cross-sectional study was designed to shed light on the clinical sequelae and patient satisfaction after dental implant removal (IR).

Methods: Patients undergoing ≥ 1 IRs were eligible. The reasons for implant failure, clinical and radiological parameters before and after IR, and the surgical and prosthetic treatments offered after IR was assessed. Patient satisfaction was recorded and the Oral Health Impact Profile (OHIP)-14 was used to document patient self-reported dysfunction and discomfort attributed to IR. Lastly, patient expectations after IR were also evaluated.

Results: Thirty-one patients with 45 implants were analyzed. Peri-implantitis was the main reason for IR (64.5%). The average implant survival time before IR was 120.3 ± 88.2 months. Signs of infection (51.7%) and bleeding on probing (37.5%) were common signs detected at the time of IR. Guided bone regeneration was the intervention most commonly applied simultaneously to IR (74.1%). The reported degree of satisfaction was high, and the overall OHIP-14 score was low. However, a certain patient reluctance to undergo future implant placement in the same clinic or with the same professional was recorded, and a statistically significant increase in adherence to the implant maintenance routine was observed after IR.

Conclusions: Peri-implantitis is the leading cause for IR. Guided bone regeneration is commonly applied to attenuate the clinical sequelae of IR. Nonetheless, IR does not seem to affect patients' satisfaction nor their quality of life, though a certain patient reluctance to undergo future implant placement in the same clinic or with the same professional was reported.

KEYWORDS

dental implant, patient satisfaction, peri-implantitis, quality of life, retreatment

1 | INTRODUCTION

Oral rehabilitation with dental implants after tooth loss has become a common and predictable treatment modality.^{1–5} The popularity of dental implant therapy is

largely attributable to the possibility of better treatment quality and patient perception compared with non-implant rehabilitations.⁶ Nevertheless, long-term dental implant therapy success is conditioned by many clinical factors, including prosthetic-driven implant positioning,



lack of inflammation and infection, and many others.^{7–16} Overall, peri-implantitis seems to be one of the main reasons for implant failure at this moment.^{17,18}

The reported prevalence of peri-implantitis varies greatly: 6.2% to 39.3% at implant level and from 10.5% to 47.8% at patient level, due to different adopted criteria.^{17,18} Berglundh et al. 2018¹⁹ in the World Workshop publication have clearly defined peri-implantitis as an inflammatory process around an implant, including soft tissue inflammation and progressive bone loss following initial bone remodeling.

Despite the high prevalence of peri-implantitis, patients usually have limited perception about the risks of having peri-implantitis and are deeply troubled when peri-implantitis occurs.²⁰ Additionally, patients tend to have unrealistically high expectations on dental implant therapy, viewing such treatment to be a definitive solution, without complications, and not conditioned to continuous oral/professional care.²¹

Nonetheless, the consequences of implant removal, particularly from patients' perspectives and their subjective view towards willingness for undergoing an implant therapy procedure again, to the best of our knowledge, has not been investigated in the literature. Some authors²² have recommended the insertion of a new implant in the same position of the failed implant, especially in the case of single-implant rehabilitation. The decision to place a new implant immediately after implant removal (IR) concomitant to peri-implantitis in a potentially infected location may seem to be a risky decision, though the literature describes this approach as an option that does not adversely affect new implant survival rates.^{23–25} Interestingly, Covani et al.²⁶ reported that half of all IRs did not require regenerative procedures for placing a new implant, while the other half needed the addition of bone grafts and a resorbable membrane. Most of the clinical decisions after IR are purely based on clinician presumptions and their experience without strong supporting evidence.

Therefore, the aim of this cross-sectional study was to evaluate the reasons for implant removal and the therapeutic options that were offered thereafter, and to focus on the patients-related factors such as their satisfaction and perception of implant therapy, and possible willingness for re-implant treatment following IR.

2 | MATERIALS AND METHODS

2.1 | Patient selection

Prior approval of the study was obtained from the Institutional Review Board (IRB) of the University of

Michigan (USA) (Ref. HUM00142189), and it was conducted in consonance with the Helsinki Declaration of 1975, as revised in 2013.²⁷ Dental records between January 1, 1999 and September 30, 2017 from the University of Michigan School of Dentistry (UMSOD) who underwent implant removal (IR) were carefully screened.

The patient inclusion criteria were: aged ≥ 18 years, subjected to IR at the UMSOD, and agreeance to take part in this study. Implants with unclear and/or distorted radiographs, pregnant patients or cases with unsure (self-reported) pregnancy status, and individuals with uncontrolled systemic diseases or known conditions capable of influencing the results of the study, such as neurological or psychiatric disorders were excluded.

The eligible patients received a letter inviting them to participate in the study. In addition, a follow-up phone call was made ≈ 1 to 2 weeks after the letter was sent. Patients who agreed to participate provided informed consent at the screening visit.

2.2 | Implant removal

Implants without mobility or significant marginal bone loss (mechanical issues or implant malpositioning) had been retrieved using the fixture remover kit.* Before the fixture removal kit was available in our clinic (2008), trephine burs were used to retrieve the implants. Implants with mobility or those lacking osseointegration were removed using tissue or dental forceps.

2.3 | Data compilation

The dental records of the recruited patients were reviewed. Patients' age, sex, smoking history, medical antecedents such as diabetes, osteoporosis, or immunodeficiencies, and any allergies to drugs and metals were recorded. The patient information was protected according to the privacy regulations of the Federal Health Insurance Portability and Accountability Act (HIPAA) of 1996. All included subjects underwent clinical evaluation, intraoral radiographs, and photographs of the IR site. The reasons for implant failure, clinical and radiological parameters before and after IR, and the surgical and prosthetic treatments after IR were recorded. In addition, subjective assessment of patients' satisfaction and impact on quality of life were obtained through questionnaires.

* Remove failed implant kit, Neobiotech, Seoul, South Korea.



2.4 | Clinical measurements

The recorded clinical parameters were evaluated before and after IR, according to Buser criteria.⁴ Data regarding the implant and previous patient history (before the IR) were collected from dental records, which were then merged with and verified by the clinical and gathered patient-responses obtained the time of screening examination (in particular to clinical assessment that followed the IR procedure). The presence or absence of subjective complaints (pain, foreign body sensation, dysesthesia), recurrent peri-implant infections (with/without supuration), modified plaque index (mPI), probing depth (PD) (measured in millimeters with a manual probe[†] at four sites [buccal, lingual, mesial, distal]), bleeding on probing, implant mobility (yes or no), the presence of an adjacent tooth or implant, history of periodontal disease, frequency of maintenance visits, extracted implant and new implant survival time, and simultaneously or delayed new implant placement and the positioning in relation to the extracted implant were all recorded. In addition, bone regenerative techniques before and after IR, and their nature (simultaneous or delayed) after IR were also assessed.

2.5 | Radiological measurements

Radiological examination was performed on the basis of the intraoral radiographs which had all been taken with the paralleling technique using the same digital film holder.[‡] Intra-examiner calibration was performed by taking all measurements two times on different days.²⁸ The intraoral radiographs before implant removal were obtained and compared with the new radiographs taken on the study visit appointment.

2.6 | Patient satisfaction and quality of life assessment

The patients who agreed to participate in the study were asked to complete a written questionnaire at their visit to assess personal satisfaction according to surgical and prosthetic parameters:

1. Were you satisfied with the implant treatment you received?
2. If you had a new implant placed, how satisfied are you with the new implant?

3. Were you satisfied with the previous surgical (implant placement) part of the treatment?
4. Were you satisfied with the previous prosthetic (denture) part of the treatment?
5. Would you accept to place more dental implants if needed in the future?

The patients scored their perceived satisfaction on a scale of 0 to 5 points for each question: 0 = unable to answer, 1 = unsatisfied, 2 = slightly satisfied, 3 = neutral, 4 = satisfied, and 5 = very satisfied. The mean total score of each patient yielded individual global satisfaction. In addition, the Oral Health Impact Profile-14 (OHIP-14) patient report was completed to provide a comprehensive measurement relating to the oral status and sociodemographic variables such as social impact, self-reported dysfunction, discomfort, and disability attributed to IR over a maximum score of 56 (see Table S1 in online *Journal of Periodontology*).²⁹

2.7 | Sequelae of implant removal

The consequences of the surgical and prosthetic treatments after IR were also evaluated during the screening visit. The items collected included presence of enough bone to place a new implant; need for bone regeneration; the type of bone regeneration technique required; treatment plan for more implants, and the need for a new prosthesis. Additionally, patients' expectations and their willingness were determined in response to the following: 1) "Have you received a new implant in the same clinic or another clinic?"; 2) "Have you received no new implant placement?"; 3) "Would you be willing to receive another implant in the same or another clinic?"; and last, 4) "Would you be willing to receive another implant with the same or a different provider?"

2.8 | Data processing and statistical analysis

Descriptive statistics were used to demonstrate the gathered continuous (mean, SD, minimum, maximum, median) and categorical variables (absolute and relative frequencies). A bivariate analysis was performed to explore the association between certain variables representative of implant failure (survival time, reason of failure), subsequent treatment, and patient satisfaction.

The survival analysis was based on the Kaplan-Meier method, estimating the survival function for the time in which each of the failures of the first implants had taken place. Mean survival, standard error and 95% confidence

[†] Periodontal probe CP15 North Carolina, Hu-Friedy, Chicago, IL.

[‡] Super-Bite Senso. Kerr, Bioggio, Switzerland.



interval (95% CI) were determined, based on the normal distribution approach. The Chi-square test was used to measure the degree of association between two categorical variables. The Fisher exact test was used when the expected frequencies were too low. The Mann-Whitney *U* test was used for the comparison of distributions of a variable in two groups. In turn, the Kruskal-Wallis test was applied in the case of >2 independent groups, and the McNemar test was used for the before-after intervention (IR) assessment of changes in the incidence of binary response variables (presence or absence of pain, suppuration, bleeding, mobility). Binomial testing was used to determine whether a binary response was produced in equally probable proportions (50% to 50%) or whether one of the two possibilities prevailed over the other. The level of significance used in the analyses was set at 5% ($\alpha = 0.05$).

3 | RESULTS

3.1 | Descriptive analysis

Out of 122 individuals initially assessed for eligibility, 31 patients ($n_{\text{implants}} = 45$) met the inclusion criteria: 19 males (61.3%), and 12 females (38.7%), with a mean age of 66.5 ± 9.9 years (range, 46 to 85). Initial patient's selection involved IR treatment performed from February 12, 2001 to March 28, 2017, and 69 selected patients were aged ≥ 70 years at the time of IR surgery. Consequently, patient age and the long follow-up after IR in some patients entailed patient recruitment difficulties.

Sixteen procedures involved the maxilla (51.6%), and 15 in the mandible (48.4%). Most of the IR had occurred in molars (50%), followed by incisors (26.9%), premolars (19.2%), and canines (3.85). The majority of patients were White (89%). The most-reported systemic disorders were osteoporosis (25.8%), followed by diabetes (16.1%), arterial hypertension (6.5%), osteoarthritis (6.5%), and others (<3.5%); 25.8% of these patients were smokers and 19.4% had some type of allergy (12.9% corresponded to penicillin allergy).

3.2 | Reasons for implant removal

The mean implant survival time before IR was 120.3 ± 88.2 months (≈ 10 years). The median was 108 months (half of the implants failed within 9 years at most). Regarding the reasons for failure, peri-implantitis was the most prevalent (64.5%), followed by lack of osseointegration (22.6%), mechanical failure (9.7%), and implant malpositioning (3.2%). According to the Chi-square test, not all reasons were represented in the same proportion ($P < 0.001$),

and peri-implantitis showed a statistically higher prevalence of 12.3%. However, it cannot be affirmed that peri-implantitis was significantly more frequent than all the other causes combined ($P = 0.150$).

The statistical tests to evaluate the association between cause of implant failure and independent factors focused on the comparison between peri-implantitis and a lack of osseointegration. Regarding the influence of sex, 91.7% of the female patients had peri-implantitis associated to failure versus only 47.4% of the males, who suffered a comparatively much greater number of osseointegration problems (36.8%). Clearly, presence of signs of infection before IR was a much more frequent symptom of failure due to peri-implant disease (93.3% of cases). No analyzed factor was found to significantly affect the implant survival rate.

Regarding the survival rate of the newly placed implants, none showed signs of non-osseointegration. The mean survival time was 51.9 ± 36.5 months (just over 4 years), with a median of 45.5 months.

3.3 | Signs and symptoms before and after implant removal

Regarding the signs and symptoms detected before IR, signs of infection (51.7%), bleeding on probing (37.5%), foreign body sensation (25%), mobility (20.7%), and pain (19.4%) were quite common. However, the incidence of signs and symptoms was low after IR: pain, 10%; bleeding, 7.7%; and signs of infection, 3.4%.

Infection/suppuration was the sign with a significant change in incidence between the two evaluation time-points ($P = 0.001$); 51.9% of the total subjects presented signs of infection before IR, but not after removal. On the other hand, although bleeding failed to reach statistical significance ($P = 0.125$), a decrease was also evident (30% versus 5% before and after IR, respectively).

3.4 | Interventions at previously failed implant sites

Bone regeneration was a common procedure during IR (74.1%), and generally involved the use of allografts (76.2%) followed by xenografts (4.8%). The use of a membrane was recorded in 57.1% of the total cases. In addition, retreatment with a new implant was documented in 67.7% of the cases, and most new implants were placed in the same position as before (20 patients; 64.5%). Furthermore, most new implants were not placed immediately after extraction (94.7%). No association was observed between the decision to place a new implant in the same position and

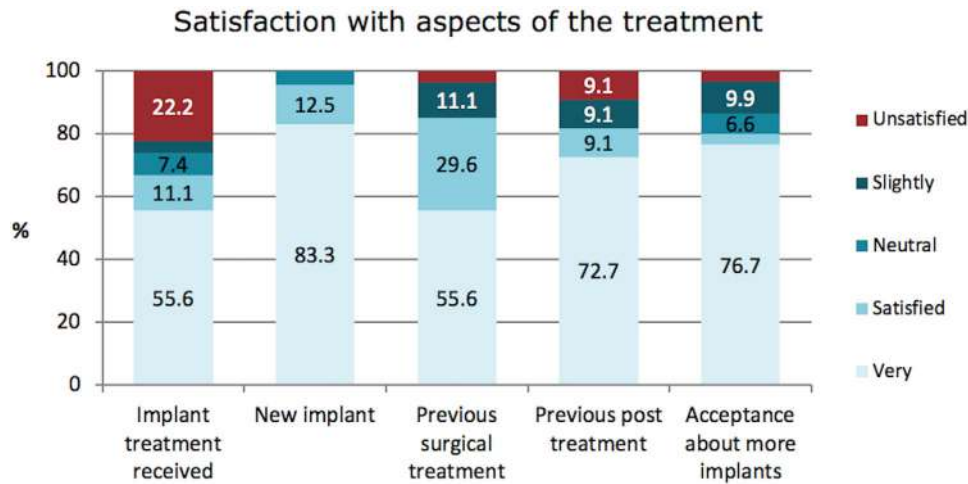


FIGURE 1 Patient satisfaction with the treatment phases

other independent variables. On the other hand, according to the binominal statistical test related to post-IR treatment, it was significantly more frequent to perform a guided bone regeneration procedure ($P = 0.019$), with a significantly greater frequency of new implants placed ($P = 0.071$)—though statistical significance was not observed on analyzing the placement of a new implant in the same position ($P = 0.150$). Furthermore, it was almost equally common to perform bone regeneration during the placement of the new implant ($P = 0.774$).

3.5 | Patient satisfaction

In general, the reported degree of satisfaction was high (Fig. 1). The most critical scores referred to initial implant placement were as only 66.7% of the patients had been satisfied/very satisfied, and 22.2% (six patients) were dissatisfied. Table 1 shows the descriptive data of the five satisfaction questions in terms of means, including an average satisfaction score.

On analyzing the association between general level of satisfaction (average of five items) and independent fac-

tors, the existence of signs of infection with the initial implant placement was seen to significantly affect the level of patient satisfaction ($P = 0.016$). The presence of infection/suppuration had a negative impact on the patient satisfaction scores. The median satisfaction score in the absence of signs of infection was 4.7 versus 4.0 when signs of infection were present.

3.6 | OHIP-14 analysis

Table 2 displays the scores from the OHIP-14 questionnaires (the lower the score, the less frequent the perceived discomfort from the treatment). The presence of signs of infection with the first implant showed to significantly influence the final OHIP-14 score ($P = 0.037$) (Fig. 2). The median OHIP-14 distribution was 8.2 when infection/suppuration was present, versus 3.3 in its absence. Furthermore, when periodontitis was the main cause of the failure, the OHIP-14 score was significantly higher in comparison with a lack of osseointegration ($P = 0.036$), indicating that patient quality of life was more affected (Fig. 2).

TABLE 1 Patient satisfaction scores

	n	Mean	SD	Minimum	Maximum	Median
Satisfaction implant treatment received	27	3.7	1.7	1.0	5.0	5.0
Satisfaction new implant	24	4.8	0.5	3.0	5.0	5.0
Satisfaction previous surgical treatment	27	4.2	1.2	1.0	5.0	5.0
Satisfaction previous post-treatment	22	4.3	1.4	1.0	5.0	5.0
Satisfaction would you accept to place more implants in the future	31	4.3	1.4	.0	5.0	5.0
Mean total satisfaction score	31	4.1	1.1	.0	5.0	4.4
Total OHIP-14 score	31	5.8	7.7	.0	27.4	2.0



TABLE 2 Association between the OHIP-14 score and independent factors (Mann-Whitney *U* test and Kruskal-Wallis test)

Independent factors	<i>P</i> value
Sex	0.071 (MW)
Diabetes	0.387 (MW)
Periodontitis	0.071 (MW)
Smoker	0.219 (MW)
Osteoporosis	0.317 (MW)
Position	0.733 (KW)
Arch	0.830 (MW)
Bone regeneration	0.202 (MW)
Pain pre-IR	0.679 (MW)
Foreign body sensation pre-IR	0.378 (MW)
Infection pre-IR	0.037* (MW)
Bleeding pre-IR	0.726 (MW)
Mobility pre-IR	0.896 (MW)
Survival time pre-IR	0.275 (KW)
Reason for failure	0.036* (MW)
Guided bone regeneration post-IR	0.315 (MW)
Membrane post-IR	0.282 (MW)
New implant	0.268 (MW)
Maintenance new implant	0.235 (KW)
Survival new implant	0.295 (MW)

KW, Kruskal-Wallis test; MW, Mann Whitney *U* test

Bold *P* values indicate statistical significance.

3.7 | Clinical evaluation and patient attitude towards future new implants

The clinical evaluation after IR suggested that in the majority of cases there was enough bone to place another implant (binominal test, $P = 0.029$), even though some type of bone regeneration procedure was considered nec-

essary. Additionally, guided bone regeneration was found to be the most commonly suggested bone regeneration technique, and the most commonly selected new implants were 4 mm in diameter and 10 mm in length. On the other hand, changing the prosthesis was almost always performed (binominal test, $P = 0.002$) (Fig. 3), and half of the patients had already received another implant. However, the patients expressed some reluctance in accepting new implants at the same clinic or with the same professional.

The patient attitude changed completely in relation to the maintenance appointments. Eleven patients (35.48%) remembered the maintenance routine they followed before IR, typically on a semi-annual basis (81.8%). In contrast, the maintenance appointment routine after IR improved substantially, since most patients (85.2%) reported for maintenance visits at least once every 6 months. Furthermore, a total of 16 patients (51.6%) reported not remembering the maintenance routine before the IR, while they mentioned adhering to a strict maintenance protocol after, differences which reached statistical significance representing the increased tendency for implant maintenance appointments after IR had occurred ($P < 0.001$).

4 | DISCUSSION

IR is a consequence of implant complications. Results from this study found peri-implantitis to be the most common reason for IR, corresponding to late implant failure.²² Lack of osseointegration (22.6%) was the second most frequent reason for IR, often referred to early implant failure.^{30–33} Furthermore, a new implant was placed after IR in 67.7% of the cases (64.5% of them in the same position), and guided

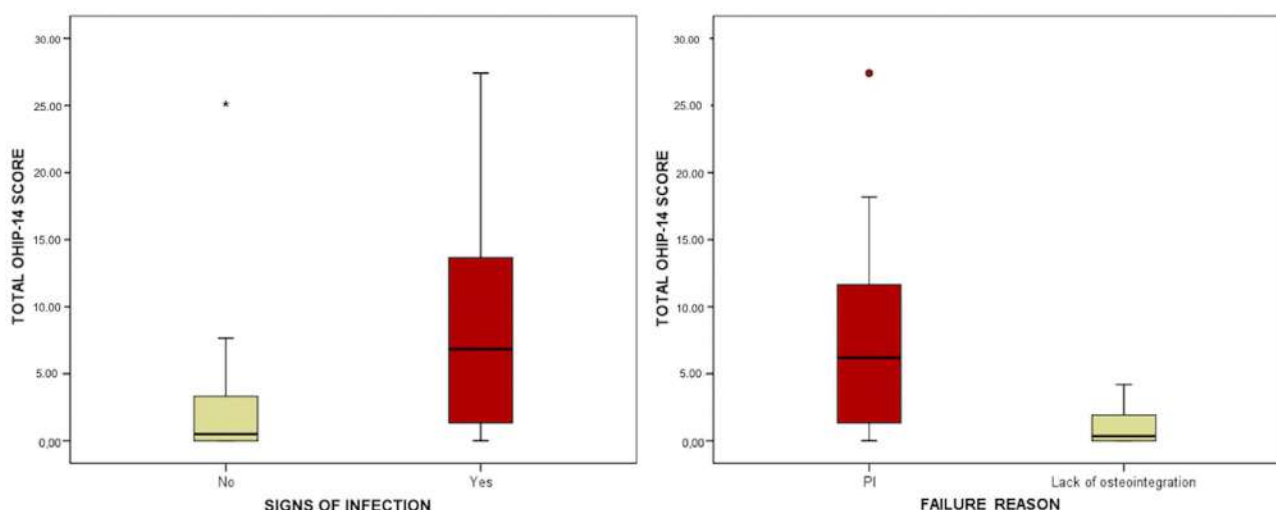


FIGURE 2 Impact of signs of infection and implant failure upon the OHIP-14 score. (PI: peri-implantitis)

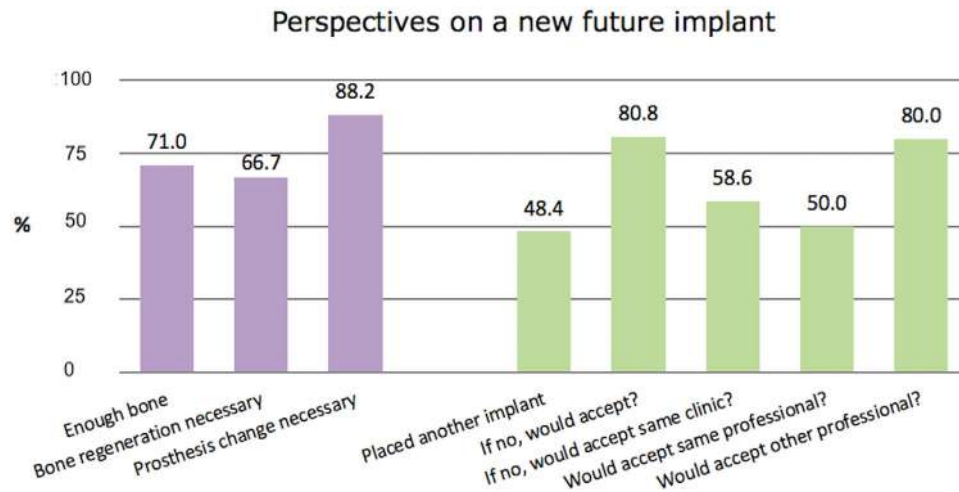


FIGURE 3 Perspectives referred to new implant placement (in purple: questions answered by the clinician; in green: questions answered by the patient)

bone regeneration was performed in 74.1% of the cases. Interestingly and contrary to the initial hypothesis, patient reported satisfaction was generally high, supporting that IR has a low impact on patient well-being according to the OHIP-14 scale.

Our findings are consistent with those of Stajcic et al.,²² who assessed peri-implantitis as the most common reason of IR, and partially agree with those of Buhara et al.,³⁴ who found “periodontitis” to be the most sensitive risk factor associated with implant failure (16.1% of the patients in our study). In fact, peri-implantitis is a chronic inflammatory condition evoked by bacterial plaque and has been linked to local predisposing/precipitating factors such as implant malpositioning, cement remnants, and specific prosthetic features related to the emergence profile and access for cleansability.^{35,36} Interestingly, our findings further showed that mechanical complications (9.7%) and implant malpositioning (3.2%) are secondary reasons for IR. Hence, considering the sequelae of IR, it is critical to monitor dental implants using primary diagnostic tools for the prompt diagnosis of biologic disorders and hence, to improve the long-term prognosis of dental implants.³⁷

Furthermore, some systemic conditions have been attributed to implant failure, such as diabetes and smoking³⁸ (16.1% and 25.8% in our study, respectively)—though osteoporosis was the predominant systemic condition (25.8%) in our series. Peri-implant inflammatory conditions are increased in smokers and patients with diabetes.^{38–40} However, Dreyer et al.⁴¹ and Corcuera-Flores et al.⁴² failed to find any correlation between osteoporosis and peri-implantitis or marginal bone loss. Overall, those mentioned studies were focused on peri-implantitis, but instead, our results were focused on IR. In turn, Salomó et al.⁴³ reported that patients allergic

to penicillin had a higher risk of implant failure, with a risk ratio of 3.84 compared with non-allergic patients. This proportion is slightly higher than in our study, where 12.9% of the patients were seen to be allergic to penicillin. The majority of implant failures reported that the Salomo et al study⁴³ (78.95%) corresponded to early implant failures (lack of osseointegration). Alternately, peri-implantitis revealed to be the main reason of IR in our series, corresponding to late implant failures, showing differences in the population recruited on both studies.

The placement of a new implant after IR seems to be a good treatment option, especially if placed in the same position as the failed implant.^{22,30,31} Avoiding immediate implant placement and waiting an adequate healing time before placing the new implant seems to be a reasonable option.³¹ This is consistent with the observations of our study, where 94% of the new implants were delayed implants, and also in line with our impression that most of the IR patients would need more time to think over the further implant treatment, even though eventually most of them agreed to have a new implant placement, but they did require additional time. This is actually reflected in the survey that most of these patients would go for a new clinic and new professional to place new implants. Additionally, it has been advised to combine hard and soft tissue reconstruction after failed implants,^{31,32} similar to our results, where guided bone regeneration was performed in 74.1% of the cases. In contrast, Covani et al.²⁶ reported that only half of the sites require guided bone regeneration following IR for the placement of a new implant. This can most likely be due to the notion that the implant explantation cases corresponded with biomechanical fractures, without affecting the body walls surrounding the implant. In contrast, in



our study the majority of the IR cases corresponded to peri-implantitis with peri-implant bone loss.

However, some recent publications assessed that implants replacing failed implants had lower survival rates when comparing with the initial implants inserted.^{44,45} Agari et al.⁴⁴ observed that the flapless technique and a narrower implant than the previous implant inserted, increased the implant failure rate. Additionally, Chrcanovic et al.⁴⁵ suggested that there might be a site-specific effect and a certain patient risk related to systemic disorders or medication intake. Above all these considerations, the present study supports the importance to enhance the bone and the soft-tissue condition previously or simultaneously to the new implant placement, avoiding flap-less surgery and immediate implant placement.

IR procedure after dental implant failure could negatively affect patients' perception towards implant therapy and towards the clinician. Based on patient satisfaction surveys and the OHIP-14 item questionnaire, 83.3% of the patients yielded a high satisfaction score in relationship to the new implant placed after IR, indicating that implant treatment modality satisfies patients' expectations. Furthermore, 76.7% of the patients were not reluctant to accept more implants in the future. Also, the OHIP-14 questionnaire, derived from the OHIP-49,²⁹ supported our observation that IR has a low impact on patient well-being (total mean score 5.8 and median score 2.2 over a total score of 56). Interestingly, the presence of signs of infection before IR did have a negative impact on the outcomes of implant treatment by increasing the final OHIP-14 score.

Findings from this study suggest that when recommending new implant treatment, clinicians should clearly communicate with patients about implant longevity, prosthetic concerns, and maintenance interval needed to preserve implant long-term stability to minimize any misperceptions or misunderstandings.⁴⁶ Special emphasis should be placed on maintenance, since a lack of patient compliance has been widely linked to higher peri-implantitis incidence.^{47,48} Monje et al.⁴⁷ found that peri-implant maintenance at least once every 6 months is a key to prevent peri-implantitis in healthy patients, but compliance with such supportive peri-implant maintenance therapy seems to be largely unsatisfactory.⁴⁸ The reason for this high non-compliance rate is unclear, although a recent study⁴⁹ described certain psychological traits and a lack of information and motivation as important parameters to be addressed to enhance patient compliance. Accordingly, in line with these psychological attitudes, our study found that IR after dental implant failure can influence patient motivation, resulting in better compliance with implant maintenance therapy.

Limitations of this study include but are not limited to patient recruitment difficulties, due to the following rea-

sons: patients seek treatment in other locations (not at a university clinic anymore), some did not find a good reason to come up for examination, and some patients had moved away or were deceased. All this influenced patient recruitment and certainly had an impact on data compilation. Furthermore, the majority of IR cases had failed long after placement (the mean implant survival time before IR being ≈ 10 years), which implied some heterogeneity in the dental records reflected in the dental history, and a number of patients could not remember some information that may have been related to the failed implants. Even though, this study has clearly clarified the etiology factors, assessed the treatment modalities, and, furthermore, figured out the patient's satisfaction, the impact on patient well-being, and the patient attitude towards future new implants related to IR.

5 | CONCLUSIONS

Peri-implantitis is the leading cause for IR, which in majority of cases occurred ≈ 10 years after implant placement. Guided bone regeneration is commonly performed to attenuate the clinical sequelae of IR. Nonetheless, IR does not seem to affect patients' satisfaction nor their quality of life, though a certain patient reluctance towards undergoing future implant placement in the same clinic or with the same professional was noted.

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AUTHOR CONTRIBUTIONS

All authors have made substantial contributions to the conception and design of the study. Dr. Gargallo, Dr. Tavelli, and Dr. Barootchi have been involved in data collection and data analysis. Dr. Gargallo, Dr. Tavelli, Dr. Barootchi, Dr. Monje, and Prof. Wang have been involved in data interpretation, drafting the manuscript, and critical revision, and all have given final approval of the submitted version to be published.



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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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