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Evaluation of Implant Survival in Xenograft-Grafted Sites: A Retrospective Study in a French Population

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Keywords

Implant survival, Xenograft, Peri-implantitis, Bone loss

Abstract

Patients with a history of periodontitis often require bone augmentation prior to implant placement; however, the mid-term outcomes of implants in augmented sites are not well documented. The aim of this retrospective study was to evaluate the mid-term survival and peri-implant health of implants placed in xenograft-augmented sites in patients with a history of periodontitis. Records of 34 patients (mean age: 65.3 ± 12 years; 64.7% Stage III, 29.4% Stage IV periodontitis) treated at the University of Strasbourg between 2015 and 2023 were analyzed, including 62 implants placed in xenograft-augmented sites. The mean follow-up was 5.74 ± 2.3 years. No implant failures occurred, yielding a 100% survival rate. The mean probing depth was 2.98 mm, and bleeding on probing averaged 25.5%. Marginal bone loss averaged 0.86 mm (distal) and 0.87 mm (mesial), corresponding to an annual bone loss of 0.18 mm; the most frequent bone loss pattern was vertical (71%). No peri-implantitis was observed; 54.8% of implants presented peri-implant mucositis, and 45.2% were classified as healthy. Within the limitations of this study, implants placed in xenograft-augmented sites in periodontally compromised patients demonstrated excellent mid-term survival and peri-implant tissue stability.

Introduction

Dental implants are considered a reliable and predictable solution for replacing missing teeth with survival rates consistently reported above 90% after five years of function [1]. However, survival does not mean success, as the latter also encompasses the absence of biological and mechanical complications [1]. Among biological complications, peri-implant diseases, namely peri-mucositis and peri-implantitis, represent a major threat to long-term implant stability [1,4].

Peri-implant mucositis is defined as an inflammatory lesion of the peri-implant mucosa in the absence of marginal bone loss. It is clinically diagnosed when one or more sites exhibit bleeding and/or suppuration on gentle probing, often with erythema, swelling, or increased probing depth due to edema [2]. This condition is considered reversible and is primarily caused by dental plaque biofilm accumulation. Peri-implantitis is a biofilm-associated pathological condition occurring in the tissues around dental implants, characterized by bleeding and/or suppuration on probing at one or more sites, with increased probing depth and progressive bone loss visible on radiographs [2]. Peri-implantitis is irreversible and poses a considerable risk to implant longevity. The prevalence of peri-implantitis has been estimated at 12.5% at the implant level and 19.5% at the patient level [5], although this varies according to the used diagnostic criteria [6,7].

Both patient-related factors—such as a history of periodontitis [8,9], systemic conditions such as diabetes [10], smoking [12], and poor adherence to maintenance programs [11]—and implant-related parameters—including implant design, location, and prosthetic characteristics—have been identified as risk indicators/factors for peri-implant disease [13–15].

Another key determinant of implant success is adequate bone volume at the intended placement site. Tooth extraction often leads to severe resorption: up to 25% of bone volume is lost within the first year, potentially increasing to 40–60% over three years [4]. Bone augmentation techniques such as guided bone regeneration (GBR), sinus floor elevation, and alveolar ridge preservation (ARP) are routinely used to overcome anatomical limitations [16,17]. The selection of graft material is fundamental to the success of these interventions. Autografts, while considered the gold standard due to their osteogenic potential, are limited by donor site morbidity and availability [17]. Allografts and xenografts are more readily accessible and eliminate the need for a second surgical site. Among these, xenografts—particularly those derived from bovine or porcine sources—offer an osteoconductive and biocompatible scaffold but lack osteogenic cells [17,18].

Although xenografts have demonstrated favorable biological properties and clinical performance, evidence on mid-term implant survival and peri-implant tissue outcomes in xenograft augmented sites remains limited. Thus, this retrospective clinical study aims to evaluate the medium- to long-term survival of implants placed in xenograft-grafted sites and to analyze clinical and radiographic indicators of peri-implant health.

Materials and methods

Study population

This retrospective study was conducted at the Periodontology Department of the Faculty of Dental Surgery, University of Strasbourg. Its design was approved by the Ethical Committee of the Faculty of Medicine of the University of Strasbourg (CE -2025-89). The study included patients who received dental implants between 2015 and 2023 in sites previously grafted with xenogenic bone substitute.
Patients were eligible if they met all the following inclusion criteria:

- Age ≥18 years
- Placement of ≥1 dental implant in a site grafted with a xenogenic bone substitute (Cerabone® (Botiss, Germany) or Bio-Oss®(Geistlich, Germany), with or without the use of a membrane
- Implant in function for ≥1 year
- Available clinical and radiographic follow-up data

Exclusion criteria included:

- Presence of systemic diseases at the time of implant placement (diabetes, cancer)
- Use of autogenous or allogenic graft materials
- Lack of follow-up data or radiographs
- Implant function <1 year

Critical examination

All clinical evaluations were conducted during recall appointments. The following variables were collected:

- Demographic and medical factors: age, gender, smoking status, diabetes, and history of periodontal disease and initial periodontal diagnosis.
- Compliance with maintenance care, recorded as [20]:
  - Regular compliers (RC): patients who attended all maintenance visits with a maximum between-visit interval ≤6 months.
  - Irregular compliers (IC): patients who missed one or more visits but continued follow-up, with a maximum between-visit interval ≤18 months.
  - Non-compliers: patients who did not attend recall visits or exceeded 18-month intervals.
- Type of procedure: GBR, ARP, sinus elevation.
- Type of xenograft: Cerabone® or Bio-Oss®, with or without the use of a membrane
- Clinical parameters:
  - Tooth location (tooth type)
  - Periodontal biotype and width of keratinized tissue
  - Vestibular depth
  - Type of implant (brand, bone or tissue level, diameter, length)
  - Type of prosthetic restoration: single-unit vs. multi-unit; screw-retained vs. cement-retained
- Periodontal parameters:
  - Probing pocket depth (PPD)
  - Bleeding on probing (BOP, % of sites with bleeding)
  - Clinical attachment level (CAL)
  - Plaque index (PI)
  - Suppuration (presence/absence)
- Peri-implant diagnosis was assigned based on the EFP 2018 criteria [2] as follows:
  - Healthy: no bleeding on probing (BOP) and no bone loss
  - Peri-implant mucositis: BOP and/or suppuration at ≥1 site, without radiographic bone loss
  - Peri-implantitis: BOP and/or suppuration at ≥1 site, increased PPD, and radiographic bone loss compared to baseline

Radiographic analysis

Marginal bone loss (MBL) was assessed using standardized intraoral radiographs. Two time points were considered:

- T1: baseline radiograph immediately after implant placement.
- T2: radiograph at the last recall appointment.

Bone loss was measured from the implant platform to the first bone-to-implant contact, mesially and distally. The mean marginal bone loss (MBL) and annual bone loss were calculated per implant.

Outcome measures

The primary outcome of this study was implant survival, defined as the presence of the im-plant in the oral cavity at the time of follow-up, irrespective of its functional or esthetic condition. Implants were considered as surviving even in the presence of peri-implant disease, as long as they remained in situ [2].

Secondary outcomes included

- Peri-implant diagnosis (healthy, mucositis, or peri-implantitis) [2]
- Mean probing pocket depth (PPD)
- Bleeding on probing (BOP)
- Radiographic marginal bone loss (MBL) and annual bone loss
- Compliance with maintenance care
- Prosthetic type

Statistical analyses

Descriptive statistics were used to summarize the data. Continuous variables are reported as means ± standard deviations, and categorical variables as counts and percentages.

Results

Patient Demographics and Clinical Parameters

Thirty-four patients with a total of 62 implants placed in xenograft-augmented sites were included in the present study. The mean number of implants per patient was 1.82, ranging from 1 to 8. Thirteen patients (38.2%) had two or more implants. The mean age of the cohort was 65.3 ± 12.0 years (range 37–85) and all patients had a documented history of periodontitis (100%). Among them, 22 patients (64.7%) had a history of stage III periodontitis, while 10 patients (29.4%) were previously diagnosed with stage IV periodontitis. Nine patients (26.5%) were smokers, and three (8.8%) had a history of diabetes. The mean follow-up period was 5.74 ± 2.38 years. Detailed demographic and clinical characteristics

are summarized in Table 1. Some representative cases are presented in Figures 1-4.

Table 1. Demographic characteristics of the study population.

Parameter	
Number of patients	34
Age (mean ± SD)	65.3 ± 12.0 years
Gender (%)	
Female (%)	18 (52.9)
Male (%)	16 (47.1)
Smoking status	
Nonsmoker (%)	16 (47.1)
Former smoker (%)	5 (14.7)
Smoker (%)	4 (11.8)
Diabetes (%)	3 (8.8)
Other systemic conditions	
Hypertension (%)	1 (2.9)
Osteoporosis (%)	1 (2.9)
Hypothyroidism (%)	1 (2.9)
Cancer with radiotherapy (%)	1 (2.9)
Cardiac arrhythmia (%)	1 (2.9)
Periodontitis history (%)	31 (100)
Parafunctional habits	1
Average follow-up (mean ± SD)	5.74 ± 2.4 years

***Note**. Overview of the included patients (n = 34), including age, gender distribution, smoking status, systemic conditions, and history of periodontitis. The mean age and standard deviation (SD) are reported, along with percentage distribution for categorical variables.*

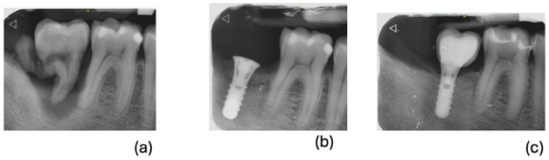

Figure 1. Radiographic and clinical follow-up of representative cases. Guided Bone Regeneration (GBR) at site 47: **(a)** pre-operative condition, **(b)** Baseline radiograph taken immediately after implant placement, **(c)** Radiograph at the follow-up visit at 6 years.

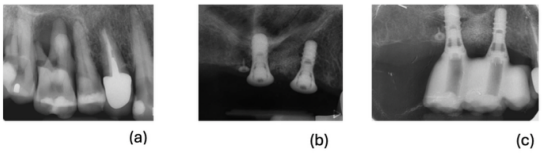

Figure 2. Radiographic and clinical follow-up of representative cases. Sinus lift procedure at site 16-15: **(a)** pre-operative condition, **(b)** Baseline radiograph taken immediately after implant placement, **(c)** Radiograph at the follow-up visit at 6 years.

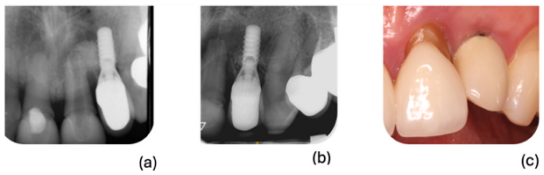

Figure 3. Radiographic and clinical follow-up of representative cases. Implant placement following GBR: **(a)** Baseline radiograph taken immediately after im-plant placement **(b)** Radiograph at the follow-up visit at 9 years **(c)** Clinical photograph at the follow-up visit.

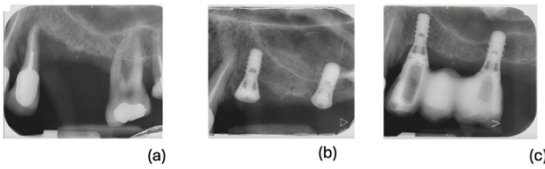

Figure 4. Radiographic and clinical follow-up of representative cases. Sinus lift procedure at sites 25–26: **(a)** pre-operative condition **(b)** Baseline radiograph taken immediately after implant placement **(c)** Radiograph at the follow-up visit at 6 years.

Periodontal characteristics of the sample population

Among the 62 implants included in the analysis, all implants were placed in patients previously diagnosed with periodontitis and treated. The average full-mouth plaque score (FMPS) was 36.6% ± 25.7, with a mean bleeding on probing (BOP) of 25.5% ± 23.0 at T2. Mean probing depth (PPD) was 2.55 ± 0.23 mm, and 14.7% ± 11.5 of sites exhibited PPD >3 mm. A total of 14 patients (34%) reported no use of interproximal brushing. Regarding compliance with supportive care, 15 patients (44.1%) were classified as regular compliers, 14 (41.1%) as irregular, and 5 (14.7%) as non-compliers (Table 2).

Table 2. Periodontal characteristics of the study population.

Parameter	
Number of implants	62
FMPS% (SD)	36.6 (25.7)
BOP % (SD)	25.5 (23)
Mean CAL mm (SD)	3.3 (0.8)
Mean PPD mm (SD)	2.55 (0.23)
PPD > 3 mm % (SD)	14.7 (11.5)
Initial periodontal diagnosis	
Stage III (%)	22 (64.7)
Stage IV (%)	10 (29.4)
No interproximal brushing (%)	14 (34)
Compliance	
Regular (%)	15 (44.1%)
Irregular (%)	14 (41.1%)
Non-compliers (%)	5 (14.7%)
Periodontal phenotype (%)	
Thin	10 (29.4)
Thick	24 (70.5)
Vestibular depth mm (%)	
>2mm	26 (76.4)
<2mm	8 (23.5)

***Note**. Full-mouth periodontal data including plaque score (FMPS), bleeding on probing (BOP), clinical attachment level (CAL), and probing depth (PPD). The table also reports compliance with supportive therapy, periodontal phenotype, interproximal hygiene habits, and initial periodontal diagnosis according to the 2018 classification system. Data are expressed as mean ± SD or as percentages.*

Implants characteristics

Most of the implants (71%) were placed in posterior regions (premolars and molars), with tissue-level implants representing the majority (69.3%). All implants were screw-retained. The most common diameter was 4.1 mm, while the mean diameter was 3.78 mm and the mean length was 9.38 mm. Nearly all implants (96.7%) were from the Straumann® brand. Guided bone regeneration was the most frequently performed procedure (61.2%), followed by ARP (22.5%) and sinus elevation (16.1%). Cerabone® was the most commonly used xenograft (67.7%), and membranes were utilized in 22.5% of cases. Prosthetic restorations were evenly distributed between single-unit and multi-unit prostheses (Table 3).

Table 3. Implant and prosthetic characteristics.

Parameter	
Location (%)	
Incisor	16 (25.8)
Canine	2 (3.2)
Premolar	21 (33.9)
Molar	23 (37.1)
Type of implants (%)	
Tissue level	43 (69.3)
Bone level	19 (30.6)
Type of retention (%)	
Cement-retained	0
Screw-retained	62 (100)
Implant diameter mm (%)	
2.9	1 (1.61)
3.3	22 (35.48)
3.4	1 (1.61)
3.8	1 (1.61)
4.1	34 (54.84)
4.8	3 (4.82)
Implant length mm (SD)	9.38 (1.2)
Implant brand (%)	
Straumann	60 (96.7)
Dentsply	2 (3.2)
Type of procedure (%)	
GBR	38 (61.2)
ARP	14 (22.5)
Sinus	10 (16.1)
Type of xenograft (%)	
Bio-oss®	20 (32.2)
Cerabone®	42 (67.7)
Membrane utilization	
Jason® membrane (Botiss)	38 (61.2)
No membrane	24 (38.7)
Type of prosthesis (%)	
Single-unit	31 (50)
Multi-unit	31 (50)

***Note**. Details of the 62 implants placed in xenograft-augmented sites. Variables include implant location, diameter and length, brand, retention type, surgical procedure (GBR, ARP, sinus elevation), type of xenograft used, membrane utilization, and type of prosthesis. All implants were screw-retained. Values are expressed as absolute numbers and percentages.*

Peri-implants characteristics

The mean peri-implant probing depth (PiPD) was 2.98 ± 0.7 mm. The mean peri-implant gingival index

(GIi) was 0.25 ± 0.32, mean suppuration on probing (SoP) and peri-implant plaque index around implants (PIi) were 0.03 ± 0.17 and 0.24 ± 0.31, respectively. Radiographic analysis revealed that 5 implants (8.1%) presented no detectable bone loss, while 5 (8.1%) exhibited a crater-like defect. The most frequent pattern was vertical bone loss, observed in 44 implants (71.0%), followed by horizontal (9.7%) and combined (3.2%) bone loss patterns. The mean distal and mesial marginal bone losses were 0.86 ± 0.72 mm and 0.87 ± 0.65 mm, respectively corresponding to a mean annual bone loss of 0.18 ± 0.15 mm/year, with a mean percentage of bone loss relative to implant length of 9.47 ± 7.03%, and annual bone loss rate of 1.99 ± 1.87%. Regarding peri-implant diagnosis, 34 implants (54.8%) were classified as presenting mucositis, 28 (45.2%) were healthy, and no case of peri-implantitis was diagnosed. The overall implant survival rate was 100% at the time of evaluation (Table 4).

Table 4. Peri-implant clinical and radiographic characteristics.

Parameter	
Number of implants	62
Mean PiPD mm (SD)	2.98 (0.7)
Mean GIi (SD)	0.25 (0.32)
Mean SoP (SD)	0.03 (0.17)
Mean PIi (SD)	0.24 (0.31)
Type of bone loss (%)	
No bone loss	5 (8.1)
Crater	5 (8.1)
Vertical	44 (71)
Horizontal	6 (9.7)
Combined	2 (3.2)
Marginal bone loss mm (SD)	
Distal MBL (SD)	0.86 (0.72)
Mesial MBL (SD)	0.87 (0.65)
Mean Annual Bone Loss (SD)	0.18 (0.15)
Percentage of bone loss relative to implant length (%)	9.47 (7.03)
Annual Bone Loss (%)	1.99 (1.87)
Peri-implant diagnosis (%)	
Health	28 (45.2)
Mucositis	34 (54.8)
Peri-implantitis	0
Survival rate (%)	100

***Note**. Peri-implant tissue parameters including probing depth (PiPD), gingival inflammation index (GIi), suppuration on probing (SoP), and peri-implant plaque index (PIi). Radiographic patterns of bone loss are classified as none, crater-shaped, vertical, horizontal, or combined. Marginal bone loss (mesial and distal), mean annual bone loss, and implant survival rate are presented. Peri-implant diagnoses were assigned according to the EFP 2018 case definitions*

Discussion

This retrospective study aimed to evaluate the long-term survival and peri-implant health in a French population receiving implants in sites previously augmented with xenogenic bone grafts. Overall, the findings support the predictability of xenografts for pre-implant bone regeneration, as evidenced by excellent implant survival, low levels of marginal bone loss, and the absence of peri-implantitis after an average of 5.7 years of follow-up.

The implant survival rate in this cohort was 100%, in line with previous studies reporting high survival rates following xenograft-based augmentation procedures [22]. This is particularly noteworthy considering that all implants were placed in periodontally compromised patients (100% with history of periodontitis), including 64.7% with stage III and 29.4% with stage IV periodontitis. Despite this, none of the implants were diagnosed with peri-implantitis at follow-up. This contrasts with epidemiological estimates reporting peri-implantitis in up to 20% of patients [13] and highlights the role of stable maintenance protocols and proper implant planning.

Peri-implant mucositis was identified in 54.8% of implants, which is consistent with previous literature indicating it as the most frequent biological complication [1]. However, the complete absence of peri-implantitis in our sample diverges from many other findings. For instance, a systematic review reported a weighted mean prevalence of peri-implantitis of 21.7% (95% CI: 14–30%) at the implant level [25]. This discrepancy might be due to the strict inclusion criteria of our study, which required at least one year of follow-up and full clinical and radiographic records, as well as the relatively high rate of maintenance compliance (14.7% were non-compliant) [20].

Radiographic analysis demonstrated minimal marginal bone loss, with average distal and mesial values of 0.86 mm and 0.87 mm, respectively. These values are well below the 1.6 mm threshold often associated with peri-implantitis onset, as defined by probing depth into inflamed connective tissue [23]. The mean annual bone loss was 0.18 mm/year, again within the range reported in long-term cohort studies [26]. Vertical bone loss was the most

frequent radiographic pattern (71%), consistent with prior classifications highlighting the predominance of vertical defects in peri-implantitis-affected sites [27].

An average of 9.47% of implant length was lost, with an annualized loss of 1.99%. This rate is clinically acceptable in the context of previously grafted sites, particularly considering the use of xenografts that are osteoconductive but lack osteoinductive properties [22].

All implants were screw-retained, with an equal distribution between single- and multi-unit restorations. While the misfitting restorations and convex emergence profiles have been identified as risk factors for peri-implantitis in previous studies [28], such elements were not evaluated in this study. Implant diameter and length were within standard dimensions (mean diameter: 3.78 mm; length: 9.38 mm), and nearly all implants were Straumann® (96.7%), which may have influenced the positive outcomes due to their surface characteristics and well-documented clinical reliability [29].

Most implants were placed in posterior regions (71%) and were preceded by GBR (61.2%). Cerabone® was the most frequently used xenograft (67.7%). These findings align with clinical protocols supporting GBR as a reliable technique for ridge augmentation and demonstrate the stability of xenografts over time [16,18].

Unlike previous studies that found strong associations between peri-implantitis and systemic conditions such as diabetes or smoking [12,31], our study did not observe such correlations—likely due to the small sample size (3 diabetics and 4 smokers). Similarly, parafunctional habits such as bruxism were reported in only one patient and were thus not analyzed. In contrast with studies reporting high disease prevalence in patients lacking regular supportive care [20], the relatively high percentage of regular and irregular compliers (85.2% combined) in our cohort may explain the favorable peri-implant health status. Notably, 34% of patients reported no interproximal brushing, a known risk indicator [20], yet this did not result in peri-implantitis, possibly due to low plaque and bleeding scores (PIi: 0.24 ± 0.31, BOP: 25.5% ± 23.0).

This study has several limitations. Its retrospective design and single-center nature limit the generalizability of results. The relatively small sample size restricts the statistical power to assess associations between clinical parameters and peri-implant disease development. Additionally, some clinical parameters (e.g., occlusion, prosthetic fit, or emergence profile) were not assessed. Future studies should include larger, multicenter cohorts and prospective designs to confirm the protective role of xenografts and maintenance care against peri-implantitis development.

Conclusions

Implants placed in xenograft-augmented sites demonstrated excellent mid-term survival in this French cohort while maintaining stable peri-implant tissue conditions. The absence of peri-implantitis, low bone loss, and high compliance with maintenance care suggest that xenogenic grafts represent a reliable option in implant dentistry. Further studies are needed to investigate specific implant and prosthetic-related factors that may influence peri-implant health in grafted sites..

Acknowledgements

The authors declare no potential conflict of interests with respect to this study.

Zusammenfassung

Einleitung

Diese retrospektive Studie untersuchte das Mittelleitüberleben und die peri-implantäre Gesundheit von Implantaten, die in mit xenogenen Knochentransplantaten augmentierten Bereichen eingesetzt wurden. Alle eingeschlossenen Patienten hatten eine Vorgeschichte von Parodontitis, was ein erhöhtes Risiko für periimplantäre Komplikationen darstellt.

Material und Methoden

Eingeschlossen wurden Patienten, die zwischen 2015 und 2023 mindestens ein Implantat in mit Bio-Oss® oder Cerabone® augmentierten Bereichen erhalten hatten. Erfasst wurden klinische Parameter (Sondierungstiefe, Sondierungsbluten, Plaque, Suppuration), Implantatmerkmale (Typ, Lage, Durchmesser, Länge) und prothetische Versorgungen. Der marginale Knochenverlust wurde radiologisch beurteilt und die periimplantären Diagnosen gemäß EFP 2018 vergeben.

Resultate

Insgesamt wurden 34 Patienten mit 62 Implantaten eingeschlossen, mit einer durchschnittlichen Nachbeobachtungszeit von 5,74 Jahren. Alle Patienten hatten eine Parodontitisvorgeschichte (64,7 % Stadium III, 29,4 % Stadium IV). Die Überlebensrate der Implantate betrug 100 %. Die durchschnittliche Sondierungstiefe lag bei 2,98 mm, mit einem durchschnittlichen BOP-Wert von 25,5 %. Der durchschnittliche marginale Knochenverlust betrug distal 0,86 mm und mesial 0,87 mm, mit einem jährlichen Verlust von 0,18 mm. Kein Fall von Periimplantitis wurde festgestellt, aber 54,8 % der Implantate wiesen eine Mukositis auf.

Diskussion

Trotz Risikofaktoren wie Parodontitis oder Rauchen zeigten Implantate in xenogen augmentierten Bereichen eine mittelfristige Stabilität des periimplantären Gewebes. Diese Ergebnisse belegen die Zuverlässigkeit xenogener Transplantate für die präimplantologische Knochenaugmentation.

Résumé

Introduction

Cette étude rétrospective visait à évaluer la survie à moyen terme et la santé péri-implantaire des implants dentaires placés dans des sites greffés avec des substituts osseux xénogéniques. Les patients inclus avaient tous des antécédents de parodontite, ce qui en fait une population à haut risque de complications péri-implantaires.

Matériels et méthodes

Les patients ayant reçu au moins un implant dans un site greffé avec du Bio-Oss® ou Cerabone® entre 2015 et 2023 ont été inclus. Les données cliniques (profondeur de sondage, saignement au sondage, plaque, suppuration), les caractéristiques des implants (type, localisation, rétention, diamètre, longueur) et les restaurations prothétiques ont été collectées. La perte osseuse marginale a été évaluée radiographiquement, et les diagnostics péri-implantaires ont été établis selon les critères EFP 2018.

Résultats

Trente-quatre patients (62 implants) ont été inclus, avec un suivi moyen de 5,74 ans. Tous présentaient des antécédents de parodontite (Age : 65.3 ± 12 ans; 64,7 % stade III, 29,4 % stade IV). Le taux de survie implantaire était de 100 %. La profondeur moyenne de sondage était de 2,98 mm, avec un taux moyen de BOP de 25,5 %. La perte osseuse marginale moyenne était de 0,86 mm (distal) et 0,87 mm (mésial), soit une perte annuelle moyenne de 0,18 mm. Aucun cas de péri-implantite n'a été diagnostiqué. Une mucosite a été observée dans 54,8 % des cas.

Discussion

Malgré la présence de facteurs de risque (parodontite, tabagisme), les implants placés dans des sites greffés avec des substituts osseux xénogéniques ont montré une excellente stabilité tissulaire à moyen terme. Ces résultats soutiennent la fiabilité des xénogreffes pour la régénération osseuse avant implantation.

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