# Clinical and radiographic assessment of narrow-diameter dental implants in posterior regions: A retrospective study with a mean follow-up of 11.5 years

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**Abstract:**

**Aim:** The aim of this study was to assess the factors influencing the survival and success rates of narrow diameter implants (NDIs) placed in the posterior area. Additionally, the study evaluated marginal bone changes, along with biological and prosthetic complications.

**Materials and methods:** This retrospective study investigated the clinical and radiographic outcomes of 225 narrow-diameter implants (NDIs) placed in the premolar and molar regions of 120 patients. The analysis focused on implant survival and success rates, marginal bone levels (MBL), and the incidence of biological and mechanical complications. Generalized estimating equations (GEE) were employed to assess the impact of patient- and implant-related characteristics on these outcomes.

**Results:** Over a mean follow-up period of 11.51 years (SD: 4.03) years the study recorded the loss of twelve NDIs in seven patients. The Kaplan–Meier survival rates were 94.67% at the implant level and 92.50% at the patient level, while success rates were 83.33% and 78.45%, respectively. The average marginal bone loss (MBL) was estimated at -0.75 mm. Mucositis was observed in 32.89% of the implants and peri-implantitis in 9.78% of the sample.

**Conclusion:** This study offers valuable understanding of narrow-diameter implants (NDIs) as a predictable option in implant dentistry, particularly for patients with challenging anatomical conditions. However, careful case selection and comprehensive treatment planning are crucial to minimize the risk of implant fractures.

## 1. Background:

Dental implants are widely regarded as an effective solution for replacing missing teeth (1, 2). Recent research highlights favorable trends in implant dentistry, with studies reporting improved success rates and fewer complications (3). These advancements are largely attributed to innovations in biomaterials and dental methodologies (4). Nevertheless, insufficient bone volume remains a common challenge in treatment planning. To address this, various surgical techniques have been developed to enhance horizontal and vertical bone dimensions, either prior to or during implant placement (5, 6, 7). However, these augmentation procedures often require advanced surgical skills, extend treatment duration, increase costs, and elevate patient morbidity (7).

To overcome these limitations, alternative approaches, such as narrow-diameter implants (NDIs) have gained growing clinical and scientific attention (8–10). NDIs, typically defined as implants with a diameter of ≤3.5 mm or ≤3.75 mm (11, 12), were initially designed for placement in areas with limited interdental space, particularly for the replacement of narrow teeth, such as maxillary lateral incisors and mandibular incisors (8). NDIs have been recently classified into three different categories according to their diameter: Category 1, <2.5 mm; Category 2 between 2.5 mm and <3.3 mm; and Category 3, between 3.3 mm and 3.5 mm (10). Category 3 NDIs have demonstrated promising results, with high survival and success rates, significant patient satisfaction, and

marginal bone loss comparable to that of standard-diameter implants (SDIs) (9–11, 13–15). Consequently, narrow-diameter implants (NDIs) are being increasingly used in posterior regions for patients who would otherwise require horizontal bone augmentation to enable the placement of standard-diameter implants (SDIs) (13, 16). Despite these positive outcomes, in vitro studies have reported that NDIs may have a reduced capacity to withstand load fatigue and are more prone to structural deformation compared to SDIs (17, 18). Furthermore, clinical studies have suggested that the reduced diameter of NDIs may increase the risk of fractures compared to SDIs (19, 20). On the other hand, several implant features, such as the implant-abutment connection (21) and implant surface characteristics (22), as well as clinical conditions, appear to contribute to the success of NDIs in posterior regions (23). These findings are particularly relevant in posterior areas where masticatory forces can reach up to 700 N, especially in the second molar regions (24).

Considering the current evidence, the aim of this study was to assess the factors influencing the survival and success rates of narrow implants placed in the posterior area. Additionally, the study evaluated marginal bone changes, as well as biological and prosthetic complications.

## 2. Material and methods

### 2.1 Study design

The study is an observational retrospective case series study of patients with at least one NDI in the position of premolar or molar placed from 2003 till 2018 by a single EFP-certified periodontist (C.S) in a private periodontal practice (Studio Dentistico SBM, Vicenza, Italy).

The study was approved by *Comitato Etico per le Sperimentazioni Cliniche (CESC) della Provincia di Vicenza*, Italy (*93/22*). Written informed consent was obtained from each enrolled patient before study initiation and was performed following the Helsinki Declaration of 1975 (as revised, amended, and clarified in its version of 2013). The study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement (25).

### 2.2 Study population

Medical data of patients with at least one NDI in the premolar or molar position, placed between January 2003 and December 2018 were reviewed. At their routine supporting peri-implant care (SPIC) appointment, all patients were consecutively informed about the study by a certified periodontist (M.C.S). Eligible subjects who were unable to attend their SPIC appointment were invited to a follow-up examination by telephone. Unwilling participants were excluded from the study.

### 2.2.1 Surgical and prosthetic treatment:

All implant placements and prosthetic rehabilitations were carried out by the same EFP-certified periodontist (C.S.). All the patients underwent the same surgical prophylaxis and post-operative instructions. Pre-operative antimicrobial prophylaxis consisted of 1 gr of amoxicillin (Zimox® Pfizer Italia s.r.I., Milan, Italy) was provided 1 hour before surgery and up to 6 days afterward, depending on the surgical procedure used. Clindamicin 600mg (DALACIN®, Zimox® Pfizer Italia s.r.I,, Milan, Italy) was provided in case of penicillin allergy. The surgical procedure involved the elevation of a full-thickness flap, followed by the placement of one or more narrow-diameter implants (NDIs), with simultaneous guided bone regeneration when needed, using either a submerged or nonsubmerged approach. All implants were placed according to the manufacturer's recommendations, and all the prosthetic rehabilitation were performed with original components. Implants included in this study were bone level NDIs belonging to different brands: Ankylos® implants (Dentsply-Friadent GmbH, Mannheim, Germany), Astra OsseoSpeed™ (Astra TechAB, Molndal, Sweden), CLC CONIC® implants (CLC Scientific, Vicenza, Italy), Kontact™ implants (Biotech, Englewood, NJ, US) Patients were instructed to rinse with 0.12% chlorhexidine solution twice a day for 14 days post-surgery (Corsodyl®, GlaxoSmithKline Spa, Verona, Italy). As a painkiller, Ibuprofen 600 mg (Brufen ®, Mylan Italia Srl, Milano Italy) was recommended 2 to 4 times a day for 7 days after surgery, if needed. The patient was seen at 1 or 2 weeks for suture removal and at 12-16 weeks post-surgery impressions were taken or second stage surgery was performed, during which osseointegration was confirmed with manual torque. All patients received denture restorations loaded according to the standard protocol. Supportive maintenance therapy (i.e SPIC) schedule was proposed for all patients, with recall intervals of 3 or 6 months according to the patient's profile (26).

### 2.2.2 SPIC (supportive peri-implant care):

At each SPIC appointment, the following procedures were performed**:**

- Patients' anamnesis and dental history were actualized;
- Supragingival debridement using ultrasonic and manual devices was conducted;
- Oral hygiene instruction and re-enforcement were provided;
- Implant survival was assessed;
- The cleanability of the prosthesis by the use of an appropriate interproximal brush (TePe®, Cornaredo, MI, Italy) was checked;
- Excess of luting cement was assessed and removed if present;
- Biological and/or technical complications were reported.

Once a year during SPIC appointment, the following procedures were carried out**:**

- Peri-implant probing pocket depth (PPD) was probed in four sites with periodontal probe PCP-UNC 15 (HuFriedy®, Rockwell St, Chicago, IL, USA), and PPD >4mm was recorded;
- Plaque index (PI), was assessed as the presence of plaque along the mucosal margin (27);
- Bleeding on probing (BOP), was dichotomously evaluated as the presence of bleeding within 15 s after probing (28);
- Suppuration on probing (SOP), was dichotomously evaluated as the presence of suppuration within 15 s after probing;
- A parallelized digital radiograph was obtained using a long-cone parallel technique with a film holder (Dürr Dental AG, Bietigheim-Bissingen, Germany).

**2.3 Inclusion criteria:**

- Patients age ≥18;
- Patients rehabilitated with at least one NDI during the period between January 2003 and December 2018;
- Patients with a minimum functional loading of 4 years;

**2.4 Exclusion criteria**:

- Absence of radiological image available at implant placement (T0);
- Absence of radiological image available at the last SPIC;
- Unwilling participants or patients refused to sign informed consent.

**2.5 Data collection**

Patient and implant-related data were retrieved from the clinic's patient records and entered into a dedicated database created exclusively for this study by a single examiner (I.A).

*2.5.1 Subjects*

Patients' medical history was examined, and information regarding age, race, gender (female/male), medical history, and medication was obtained. Smoking habit [current smoker, former smoker, or never-smoker (29)] and reported smoking exposure [pack-years: number of cigarettes smoked per day multiplied by the number of years the patient has smoked and divided by 20 (a standard pack of cigarettes)] (30) were also registered. Patients' periodontal stage and grade were retrospectively assessed at the time of implant placement (31). Bruxism (e.g. tooth wear - American Academy of Sleep Medicine) was also recorded (32, 33).

Regarding SPIC, patients were divided into four groups according to the frequency of the maintenance appointments: non-compliers (i.e., patients missing sporadically or not attending the scheduled SPIC intervals), 1 time /year (i.e., patients attending to one SPIC intervals each year

during the observation period with a maximum delayed of 1 month), 2 time /year (i.e., patients attending to two SPIC intervals each year during the observation period with a maximum delayed of 1 month), 3 time /year (i.e., patients attending to three SPT intervals each year during the observation period with a maximum delayed of 1 month).

*2.5.2 Implants*

The implant characteristics were extracted from the patient records and included the following parameters: the number of narrow-diameter implants (NDIs), their positions according to the F.D.I. notation system, the implant brand, the anatomical location (maxilla or mandible, further categorized as anterior [canine to canine] or posterior), implant diameter (mm), implant length (mm), surgical protocol (one-stage [nonsubmerged] or two-stage [submerged]), and details of bone grafting procedures. Information on the type of prosthesis (single, partial, or complete, including fixed full arch restorations or overdentures) and the prosthesis retention method (cemented, screwed, ball attachment, or bar attachment) was also recorded.

Digital periapical radiographs were taken with an intra-oral phosphor plate using a long-cone parallel technique. Radiographs were stored using a digital intraoral imaging system (Dürr Dental AG, Bietigheim-Bissingen, Germany). Radiographic measurements were performed using an image analysis software (ImageJ64; National Institutes of Health, Bethesda, MD, USA) by two previously calibrated examiners (R.P and E.R). The two examiners were calibrated at the start of the study: the inter-rater agreement was calculated between the two examiners on the same day for 10 patients with 22 implants, and resulted in (ICC=0.88; $p<0.001$). Radiographs were calibrated using the known implant dimensions as reference values.

**2.6 Outcome assessment**

**2.6.1 Survival rate**

The survival rate was defined by the percentage of implants that remained in situ with or without modifications (14*).*

**2.6.2 Success rate**

Success rate was calculated based on the criteria proposed by Misch et al. 2008: (a) No pain or tenderness upon function, (b) 0 mobility, (c) <2 mm radiographic bone loss, (d) No exudates history (34).

**2.6.3 Mean bone level changes**

Mean bone level (MBL), defined as the mean distance (mm) between the implant shoulder and the first visible bone-to-implant contact, was assessed at the mesial and distal aspects of each implant, and the mean of both values was calculated (35). The amount of mean bone change that occurred from the baseline (T0) to the different follow-ups was determined. These measurements could be a negative number (if the crestal bone level was apical to the implant shoulder) zero (if the crestal bone level was located at the implant shoulder), or a positive number (if the crestal bone level was located coronal to the implant shoulder).

**2.6.4 Biological complications:**

Mucositis was retrospectively diagnosed based on the presence of bleeding upon gentle probing (0.15 N/cm) at one or more sites evaluated during the SPIC (36). Peri-implantitis was retrospectively identified in cases where bleeding and/or suppuration occurred upon gentle probing, with a probing pocket depth (PPD) of ≥6 mm, and bone levels ≥3 mm apical to the most coronal portion of the intraosseous part of the implant (37).

**2.7.5 Technical complications:**

Technical complications were classified as fractures of the implants, screws or abutments; loss of prosthetic screw or abutment, chipping or fracture of the ceramic material, and fractures or deformations of the framework (38).

**2.8 Data analysis**

The descriptive analysis provides the most relevant statistics for all the variables collected in the research: absolute and relative frequencies (for categorical variables) and mean, standard deviation, range, and median (for continuous variables). At the implant level, simple binary logistic regression models were estimated using generalized estimating equations (GEE) to explain the probability of survival, success, mucositis, peri-implantitis and mechanical complications as a function of the clinical profile of the patient and implant characteristics. Unadjusted OR estimates and 95% confidence intervals are obtained from the Wald Chi2 statistic. A multiple model was then used to adjust the results for all independent variables at the same time. This methodology is suitable for controlling intra-subject correlation inherent to the multi-level structure of the data, as individual patients contribute multiple implants to the analysis.

The MBL was analysed using a similar methodology (GEE) but with linear regression models. Unadjusted beta coefficient estimates were obtained from simple models and adjusted in the subsequent multiple models.

## 3. Results

### 3.1 Demographic data

The records of 153 patients with 276 NDIs placed between January 2003 and December 2018 were initially reviewed and considered for inclusion. Finally, one hundred and twenty patients with 225 NDIs met the inclusion criteria (Figure 1).

The study sample consisted of 54 men (45.00%) and 66 women (55.00%), with a mean age of 67.12 (SD: 10.96) years. Each patient contributed with a variable number of implants, ranging from 1 to 7, with an average of 1.88 implants per patient. More than half of the subjects (62.19%) had a history of severe periodontitis (Stage III and IV), 90 patients (76.27%) were non-smokers, and 30 patients (23.73%) were former or current smokers. The rest of the demographic characteristics of the study sample are summarized in Table 1.

### 3.2 Survival rate and related factors

During the observation period (mean: 11.51 years, SD: 4.03 years), twelve NDIs in seven patients were lost. Three patients lost a total of eight NDIs 5-10 years after placement, while four patients each lost a single implant over a follow-up period ranging from 3 to 14 years. The calculated Kaplan–Meier survival rates of NDI were 94.67% and 92.50% at implant- and patient-level, respectively (Figure 2,3,4; Table 2).

Results of multivariate generalized estimating equations (GEE) analysis revealed that factors such as implant placement in the mandible (OR: 13.30; ($p$=0.044)., implant length greater than 10mm (OR: 14.00; ($p$=0.003) and the presence of bleeding on probing (BOP) (OR: 1.74; ($p$=0.007) negatively impacted implant survival. Conversely, an extended follow-up time was positively correlated with implant survival (OR: 0.71; ($p$<0.001), indeed 7/12 failure occurred between the $4^{th}$ and the $6^{th}$ year of follow-up (Table 3).

### 3.3 Success rate and related factors

The calculated success rates of NDI were 83.33% and 78.45% at implant- and patient-level, respectively (Table 2).

Results of multivariate generalized estimating equations (GEE) analysis revealed that an increased number of sites with BOP during the different SPIC appointment reduced the probability of success (OR: 0.51; ($p$<0.001). (Table 4)

### 3.4 Marginal bone level changes

Table 5 displays the MBL change between implant placement and the last follow-up calculated on 210 implants. The average MBL change of the implants included in the study was estimated to be -0.75 (SD: 1.33), particularly most of the implants lose between 0 to 1mm of MBL during

the follow-up period (47.41%) (Figure 5), one-fourth of the sample experienced a certain amount of MBL gain (26.72%) and 13.81% of the implant lose more than 2mm of MBL. The amount of bone change at different time points is shown in Table 6. Results of the multivariate generalized estimating equations (GEE) analysis revealed that the implants with the greatest MBL loss since T0 are also those with the greatest number of BOP sites (OR:-0.51; ($p$<0.001) (Table 7).

### 3.5 Biological complications

Concerning the presence of biological complications, specifically peri-implant diseases, the prevalence of mucositis and peri-implantitis was evaluated along with their association with patient and implant characteristics. The prevalence of mucositis was 32.89% at the implant level and 44.17% at the patient level, and that of peri-implantitis was 9.78%, and 14.17% at the implant and patient level respectively (Table 8).

Regarding mucositis, results of multivariate GEE analysis revealed that the number of sites with plaque per implant during the follow-up was the variable that most significantly influenced the probability of developing mucositis. Specifically, the risk of developing mucositis increased by 1.5 times for each additional site with plaque accumulation (OR: 1.54, $p$<0.001). Furthermore, two other factors that exhibited some degree of association with the development of mucositis: diagnosis of hypertension and a longer follow-up period-. However, these associations did not reach statistical significance (Table 9).

On the other hand, regarding peri-implantitis, the multivariate analysis determined that patients with hypertension had a significantly higher likelihood of developing peri-implantitis (OR: 3.79, $p$<0.001). Additionally, a greater number of BOP sites during follow-up was significantly associated with an increased probability of peri-implantitis development (OR;1.80, $p$<0.001) (Table 10).

### 3.5 Mechanical complications

Regarding the mechanical complication, it is worth mentioning that out of the 225 implants included in the study, 10.67% (n=24) experienced some mechanical complication during the follow-up period. The most common complications were abutment loosening (3.99%), prosthetic screw loosening (2.23%), and implant fracture (1.78%) (Table 8). Throughout the entire follow-up period, only three prostheses had to be modified in the laboratory: one reason was to allow for proper patient hygiene, another to correct the prosthesis's emergence profile, and the third to replace the resin teeth of an overdenture.

## 4. Discussion

This retrospective study, with a mean follow-up of 11.51 years (SD: 4.0 years), aimed to assess the survival and success rates, marginal bone level changes, clinical parameters, and mechanical and biological complications, of narrow-diameter implants (NDIs) placed in the posterior area.

In this study, it was observed a survival rate of 94.67% at the implant level and 92.50% at the patient level, while the cumulative success rate was 83.33% at implant level and 78.45% at patient level. When comparing these results with the available literature on dental implant in general, a systematic review based on a 5-year follow-up reported a survival rate of 97.1% (95% CI: 95.6%-98.1%) at implant level (39). A retrospective study based on a 10-year follow-up focused on NDIs indicated survival rates of 96.9% at implant level (14). Indeed, our results agree with most of the current literature, where the performance of NDI implants in posterior regions, both in the maxilla (40, 9, 16) and mandible (40, 9, 41, 16), shows survival and success rates comparable to those of regular-diameter implants.

Among the factors that influenced implant survival, this study showed that NDIs in the posterior region of the mandible had a four times higher risk (OR: 4.96) of failure than those in the maxilla. This finding is in agreement with a meta-analysis of prospective clinical studies, where NDIs in maxilla failed five times less frequently than NDIs in mandibula (42*).* Indeed, in our study 10/12 failure occurred in mandibular implants. The fact extended follow-up time was positively correlated with implant survival, can be explained by the fact that most of the failures occurred between the $4^{th}$ and the $6^{th}$ year of follow-up.

In addition to these factors, the risk of implant failure was found to nearly double for each additional site exhibiting bleeding on probing (BOP) (OR: 1.74; p=0.024). From a biological perspective, this finding may be attributed to the strong association between BOP and peri-implant diseases, such as mucositis and peri-implantitis (43). Moreover, the severity of BOP has been correlated with the extent of peri-implant bone loss (43), suggesting a potential link between BOP, peri-implant diseases, marginal bone loss, and implant failure. Supporting this hypothesis, our study demonstrated that an increasing number of BOP sites has a significant negative impact on marginal bone levels (OR=-0.51; p<0.001). Additionally, most implant failures (8 out of 12) occurred in three patients, primarily due to peri-implantitis. These findings suggest that more frequent and pronounced BOP is associated with greater bone loss and an increased likelihood of biological complications, which may ultimately compromise implant survival.

The marginal bone level (MBL) changes observed in this study are consistent with several clinical investigations that reported peri-implant bone loss of less than 1 mm associated with NDI (15, 44, 45). Notably, our findings demonstrate a more favorable outcome compared to a retrospective

clinical study with a similar follow-up period (10.1 years), which reported an MBL change of -1.19 mm (SD: 1.07) (14*)*.

Interestingly, no significant difference regarding survival rate, success and MBL was reported between different restoration type (single crown vs. splinted restoration) and implant location (molar site vs. premolar site). This finding aligns with the study by Shi et al. and can be attributed to the comprehensive pretreatment diagnostic evaluation that was performed in this private clinic. This evaluation involved defining the prosthetic objectives, determining the ideal prosthetic-oriented position for the implant, and assessing local risk factors (such as distal cantilever and the presence of parafunctional habits, among others) (14, 46).

Regarding biological complications, peri-implant mucositis prevalence in this study was 32.89% at the implant level and 44.17% at the patient level, while the prevalence of peri-implantitis was 9.78% at the implant level and 14.17% at the patient level. Our results are comparable with the literature where mucositis ranges from 33.42% to 60.2% (47, 48) and peri-implantitis from 12% to 15.1% (14, 48) in studies with a long (≥9years) follow-up. The prevalence of peri-implantitis observed in our study may be associated with the high level of adherence among participants to the recommended supportive periodontal implant therapy (SPIT), with nearly 90% visiting the dental clinic at least once per year for this purpose.
Moreover, the surgeon's expertise as a periodontist likely facilitated the prompt identification and management of mucositis cases, which are at a higher risk of progressing to peri-implantitis, leading to bone loss and possible implant failure.

This study identified several factors associated with peri-implant diseases. The diagnosis of hypertension appears to be associated with an increased risk of peri-implant diseases, specifically mucositis (OR:1.96; $p$=0.061) and peri-implantitis (OR: 3.79; $p$=0.022). This finding aligns with a recent cross-sectional study by Papi et al., which reported a correlation between peri-implant mucositis and elevated carotid intima-media thickness, a marker of subclinical atherosclerosis. The authors suggested that due to the etiological similarities between periodontitis and peri-implantitis, the latter may also affect the systemic host-immune response and increase bacterial load, potentially increase the risk of vascular complications (49). However, evidence linking systemic conditions, aside from diabetes, as risk factors or indicators for peri-implant diseases remains limited and sparse (50).
Data from the present study also identified an association between the number of sites with plaque and a higher risk of mucositis (OR: 1.52; $p$ <0.001). In this context, outcomes of several cross-sectional clinical studies have indicated that biofilm accumulation is associated with the presence of peri-implant mucositis around dental implants (51, 52).

Regarding peri-implantitis, this study showed that each additional site showing BOP, doubled (OR: 1.80; p <0.001) the risk of developing this disease. Similarly, a case-control study evaluating the diagnostic accuracy of clinical parameters for monitoring peri-implant conditions found that BOP was significantly associated with peri-implantitis compared to peri-implant health (OR = 2.32) (43). However, it is important to highlight that this parameter alone is insufficient to detect peri-implantitis and should therefore be always combined with peri-implant marginal bone loss (53, 37).

Regarding mechanical complications, the use of NDIs in posterior area is often associated with a lower load fatigue performance leading to an increased risk of fracture compared to SDIs (54, 55). In this study 1.78% of the implants (4 out of 225) fractured during the follow-up period, while similar results in NDIs were reported by Lustosa et al. (1.05%) and by Chrcanovic et al (1.35%) where NDI were used also in anterior area (22, 19). Although NDI fractures are rare occurrences in NDIs, when we compare these rates to the overall incidence of implant fractures (i.e NDIs and SDIs), the frequency is lower, ranging from 0.5% to 0.75% (56, 19). It is interesting to point out that in the study of Lustosa et al. most of the fractures in NDIs occurring in patients that showed signs of parafunctional activity (22) while Chrcanovic et al. found that NDIs failure rates was 13.0% in bruxers compared to 4.6% in non-bruxers (P < 0.001) (22, 19). In our study, even if the analysis did not show an association between implant fracture and bruxism, all the implant fractures occurred in those patients without a nightguard. These considerations may point out the importance of the management of parafunctional habits in patients with NDIs.

## 5. Conclusion:

Narrow diameter implants may serve as a reliable long-term treatment option for the rehabilitation of posterior area, potentially reducing the needs for surgical interventions in patients with reduced residual bone. This study observe that the survival and success rates of NDIs are comparable to SDIs in long term follow-up in posterior area. Nevertheless, to minimize the risk of implant fracture, it is crucial to exercise caution in the case selection and treatment plan.

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## 7. Tables

**Table 1: Description of the studied patients and implants at initial examination**

| **Description of the studied patients** | | |
|---|---|---|
| **Overall.** (N=120) | | |
| **Variable** | | **Mean ± SD or n (%)** |
| **Mean follow-up (range) (years)** | | 11.51 ± 4.03 (4-19) |
| **Age** (years). mean (SD) | | 67.12 ± 10.96 |
| **Sex** | Male | 54 (45.00) |
| | Female | 66 (55.00) |
| **Smoke** | Non-smokers | 90 (76.27) |
| | Former smokers | 1 (0.85) |
| | Current smokers | 27 (22.88) |
| **Smoking exposure (pack /year)** mean ±SD | 20 ± 13.6 | |
| **Diabetes** | No | 113 (94,95) |
| | Yes | 6 (5.04) |
| **HTA** | No | 69 (57.50) |
| | Yes | 51 (42.50) |
| **Periodontal disease** | No | 1 (0.80) |
| | Yes | 119 (99.20) |
| **Periodontitis extension** | Generalized | 91 (76.47) |
| | Localized | 28 (23.53) |
| **Periodontitis stage** | **1** | 7(5.88) |
| | **2** | 38 (31.93) |
| | **3** | 28 (23.53) |
| | **4** | 46 (38.66) |
| **Periodontitis grade** | **A** | 41 (34,45) |
| | **B** | 57 (47.90) |
| | **C** | 21 (17.65) |
| **SPIC** | <1 times a year | 13 (10,92) |
| | 1 time a year | 26 (21,84) |
| | 2 times a year | 73 (61,34) |
| | 3 times a year | 7 (5,88) |
| **Parafunctional habit** (Bruxism) | No | 86 (75,43) |
| | Yes | 28 (24,56) |
| **Number of implants** mean (SD) (range) | 1.88 ± 1.21 (1-7) | |
| **Description of the studied implants** | | |
| | **Overall** (N=225) | |

| | | |
|---|---|---|
| **Arch** | Maxilla | 108 (48.00) |
| | Mandible | 117 (52.00) |
| **Tooth type** | Premolar | 147 (65.33) |
| | Molar | 78 (34.67) |
| **Prothesis type** | Single crown | 60 (26.67) |
| | Splinted crown | 165 (73.33) |
| **Retention** | Screwed | 131 (58.48) |
| | Cemented | 88 (39.29) |
| | Ball attachment | 3 (1.34) |
| | Bar attachment | 2 (0.89) |
| **Brand** | Astra | 46 (21.40) |
| | Ankylos | 42 (19.53) |
| | CLC CONIC | 111 (51.63) |
| | Biotech | 13 (6.05) |
| | Others | 3 (1.40) |
| **Diameter** | 3.25 | 2 (0.89) |
| | 3.50 | 208 (92.44) |
| | 3.60 | 13 (5.78) |
| | 3.75 | 2 (0.89) |
| **Lenght** | 8.0 | 88 (39.46) |
| | 9.0 | 28 (12.56) |
| | 9.5 | 15 (6.73) |
| | 10.0 | 38 (17.04) |
| | 11.0 | 32 (14.53) |
| | 12.0 | 13 (5.83) |
| | 13.0 | 5 (2.24) |
| | 14.0 | 4 (1.8) |
| **Surgical protocol** (1-stage, 2-stages) | 1 | 116 (52.49) |
| | 2 | 105 (47.51) |
| **GBR** | No | 178 (80.2) |
| | Yes | 44 (19.82) |

Abbreviations: SD, standard deviation; HTA, hypertension; SPIC, supportive peri-implant care; GBR, guided bone regeneration

**Table 2. Survival and succees**

| **Variable** | | **Position** | | **Prosthesis** | |
|---|---|---|---|---|---|
| **Survival** | **Overall** | **Premolar** | **Molar** | **Single crown** | **Splinted crown** |

| | **N=225** | **N=147** | **N=78** | **N=60** | **N=165** |
|---|---|---|---|---|---|
| N (%) | 213 (94.67) | 141 (95.92) | 71 (92.31) | 57 (95.00) | 156 (94.55) |
| **Variable** | | **Position** | | **Prosthesis** | |
| **Success** | **Overall N=210** | **Premolar N=137** | **Molar N=73** | **Single crown N=57** | **Splinted crown N=153** |
| N (%) | 175 (83.33) | 117 (85.40) | 58 (79.45) | 50 (87.72) | 125 (81.70) |

**Table 3. Probability of failure according to patient profile and clinical characteristics of the implant: univariate and multivariate logistic regression models using generalized estimating equations (GEE), unadjusted OR and 95% confidence interval. Baseline event=failure.**

| | **Univariate** | | | **Multivariate** | | |
|---|---|---|---|---|---|---|
| | **Estimate** | **95% CI** | ***p* value** | **Estimate** | **95% CI** | ***p* value** |
| **Age** | 1.04 | 0.98-1.11 | 0.213 | | | |
| **Sex:** Female | 2.33 | 0.46-11.6 | 0.305 | | | |
| **HTA:** Yes | 1.17 | 0.30-4.61 | 0.819 | | | |
| **Diabetes:** Yes | - | - | - | | | |
| **Smoker:** Yes | 0.70 | 0.08-5.91 | 0.747 | | | |
| **Smoking exposure** | 0.99 | 0.95-0.14 | 0.754 | | | |
| **Periodontitis extension:** Localized | - | - | - | | | |
| **Periodontitis stage** | | | | | | |
| **2** | - | - | - | | | |
| **3** | - | - | - | | | |
| **4** | - | - | - | | | |
| **Periodontitis grade** | | | 0.460 | | | |
| **B** | 1 | | | | | |
| **C** | 1.87 | 0.34-10.1 | 0.469 | | | |
| **SPIC** | | | - | | | |
| 2 times a year | - | - | - | | | |
| 1 time a year | - | - | - | | | |
| <1 times a year | - | - | - | | | |
| **Parafunctional habit** (Bruxism): **: yes** | 0.96 | 0.18-5.18 | 0.958 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Arch:** Mandible | 4.96 | 1.12-21.9 | 4.96 | 13.30 | 1.08-164.8 | **0.044*** |
| **Tooth type:** molar | 1.96 | 0.47-8.10 | 0.353 | | | |
| **Prothesis type:** splinted | 1.10 | 0.26-4.63 | 0.901 | | | |
| **Retention:** cemented | 1.52 | 0.37-6.21 | 0.556 | | | |
| **Lenght** | | | 0.088 | | | |
| 9-10mm | 0.43 | 0.05-3.69 | 0.439 | 0.91 | 0.07-12.2 | 0.942 |
| >10mm | 2.78 | 0.94-8.21 | 0.065 | 14.00 | 2.42-81.3 | **0.003**** |
| **Surgical protocol:** 2 stages | 0.21 | 0.04-1.04 | 0.055 | 0.21 | 0.03-1.40 | 0.107 |
| **GBR:** yes | 0.35 | 0.04-2.95 | 0.336 | | | |
| **Number of sites with BOP** | 1.54 | 1.06-2.24 | **0.024*** | 1.74 | 1.16-2.60 | **0.007**** |
| **Number of sites with plaque** | 0.85 | 0.49-1.46 | 0.552 | | | |
| **Follow-up (years)** | 0.79 | 0.62-0.99 | **0.039*** | 0.71 | 0.59- 0.85 | **<0.001***** |

Abbreviations: CI, confidence interval; OR, odds ratio; HTA, hypertension; SPIC, supportive peri-implant care; GBR, guided bone regeneration BOP, bleeding on probing.

**Table 4. Probability of success according to patient profile and clinical characteristics of the implant: univariate and multivariate logistic regression models using generalized estimating equations (GEE), unadjusted OR and 95% confidence interval. Baseline event=success**

| | **Univariate** | | | **Multivariate** | | |
|---|---|---|---|---|---|---|
| | **Estimate** | **95% CI** | ***p* value** | **Estimate** | **95% CI** | ***p* value** |
| **Age** | 0.99 | 0.95-1.02 | 0.375 | | | |
| **Sex:** Female | 1.18 | 0.47-2.95 | 0.732 | | | |
| **HTA:** yes | 0.38 | 0.16-0.91 | **0.029*** | 0.69 | 0.28-1.71 | 0.421 |
| **Diabetes:** yes | 0.35 | 0.07-1.70 | 0.193 | | | |
| **Smoker:** yes | 0.77 | 0.29-2.05 | 0.596 | | | |
| **Smoking exposure** | 1.00 | 0.93-1.08 | 0.917 | | | |
| **Periodontitis extension:** Localized | 2.11 | 0.87-5.11 | 0.098 | 2.47 | 0.84-7.21 | 0.099 |
| **Periodontitis stage** | | | | | | |
| 1 | - | - | - | | | |
| 3 | 0.64 | 0.23-1.83 | 0.410 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | 0.54 | 0.23-1.83 | 0.252 | | | |
| **Periodontitis grade** | | | **0.038*** | | | |
| B | 0.43 | 0.16-1.21 | 0.111 | 0.51 | 0.19-1.38 | 0.185 |
| C | 0.19 | 0.05-0.68 | **0.011*** | 0.42 | 0.11-1.65 | 0.214 |
| **SPIC** | | | 0.458 | | | |
| 2 times a year | 0.25 | 0.03-2.41 | 0.230 | | | |
| 1 time a year | 0.42 | 0.04-4.22 | 0.459 | | | |
| <1 times a year | 0.47 | 0.03-6.51 | 0.572 | | | |
| **Parafunctional habit** (Bruxism): **: yes** | 0.73 | 0.28-1.87 | 0.506 | | | |
| **Arch:** Mandible | 1.10 | 0.51-2.33 | 0.813 | | | |
| **Tooth type:** Molar | 0.66 | 0.31-1.41 | 0.284 | | | |
| **Prothesis type:** splinted | 0.63 | 0.25-1.59 | 0.323 | | | |
| **Retention:** cemented | 0.48 | 0.18-1.28 | 0.143 | | | |
| **Lenght** | | | 0.415 | | | |
| 9-10mm | 0.55 | 0.22-1.36 | 0.55 | | | |
| >10mm | 1.03 | 0.45-2.39 | 1.03 | | | |
| **Surgical protocol:** 2 stages | 2.78 | 1.06-7.30 | **0.038*** | | | |
| **GBR:** yes | 4.04 | 1.01-16.2 | **0.048*** | 4.50 | 0.78-25.9 | 0.093 |
| **Number of sites with BOP** | 0.51 | 0.39-0.68 | **<0.001***** | 0.51 | 0.36-0.73 | **<0.001***** |
| **Number of sites with plaque** | 0.83 | 0.62-1.11 | 0.215 | | | |
| **Follow-up (years)** | 0.98 | 0.88-1.10 | 0.783 | 1.01 | 0.89 -1.15 | 0.853 |

Abbreviations: CI, confidence interval; OR, odds ratio; HTA, hypertension; SPIC, supportive peri-implant care; GBR, guided bone regeneration BOP, bleeding on probing.

**Table 5. Marginal bone change between implant placement and the last follow-up**

| **Patients level** | **Overall N=116** |
|---|---|
| Mean ± SD (mm) | -0.69±1.11 |
| **Range (mm)** | **n (%)** |
| MBL<0mm | 31 (26.72) |

| | | | | | |
|---|---|---|---|---|---|
| 0mm≤MBL<1mm | 55 (47.41) | | | | |
| 1mm≤MBL<2mm | 18 (15.52) | | | | |
| 2mm≤MBL<4mm | 10 (8.62) | | | | |
| MBL≥4 | 2 (1.72) | | | | |
| **Implant level** | **Overall N=210** | **Position** | | **Prosthesis** | |
| | | **Molar N=73** | **Premolar N=137** | **Single crown N=57** | **Splinted crown N=153** |
| Mean ± SD (mm) | -0.75±1.33 | -0.90±1.52 | -0.66±1.22 | -0.71±1.14 | -0.76±1.40 |
| **Range (mm)** | **n (%)** | **n (%)** | **n (%)** | **n (%)** | **n (%)** |
| MBL<0mm | 64 (30.48) | 20 (27.40) | 44 (32.12) | 15 (26.32) | 49 (32.03) |
| 0mm≤MBL<1mm | 90 (42.86) | 31 (42.47) | 59 (43.07) | 24 (42.11) | 66 (43.14) |
| 1mm≤MBL<2mm | 27 (12.86) | 9 (12.33) | 18 (13.14) | 13 (22.81) | 14 (9.15) |
| 2mm≤MBL<4mm | 21 (10.00) | 9 (12.33) | 12 (8.76) | 4 (7.02) | 17 (11.11) |
| MBL≥4 | 8 (3.81) | 4 (5.48) | 4 (2.92) | 1 (1.75) | 7 (4.58) |

Abbreviations: MBL, marginal bone level

**Table 6. Amount of bone change between prosthesis connection at different time points**

| **Bone change at different time point** (years) | **N** | **Marginal bone change** Mean ± SD or n (%) |
|---|---|---|
| **1** | 126 | -0.29±0.62 |
| **2** | 132 | -0.40±0.79 |
| **3** | 136 | -0.47±0.48 |
| **5** | 125 | -0.33±0.82 |
| **8** | 125 | -0.62±0.88 |
| **10** | 71 | -0.83±1.31 |

**Table 7. Mean bone level changes according to patient profile and clinical characteristics of the implant: univariate and multivariate logistic regression models using generalized estimating equations (GEE), unadjusted OR and 95% confidence interval.**

| | **Univariate** | | | **Multivariate** | | |
|---|---|---|---|---|---|---|
| | **Estimate** | **95% CI** | ***p* value** | **Estimate** | **95% CI** | ***p* value** |
| **Age** | -0.01 | -0.03-0.01 | 0.398 | | | |
| **Sex:** Female | 0.10 | -0.42-0.61 | 0.705 | | | |
| **HTA:** yes | -0.32 | -0.83-0.19 | 0.221 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Diabetes:** yes | -0.30 | -1.00-0.41 | 0.408 | | | |
| **Smoker:** yes | -0.14 | -0.74-0.46 | 0.639 | | | |
| **Smoking exposure** | 0.99 | 0.93-1.09 | 0.919 | | | |
| **Periodontitis extension:** Localized | 0.19 | -0.24-0.62 | 0.377 | | | |
| **Periodontitis stage** | | | | | | |
| 2 | -0.28 | -0.66-0.09 | 0.145 | -0.01 | -0.38-0.35 | 0.948 |
| 3 | -0.71 | -1.13-0.28 | **0.001**** | -0.33 | -0.77-0.12 | 0.150 |
| 4 | -0.60 | -1.14 -0.06 | **0.030*** | -0.31 | -0.71-0.09 | 0.125 |
| **Periodontitis grade** | | | | | | |
| B | -0.23 | -0.59-0.13 | 0.217 | | | |
| C | -0.66 | -1.55-0.23 | 0.148 | | | |
| **SPIC** | | | | | | |
| 2 times a year | -0.34 | -0.98-0.29 | 0.290 | | | |
| 1 time a year | -0.14 | -0.77-0.48 | 0.653 | | | |
| <1 times a year | 0.12 | -0.59-0.83 | 0.741 | | | |
| **Parafunctional habit** (Bruxism): **: yes** | 0.11 | -0.36-0.58 | 0.651 | | | |
| **Arch:** Mandible | -0.31 | -0.71-0.08 | 0.114 | | | |
| **Tooth type:** Molar | -0.24 | -0.65-0.16 | 0.243 | | | |
| **Prothesis type: S**plinted | -0.06 | -0.47-0.36 | 0.789 | | | |
| **Retention:** Cemented | -0.16 | -0.71-0.39 | 0.566 | | | |
| **Lenght** | | | | | | |
| 9-10mm | 0.14 | -0.47-0.75 | 0.649 | | | |
| >10mm | 0.19 | -0.14 0.52 | 0.249 | | | |
| **Surgical protocol:** 2 stages | 0.50 | 0.01-0.99 | **0.044*** | 0.27 | -0.20-0.74 | 0.258 |
| **GBR:** yes | 0.26 | -0.15-0.68 | 0.211 | | | |
| **Number of sites with BOP** | -0.54 | -0.81-0.27 | **<0.001***** | -0.51 | -0.76-0.27 | **<0.001***** |
| **Number of sites with plaque** | -0.06 | -0.26-0.15 | 0.596 | | | |
| **Follow-up (years)** | -0.04 | -0.09-0.02 | 0.174 | -0.03 | -0.08 -0.03 | 0.334 |

Abbreviations: CI, confidence interval; OR, odds ratio; HTA, hypertension; SPIC, supportive peri-implant care; GBR, guided bone regeneration BOP, bleeding on probing.

**Table 8. Biological complications and mechanical complications at follow-up**

| **Biological complication** | | | | | |
|---|---|---|---|---|---|
| **Patients level** | **Overall N=120** | | | | |
| Mucositis | 53 (44.17) | | | | |
| Peri-implantitis | 17 (14.17) | | | | |
| **Implant level** | **Overall N= 225** | **Position** | | **Prosthesis** | |
| | | **Molar N=78** | **Premolar N=147** | **Single crown N=60** | **Splinted crown N=165** |
| Mucositis | 74 (32.89) | 25 (32.12) | 49 (33.34) | 26 (43.33) | 48 (29.09) |
| Peri-implantitis | 22 (9.78) | 11 (14.10) | 11 (7.48) | 4 (6.67) | 18 (10.91) |
| **Mechanical complication** | | | | | |
| **Patients level** | **Overall N=120** | | | | |
| All mechanical complication | 20 (16.67) | | | | |
| | | **Position** | | **Prosthesis** | |
| **Implant level** | **Overall N= 225** | **Premolar N=147** | **Molar N=78** | **Single crown N=60** | **Splinted crown N=165** |
| All mechanical complication | 24 (10.67) | 17 (11.56) | 7 (8.97) | 8 (13.33) | 16 (9.70) |
| Implant fracture | 4 (1.78) | 2 (1.36) | 2 (2.56) | 0 (0.00) | 4 (2.42) |
| Abutment fracture | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) |
| Prosthetic screw fracture | 2 (0.89) | 1 (0.68) | 1 (1.28) | 1 (1.67) | 1 (0.61) |
| Prosthetic screw loosening | 5 (2.23) | 2 (1.36) | 3 (3.85) | 1 (1.67) | 4 (2.42) |
| Abutment looseing | 9 (3.99) | 8 (5.44) | 1 (1.28) | 3 (5.01) | 6 (3.63) |
| Chipping or fracture of the ceramic material | 3 (1.33) | 3 (2.04) | 0 (0.00) | 3 (5.00) | 0 (0.00) |
| Fractures of metal framework | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) | 0 (0.00) |
| Occlusal wear resin teeth of toronto | 1 (0.44) | 1 (0.68) | 0 (0.00) | 0 (0.00) | 1 (0.61) |

**Table 9. Probability of mucositis according to patient profile and clinical characteristics of the implant: univariate and multivariate logistic regression models using generalized estimating equations (GEE), unadjusted OR and 95% confidence interval.**

| | **Univariate** | | | **Multivariate** | | |
|---|---|---|---|---|---|---|
| | **Estimate** | **95% CI** | ***p* value** | **Estimate** | **95% CI** | ***p* value** |
| **Age** | 0.99 | 0.96-1.02 | 0.645 | | | |
| **Sex:** Female | 0.89 | 0.47-1.69 | 0.721 | | | |
| **HTA:** yes | 1.74 | 0.92-3.29 | 0.090 | 1.96 | 0.97-3.97 | 0.061 |
| **Diabetes:** yes | 1.54 | 0.38-6.17 | 0.546 | | | |
| **Smoker:** yes | 1.28 | 0.6-2.67 | 0.517 | | | |
| **Smoking exposure** | 0.97 | 0.89-1.05 | 0.467 | | | |
| **Periodontitis extension:** Localized | 0.56 | 0.26-1.23 | 0.147 | | | |
| **Periodontitis stage** | | | 0.283 | | | |
| 2 | 0.89 | 0.15-5.37 | 0.898 | | | |
| 3 | 1.14 | 0.21-6.28 | 0.878 | | | |
| 4 | 1.94 | 0.35-10.8 | 0.451 | | | |
| **Periodontitis grade** | | | 0.552 | | | |
| B | 1.38 | 0.71-2.69 | 0.346 | | | |
| C | 1.53 | 0.60-3.92 | 0.377 | | | |
| **SPIC** | | | 0.165 | | | |
| 2 times a year | 2.36 | 1.00-5.56 | 0.050 | | | |
| 1 time a year | 2.92 | 1.09-7.84 | **0.034*** | | | |
| <1 times a year | 1.80 | 0.46-7.04 | 0.401 | | | |
| **Parafunctional habit** (Bruxism): **: yes** | 1.55 | 0.73-3.30 | 0.259 | | | |
| **Arch:** Mandible | 0.76 | 0.40-1.42 | 0.382 | | | |
| **Tooth type:** Molar | 0.94 | 0.55-1.63 | 0.835 | | | |
| **Prothesis type: S**plinted | 0.54 | 0.28-1.04 | 0.065 | 0.60 | 0.29-1.25 | 0.176 |
| **Retention:** Cemented | 1.02 | 0.52-2.03 | 0.949 | | | |
| **Lenght** | | | 0.439 | | | |
| 9-10mm | 1.58 | 0.72-3.45 | 0.255 | | | |
| >10mm | 0.94 | 0.44-1.97 | 0.861 | | | |
| **Surgical protocol:** 2 stages | 0.53 | 0.28-1.01 | 0.054 | 0.64 | 0.31-1.33 | 0.232 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **GBR:** yes | 0.92 | 0.47-1.80 | 0.803 | | | |
| **Number of sites with BOP** | -- | -- | **--** | | | |
| **Number of sites with plaque** | 1.54 | 1.29-1.83 | **<0.001*****| 1.54 | 1.29-1.84 | **<0.001***** |
| **Follow-up (years)** | 1.04 | 0.96-1.12 | 0.395 | 1.08 | 0.99-1.18 | 0.079 |

Abbreviations: CI, confidence interval; OR, odds ratio; HTA, hypertension; SPIC, supportive peri-implant care; GBR, guided bone regeneration BOP, bleeding on probing.

**Table 10. Probability of peri-implantitis according to patient profile and clinical characteristics of the implant: univariate and multivariate logistic regression models using generalized estimating equations (GEE), unadjusted OR and 95% confidence interval.**

| | **Univariate** | | | **Multivariate** | | |
|---|---|---|---|---|---|---|
| | **Estimate** | **95% CI** | ***p* value** | **Estimate** | **95% CI** | ***p* value** |
| **Age** | 1.02 | 0.00-0.26 | 0.259 | | | |
| **Sex:** Female | 1.34 | 0.44-4.05 | 0.605 | | | |
| **HTA:** yes | 4.55 | 1.61-12.8 | **0.004**** | 3.79 | 1.22-11.8 | **0.022*** |
| **Diabetes:** yes | 0.92 | 0.11-7.39 | 0.936 | | | |
| **Smoker:** yes | 2.26 | 0.77-6.59 | 0.136 | | | |
| **Smoking exposure** | 0.99 | 0.92-1.08 | 0.917 | | | |
| **Periodontitis extension:** Localized | 0.46 | 0.15-1.47 | 0.191 | | | |
| **Periodontitis stage** | | | | | | |
| 2 | 1 | | | | | |
| 3 | 2.31 | 0.71-7.46 | 0.163 | | | |
| 4 | 1.92 | 0.55-6.78 | 0.309 | | | |
| **Periodontitis grade** | | | 0.103 | | | |
| B | 2.36 | 0.68-8.14 | 0.174 | | | |
| C | 4.95 | 1.14-21.6 | **0.033*** | | | |
| **SPIC** | | | | | | |
| 2 times a year | 1 | | | | | |
| 1 time a year | 0.81 | 0.30-2.16 | 0.666 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| <1 times a year | 0.45 | 0.05-3.80 | 0.459 | | | |
| **Parafunctional habit** (Bruxism): **: yes** | 1.09 | 0.36-3.28 | 0.882 | | | |
| **Arch:** Mandible | 1.70 | 0.62-4.68 | 0.305 | | | |
| **Tooth type:** Molar | 2.03 | 0.86-4.81 | 0.108 | | | |
| **Prothesis type: S**plinted | 1.71 | 0.55-5.40 | 0.357 | | | |
| **Retention:** Cemented | 1.91 | 0.66-5.52 | 0.231 | | | |
| **Lenght** | | | 0.180 | | | |
| 9-10mm | 2.17 | 0.68-6.94 | 0.193 | | | |
| >10mm | 0.62 | 0.16-2.46 | 0.500 | | | |
| **Surgical protocol:** 2 stages | 0.29 | 0.10-0.85 | **0.024*** | 0.39 | 0.12-1.22 | 0.106 |
| **GBR:** yes | 0.17 | 0.02-1.26 | 0.084 | 0.20 | 0.02-2.21 | 0.190 |
| **Number of sites with BOP** | 1.98 | 1.51-2.59 | **<0.001***** | 1.80 | 1.35-2.39 | **<0.001***** |
| **Number of sites with plaque** | 1.25 | 0.91-1.72 | 0.173 | | | |
| **Follow-up (years)** | 1.00 | 0.89-1.13 | 0.965 | 0.99 | 0.86-1.14 | 0.893 |

Abbreviations: CI, confidence interval; OR, odds ratio; HTA, hypertension; SPIC, supportive peri-implant care; GBR, guided bone regeneration BOP, bleeding on probing.

## 8. Figures

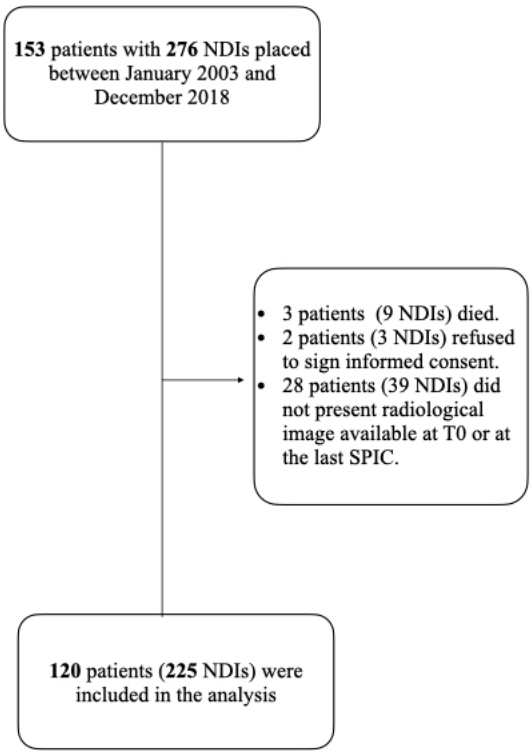


Figure 1. Flowchart of the study
*Abbreviations: NDI, narrow diameter implant; SPIC, supportive peri-implant care*

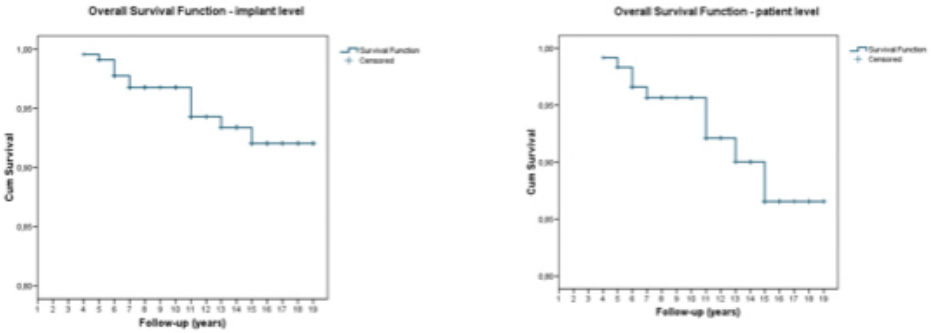


Figure 2. Overall survival function by implant (a) and by patients (b)

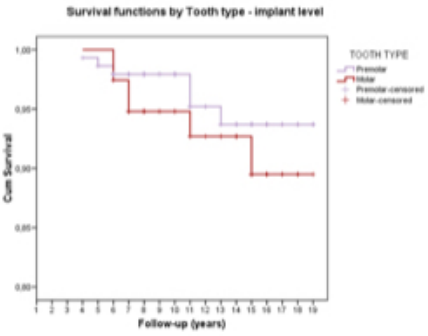


Figure 3. Overall survival function by tooth type

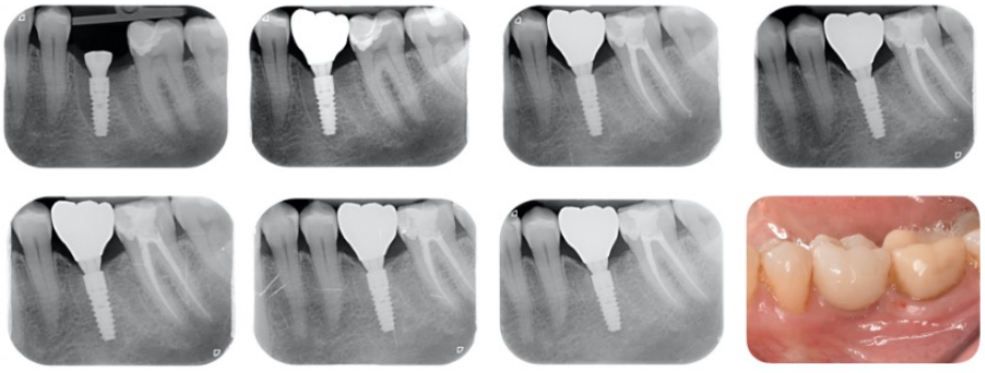

Figure 4. Radiographic and clinical follow-up of a CLC CONIC NDI
*Abbreviations: NDI, narrow diameter implant*