ly restored XiVE implants

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Abstract

Objective: The aim of this prospective cohort study was to assess the ten-year performance of the condensing thread, self-tapping apex and internal hexagonal connection XiVE implant supportingpartial fixed prostheses placed with an immediate restoration approach.

Material and methods: All patients received a fixed two- to four-unit partial provisional restoration supported by immediately loaded implants. The final gold alloy/ceramic restorations were cemented approximately 28 weeks after implant insertion. Marginal bone level, pocket probing depth and percentage of bleeding on probing, biological or technical complications and any other adverse events were measured annually up to ten years after surgery. The overall success and survival rates at implant level were evaluated following the International Congress of Oral Implantologists (ICOI) Pisa Consensus Conference criteria. Implant placement inpost-extractive or healed sites, smoking and a history of periodontal treatment were evaluated to assess whether they had an influence on bone resorption or on implant survival.

Results: Of 114 patients, for a total of 284 implants, fulfilled all the inclusion criteria and were enrolled in the study. 78 (27.5%) implants placed in 30 (26.3%) patients were lost to follow-up. Eight of 284 (2.8%) implants failed in 8 of 114 (7.0%) patients: one (12.5% of losses) due to failureto achieve osseointegration and seven (87.5% of losses) due to peri-implantitis. No cluster implant failures were assessed. The failure of the implant caused the failure of the prosthesis due to the strategic position of the implant in four patients. At the final ten-year follow-up, 121 (61.4%) implants exhibited a "full success" status with an optimal health condition, 21 (10.9%) implants scored a "satisfactory survival" condition, while 49 (25.49%) of the implants were classified as "compromised survival" status (Misch et al. 2008). Smoking was found to be statistically associated with "implant failure" ($P = 0.010$), while no association was found for patients treated for periodontal disease ($P = 0.679$) and post-extractive surgical sites ($P = 0.664$). Statistically significant more marginal bone loss was found in patients treated for periodontal disease ($P < 0.0001$). An increased bone loss was also observed in smokers, but the difference with the non-smokers was not statistically significant ($P = 0.06$).

Conclusions: The XiVE implants can be successfully used to support immediate prosthesis. Patients with a history of periodontitis show increased bone loss and risk to develop peri-implant disease.Smoking seems to jeopardize the long-term implant survival.

The prevention and the diagnosis of the bio- logical complications of an implant treat- ment are well described (Lang et al. 2000; Karoussis et al. 2003). The beginning of the year 2000 brought the development of moder- ately rough implant surfaces and macrode- signs that are nowadays considered to represent the gold standard for implant treat- ment. In recent years, an increasing number of papers have reported on the long-term results of these implants (Rasmusson et al. 2005; Al-Nawas et al. 2012; Covani et al.2012; Degidi et al. 2012a; Ortorp & Jemt 2012; Ostman et al. 2012; Roccuzzo et al. 2012). Some of those investigations claimed to have spotted key factors that may haveinfluenced the outcome of the implant treat- ment.

The 10-year results of the study involving periodontally compromised patients (Roccuzzo et al. 2012) led the authors to the conclusion that patients with a history of peri- odontitis presented a statistically significant higher number of sites which required addi- tional treatment. 112 patients wearing partial restorations were classified according to their initial periodontal condition: healthy, moder- ately compromised and severely compro- mised. Statistically significant differences were found between the groups in need of both antibiotic and/or surgical therapy and the pres- ence of a probing depth ≥6 mm. Degidi assessed the 10-year performance of immedi- ately loaded parallel design, self-tapping implants with a porous anodized surface (De- gidi et al. 2012a). The implants supported fixed prostheses placed with an immediate loading approach in both post-extractive and healed sites. 18 (37.5%) patients, for a total of

29 (18.34%) implants, exhibited signs of adverse events in soft tissues over the whole follow-up period, and a mean marginal bone resorption of 1.95 mm (SD: 0.38; min:
1.5 mm; max 2.7 mm) was found in each patient. The authors concluded that positive long-term results for bone maintenance were to be expected only when adequate levels of oral hygiene were maintained. In their 9-year follow-up of full-arch, implant-supported reha- bilitations, Vervaeke et al. recently concluded that both smoking and history of periodontitis affected long-term peri-implant bone stability (Vervaeke et al. 2014).

Short-term studies involving the condens- ing thread, a self-tapping apex and internal hexagonal connection XiVE (XiVE DENTS- PLY Implant manufacturing GmbH, Mann- heim, Germany) implant (Degidi et al. 2006, 2012b) were unable to find any statistically significant correlation between the failures of the implants examined and factors such as smoking or a history of treated periodontitis.

The aim of this prospective study was to assess the long-term performance of the XiVE implants supporting fixed partial prostheses placed with an immediate restoration approach. Marginal bone level, pocket probing depth and percentage of bleeding on probing were measured annually up to ten years after surgery. Implant placement in post-extractive or healed sites, smoking and a history of peri- odontal treatment were evaluated to assess whether they had an influence on bone resorp- tion or on implant survival. The overall suc- cess and survival rates at implant level were evaluated following the International Con- gress of Oral Implantologists (ICOI) Pisa Con- sensus Conference criteria (Misch et al. 2008).

Material and methods

The present prospective cohort study included adult patients with the need of a partial resto- ration. The study was designed and conducted in full accordance with the ethical principles for medical research involving human sub-jects published in the year 2000 fifth revision of World Medical Association Declaration of Helsinki. All patients signed a specific written informed consent form. Exclusion criteria were as follows: (i) presence of infection in the oral cavity, such as untreated pocket on natu- ral teeth or peri-apical fistulae; (ii) systemic disease that could compromise osseointegra- tion such as untreated diabetes; (iii) radiation therapy in the craniofacial region within the previous 12 months; (iv) pregnancy or lacta- tion; and (v) bruxism. During the implant placement procedure, the insertion torque and the implant stability quotient (ISQ) were recorded using a surgical unit (FRIOS Unit E, W&H Dentalwerk GmbH, Buermoos, Austria) and a digital measurement probe (Osstell AB, Göteborg, Sweden). Patients were dropped from the study if any kind of loss of integrity was observed in the socket walls or in the healed bone, such as unexpected dehiscences, fenestrations or fractures caused by implant insertion or tooth extraction. Patients were also dropped if after the surgery, any of the implants met one of the following conditions:
(i) insertion torque <25 Ncm and (ii) an implant stability quotient (ISQ) of <60. Patients were classified as non-smokers only if they declared the complete abstinence from cigarettes from at least five years prior to treatment. If a patient quitted smoking during the observational period was nevertheless kept in the smokers group. Patients were clas- sified as positive for a history of treated peri- odontitis if they underwent any periodontal therapy (Sbordone et al. 1999) excluding only routine professional hygiene sessions. Tooth extraction was considered in cases that jeop-sardized the integrity of the root such as end- odontic failure, destructive decay or traumatic root fractures. At least one week before sur- gery, all patients were instructed to be in good oral hygiene and informed of its long-term importance and underwent professional scal- ing and root planning if needed. All implants were placed by a single experienced surgeon (MD) in a private dental office in Bologna, Italy. The patients were treated using 3.4- mm-, 3.8-mm- or 4.5-mm-diameter XiVE implants. Implants with lengths from 8.0 mm to 15.0 mm were used.

Preoperative analysis of anatomical features was performed using analogical peri- apical and panoramic radiography. All patients underwent the same surgical proto- col. Antimicrobial prophylaxis was obtained with amoxicillin 500 mg (Amoxicillin; Pfizer Manufacturing, Puurs, Belgium), twice daily for 5 days starting one hour before surgery. Local anesthesia was induced by infiltration with articaine 4% (40 mg/ml). After a crestal incision, a mucoperiosteal flap was elevated. Depending on the site of surgery, sensitive anatomical features such as the mental foramina were located. In cases for which a post-extractive procedure was planned, care was taken during tooth extraction to preserve the socket

walls. All implants were inserted with the 1.1-mm smooth crestal implant collar above the alveolar crest in accordance with the procedures recommended by the manufacturer in both post-extractive and healed sites. No bone-grafting material was employed, and extensions at implants and on tooth abutments were always avoided. The provisional bridges were always prefabricated and were relined over the temporary abutments (TempBase; DENTSPLY Implant manufacturing GmbH, Mannheim Germany) that came with the implant package using acrylic resin. The restoration was then removed, trimmed, polished and screw- retained using a 15.0-N-torque wrench. Occlusal contacts were checked with an8-lm shimstock foil (Almore International; Portland, OR, USA) and avoided in both centric and lateral excursions. Sutures were removed 14 days after surgery. 18 weeks after implant insertion, the provisional restoration was unscrewed, implant stability was checked, and a final impression of the implant was recorded using a custom tray, a polyvinylsiloxane impression material and a pickup transfer. The final gold alloy/ceramic restoration was cemented (TempBond; Kerr Corporation, Orange, CA, USA) approxi- mately 28 weeks after implant insertion. All final restorations were placed in full occlu- sion checked firstly with a 60-lm-thin articu- lating paper (Dr. Jean Bausch Gmbh & Co, Köln Germany) and then with an 8-lm shimstock foil (Almore International). Post- surgical analgesic treatment was performedwith Nimesulid (Merck, Cinisello Balsamo, Milano, Italy) 100 mg twice daily for three days. Patients were instructed to have a soft diet for at least four weeks. The patients were recalled for a professional cleaning treatment by a dental hygienist every six months. Scaling or scaling and root planing were performed as needed. The final prosthe- ses were not routinely removed to confirm the stability of the implants. These data were recorded only once at the time of the removal of the temporary restoration, 18 weeks after surgery.

Analogic peri-apical radiographs were taken with a polyvinylsiloxane positioning jig and holder. A set of factors were assessed at each follow-up:

- Changes in marginal peri-implant bonelevel defined as modification of the distance between the implant–abutment junction and the highest coronal point of the supporting bone. The measurement was rounded off to the nearest 0.1 mm. A Peak Scale Loupe (Peak Optics, GWJ Co., Hacienda Heights, CA, USA) with a mag- nifying factor of 79 and a scale graduated in 0.1 mm were used. Measurements were taken mesially and distally and then averaged for each implant.
- Pocket depth and frequency of bleeding on probing assessed with mesial, distal and buccal probing made using a metal probe (PCP-UNC-15; Hu-Friedy, Chicago, IL, USA) rounded off to the nearest millimeter.
- Presence of mucositis defined as "reversible inflammatory reactions in the soft tissues surrounding a functioning implant" (Albrektsson & Isidor 1994) was clinically manifested as inflammation of the muco- sal cuff around the neck of the implant associated with edema, redness and bleed-ing on probing assessed using a metal probe (PCP-UNC-15; Hu-Friedy).
- Presence of peri-implantitis defined as "inflammatory reaction with loss of supporting bone in the tissues surrounding a functioning implant" (Albrektsson & Isi-dor 1994) was clinically manifested as infection associated with milky exudate and bone loss around the implant in the form of radiological translucency.
- Prosthetic complications and any other adverse events.

Follow-up frequency was as follows:

- T0: after surgery and fitting of the imme-diate provisional restoration;
- T1: six months after surgery, first final restoration check;
- T2: one year after surgery.
- T3 to T11: yearly follow-up up for a period of ten years after surgery.

Statistic

Success and survival rates at implant level were evaluated following the International Congress of Oral Implantologists (ICOI) Pisa Consensus Conference criteria (Misch et al. 2008).

Life table analysis of implant survival data was performed for the pool of all implants placed using the following criteria:

- Time interval: the duration of this study is divided into 11 intervals.
- Number of implants at the beginning of the time interval.
- Number of implants failed during the time interval. Implants were considered failed when removed from the patient for mobility or failure to completely eradicate a peri-implant infection.
- Number of dropouts during the time interval.
- Survival rate during the time interval.
- Cumulative survival rate.

The pool was then divided for pairwise comparisons between the following sub- groups:

- healed vs. post-extractive sites.
- smokers vs. non-smokers patients.
- periodontally untreated vs. periodontally treated patients.

The Shapiro–Wilk test was used to assess the data normality. The Cox proportional hazards model was used to test the three variables: post-extractive surgical site, smoke and past periodontal disease, against the event "implant failure". The nonparametric two-tailed Mann–Whitney test was used to compare the average amount of bone loss. The significance level was set at 5%. Statisti- cal analysis was performed by an independent statistician using Statistical Product and Service Solutions – SPSS 20 (IBM Corpora- tion, Armonk, NY, USA) software.

Results

The inclusion period of this study lasted for 18 months from September 2001 to July 2003. 125 patients were enrolled and treated using 315 implants. Eleven patients with 31 implants were excluded because they failed to meet the surgical inclusion criteria. Four patients (13 implants) were excluded due to failure to achieve the established primary stability prerequisites. Seven patients (18 implants) were excluded because of an impairment of the surgical site. Therefore, 114 patients for a total of 284 implants ful- filled the post-surgery inclusion criteria and were enrolled in the study. The mean age of the patients at the time of surgery was 53.1 years (SD = 15.7). 88 (30.9%) and 196(69.0%) implants were, respectively, placed in 34 (28.8%) smoking and 80 (71.2%) non-smoking patients. 203 (71.5%) and 81 (28.5%) implants were, respectively, placed in 82 (71.9%) periodontally untreated and 32 (28.07%) periodontally treated patients. 191 (67.2%) and 93 (32.7%) implants were, respectively, placed in healed and post- extractive sites. 80 patients for a total of 193 implants were available for the final ten-year follow-up. 30 (26.3%) patients with 78 (27.5%) implants were lost during the course of the study because they were unavailable or unwilling to attend the follow-up. Eight patients experienced an implant failure. The details of the failed implants are presented in Table 3. No clus- ter implant failures were assessed. In four patients (50% of losses), the failure of the implant caused the failure of the prosthesis due to the strategic position of the implant. The cases were consequently dropped from the study, causing a loss to follow-up of four patients and five stable implants. The average insertion torque and ISQ values of the 284 implants included in the study are listed in Table 1. No implant fractures were recorded (Tables 2 and 4). The scores of the ICOI success and survival rates at implant level (Misch et al. 2008) are listed in Table 5. Nonparametric statistics was used because some data subgroups were not normally distributed. Smoking was found to be statisti- cally significant associated with "implant failure" ($P = 0.010$), while no significant association was found for the patients treated for periodontal disease ($P = 0.679$) and the post-extraction sites ($P = 0.664$). A statistically significant increased bone loss ($P < 0.0001$) was assessed in patients treated for periodontal disease (2.01 mm [SD 0.27] vs. 1.79 mm

[SD 0.34]). A concomitant aver- age increase in the pocket depth, 3.3 mm (SD 0.58) vs. 2.2 mm (SD 0.66), was also assessed. No statistically significant bone loss was found in smoking patients (P = 0.06) (1.81 mm [SD 0.35] vs. 1.94 mm [SD 0.29]) and when comparing healed with post-extrac- tive sites (P = 0.14) (1.87 mm [SD 0.33] vs. 1.83 mm [SD 0.23]).

Prosthetic complications

45 of the 114 patients (39.5%) that were approved for inclusion in the study reported prosthetic-related problems, of which 18 (40%) occurred during the first six-month temporary phase of the treatment and 27 (60%) involved the final metal ceramic restoration.

A repeated relining procedure was required in three (2.6%) patients to avoid food entrap- ment. Two (1.7%) patients that wore a the detachment of the prosthesis because of cement failure. Nine (7.9%) patients reported minor chipping of the porcelain veneer of the final restoration, which were repaired with a specific light-cured composite resin, polished and delivered to the patients in less than one hour. A complete detachment of the ceramic veneer was assessed in seven (6.1%) patients. The prostheses were then sent to a dental laboratory for a complete reapplication of the esthetic veneer.

Biological complications

One patient, a 55-year-old male non-smoker, reported moderate discomfort associated with redness and swelling in the anterior maxilla three weeks after surgery. The temporary restoration, a two-unit bridge, was removed and subsequent examination revealed that a 15-mm-long 3.8-mm-diameter implant placed in the left lateral incisor post-extractive site was mobile. The implant was removed, and the patient underwent a cycle of 500 mg beta-lactam antibiotics twice daily for 5 days. The patient was dropped from the study and was treated with a bone graft and a new two- stage implant surgery.

One patient reported a prolonged sensorial disturbance after the placement of a three-unit prosthesis in the mandible near the mental foramina area. A 2.0 mm distance from the distal implant to the nerve was assessed at the immediate the radiographic control. The patient recovered spontaneously five weeks after surgery without any extra drug treatment.

Three patients reported nuisance associated with moderate chewing difficulties in the days following the surgery. All patients were then recalled for a control of the occlusion scheme of the temporary restoration, which was carefully adapted to clear any early con- tact.

During the course of the study, a total of 35 (18.13%) of the 193 implants available for the final ten-year follow-up placed in 26 (32.5%) patients presented signs of inflammation of the mucosal cuff around the neck of the implant associated with edema, redness and bleeding on probing. The implants were classified as positive for mucositis and were treated with weekly professional submucosal debridement sessions and home mouth rinses with 0.2% chlorhexidine until the complete remission of the symptoms. 16 (8.29%) implants placed in 14 (17.5%) patients presented more important signs of infection, associated with purulence and peri-implant radiological translucency. The implants were then classified as positive for peri-implantitis. The restorations were removed, and a full-thickness flap was ele- vated. The bone defect and implant surface were deeply cleaned and debrided using car- bon curettes. Local irrigation with 1 g of tet- racycline was performed, and the soft tissues were sutured in place. Home mouth rinses with 0.2% chlorhexidine and local applica- tion of 1% chlorhexidine gel were prescribed; the prostheses were cemented again at the complete remission of the symptoms. Two (1.04%) of the implant subject to peri-im- plantitis placed in two (2.5%) patients pre- sented recurrent signs of infection and underwent a further therapy cycle. The final restoration was removed, and an implantopl- asty at the supracrestally exposed implant parts was performed to smoothen the implant surface. A total of seven (2.47%) of the 284 implants placed in seven (6.1%) of the 114 patients included in this study were lost because the treatment failed to completely eradicate the peri-implant infection. In three patients, the implant was removed and the prosthesis was carefully relined and modified. Pain was immediately controlled with 1000 mg of paracetamol, and the patient underwent an antimicrobial cycle, consisting of 500 mg beta-lactam antibiotic twice daily for five days. The modified prosthesis was delivered to the patients two days after implant removal. In four cases, the final

pros-thesis was lost because of the strategic posi- tion of the implant.

Discussion

This prospective cohort study assessed the ten-year performance of the condensing thread, self-tapping apex and internal hexagonal connection XiVE implant sup- porting partial fixed prostheses placed with an immediate restoration approach. At the final ten-year follow-up, 121 (61.4%) implants exhibited an optimal health condi- tion, with no pain, mobility or tenderness upon function, <2.0 mm of radiographic bone loss from surgery and no exudates his- tory. At the same time point, 21 (10.9%) implants scored a "satisfactory survival" condition, while 49 (25.49%) of the implants were classified as "compromised survival" status (Misch et al. 2008). The implants placed in post-extractive sites exhibited a similar bone loss pattern com- pared to the implants placed in healed sites. No difference in survival rate, bone loss or pocket probing depth was found between the two groups. Approximately 45% of the supporting bone lost during the whole 10- year follow-up reabsorbed within the first year after surgery. A minor but considerable remodeling, consisting in 0.4 mm average, was assessed in the hard tissue after the five-year follow-up. Minor prosthetic problems, such as porcelain veneer chipping from the final restoration and final abutment screw loosening, were reported by 45 of the 114 patients (39.5%) that were approved forinclusion in the study. This result is comparable with a previous 10-year report of our group involving porcelain-fused-to-gold alloy final restorations (Degidi et al. 2012a), and other long-term reports involving the most common prosthetic complications for fixed partial implant-sup- ported dental prostheses (Zurdo et al.2009).

Although previous studies reported cluster implant failures, especially in maxillary cases (Ekfeldt et al. 2001;Ortorp & Jemt 2012), all implants removed in this study were single failures. Due to the fact that our study included only partial cases, in four of eight patients (50%), the failure of one implant caused the failure of the prosthesis due to the strategic position of the implant. While the short-term studies published were not able to assess a significant correlation between the failures of the studied implant and smoking (Degidi et al. 2006, 2012b), the results of this study suggest that smoking significantly influences longterm survival prospects. Except for one case, all implant failures happened in smokers, and a statistically significant association was found between the smoking habit and "implant failure" (P=0.010). This result is partially consistent with the outcomes already reported (€ Ortorp & Jemt 2012), as those authors reported an increased loss of implants in smokers compared with non-smoker group (P<0.01). In the interval between the 5th and the 10th year of function, Al-Nawas and coworkers reported a rate of loss of 6% for non-smokers compared to the 13% of the smoking patients (Al-Nawas et al. 2012). Smoking also seems to affect bone remodeling. As far as bone levels were concerned, statistical differences were already observed (€ Ortorp & Jemt 2012) between smokers and non-smokers only in the first year of examination. In our study, a increasing but not statistically significant difference was found between smokers and non-smokers. It is of interest that, at the ten-year follow-up, smoking patients retained higher average values of marginal probing, 2.8 mm (SD 1.03) vs. 2.4 mm (SD 0.63), but a lesser incidence of bleeding onprobing (15.2% vs. 18.9%). This result may be explained by a possible influence of smoke on the microvascularization of the soft tissues. As already pointed out by Ostman, the combination of poor oral hygiene and smoke is sufficient to jeopardize the favorable results of implant rehabilitation (Ostman et al. 2012). Although our study did not classify the patients in terms of good or poor oral hygiene performance, the majority of the cases that presented an implant failure featured the presence of plaque and dental calculus in the inferior lingual sector, moderate or severe staining in the non-occlusal surfaces and halitosis.

Notwithstanding repeated oral hygiene and debridement sessions, patients unwilling to maintain the chair-side cleaning results at home are to be considered "at risk". ". A comparable conclusion was made by our group in another long-term study, as the results led us to state that, in the long term, positive results in regard to bonemaintenance when using implants with a porous anodized surface were to be expected only when adequate levels of oral hygienewere maintained (Degidi et al. 2012a). Both the importance of hygiene motivation and the adhesion to a strict supporting peri- odontal therapy as key factors in enhancing long-term outcomes of implant therapy by preventing or controlling any possible further infection were already discussed (Roccuzzo et al. 2012). In our study, acomparison was performed between peri- odontally untreated patients and patients treated for periodontal disease. No differ- ence was found in the long-term survival rate of the implants, respectively, 97.3% and 95.6%. Heitz-Mayfield

suggested that individuals with a history of periodontitis that are treated with implant-supported prosthesis have an increased risk to develop peri-implant disease (Heitz-Mayfield 2008). As far as bone levels were considered, a statistically significant difference ($P < 0.0001$) was found between periodontally untreated (1.79 mm SD 0.34) and periodontally treated (2.01 mm SD 0.27) patients in bone level changes. Moreover, three of the 138 (2.2%) implants placed in the first group (periodontally untreated) presented peri-implantitis during the observation period. In comparison, 13 of the 55 implants (23.6%) placed in the second group (periodontally treated) were found to be positive for peri-implantitis. These figures represented a ten-fold increase in the risk of being prone to peri-implantitis in patients with previous records of treated periodontal disease good or poor oral hygiene performance, the (Fig. 1). A precise comparison with the results of Roccuzzo (Roccuzzo et al. 2012) cannot be made as our study was planned with a less precise patient classification at the beginning of treatment. However, a comparable conclusion can be drawn as patients with natural teeth and a history of periodontitis presented a higher risk of infective complications related to their implants, in concordance with a systematic review (Schou 2008).

This cohort study was designed in the year 2000 and presents some intrinsic limits. Accessibility for oral hygiene at the implant sites (Serino & Ström 2009), the cement presence (Wilson 2009) and the height of the prosthetic abutment (Linkevicius et al. 2013), factors today related to the presence or absence of peri-implantitis, were not recorded. The definitions of mucositis and peri-implantitis that were the gold standard more than ten years ago (Albrektsson & Isidor 1994) could be considered nowadays generic, as the proportions of implants and patients that exhibit peri-implant diseases are influenced by used criteria and percentages may greatly vary with respect to the disease definition (Cecchinato et al. 2014).

Conclusions

The XiVE implants can be successfully used to support immediate partial prosthesis in the long term. Patients with a history of periodontitis show increased bone loss and risk to develop peri-implant disease. Smoking seems to jeopardize the long-term implant survival.

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Table 1 Average insertion torque and TSQ values

Torque (Ncm) (*n* = 284; min: 25, max: 79)	46.79 (SD 13.61)
ISQ (*n* = 284; min: 61, max: 82)	71.66 (SD 6.13)

Table 2. Bone loss patterns (mm)

	Cumulative				
Months	Mean	SD	Min	Max	Median
6	0,44	0,15	0,08	0,96	0,46
12	0,84	0,20	0,27	1,27	0,89
24	1,02	0,22	0,34	1,54	1,04
36	1,17	0,24	0,41	1,78	1,17
48	1,30	0,28	0,55	1,95	1,31
60	1,41	0,29	0,58	2,06	1,44
72	1,52	0,32	0,61	2,21	1,55
84	1,61	0,32	0,75	2,35	1,65
96	1,68	0,34	0,83	2,56	1,78
108	1,75	0,35	0,88	2,52	1,87
120	1,81	0,36	0,81	2,56	1,93

	Healed sites			Post-extractive sites		
Months	Mean	SD	Median	Mean	SD	Median
6	0.44	0.15	0,47	0.44	0.14	0,45
12	0.85	0.20	0,89	0.83	0.21	0,88
24	1.03	0.21	1,05	1.03	0.22	1,03
36	1.19	0.23	1,18	1.17	0.24	1,12
48	1.31	0.28	1,31	1.31	0.27	1,30
60	1.42	0.29	1,42	1.43	0.28	1,44
72	1.54	0.32	1,55	1.53	0.31	1,58
84	1.63	0.33	1,64	1.62	0.30	1,67
96	1.72	0.34	1,78	1.71	0.32	1,75
108	1.80	0.34	1,87	1.79	0.31	1,88
120	1.87	0.33	1,93	1.83	0.33	1,93

	Non-smokers			Smokers		
Months	Mean	SD	Median	Mean	SD	Median
6	0.42	0.14	0,43	0.50	0.16	0,51
12	0.81	0.20	0,87	0.91	0.17	0,94
24	1.00	0.21	1,02	1.09	0.19	1,08
36	1.16	0.23	1,14	1.25	0.23	1,24
48	1.27	0.27	1,26	1.39	0.27	1,37
60	1.38	0.28	1,38	1.51	0.28	1,53
72	1.49	0.31	1,51	1.64	0.31	1,68
84	1.57	0.31	1,59	1.74	0.32	1,82
96	1.66	0.32	1,68	1.84	0.33	1,89
108	1.76	0.34	1,84	1.88	0.30	1,95
120	1.81	0.35	1,88	1.94	0.29	1,97

	Periodontally healthy			Periodontally treated		
Months	Mean	SD	Median	Mean	SD	Median
6	0.43	0.15	0,44	0.48	0.15	0,49
12	0.83	0.21	0,88	0.89	0.17	0,90
24	1.02	0.22	1,04	1.07	0.18	1,07
36	1.17	0.24	1,14	1.22	0.21	1,20
48	1.30	0.28	1,28	1.34	0.25	1,32
60	1.40	0.29	1,42	1.48	0.27	1,48

72	1.50	0.32	1,51	1.63	0.29	1,64
84	1.58	0.32	1,59	1.74	0.30	1,79
96	1.66	0.32	1,68	1.87	0.31	1,89
108	1.74	0.33	1,81	1.95	0.28	2,01
120	1.79	0.34	1,86	2.01	0.27	2,04

Table 3. Details of the failed implants

Site	Diameter	Length	Smoke habit	Periodontal status	Time of loss	Status of the site	Bridge units number
16	4.5	13 mm	Smoker	Healthy	T10 – nine years	Post-extraction	Four elements
22	3.8	15 mm	Non-smoker	Treated	Failed to integrate	Post-extraction	Four elements
22	3.4	13 mm	Smoker	Treated	T6 – five years	Healed	Three elements
23	3.8	13 mm	Smoker	Healthy	T9 – eight years	Post-extraction	Two elements
21	3.8	15 mm	Smoker	Treated	T8 – seven years	Healed	Three elements
47	4.5	11 mm	Smoker	Healthy	T8 – seven years	Post-extraction	Three elements
45	3.8	11 mm	Smoker	Healthy	T9 – eight years	Healed	Four elements
34	3.4	13 mm	Smoker	Healthy	T11 – ten years	Healed	Four elements

Table 4. Pocket probing pattern (mm)

	Cumulative				Non-smokers		Smokers	
Months	Mean	SD	Min	Max	Mean	SD	Mean	SD
6	1.9	0.40	1	3	1.9	0.36	1.8	0.46
12	1.9	0.42	1	3	2.0	0.37	1.9	0.52
24	2.0	0.46	1	3	2.0	0.38	2.0	0.61
36	2.0	0.46	1	3	2.0	0.39	2.0	0.62
48	2.2	0.59	1	3	2.2	0.53	2.1	0.71
60	2.3	0.60	1	4	2.2	0.54	2.4	0.69
72	2.4	0.61	1	5	2.3	0.55	2.5	0.70
84	2.3	0.60	1	5	2.2	0.49	2.5	0.74
96	2.4	0.69	1	4	2.2	0.56	2.7	0.83
108	2.5	0.77	1	4	2.3	0.57	2.8	1.01
120	2.5	0.82	1	4	2.4	0.63	2.8	1.03

	Periodontally untreated		Periodontally treated		Healed sites		Post-extractive sites	
Months	Mean	SD	Mean	SD	Mean	SD	Mean	SD
6	1.9	0.38	1.9	0.46	1.9	0.43	1.9	0.34
12	1.9	0.37	2.0	0.48	1.9	0.46	1.9	0.35
24	1.9	0.39	2.1	0.58	2.0	0.50	1.9	0.37
36	1.9	0.38	2.1	0.52	2.0	0.51	1.9	0.36
48	2.1	0.51	2.3	0.74	2.2	0.63	2.1	0.52
60	2.1	0.53	2.8	0.54	2.3	0.62	2.3	0.55
72	2.2	0.49	2.8	0.58	2.4	0.62	2.3	0.57
84	2.1	0.57	2.7	0.63	2.3	0.68	2.2	0.55
96	2.1	0.60	3.1	0.47	2.4	0.69	2.4	0.73
108	2.2	0.58	3.3	0.61	2.5	0.76	2.5	0.79
120	2.2	0.66	3.3	0.58	2.5	0.81	2.6	0.87

Table 5. Success and survival rate at implant level (International Congress of Oral Implantol-ogists (ICOI) Pisa Consensus Conference criteria) (Misch et al.2008)

Months	Health scale I	II	III	IV	Available implants
6	282	0	0	0	282
12	282	0	0	0	282
24	279	0	0	0	279
36	274	0	0	0	274
48	268	0	2	0	270
60	247	2	9	0	258
72	230	5	16	1	252
84	208	13	24	1	246
96	179	18	34	1	232
108	151	17	41	2	211
120	121	21	49	2	193

I: success; II: satisfactory survival; III: compro-mised survival; and IV: clinical or absolute failure.

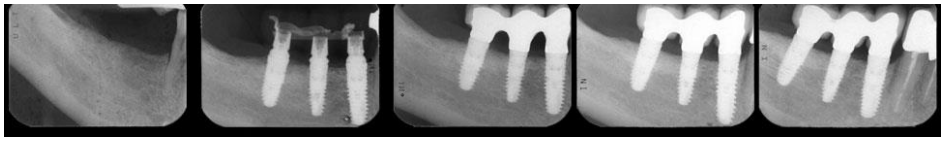

Fig. 1. Periapical radiographs taken before surgery, immediately after implant placement and provisionalization, at the delivery of the final restoration, at the five and at the ten-year follow-up.