Crestal Bone Resorption 5 Years After Implant Loading: Clinical and Radiologic Results with a 2-stage Implant System

Giano Ricci, MD, MScD[1]/Mario Aimetti, DDS[2]/Walter Stablum, DDS[3]/Alessandro Guasti, DDS[4]

Purpose: *The aim of the present study was to assess crestal bone resorption 5 years after loading by conducting a clinical and radiographic evaluation of 112 Frialit-2 implants consecutively placed in 51 patients from January 1994 through June 1994.* ***Materials and Methods:*** *All implants were placed in the same private-practice clinic by the same surgeon. Clinical assessment included plaque score monitoring, bleeding on probing, probing depth, type of occlusion, and prosthetic adaptation. Intraoral radiographs were taken and compared using suitable software to accurately measure peri-implant bone resorption.* ***Results:*** *The survival rate of the implants was 100%. Plaque was present on 47 (42%) implants. Bleeding on probing was detectable at 17 implants (15.5%). Probing depth was > 5 mm for 5 implants (4.5%). Crestal bone resorption was > 3 mm for 32 implants (28.6%); the average observed crestal bone resorption was 2.17 ± 1.6 mm.* ***Discussion:*** *The survival rate of the implants may be the result of the relatively short functional period as well as the strict and frequent clinical evaluations associated with oral hygiene procedures during the supportive periodontal therapy.* ***Conclusion:*** *The results suggest that with strict plaque control, and provided that the patient follows a regular program of supportive therapy, crestal bone resorption around a 2-stage implant system may be limited.* INT J ORAL MAXILLOFAC IMPLANTS 2004;19:597–602

Key words: *crestal bone resorption, wide-diameter dental implants*

Endosseous osseointegrated implants provide a predictable method for restoring completely and partially edentulous patients with fixed or removable restorations. A large number of investigations have focused on the complex biomechanical phenomena that occur at the bone-implant interface.[1,2] Some studies have reported positive outcomes for wide-diameter implants,[3–5] which are designed to better dissipate functional loads across bone-implant interfaces.[3–7]

[1]Private Practice in Periodontics and Implant Dentistry, Florence, Italy.
[2]Specialist in Stomatology and Maxillofacial Surgery, Department of Periodontology, University of Turin, Turin, Italy; Private Practice, Turin, Italy.
[3]Private Practice, Trento, Italy.
[4]Private Practice in Prosthodontics, Florence, Italy.

Correspondence to: Dr Giano Ricci, Via G. Capponi, 26, Florence, Italy. Fax: + 39 055 24 27 63. E-mail: dr.gianoricci@libero.it

The Frialit-2 implant system (Friadent, Mannheim, Germany), which represents the evolution of the Tübingen and Munich Frialit implants, has been described previously.[7–11] Tapered implants may offer multiple benefits. With tapered implants, lingual and buccal fenestrations are less likely to occur in maxillary and mandibular concavities. They are useful when adjacent teeth have converging roots, a situation in which the use of traditional cylindric implants may be problematic. Furthermore, large-diameter implants enable the prosthodontist to create emergence profiles that are closer to those of the natural dentition. Some authors have suggested that there may be a correlation not only between implant length and bone load but also between implant diameter and bone load.[3–5] A larger implant surface may lessen the amount of local bone deformation that occurs.[5,9]

The purpose of this retrospective study was to evaluate clinical outcomes of implants loaded for 60 months. Criteria evaluated were implant survival, bleeding on probing, clinical probing depth, and marginal bone levels.[12,13]

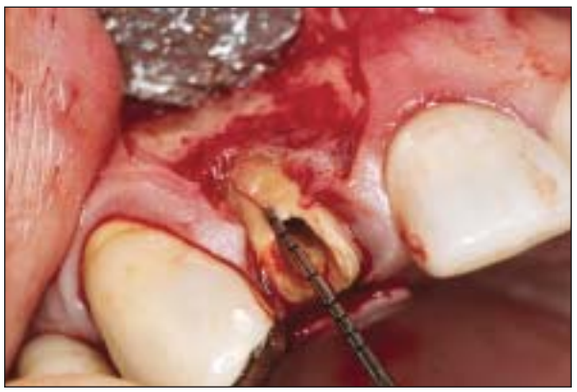

Fig 1a Incisive maxillary root showing vertical fracture of a lateral incisor root.

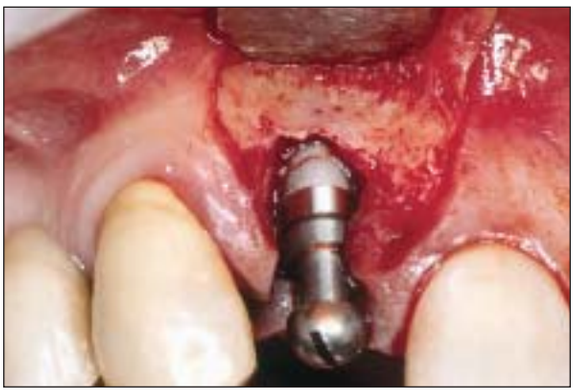

Fig 1b Postextraction positioning of the implant.

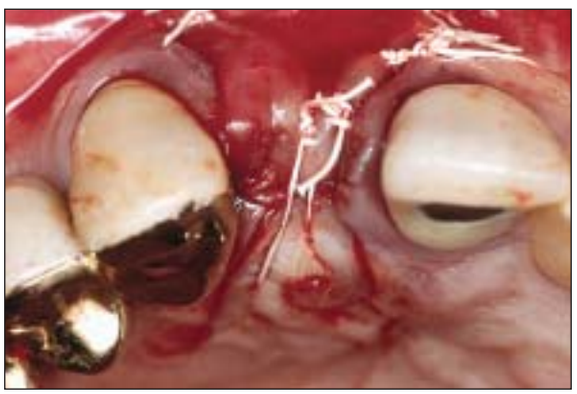

Fig 1c A Gore-Tex suture was used for primary closure of the flaps.

MATERIALS AND METHODS

Fifty-one patients (25 men and 26 women) were consecutively treated with 112 Frialit-2 implants in the same private dental clinic by the same surgeon from January 1994 through June 1994. Prior to surgery, all patients underwent a pretreatment phase consisting of oral hygiene instruction, scaling and root planing, and surgical periodontal treatment where necessary to obtain optimal periodontal health of the residual natural dentition. Thirty (58.8%) of the patients were nonsmokers. The patients ranged in age from 18 to 72 years; the average age was 47.7 years.

Prior to the implant placement surgery, the patients received antibiotic therapy (amoxicillin and clavulanic acid or 1 g Erythrocin [Abbott Pharmaceutical, Abbott Park, IL] 1 hour before surgery), and the oral cavity was disinfected by rinsing the mouth with a 0.12% chlorhexidine mouthwash for 1 minute. After preparation of the surgical field to ensure a sterile environment, local anesthesia (2% Xylocaine [AstraZeneca, London, United Kingdom] and norepinephrine 1:100,000) was administered. A crestal incision was made, and 2 mucoperiosteal flaps (buccal and lingual) were elevated. Following tooth removal when indicated, the implants were placed and primary closure of the flaps was obtained over each implant head, creating optimal conditions for uneventful healing. Interrupted sutures and horizontal mattress sutures were placed using a nonresorbable material (Gore-Tex; W. L. Gore and Associates, Newark, DE) (Figs 1a to 1c).

Postoperative pain and edema were controlled by administering 100 mg nimesulide every 12 hours. In the first week after surgery, amoxicillin and clavulanic acid were administered, or 1 g Erythrocin every 12 hours in the case of allergy to penicillin. Patients were instructed to rinse twice daily with a 0.12% chlorhexidine mouth rinse and to avoid brushing the surgical site for 3 weeks. In the first few hours after surgery, patients were instructed to apply an icepack at the surgical site. All patients were told to follow a soft diet for at least 7 days to avoid masticatory trauma at the operation site. Suture removal was performed at 10 days. Subsequently, patients were examined every month for 6 months before second-stage surgery.

Second-stage surgery, which consisted of the creation of buccal and lingual apically based flaps in the mandible and of buccal apically based flaps associated with thinned palatal flaps in the maxilla, was conducted to gain access to the underlying implants. In some instances, gingivectomies were performed in the maxillary arch. Healing caps were placed and interrupted expanded polytetrafluoroethylene (e-PTFE) sutures were used for flap closure. Radiographs were taken at each implant site using the long-cone technique. These radiographs were considered the standard for subsequent measurements of bone resorption. The baseline for bone resorption was set at the level of the implant head. From that

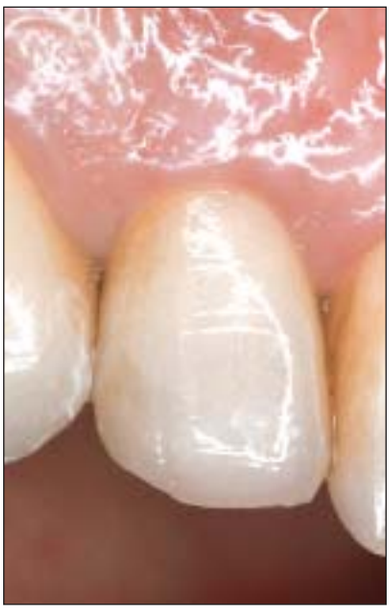

Fig 2a Definitive ceramic crown in the esthetic zone.

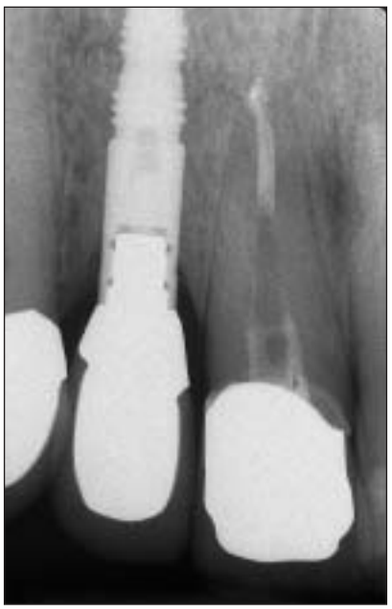

Fig 2b Radiographic image of an implant taken to measure peri-implant bone loss. Some crestal resorption can be seen on the mesial and distal aspects of the implant.

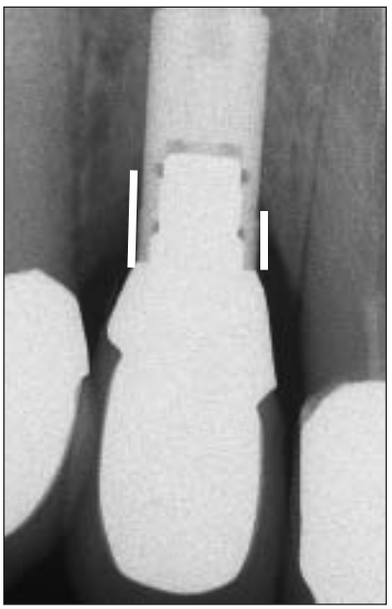

Fig 2c Bone resorption at the mesial and distal aspects of an implant.

time on, radiographs were taken every 6 months until the fifth year and were compared with the baseline radiograph. The procedure was not standardized because the idea of assembling organized data arose after several implants had been positioned.

After initial maturation of the soft tissues, temporary acrylic resin crowns were placed to provide initial loading of the implants. Postoperative instructions were similar to those given after first-stage surgery. The temporary restorations remained in situ for 3 to 6 months. After this period, definitive restorations were placed (Fig 2a). In all treated patients, the opposing dentition consisted of natural teeth. All patients were kept under regular maintenance care and received full-mouth scaling every 3 to 5 months. At each treatment visit, occlusal adjustment of the prosthetic restorations was made if necessary, and home care procedures were reinforced.

Five years after implant loading, clinical and radiographic evaluation of the implants was performed. Plaque accumulation, bleeding on probing, and probing depth were measured at 6 points around each implant without removing the crowns. Plaque accumulation and bleeding on probing were scored as either 0 (no plaque/bleeding) or 1 (plaque present/bleeding occurred).[14] To score probing depth, a calibrated mechanical probe (Florida Probe, Gainesville, FL) was used to control the probing force. Reference was made to the highest probing value.

Intraoral periapical radiographs were obtained using a Rinn alignment system (Dentsply Rinn, Elgin, IL) to enable the measurement of peri-implant bone loss (Fig 2b). Customized positioners could not be used because of the retrospective character of the study. Radiographs were scanned with HP Scanjet 5370 C (Hewlett Packard, Palo Alto, CA) and analyzed with software (Scion Image 4.02 Win; Scion, Frederick, MD) that was able to compensate for radiographic distortion on the basis of the known diameter and length of the implants. The software calculated bone resorption at the mesial and distal aspects of the implants (Fig 2c).

RESULTS

Fifty-one patients with 112 implants were recalled and re-examined with no dropouts. Implant site distribution is shown in Table 1. Twelve implants (10.7%) were placed in the anterior region of both jaws, while 100 (89.3%) were placed in the premolar and molar areas. The majority of the implants used (71.8%) were 4.5 mm in diameter. The 3.8-mm-wide implants (13.6%) were used for the replacement of maxillary lateral incisors, mandibular incisors, premolars, and situations in which crestal conditions did not allow the use of larger-diameter implants. The 5.5-mm-diameter implants (14.6%), which were suitable for molar replacement, were used when bone ridges were at least 7.5 mm wide (Fig 3). Of the implants placed, 100% were still in situ 5 years after functional loading.

Table 1a Implant Distribution in the Maxilla

	1 (18)	2 (17)	3 (16)	4 (15)	5 (14)	6 (13)	7 (12)	8 (11)	9 (21)	10 (22)	11 (23)	12 (24)	13 (25)	14 (26)	15 (27)	16 (28)
No. of implants placed	0	2	3	11	5	2	0	3	3	1	1	11	8	5	2	0

Table 1b Implant Distribution in the Mandible

	17 (38)	18 (37)	19 (36)	20 (35)	21 (34)	22 (33)	23 (32)	24 (31)	25 (41)	26 (42)	27 (43)	28 (44)	29 (45)	30 (46)	31 (47)	32 (48)
No. of implants placed	0	5	19	8	4	1	0	0	0	0	1	3	5	6	3	0

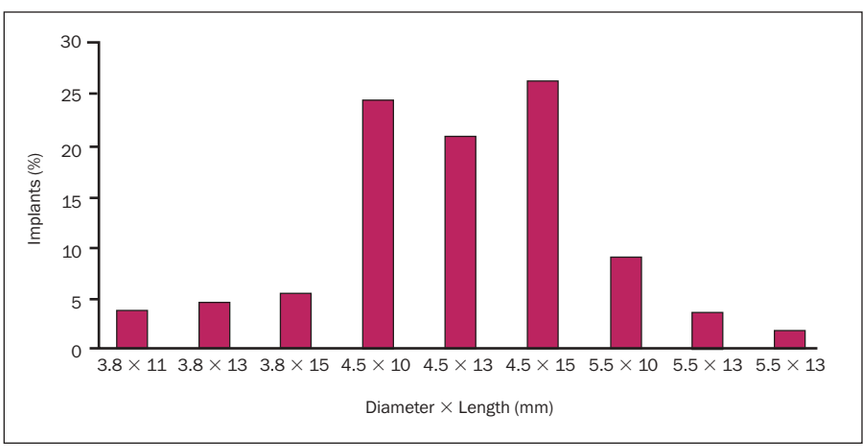

Fig 3 Implant diameter distribution.

Radiographic Results

Eighty implants (71.4%) had less than 3 mm of crestal bone loss. In 27 cases (24.1%), bone loss was between 3 and 5 mm, and in 5 cases (4.5%) it was more than 5 mm. The average mesial bone loss was 2.18 ± 1.6 mm, and the average distal bone loss was 2.16 ± 1.5 mm; overall mean bone loss was 2.17 ± 1.6 mm (Fig 4).

Periodontal Parameters

None of the examined patients demonstrated any implant mobility or tenderness upon percussion of the implants. Bacterial plaque was not detectable on 65 implants (58%), while 47 implants (42%) exhibited plaque on at least 1 of the tested sites. Ninety-five implants (84.5%) did not demonstrate any sign of gingival inflammation, while in the remaining 17 implants (15.5%) bleeding on probing was observed.

For 80 implants (71.4%), probing depth did not exceed 3 mm. Probing depth was between 3 and 5 mm around 27 implants (24.1%) and was greater than 5 mm around 5 implants (4.5%).

Prosthetic Parameters

On the basis of a static maxillomandibular analysis of occlusion, 38 patients (74.6%) had Class I malocclusion—and 2 patients (3.9%) had Angle Class I malocclusion with crossbite in the lateral segments; 9 patients (17.6%) had Class II malocclusion; and 2 patients (3.9%) had Class III malocclusion.

The presence of parafunctional activity was also investigated. Bruxism was diagnosed in 3 patients (5.9%), involving 6 implants (5.3%), while clenching was diagnosed in 3 patients (5.9%), involving 9 implants (8%).

The occlusal surface was ceramic for 109 crowns (97.3%) and gold alloy for 3 crowns (2.7%). Fifteen crowns (13.4%) were anchored to the abutments using horizontal screws, while 97 crowns (86.6%) were cemented. Fifty-two implants (46.4%) supported single-tooth restorations; 60 (53.6%) restored larger posterior edentulous areas. Of these, 40 supported prostheses with 2 connected elements and 20 supported pontics with 3 elements.

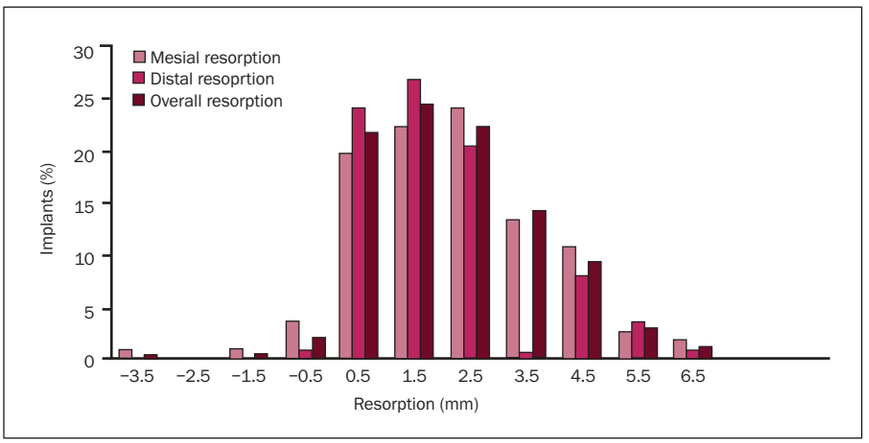

Fig 4 Peri-implant bone loss.

Table 2 Clinical and Treatment Parameters for the 5 Implants with Peri-implant Complications 5 Years After Loading

Patient/ implant no.	Smoker	Crestal bone loss	Plaque	Probing depth	Prosthetic adaptation	Bleeding on probing
1						
1	No	5 mm	0	7 mm	Inadequate	Yes
2	No	6 mm	0	8 mm	Inadequate	Yes
3	No	4 mm	1	7 mm	Inadequate	Yes
2						
1	Yes	4 mm	0	7 mm	Inadequate	Yes
2	Yes	4 mm	0	6 mm	Inadequate	Yes

For plaque, 0 = no plaque found; 1 = plaque present.

Prosthetic Complications

In 6 patients (5.35%) with a total of 8 implants (7.1%), loosening of the screw connecting the abutment to the implant was observed on 2 occasions, and it was speculated that the loosening was caused by parafunctional habits since wear facets were observed and the occlusal analysis did not detect any interference. In 2 patients (1.8%) with a total of 5 implants (4.5%), an inadequate crown-abutment connection was observed.[15] In these patients, the prosthesis consisted of a maximum of 3 screw-retained splinted units. The outcomes of poor-fitting implant-supported prostheses were worse than the outcomes of those showing good adaptation. These 5 implants did not feature optimal clinical or radiologic conditions 60 months after loading (Table 2). While radiographic examination at the time of second-phase surgery showed adequate implant-to-bone crest healing, 60 months after functional loading, coronal bone loss was more than 5 mm. The radiographs obtained at 12, 24, 36, and 48 months showed initial bone resorption but did not suggest a pathologic, progressively worsening condition. Periodontal parameters confirmed considerable loss of peri-implant support with all 5 implants. In these 2 patients, oral hygiene was compatible with periodontal health.

DISCUSSION

In this study, the Frialit-2 implant system was used primarily to treat distal-extension situations. All patients were judged to have optimal periodontal conditions before implant placement. After surgery and at each recall they were remotivated to comply with oral hygiene at home.

The small number of patients, a relatively short functional period, and rigorous periodontal and prosthetic monitoring may help to explain the high survival rate,[16] although 5 implants showed prosthetic complication, and their survival could be considered tenuous.

The mean bone resorption after 60 months of loading was 2.17 ± 1.6 mm. However, for 32 implants (28.6%) the bone loss was more than 3 mm. This might be explained by the need in the esthetic zones to place the implants deeper into the bone, including the smooth transgingival collar of 2 mm (Fig 4).

Table 2 shows that 5 (15.6%) of 32 implants that had > 3 mm of crestal bone loss demonstrated peri-implant complications at the clinical and radiologic evaluation after 60 months. In these patients the prosthesis consisted of 3 connected crowns supported by 2 or 3 implants. One restoration was cement-retained, while the other was screwed to the abutments. Since plaque control compliance was adequate, it was speculated that the cause for bone resorption could be attributed to inappropriate prosthesis adaptation to the abutments. Because of the functional ankylosis of the implant-bone connection, any horizontal stress at the coronal portion of the implant could generate tensile or compression forces at the bone-implant surface, resulting in rapid bone resorption and possibly eventual implant loss.[15–21] It is difficult to anticipate how quickly an inadequate fit can cause peri-implant damage in a single patient, since in the patients examined, previous radiographs and the assessment of periodontal parameters did not suggest any peri-implant bone loss.[15,17,18]

CONCLUSIONS

Many parameters need to be verified to support the reliability of an implant technique or system. The authors are aware that while a retrospective study can provide important information, the knowledge gained is not the equivalent of rigorous scientific data from a stringent prospective research protocol.[22] This work, however, confirmed that numerous variables must be monitored to put forward arguments that can scientifically support a given technique or system. While the study suggests the effectiveness and reliability of the implant system used, it is incomplete and stimulates further additional investigation to obtain data in a future multicenter prospective study.

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