Clinical and radiographic evaluation of immediately loaded one-piece implants placed into fresh extraction sockets

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Objective: To assess clinical survival and success rates of one-piece implants placed at the time of tooth extraction with immediate temporization and to evaluate radiographic peri-implant bone loss around one-piece implants 1 year after functional loading. **Method and Materials:** Forty-six patients (20 men and 26 women) with a mean age of 45.5 years (range, 24 to 74 years) were recruited from 4 centers for this case series report. Immediately following the extraction of untreatable teeth, all patients received one-piece implants. The implants were immediately restored and placed into function with no occlusal contact. Outcome assessments included clinical and radiographic evaluations. **Results:** Of the one-piece implants placed after extraction in the maxilla and mandible, 95.7% integrated successfully. The mean marginal bone loss after 1 year was 0.80 mm (SD, 0.53 mm). Overall peri-implant bone loss at maxillary sites was compared with overall bone loss at mandibular sites. At the 1-year follow-up, no statistically significant difference was found. The deeper the implants were placed below the crest, the more marginal bone loss was observed. However, no difference in marginal bone loss was observed as a consequence of the following three variables: implant length (10, 11.5, or 13 mm), implant diameter (3, 3.7, or 4.7 mm); and 3- and 6-month time periods after implant prosthesis placement. **Conclusion:** Based on data obtained from this sample size study, it can be concluded that one-piece implants can be successfully placed immediately after extraction with minimal peri-implant bone loss. *(Quintessence Int 2012;43:xxx–xxx)*

Key words: bone loss, extraction socket, immediate loading, one-piece dental implant, radiographic evaluation, survival rate

The complex phenomenon of peri-implant bone loss is not widely understood. A number of suggestions have been made to explain peri-implant bone loss.[1,2] These suggestions include *(1)* compromised blood supply due to surgical trauma such as incision and flap elevation during implant placement; *(2)* bone overheating and excessive pressure during drilling procedures; *(3)* reformation of biologic width[3,4]; *(4)* premature occlusal overload causing incomplete bone healing and pressure-induced bone resorption[5–9]; *(5)* peri-implantitis due to bacterial infection; and *(6)* the existence of a microgap inherent to two-piece implant procedures. The microgap creates a space between the abutment and implant body, which often leads to bacterial colonization and subsequent peri-implant bone loss.

A new one-piece implant has been developed to eliminate complications resulting from this microgap. Arguably, one-piece implants reduce peri-implant crestal bone loss and assist remodeling of soft tissue.[10–12] However, very little information is currently available regarding outcomes of immediate one-piece implant placement with provisionalization. Therefore, the objectives of this multicenter study are to assess clinical survival and success rates of one-piece implants placed at the time of tooth extraction with immediate temporarization and peri-implant bone loss around the one-piece implant 1 year after functional loading.

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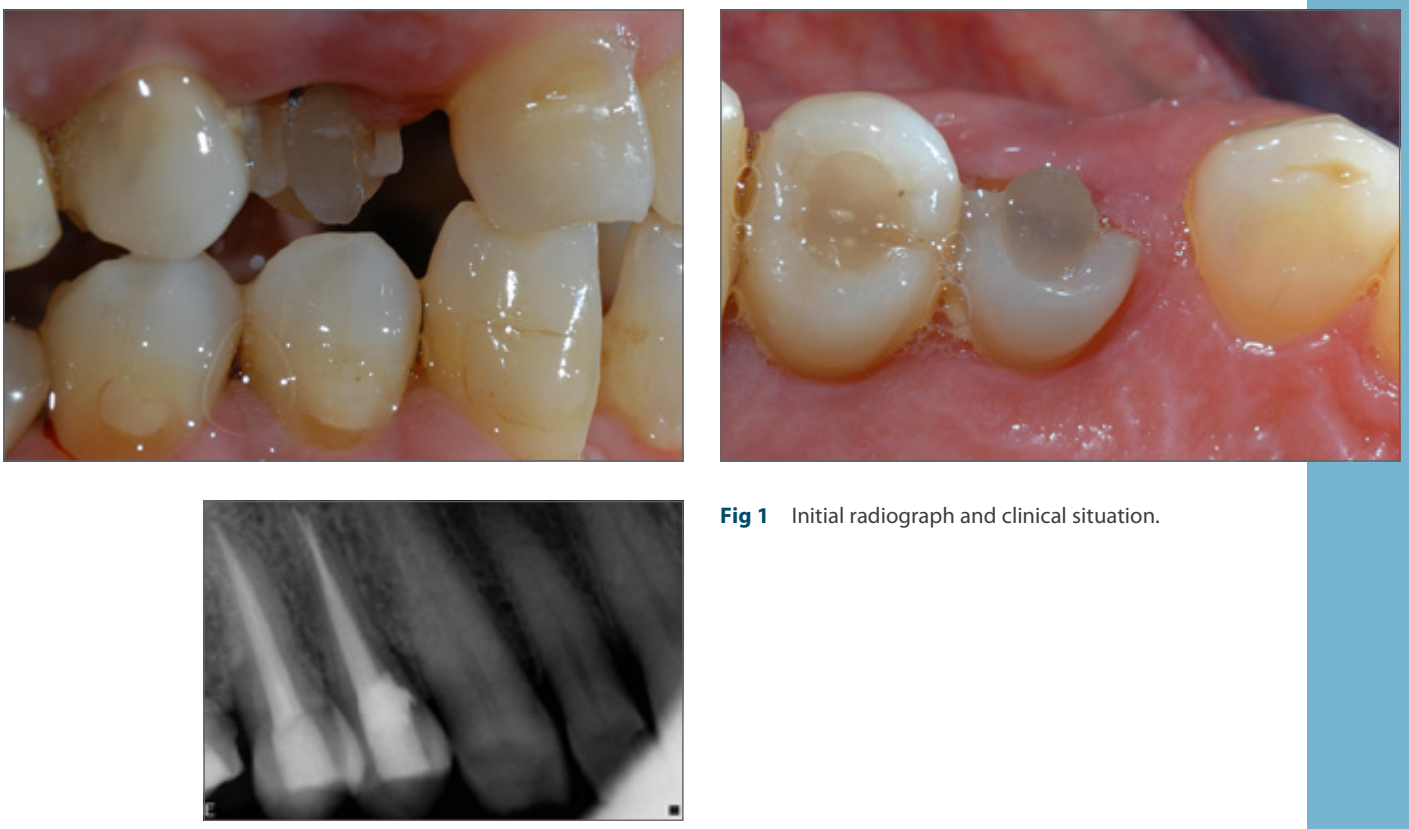


Fig 1 Initial radiograph and clinical situation.

METHOD AND MATERIALS

This case series report included 46 patients from 4 different clinical centers. Patients had to be at least 18 years of age and present adequate bone volume to support an implant without the requirement of bone augmentation.

Bone volume was determined by clinical inspection and palpation. In the event that bone volume could not be accurately determined by clinical examination, bone volume was assessed by computed tomography (CT) scans. After implant placement, both residual facial and palatal/lingual plates were required to have a thickness of at least 1.5 mm. Additionally, the implant site had to permit the placement of an implant at least 10 mm in length (Fig 1).

Exclusion criteria for this study included all medical conditions that adversely affect implant surgery (eg, severely compromised immune system, uncontrolled systemic disease, bleeding disorder, mucosal disease, etc), radiation therapy performed in the head and neck area, previous bone grafting in the surgical areas within the previous 6 months, a history of mental instability, pregnancy, medications (including anticoagulants), and untreated dental disease or pathology.

Additionally, local factors including poor oral hygiene or motivation, active infection, absence of keratinized mucosa, and lack of occlusal contacts with the opposing dentition precluded patients from participating in this study. Moreover, only nonsmokers or smokers who smoked fewer than 10 cigarettes a day were selected.

All patients received only one one-piece implant, with postplacement definitive restoration after 3 or 6 months. At the time of the definitive restoration (either 3 or 6 months after implant placement), and 12 months after implant placement, postoperative evaluations were performed.

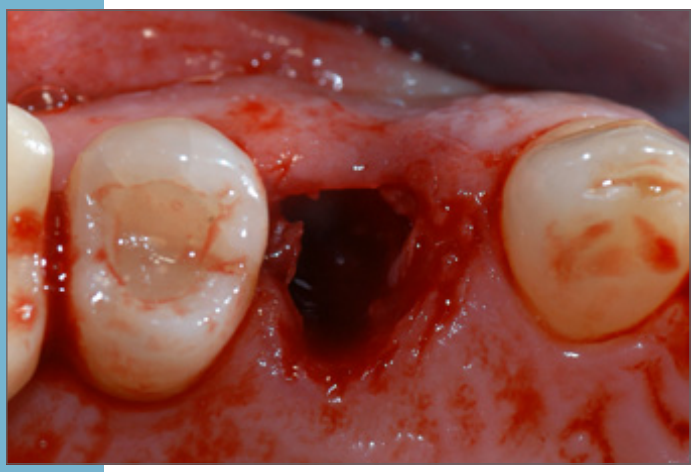
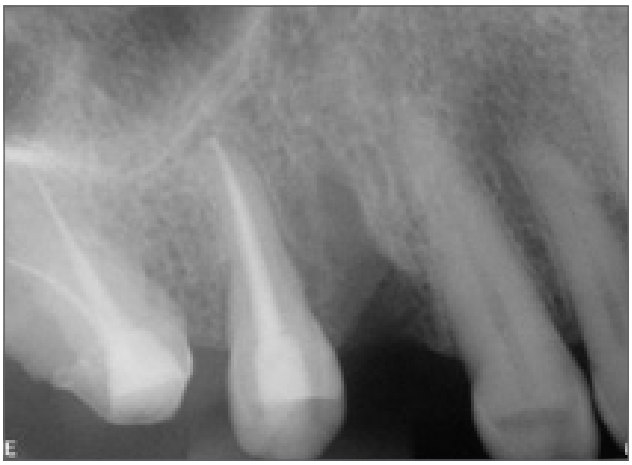



Fig 2 Alveolar socket after the atraumatic extraction.

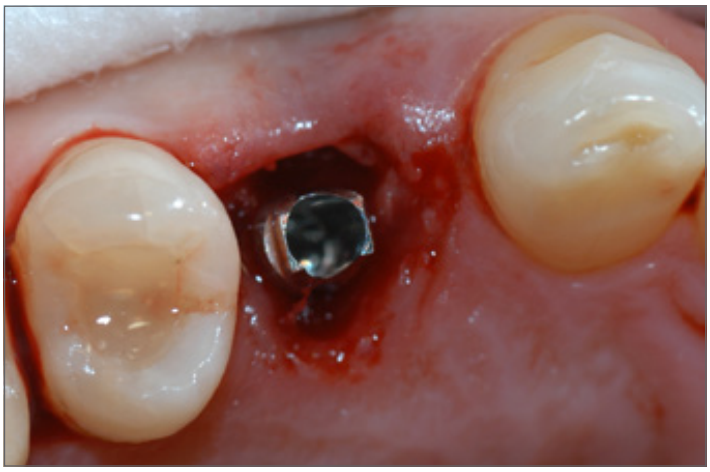
Table 1 **Demographic information of the 46 one-piece implants placed**

	Diameter (mm)		
Implant length (mm)	**3.0**	**3.7**	**4.7**
10	0	0	1
11.5	1	13	5 (1 failed)
13	6	18 (1 failed)	2
Total	7	31	8

Surgical procedures

The one-piece implant (One-Piece, Zimmer Dental) utilized for this study has a tapered body section placed into the jaw bone and an abutment section extending into the oral cavity though the soft tissue. The tapered body section with a microtextured (MTX) surface is manufactured in 3.0, 3.7, and 4.7 diameters. From a small, cylindrical cervical section, three lead threads taper downward, providing two vertical cutting grooves and one cross-vent for bone-chip harvesting at the apical end designed for self-tapping insertion. The contours of a natural tooth preparation with a straight emergence profile are reproduced in the abutment section. Different anatomical considerations are accommodated by different implant diameters.

Local anesthesia was used prior to implant placement. For precaution and standardization, all patients received prophylactic antibiotics. Prefabricated surgical guides were used to promote ideal implant site preparation. Osteotomy preparation was performed following standard surgical protocol recommended by the manufacturer. Implants were subsequently inserted with a minimal torque of 45 Ncm. Implant length and diameter were selected based on the investigator's judgment with the intention of utilizing the maximum amount of available bone. Table 1 lists information regarding implant diameters and lengths used in this study. Prior to immediate implant insertion, all bony walls of the socket had to exist and remain intact (Fig 2). Additionally, the gap between implant and surrounding socket walls had to be less than 2 mm to eliminate the need for bone grafting.[13–15] When mechanical stability of the implant was achieved, the implant was restored with a provisional prosthesis utilizing a prefabricated provisional coping (Figs 3 and 4). All excess cement was carefully removed. A standardized periapical radiograph was then taken to ensure full seating of the crown as well as the absence of



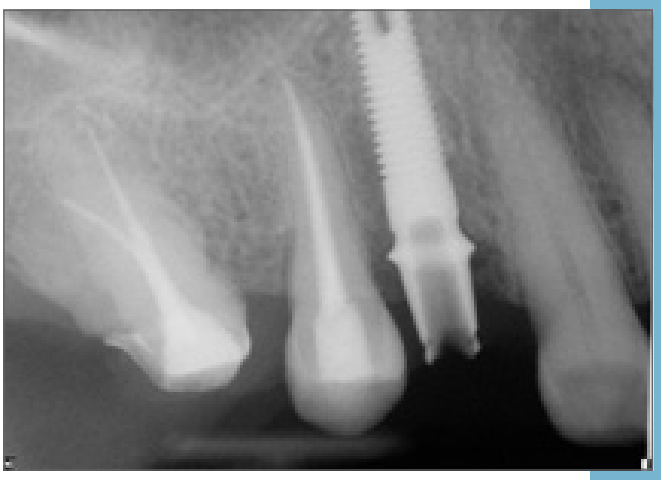
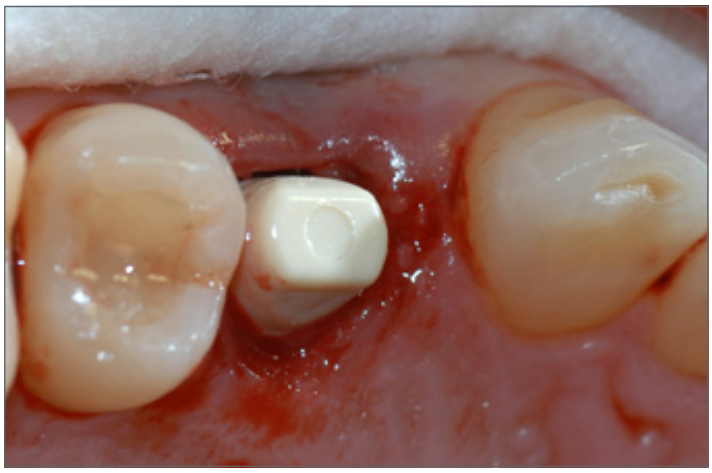
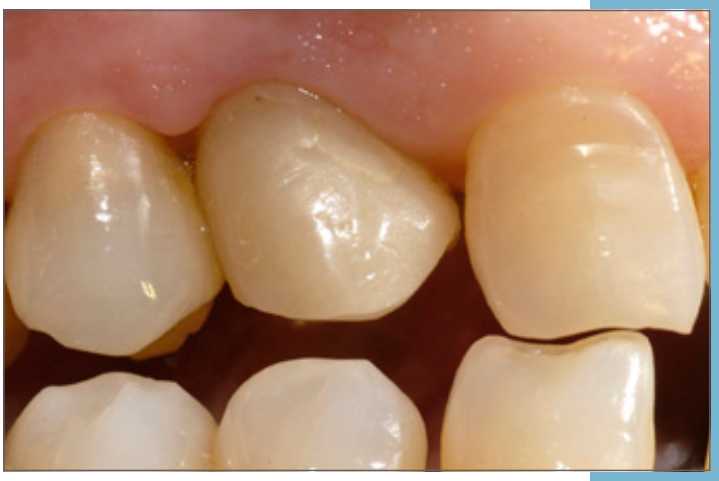


Fig 3 One-piece implant placement.





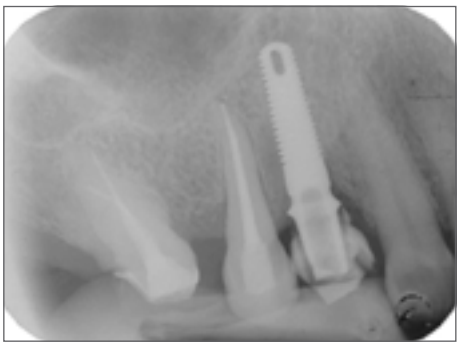


Fig 4 Immediate provisional implant.

peri-implant debris. Systemic antibiotic was prescribed for 3 additional postoperative days, as was an analgesic to control pain. Chlorhexidine mouthwash (0.12%) was prescribed twice a day for 2 weeks. Patients were instructed not to brush the surgical sites for 2 weeks. After either 3 or 6 months of healing, the provisional prosthesis was removed and a final impression was taken. A cement-retained single-unit crown was fabricated and delivered. A standardized periapical radiograph was then taken to ensure complete seating of the crown and the absence of residual cement (Fig 5).

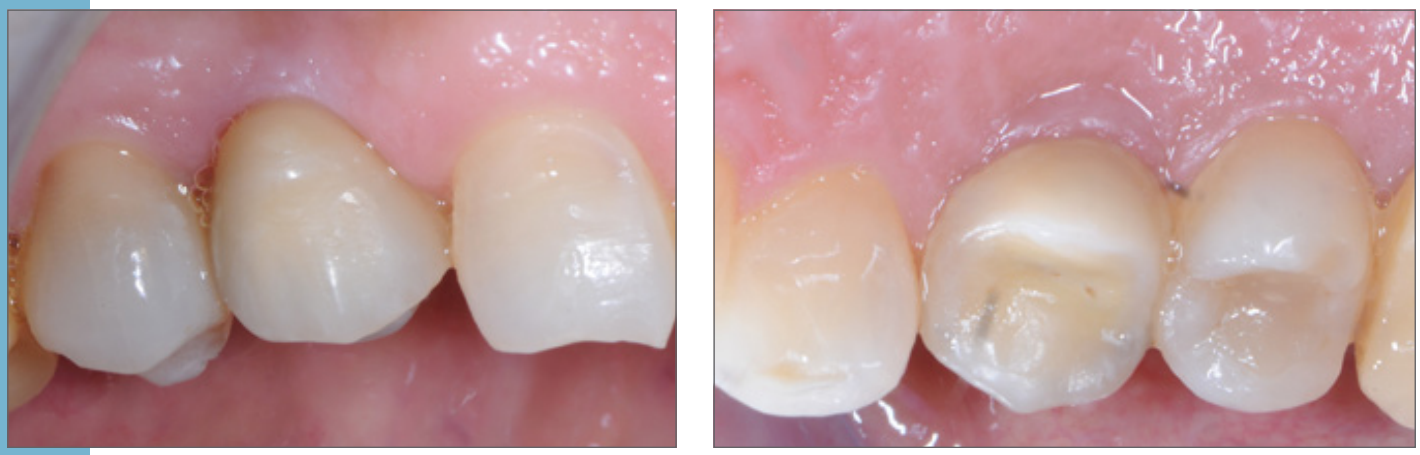
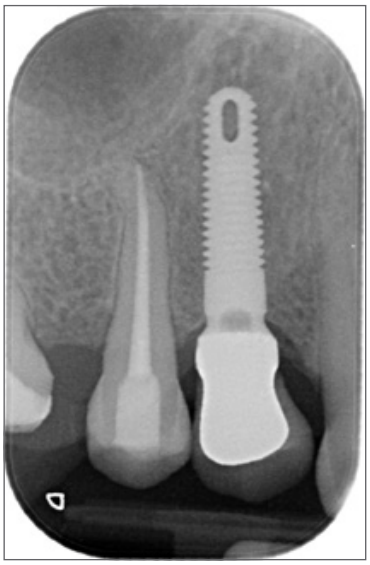


Fig 5 Definitive crown after 1 year.



The implant survival rate was scored based upon its clinical mobility.[16] Absence of clinical mobility (comparable to histologic osseointegration) signifies implant survival. Clinical mobility signifies implant failure. Mobility was detected by using the ends of two instruments, a widely used technique in dentistry.

Standardized periapical radiographs were obtained with a paralleling technique with a Rinn-type film holder attached to an acrylic jig. Radiologic measurements were performed by an independent radiologist utilizing adequate RVG software [au: manufacturer?] with a magnification of 4×. Two images, one after implant insertion and 1 year after prosthetic loading, were selected to calculate the crestal bone loss. Before calculation of marginal bone loss, the RVG images were calibrated using the calibration program in the software. The known dimension of the diameter of the implant was used to calibrate the radiograph, which ensured a correct measurement.[17]

The lower corner of the implant collar (Fig 6) was used as the reference point for calculations because it was easily identified. The first measurement calculated the distance between the lower corner of the implant collar and the most coronal bone-implant contact after implant placement on the mesial and distal aspects. The second measurement evaluated the same distance after 1 year of follow-up. The difference between these values showed the amount of peri-implant bone loss.

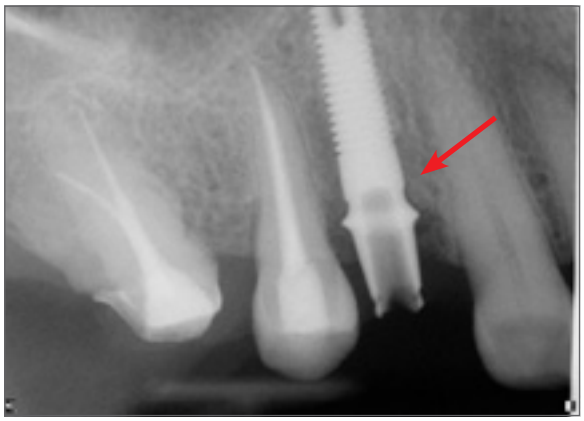


Fig 6 Peri-implant bone level measurement. Red arrow shows where the measurement was taken (reference point).

An additional analysis was conducted on those patients who demonstrated ≥ 1.5 mm of peri-implant bone loss.

Four additional subsets of radiographic analyses were also performed: *(1)* the effects of supracrestal implant platform positioning (at or above crestal bone) vs subcrestal implant platform positioning (at least 1 mm below crestal bone) were examined; *(2)* 3- vs 6-month posthealing implant loading times were compared; *(3)* effects of implant length (10, 11.5, and 13 mm) and diameter (3, 3.7, and 4.7) were investigated; and *(4)* the influence of implant location (maxilla vs mandible) was assessed.

Statistical analysis

Data was expressed as mean ± standard deviation (SD). An evaluation of the statistical difference between two groups was made using the Student *t* test. Analysis of variance (ANOVA) was used in cases in which there were three different groups (relating to implant lengths and diameters). The level of statistical significance for all tests was set at $P < .05$.

RESULTS

A total of 46 untreatable teeth were selected for immediate implant replacement. In total, 22 maxillary premolars, 6 maxillary incisors, 12 mandibular incisors, and 6 mandibular premolars were extracted. Of the 46 untreatable teeth, 16 were removed due to root fracture, 12 due to untreatable caries, 11 due to endodontic problems and 7 due to advanced periodontitis.

Forty-six one-piece implants were placed in the 46 patients for final data analysis. Each patient received one implant in maxillary or mandibulary anterior zone extraction sites (from second premolar [left] to second premolar [right]). A total of two implants failed, one each in two patients, due to dry socket formation. This yielded a 95.7% implant survival rate. Neither surgical nor prosthetic complications were noted in the remaining 44 patients.

The mean crestal bone loss was 0.80 ± 0.53 mm [au: table says –0.80] after 12 months (Table 2).

Results from this study showed that use of implants of differing length (10.0, 11.5, or 13.0 mm) and differing diameters (3.0, 3.7, or 4.7 mm) had no statistically significant effects on peri-implant bone loss at 12 month follow-up.

Mean crestal bone loss at maxillary sites (28 implants, 0.81 ± 0.57 mm) was compared with mean bone loss at mandibular sites (18 implants, 0.70 ± 0.47 mm). No statistically significant difference ($P > .05$) was noted between the two groups.

Table 3 shows the influence of implant platform position in relation to existing alveolar bone level. Subcrestal placement of implants resulted in greater bone resorption (0.86 ± 0.45 mm) than supracrestal implant platform placement (0.62 ± 0.30 mm). However, no statistically significant difference was found.

Table 2 Comparison of clinical results obtained with one-piece implants in humans

Study	Implant survival rate (%)	Location of implants	Mean marginal bone loss after 1 year (mm)
Present study	95.7%	Maxilla and mandible	–0.80 ± 0.53
Albrektsson et al[18]	89.1%	Maxilla and mandible	Not clear
Finne et al[19]	97%	Maxilla and mandible	–0.98 ± 1.38
Finne et al[20]	98.8%	Maxilla and mandible	–0.68 ± 1.25
Hahn[21]	97.9%	Maxilla and mandible	–0.78 ± 1.60
Ostman et al[22]	94.8%	Maxilla and mandible	–2.10 ± 1.30
Siepenkothen[23]	100%	Maxilla and mandible	–1.20 ± 0.40
Sennerby et al[24]	93.7%	Maxilla and mandible	–2.60 ± 1.50

Table 3 Comparison of the peri-implant bone loss (mean ± SD)

Variables analyzed with radiographic measurement	Peri-implant bone loss after 1 year (mm)
Subcrestal implant positioning (n = 28)	0.86 ± 0.45
Supracrestal implant positioning (n = 18)	0.62 ± 0.30
Functional loading after 3 mo (n = 23)	0.86 ± 0.43
Functional loading after 6 mo (n = 21)	0.73 ± 0.40
Smokers (n = 15)	0.90 ± 0.69
Nonsmokers (n = 31)	0.70 ± 0.53

SD, standard deviation. Two implants failed early. No significant difference was found.

Table 3 demonstrates the effect of implant loading time. Twenty-three implants were functionally loaded after 3 months of healing, while the remaining 21 implants were functionally loaded after 6 months of healing (two implants early failed). Functional loading after 3 months resulted in a higher amount of peri-implant bone loss than functional loading after 6 months. No statistically significant difference was found at 1 year follow-up.

Smokers, however, demonstrated a slightly higher amount of peri-implant bone loss after 1 year than nonsmokers (Table 3).

DISCUSSION

The one-piece implant has been developed by manufacturers to minimize the detrimental effects and potential concerns of microgap. To the best of the authors' knowledge, however, literature in this field is poor. Therefore, the objective of this article is to provide greater insight into the clinical behavior of one-piece implants, including any factors that may influence success and survival rates.

Results obtained from this study suggest that one-piece implants can be suc-

cessfully placed at the time of extraction. On a par with survival rates presented in other existing published reports,[18–23,25] but significantly better than the survival rate of 89.1% published by Albrektsson et al,[18] the present study demonstrates a 95.7% implant survival rate. However, unlike studies performed by Ostman et al,[22] Finne et al,[19,20] and Hahn,[21] where the survival rates of one-piece implants placed in both native bone and in post-extractive fresh sockets were examined, this present article examines the survival rate of one-piece implants in only post-extractive fresh sockets (see Table 2).

Data revealing only minimal peri-implant bone loss (0.80 mm) was obtained from radiographic assessments after 1 year. This is comparable to the data reported by Cornelini et al, who made a similar study with two-piece implants.[26] However, histologic studies in dogs have shown that one-piece implants had significantly higher amounts of bone loss compared with two-piece implants.[10–12]

Furthermore, the amount of peri-implant bone loss reported in this present study using a one-piece implant is similar to or less than the amount of peri-implant bone loss reported in a number of other studies using a different one-piece implant.[19–21] At the same time, the amount of peri-implant bone loss reported in this present study is lower than the amount of peri-implant bone loss reported in other studies using the latter (different) one-piece implant (Nobel Perfect one-piece implant, Nobel Biocare).[22–24]

This suggests that different implant systems with similar designs behave differently. The principal factor that causes this difference in behavior, however, remains undetermined due to the fact that multiple factors may be involved.

It is not surprising that data in the present study demonstrates that implant length and diameter have no significant influence on outcomes. This is in agreement with the existing literature that has reported similar clinical success rates with implants, assuming they had a minimum of 10-mm length and 3.7-mm diameter.[27–29]

Positioning of the implant platform in relation to the bony crest (supracrestal vs subcrestal) does influence the outcome. It is generally understood that the deeper the implant is inserted, the more implant bone loss is observed. This can be explained by the fact that bone generally remodels down to the level of the smooth and rough surface junction due to crest module remodeling.[2] However, our study did not find a statistically significant difference between the two groups. This may be attributed to the small sample size (see Table 3). A future study including a larger sample size should be conducted to further determine the effective influence of implant positioning. In two studies, Finne et al[19,20] reported similar results, which are in disagreement with other radiographic and histologic studies in dogs.[30,31] This can be explained by the fact that a supracrestal positioning of the implant platform may allow patients to more effectively clean the peri-implant tissue, thereby minimizing the amount of bone loss. Interestingly, supracrestal positioning of one-piece implants allows clinicians to apply bound esthetic restorations so that esthetics can be enhanced, even in difficult clinical scenarios, without placing any force on the bone. As a result, interproximal bone loss may be reduced.

Results from the present study show smoking causes slight, but not significantly greater, peri-implant bone loss than not smoking (see Table 3). This lack of difference may be attributed to the definition of smokers used in this study where only nonsmokers or smokers of fewer than 10 cigarettes a day were selected. Future studies that enroll a large sample size including both groups should be conducted to more clearly determine the true effects of smoking on the outcome of one-piece implants.

One of the limitations of this study was the potential variables stemming from the four different participating centers, even though the authors have tried to minimize these effects. Another specific concern of this present study is the small sample size (n = 46). Nonetheless, it is the intent of the authors to report this initial data in the hope that the interest of many clinicians and the science community in general may be triggered. Hopefully, a large study with adequate sample size and funding can emerge from this paper to either verify or reject current findings.

CONCLUSION

One-piece implants can be successfully placed after extractions with a high success rate and minimal peri-implant crestal bone loss.

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