A 4- to 5-Year Retrospective Clinical and Radiographic Study of Neoss Implants Placed with or without GBR Procedures

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ABSTRACT

Background: New dental implant systems are continuously introduced to the market. It is important that clinicians report their experiences with these implants when used in different situations.

Aim: The study aims to report the outcomes from a retrospective study on Neoss implants when used with or without guided bone regeneration (GBR) procedures.

Materials and Methods: The study group comprised of 50 consecutive patients previously treated with 183 Neoss implants (Neoss Ltd., Harrogate, UK) in 53 sites because of single, partial, or total tooth loss. Implants were placed in healed bone in 23 sites, while a GBR procedure was used in 30 sites in conjunction with implant placement. A healing period of 3 to 6 months was utilized in 45 sites and in 8 sites a crown/bridge was fitted within a few days for immediate/early function. The number of failures, withdrawn and dropout implants was analyzed in a life-table. All available intraoral radiographs from baseline and annual check-ups were analyzed with regard to marginal bone level and bone loss.

Results: A cumulative survival rate (CSR) of 98.2% was found for the non-GBR group and 93.5% for the GBR group with an overall CSR of 95.0% after up to 5 years of loading. In spite of the failures, all patients received and maintained their prostheses. Based on all available radiographs, the bone level was situated 1.3 ± 0.8 mm ($n = 159$) below the top of the collar at baseline and 1.7 ± 0.8 mm ($n = 60$) after 5 years of follow-up. Based on paired baseline and 1-year ($n = 70$) and 5-year radiographs ($n = 59$), the bone loss was found to be 0.4 ± 0.9 and 0.4 ± 0.9 mm, respectively. There were no statistically significant differences between GBR and non-GBR sites with regard to implant survival or bone loss.

Conclusions: The Neoss implant system showed good clinical and radiographic results after up to 5 years in function.

KEY WORDS: clinical follow-up, dental implants, GBR, radiography, retrospective study

INTRODUCTION

The prescription of implant-supported prostheses has been proven to be a safe treatment modality for the rehabilitation of the edentate patient with good clinical and radiographic long-term results.[1] Today, the use of implants is regarded as the first choice of treatment for replacement of missing teeth.[2] During the years, there has been a shift from treatment of mainly totally edentulous patients to a panorama where most patients present with the loss of one or a few teeth. This resulted in a need and development of new components and surgical/prosthetic techniques to ensure long-lasting excellent results with good esthetics. In the modern implant clinic, the implant specialist will, on a daily basis. meet demands to efficiently deal with different clinical problems. These may include the augmentation of bone and soft tissues, which has been lost because of trauma or infection, and the placement of implants in soft bone densities and in narrow spaces. Thus, an implant system that performs well in the different clinical situations is needed for a successful outcome. Several hundred implant systems are commercially available but only a few have been scientifically documented in the scientific literature.[3] It is

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important that clinicians report on their experiences with different implant systems.

Many different methods for augmentation of localized bone defects in the jaws prior to or in conjunction with implant surgery have been described.[4] Among several techniques, guided bone regeneration (GBR) is an elegant technique, which has been used to promote bone at exposed implant threads.[5] Further development of the technique has resulted in that bone grafts and/or bone substitutes are used under the membrane in order to prevent collapse and to improve the clinical outcome. Moreover, the introduction of resorbable membranes has further facilitated the technique as these do not need to be removed. The use of bovine hydroxyapatite and resorbable collagen membranes is a well-documented technique which has resulted in good clinical outcomes.[6,7]

Firm primary stability has been described as a prerequisite for good clinical outcomes with osseointegrated implants, because short implants and implants in soft bone densities have shown higher failure rates, at least with a machined surface.[8] Although the bone density at the implant site dictates the primary stability, it can be influenced by the surgical technique and the geometry of the implant.[9] For instance, reduction of the final drill diameter will increase the stability of a parallel-walled implant. Moreover, a slight tapering of the implant body will create a continuous lateral compression of the bone during insertion which results in an increased primary stability.[10] Numerous experimental studies have shown that surface modification of a titanium implant by acid etching, blasting, oxidation, or combinations of techniques results in a more rapid integration during the early healing period.[11–16] This is probably a result of the fact that the rougher surface topography can serve as a substrate for mesenchymal cells which differentiate to osteoblasts and produce bone directly to the implant surface. Clinical comparative studies have failed to show statistically significant differences between smooth and rough implant surfaces when use in two-stage procedures.[17] However, there are indications that modern implant surfaces perform better in challenging situations such as immediate loading and bone augmentation procedures.[18,19]

The aim of the present study was to retrospectively analyze the clinical outcome of Neoss implants after up to 5 years of function when used with or without adjunctive GBR procedures.

MATERIALS AND METHODS

The retrospective study group consisted of the first 50 consecutive patients (19 males, 31 females, mean age 57 years) treated with Neoss dental implants (Bimodal surface, Neoss Ltd., Harrogate, England) in 53 sites in one clinic and followed for up to 5 years. The patients were in need of implant treatment because of single ($n = 20$), partial ($n = 21$), or total loss ($n = 9$) of their teeth. The patients were examined clinically and radiographically with orthopantomograms, intraoral radiographs and computed tomographies if needed prior to surgery. The patients were thoroughly informed about the treatment and follow-up routines and gave their written consent.

The patients were given antibiotics orally prior to surgery (Dalacin, 300 mg, Pfizer AG, Zurich, Switzerland). Surgery was made under sterile conditions with local anesthesia (Ultracain D-S Forte, Sanofi-Aventis, Geneva, Switzerland). Crestal incisions were used and implant sites were drilled according to the guidelines given by the manufacturer for the different implant diameters and the implants were inserted with the drilling unit. A total of 183 implants were placed; 116 implants in the maxilla and 67 in the mandible. Implant lengths from 7 to 15 mm and diameters of 3.5, 4.0, or 4.5 mm were used (Table 1). Bone quality and quantity according to the Lekholm and Zarb index were registered (Table 2).[20] The implant collar was either not submerged in bone ($n = 108$) or to half the length ($n = 75$), depending on the thickness of the overlying mucosa.

Thirty of the patients and 126 implants underwent a GBR procedure using Bio-Oss™ and a resorbable Bio-Gide™ membrane (Geistlich Pharma AG, Wolhusen, Switzerland) simultaneously with implant placement as described elsewhere[6] (Figure 1). This was because of

TABLE 1 Length and Diameters of Implants

Implant Length (mm)	Placed Implants	Implant Diameter (mm)	Placed Implants
7	7	3.5	58
9	51	4.0	112
11	75	4.5	13
13	44	5.5	0
15	6		
17	0		
Total	183	Total	183

TABLE 2 Bone Quality and Quantity

Bone Quality	Sites	Bone Quantity	Sites
1	0	A	44
2	47	B	103
3	115	C	26
4	21	D	10
		E	0
Total	183	Total	183

insufficient bone width or remaining defects after extractions, which resulted in exposed part of the implant after placement.

Healing abutments were connected after a healing period of 3 to 6 months in 32 sites. In 21 sites, healing abutments were placed in conjunction with implant surgery and in 8 of these a crown/bridge was fitted within a few days for immediate/early function.

Prosthetics

Fixture level impressions were taken for screw-retained prosthetics using Neolink abutments (Neoss Ltd., Harrogate, UK). Gold-ceramic constructions were made in single and partial cases (Figure 2). All but one full bridge were gold-acrylic bridges (Figure 3). The crowns/bridges were attached with gold screws using a preload of 32 Ncm.

Follow-Up

The patients were scheduled for annual check-ups with clinical and radiographic examinations using intraoral or panoramic radiographs. The number of failures, withdrawn and dropout patients were registered and analyzed in a life-table. In addition, subgroups of GBR and non-GBR patients/implants were created for comparison. An implant was regarded as a failure if removed for any reason.

Marginal bone level measurements were performed by two examiners in all available baseline and follow-up intraoral radiographs using digitized images and a computer. The known diameter of the implant collar (4.0 mm for 3.5 and 4.0 mm implants, and 4.5 mm for 4.5 mm implants) was used as a reference for calibration of measurements, which were made from the top of the collar to the first bone contact at the mesial and distal aspects of the implants. A mean value was calculated for each implant.

Statistics

The Mann–Whitney test was used to compare implant survival rates between the GBR and the non-GBR groups. The two-sample *t*-test was used to compare marginal bone loss between the two groups.

RESULTS

Forty-nine of the patients attended the 1st, 45 the 2nd, 40 the 3rd, 38 the 4th, and 19 patients the 5th annual check up. A total of 10 patients were withdrawn during the follow-up because of severe illness ($n = 3$), death ($n = 3$), non-cooperation ($n = 2$), moved ($n = 1$) and adverse event ($n = 1$).

A total of nine implant failures were registered, eight during the first year in service and one after 4 years, giving an overall cumulative survival rate (CSR) of 95.0% after up to 5 years (Table 5). All but one failure occurred in the GBR group giving a CSR of 93.5% for the GBR group and 98.2 % for the non-GBR group after up to 5 years (NS) (Table 3). Failures occurred more often for short implants, in soft bone and in GBR patients (Table 4). In spite of the failures, all patients received and maintained a fixed crown/ bridge during the follow-up.

Based on all available radiographs, the bone level was situated 1.3 ± 0.8 mm ($n = 159$) below the top of the collar at baseline and 1.9 ± 0.8 mm ($n = 76$) after 1 year, 1.9 ± 1.1 mm ($n = 136$) after 3 years and 1.7 ± 0.8 ($n = 60$) after 5 years of follow-up (Table 5). Based on paired baseline and 1-year ($n = 70$), 3-year ($n = 119$), and 5-year radiographs ($n = 59$), the bone loss was found to be 0.4 ± 0.9, 0.8 ± 1.2, and 0.4 ± 0.9 mm, respectively (Table 6). No implants showed more than 3 mm of bone resorption after 1 and 5 years, two implants after 2 and 3 years, and one implant after 4 years (Table 7). No statistically significant differences were seen between the two groups (Figure 4).

DISCUSSION

The clinical and radiographic experiences from the first 50 patients treated with 183 Neoss implants in 53 sites are reported. Fifty-seven implants were placed in 23 healed sites of sufficient bone volumes and a survival rate of 98.2% was achieved after 3 years. This is in agreement with recent studies on other implant systems.[21]

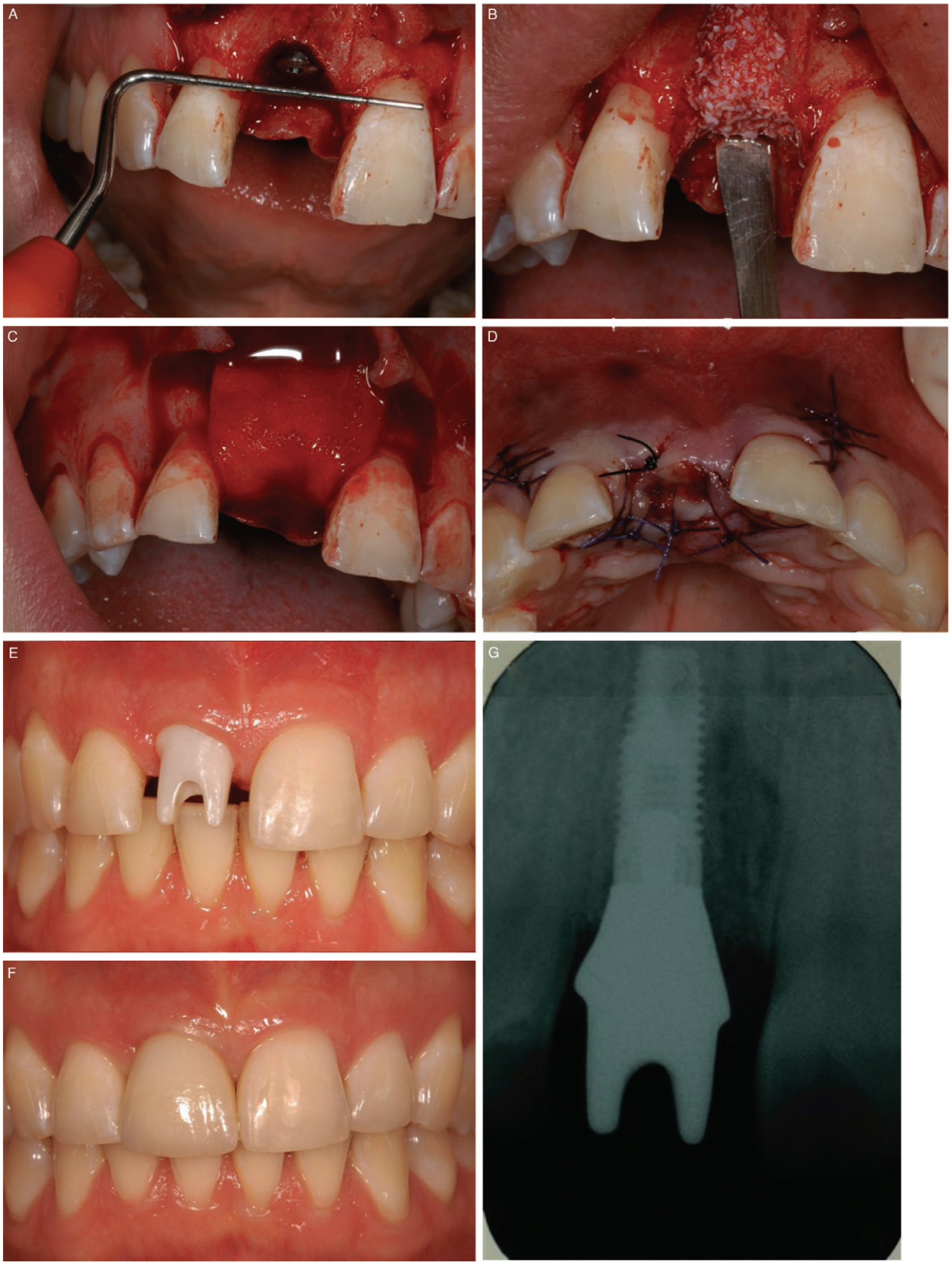

Figure 1 Showing bone augmentation in conjunction with immediate implant placement in an extraction socket of a central incisior. *A*, Placement of the implant. *B*, Application of Geistlich Bio-Oss particles. *C*, Coverage with a Geistlich Bio-Gide membrane. *D*, Suturing. *E*, Ceramic abutment 6 months later. *F*, Final result. *G*, Radiograph of finalized construction.

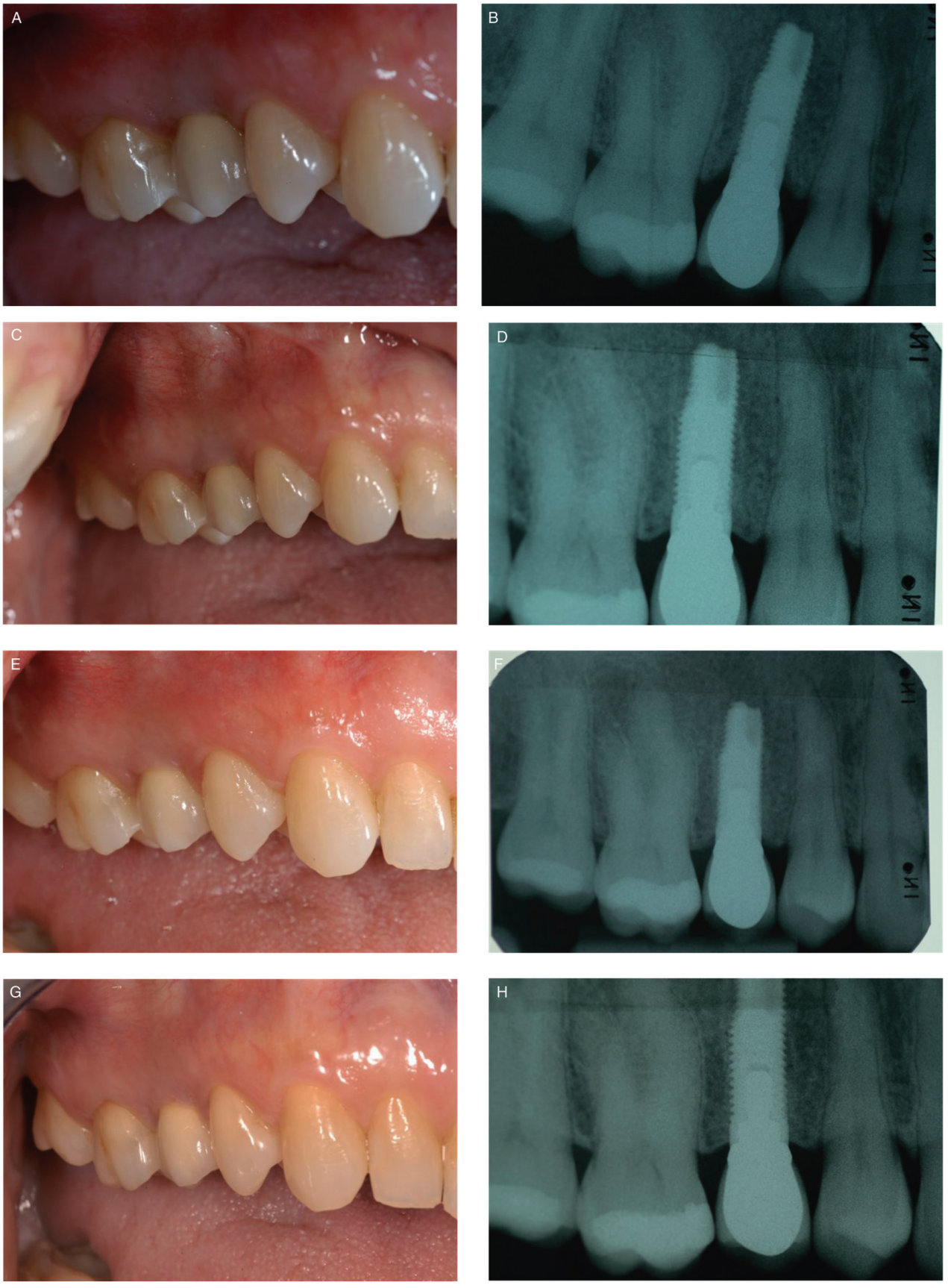

Figure 2 Replacement of a right maxillary second premolar. Clinical photos and radiographs at delivery of the crown (*A* and *B*), after 1 year (*C* and *D*), after 3 years (*E* and *F*), and after 5 years (*G* and *H*).

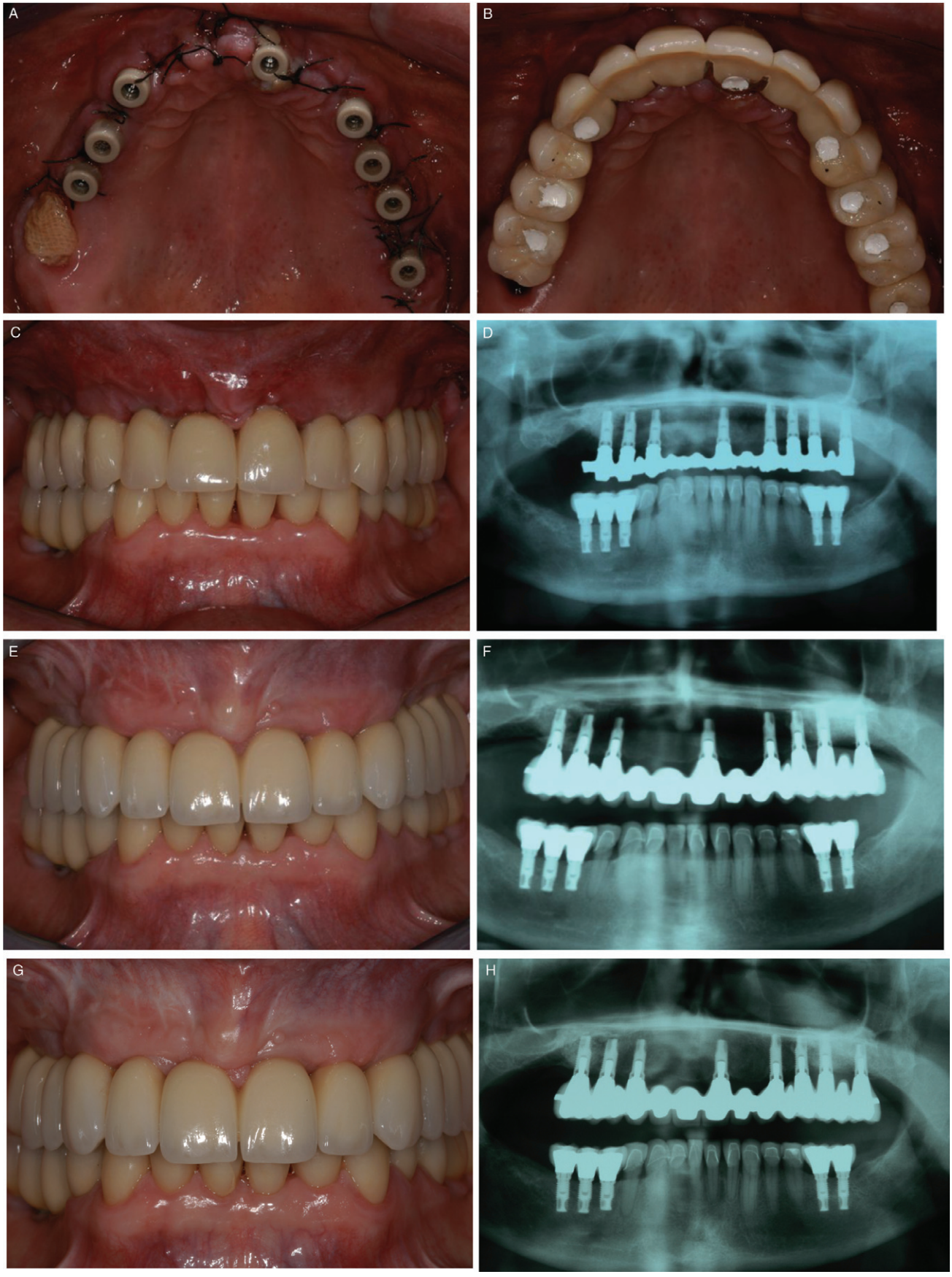

Figure 3 Implant treatment in an edentulous maxilla. *A*, Clinical photo showing healing abutments. *B*, Occlusal view at delivery of a gold acrylic bridge. *C*, Frontal view. *D*, Radiograph at delivery. *E* and *F*, 3-year check-up. A new bridge was made after 2 years. *G* and *H*, 5-year check-up.

TABLE 3 Survival Rate of Implants

Time Period	Implants	Failed Implants	Withdrawn + Not Yet Due	CSR (%)
All implants				
Implant placement–prosthesis delivery	183	2	0	98.9
Prosthesis delivery–1 year	181	6	1	95.6
1–2 years	174	0	15	95.6
2–3 years	159	0	10	95.6
3–4 years	149	0	5	95.6
4–5 years	144	1	82	95.0
5 years	61	—		—
Non-GBR implants				
Implant placement–prosthesis delivery	57	0	0	100
Prosthesis delivery–1 year	57	1	0	98.2
1–2 years	56	0	7	98.2
2–3 years	49	0	6	98.2
3–4 years	43	0	2	98.2
4 years	41	0	22	98.2
5 years	19	—		—
GBR implants				
Implant placement–prosthesis delivery	126	2	0	98.4
Prosthesis delivery–1 year	124	5	1	94.4
1–2 years	118	0	8	94.4
2–3 years	110	0	4	94.4
3–4 years	106	0	3	94.4
4–5 years	103	1	60	93.1
5 years	42	—		—

There was no statistically significant differences between the two groups.
GBR = guided bone regeneration.

One 3.5-mm wide and 9-mm long implant placed in soft maxillary bone was found to be mobile after 1 year in function, indicating a biomechanical failure and relative overload as a plausible explanation. In sites of insufficient bone volume and remaining defects where a GBR procedure was used in conjunction with implant placement, a survival rate of 93.1% was found for 126 implants after up to 5 years. This correlates with the

TABLE 4 Summary of Implant Failures

Patient Number	Position	Length	Diameter	Bone Quality and Quantity	GBR	Time of Failure
1	22	9	3.5	3/C	X	Prosthesis
2	23	9	3.5	3/C	X	Prosthesis
3	15	11	4.5	4/C	X	1 year
4	36	7	3.5	2/B	X	1 year
4	44	7	3.5	3/B	X	1 year
5	35	11	4.0	2/B	X	1 year
5	25	9	4.0	3/B	X	1 year
6	26	9	3.5	4/C	—	1 year
7	16	9	4.5	4/A	X	5 years

TABLE 5 Marginal Bone Level Measurements

	Baseline	1 Year	2 Years	3 Years	4 Years	5 Years
Mean value	1.3	1.9	2.0	1.9	1.6	1.7
SD	0.8	0.8	0.9	1.1	0.9	0.8
n	159	76	101	136	123	60

findings from Zitzmann and colleagues[6] who reported 5-year survival rates of 92.6% and 95.4% when using bovine hydroxyapatite (HA) and two different membranes. Six of eight failures in the present study, involved 7- or 9-mm long implants and four of the failures involved 3.5-mm wide implants. As the implant collar is 1.9-mm high, only 5 and 7 mm of these implants were submerged in bone and presumably exposed because of placement in localized defects. This suggests a challenging healing situation and may indicate inadequate healing and mechanical bone support of the implants during loading in these cases. It is possible that prolonged healing periods should have been utilized as also suggested for sinus lift procedures with bovine HA.[22] However, in spite of the larger number of failures, there was no statistically significant difference between the GBR and non-GBR groups.

Radiographs were available from all time points of the study, although because of the retrospective character of the present study, the quality of the radiographic follow-up varied. Roos and colleagues[23] proposed that a 25% dropout rate would be acceptable for a follow-up study on dental implants. In the present study, 86 and 74.3% of the implants had readable radiographs at baseline and after 3 years of follow-up, respectively, while lower numbers of radiographs were available for the remaining time points. However, 87% had been radiographed after at least 1 year and 77% after at least 3 years of function. The analyses of implants with pairs of readable radiographs indicated small changes over the 5 years of follow-up. Although it had been desirable to have more paired observations, the information from the bone level measurements together with the paired radiographs gave the overall impression that only small changes occurred during the follow-up, that is, from 0.3 to 0.8 mm during 5 years of follow-up. The marginal bone loss in the present study compares well with that of other implant systems, which have shown average

TABLE 6 Marginal Bone Loss as Measured in Paired Baseline (BL) and Follow-Up Radiographs

	BL–1 Year	BL–2 Years	BL–3 Years	BL–4 Years	BL–5 Years
Mean value	0.4	0.8	0.8	0.3	0.4
SD	0.9	1.1	1.2	1.1	0.9
n	70	89	119	110	59

TABLE 7 Frequency Distribution of Bone Loss from Paired Measurements (%)

	Baseline–1 Year	Baseline–2 Years	Baseline–3 Years	Baseline–4 Years	Baseline–5 Years
<0	30.0	29.2	26.1	41.8	39.0
0–1.0 mm	51.4	32.6	36.1	33.6	39.0
1.1–2.0 mm	15.7	27.0	26.1	20.0	18.6
2.1–3.0 mm	2.9	9.0	10.1	3.6	3.4
>3.0 mm	0	2.2	1.7	0.9	0.0
n	70	89	119	110	59

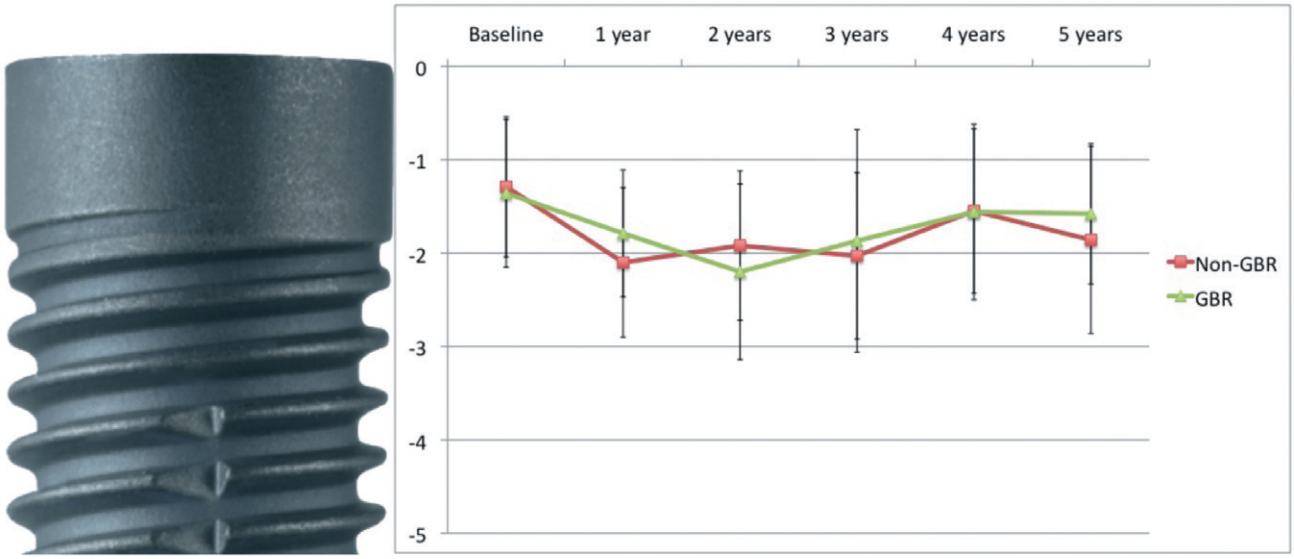

Figure 4 Schematic showing marginal bone levels in the guided bone regeneration (GBR) and non-GBR group over 5 years of follow-up. There were no statistically significant differences between the two groups.

bone loss ranging from 0.3 to 1 mm after 1–5 years of loading.[24–27] Two recent studies on Neoss implants reported a marginal bone loss of 0.6 mm after 1 year and 0.7 mm after 18 months of loading, respectively.[28,29] As for implant survival rates, there were no statistically significant differences in marginal bone loss between the GBR and non-GBR groups.

The present implant has a micro-rough surface on the implant collar which because of the placement technique was exposed to the soft tissues. According to the marginal bone measurements from this study, this presented no problems with regard to bone loss. Only two implants showed more than 3-mm bone loss after 2 (2.2%) and 3 years (1.7%) and only one implant after 4 years (0.9%). This is similar to what has been reported for other well-documented implant designs, where 0 to 4.4% of implants showed more than 3-mm bone loss after 12–18 months of loading.[30–33]

A previous in vitro study in cadavers showed that implant tapering resulted in higher stability than for parallel-walled implants and especially in soft bone densities.[10] The presently used implant has a positive tolerance, meaning that the apex is slightly thinner than the coronal part of the implant.[28] Thus, the implant behaves like a tapered implant as was also confirmed in a clinical study using insertion torque measurements.[34] Although no implant stability measurements were performed in the present study, the implant design resulted in firm primary stability in all bone qualities as assessed clinically. Concerns have been raised that too high insertion torque may lead to stress concentration and marginal bone resorption. However, as discussed previously, only small or no changes of the marginal bone levels were observed in the present study. Also Glauser and colleagues[35] reported favorable marginal tissue responses during 5 years of loading with another surface-modified and tapered implant design.

Within the limitations of the present retrospective study, it is concluded that the Neoss implant system showed good clinical and radiographic results after up to 5 years in function. Short and narrow implants seem to be more prone to failure when placed in conjunction with a GBR procedure than longer and wider implants.

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