Immediate/Early Function of Neoss Implants Placed in Maxillas and Posterior Mandibles: An 18-Month Prospective Case Series Study

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ABSTRACT

Background: An increasing number of studies show that immediate/early function of dental implants can be as successful as two-stage procedures. However, the results may not be universal for all implant types and it is important that new implants are tested for this treatment modality.

Purpose: The aim was to evaluate an immediate/early function protocol in the maxilla and in the posterior mandible using Neoss implants (Neoss Ltd., Harrogate, UK).

Materials and Methods: A total of 21 patients were provided with 69 Neoss implants (4 mm in diameter and 9–15 mm in length) and a provisional bridge within 7 days (mean 4.6 days). Sixteen implants were placed in immediate extraction sites where seven were treated with autologous bone grafts ($n = 6$) or bone grafts + resorbable membrane ($n = 1$). A final fixed prosthesis was made 3 to 6 months later. The patients were followed-up with clinical examinations for 18 months. In addition, the implants were monitored with resonance frequency analysis (RFA) measurements at surgery and after 1, 2, and 6 months. Intraoral radiographs were taken after surgery and after 1, 6, and 18 months.

Results: One implant in an extraction site in the maxilla failed after 1 month, giving a survival rate of 98.5% after 18 months. The mean marginal bone loss was 0.7 mm (SD 0.7) after 18 months. RFA showed a mean implant stability quotient (ISQ) value of 68.1 (SD 8.8) at surgery, which increased to 73.7 (SD 5.7) after 6 months. The primary stability for maxillary and mandibular implants was similar, although mandibular implants showed slightly higher values with time. Implants in extraction sockets showed a lower initial stability than in healed sites, ISQ 65.8 (SD 7.5), which increased to ISQ 67.5 (SD 6.9) after 6 months. The failed implant showed an ISQ of 74 at placement, which decreased to 42 1 month after surgery.

Conclusion: Within the limitations of the present study, it is concluded that immediate/early function with Neoss implants is a reliable method with an implant survival rate comparable to that of the traditional two-stage protocol.

KEY WORDS: clinical study, dental implants, immediate/early function, radiography, resonance frequency analysis

INTRODUCTION

Immediate loading is today a commonly used term in the dental field and indicates the possibility of applying an occlusal load to dental implants earlier than the traditional healing period of 3 to 6 months. However, the applied load is often reduced or even absent; therefore, it is more correct to use the term "immediate/early function" rather than "immediate/early loading." Moreover, the subdivision between "immediate function" – when the prosthesis is applied within hours from the implant insertion – and "early function" – when the prosthesis is applied earlier than the traditional period of 3 to 6 months – has been accepted at a previous consensus conference.[1]

The possibility to rehabilitate the aesthetics of a patient in a very short period and avoiding a removable prosthesis are without any doubt the main reasons for which the immediate function therapy is performed.

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Moreover, occlusal loading of the implants can be allowed to assure a certain degree of masticatory function in accurately evaluated and monitored patients. Not to be disregarded is the observation that early function may have a favorable effect on bone formation and mineralization,[2] determining a higher degree of bone–implant contact.[3]

The first procedures of immediate function were carried some 20 years ago and essentially considered the chin symphysis, an area of the mandible characterized by a high bone density. The results of many clinical studies have confirmed the validity of the technique applied to the anterior mandible.[4–5] Afterward, the possibility to intervene also in areas where the bone quality is less favorable, like the upper arch or, in some cases, the posterior mandible areas, was investigated. Glauser and colleagues[6] treated different areas of the arches with an immediate loading procedure, obtaining a survival rate of 66% in the posterior maxilla; while in the other areas the survival was up to 91%. Grunder and colleagues[7] inserted 48 implants in totally edentulous upper and lower arches. At the follow-up after 2 years, six implants failed in the posterior areas, resulting in a survival rate of 86%.

It was then understood that the primary stability of the implant is fundamental to obtain the successful outcome of immediate function in areas with poor bone quality. Apart from the bone density, the primary stability seems to be related to the surgical technique (underpreparation of the site) and particularly to the geometry of the implant.

In an experimental study, Glauser and colleagues[8] inserted implants with a different geometry and analyzed the initial stability by the insertion torque and the resonance frequency. The authors concluded that the positioning of slightly tapered implants in a cylindrical site gives a greater stability in comparison with cylindrical implants. These data have been clinically confirmed by a study in which the survival rate of implants in soft bone has been higher than that obtained with cylindrical implants.[9] It seems that the implant tapered design creates bone compression at the moment of the implant insertion and therefore a better stability.

In a multicenter perspective study, Vanden Bogaerde and colleagues[10] installed 124 slightly tapered implants with a smooth surface in upper arches and posterior mandibles and loaded them within 15 days from the surgery. The total survival rate of the implants was 96.8% after 18 months. The result obtained in that study was significantly better than those obtained in previous studies in which cylindrical implants were used.[6,7]A perspective clinical study confirmed the possibility to use implants with favorable geometry in the posterior regions of the maxillas, obtaining a survival rate of 98%, after 1 to 2 years.[11]

The mechanical anchorage of the implant in the bone (primary stability) tends to decrease during the first weeks following the positioning[12] and is progressively replaced by an anchorage of biological type, tied to the implant surface (secondary stability). During the last years, a progressive abandon of the smooth surface (machined) in favor of a rougher surfaces has been observed. While the surface does not seem to have any particular influence on the primary stability,[8,13] on the secondary stability, it does influence it in a determining way, accelerating the osseointegration process. A controlled study was carried out in a dog mandible,[14] comparing implants with machined surface (control side) with implants with oxidized rough surface (test side), with a resonance frequency (resonance frequency analysis [RFA]) monitoring. After 3 weeks, the test implants showed a value of implant stability quotient (ISQ) greater than that of the control implants. Another histomorphometrical and biomechanical study performed on rabbits[15] put in evidence that implants with a rough (oxidized) surface showed after 6 weeks higher values of bone–implant contact (BIC) and of "removal torque" than those of implants with machined surface. Such results have also been confirmed by Henry and colleagues[16] in a study on a dog in which implants with rough surface showed, after 6 weeks, an extraction torque higher than that of implants with machined surface.

Vanden Bogaerde and colleagues[17] carried out a multicenter study with a protocol similar to the one of the previous study of the same authors,[10] except for the use of implants with rough (oxidized) surface. One hundred eleven implants were positioned in edentulous areas of the maxillas and posterior mandibles and early loaded within 9 days from the insertion. The follow-up after 18 months showed the failure of one implant only, with a survival rate of 99.1%. The average marginal bone resorption has been 0.8 mm with a loss mainly concentrated in the first 6 months. The effectiveness of the use of the rough, oxidized surface has been confirmed by a 1 year perspective clinical research.[18] The authors

positioned 102 implants with rough surface, mainly in the posterior areas of the maxillas and in the presence of soft bone, obtaining an implant survival rate of 97.1%. Once more, a comparative study[19] using implants with smooth surface (machined) and implants with rough surface (oxidized), inserted in posterior mandibles and early loaded, showed a greater success for the rough implants (10% more) compared with the machined ones. The same authors histologically investigated the osseointegration process in implants subjected to early loading, inserting nine supplementary implants in five voluntary patients.[20] Such implants were extracted after 5 to 9 months of function and the histological analysis revealed a BIC rate of 84.5%.

The aim of the present work is to evaluate the immediate/early loading in the maxilla and in the mandible with a new type of implant (Neoss Implant System) with rough surface (bimodal) and a geometry slightly tapered in its apical part.

MATERIAL AND METHODS

Patient Selection

A total of 21 patients (12 females and nine males; mean age 60 years, range 32–79) coming from two clinical centers were consecutively included in the study. Twenty-seven partially edentulous areas were treated; 16 situated in the upper arch and 11 in the lower arch (Table 1).

The preoperative assessments included clinical and radiographical examinations using intraoral radiographs and sometimes orthopantomography (OPGs) and/or computed tomography scans.

Inclusion criteria were (1) need of implant-supported crown or bridge in the partially edentulous mandible or maxilla; (2) available bone for at least 9-mm long and 4-mm wide implants; (3) minimal peak insertion torque of 30 Ncm; (4) minimal ISQ value of 50 (Osstell™, Osstell AB, Gothenburg, Sweden); and (5) signed informed consent to participate and to follow a maintenance and observation program for 18 months. The exclusion criteria were (1) noncompensated diseases; (2) poor oral hygiene; and (3) the presence of a "deep bite" in the superior central incisors.

Smoking, bruxism, and periodontal disease were considered only as risk factors. Patients with periodontitis were treated before implant surgery. Immediate placement of implants in extraction sockets was allowed.

All patients were carefully informed about the procedure and gave their written consent to participate. They could at any time point refuse further participation.

Implants

Neoss™ implants (Neoss Ltd., Harrogate, UK) were used in the study (Figure 1). This implant is characterized by a positive tolerance, signified by a slightly tapered geometry. The implant has a modified surface obtained by double particle blasting (Bimodal™ surface, Neoss Ltd.), first with larger ceramic particles to obtain a macroroughness and then with smaller particles to obtain a

TABLE 1 Position and Length of the Implants (4 mm in Diameter) Used in the Study

Maxilla														
Length	17	16	15	14	13	12	11	21	22	23	24	25	26	27
11				1								1	1	
13				1	1							1		
15		1	2	1	4	3	4	4	3	5	5	2	1	

Mandible														
Length	47	46	45	44	43	42	41	31	32	33	34	35	36	37
9		1										1		1
11	2	1	2	1									3	3
13		3	2							1	2	1	2	
15					1						1			

Figure 1 Design of the Neoss™ implant used in the study. The implant has a 1.9-mm high collar and a threaded body with a positive tolerance and vertical flutes. The Bimodal™ surface is achieved by blasting with two different sizes of ceramic particles.

microroughness. According to the manufacturer, the roughness is higher on the body and less at the neck of the implant.

A total of 69 implants were inserted: 41 in the upper arch and 28 in the posterior area of the mandible (Table 2). Implants with lengths of 9 to 15 mm and a diameter of 4 mm were inserted (Tables 1 and 2).

Sixteen implants were positioned in immediate postextraction sites.

Surgical and Prosthetic Procedures

The patients were given 2 g of amoxicillin (Zimox®, Pfizer, Italy Srl) before implant surgery. The implant sites were exposed via a midcrestal incision followed by a releasing distal incision. A full thickness flap was elevated and the positions of the implants were marked with a round bur. Then, the receiving sites were prepared with cylindrical burs of increasing diameter, according to the recommendations of the manufacturer (2.2 mm, 3.0 mm, and 3.4 mm). In the presence of very soft bone, an under-preparation technique was used with 3.0 or 3.2 mm as final diameter.

To preserve the cortical bone as much as possible, the use of countersink was avoided. Thus, the implants were generally placed with the implant collar above the bone crest.

In the immediate postextractive sites, careful curettage of the socket was performed just after the extraction of the tooth to remove any residual inflammatory tissue or periodontal ligament. The postextraction sites were divided into groups according to the following classifications[21]:

- ESND (extraction socket, no defect) – When the diameter of the socket was smaller than that of the implant and no defect remained adjacent to the implant.
- ESCD (extraction socket, closed defect) – When the diameter of the socket was larger than that of the implant and one defect remained adjacent to the implant but with bone walls preserved (closed defect). This was treated with autologous bone grafts taken from the neighboring areas with a bone scraper (Micross®, Meta, Reggio Emilia, Italy).
- ESOD (extraction socket, open defect) – When the diameter of the socket was larger than that of the implant and one defect remained adjacent to the implant but without bone walls (open defect). This was treated with autologous bone and a resorbable polyglycolid acid (PGA)-trimethylene carbonate (TMC) membrane (WL Gore & Associates Inc., Flagstaff, AZ, USA) was used.

TABLE 2 Number of Patients, Prostheses, and Implants Used in the Study

	Patients	Prostheses	Implants
All	21	27	69
Maxilla		16	41
Mandible		11	28
7 mm			—
9 mm			3
11 mm			15
13 mm			14
15 mm			37
Postextraction			16
GBR			7

GBR = guided bone regeneration.

After the complete positioning of the implants, sterile impression transfers were connected and the flaps were sutured. Impressions were taken with an open tray using Impregum NF® (ESPE, Seefeld, Germany). Healing abutments were attached to the implants.

A bite registration was taken in centric relation with occlusion waxes. The impressions were sent to the laboratory for the manufacturing of the temporary prosthesis.

The patients were treated with a postsurgical antibiotic therapy (amoxicillin, Zimox®, Pfizer, Italy Srl), 1 g twice a day for 6 days, starting just before surgery, an anti-inflammatory therapy, (nimesulide, Aulin®, Roche, Milan, Italy), twice a day for 4 days, and they were instructed to rinse with 2% solution of chlorexidine, twice a day for 10 days.

A temporary prosthesis made of acrylic with a metal reinforcement, without distal extensions, with a reduced platform, and flattened cusps was delivered within 7 days (average 4, 6 days, range 0–7 days). In the waiting period, the patients did not use any removable prosthesis.

The occlusion was in centric, with light contacts, possibly avoiding lateral and protrusion contacts. The occlusion marking paper had to leave less marked impressions on the prosthesis and on the implants compared to those of the adjacent teeth. A fixed final prosthesis made of porcelain casted on golden alloy was made after 3 to 6 months.

Radiographic Examination

Intraoral radiographs were taken after insertion of the implant (baseline), and then after 1, 6, and 18 months from the installation of the implant using a paralleling technique (Dentsply RINN, Elgin, IL, USA).

The radiographs were examined by an independent radiologist. The upper corner of the coronal shoulder of the implant was used as reference point. Measurements from the reference point to the first bone contact at the mesial and distal aspects of the implant were performed. A mean value was calculated for each implant and time point.

RFA

Implant stability measurements were performed at baseline and after 1, 2, and 6 months using RFA measurements (Osstell Mentor™, Osstell AB) expressed in ISQ units. This novel wireless RFA technique gives for many implants two ISQ values, one low and one high. Of the two values, only the greater one was registered as recommended by the manufacturer.

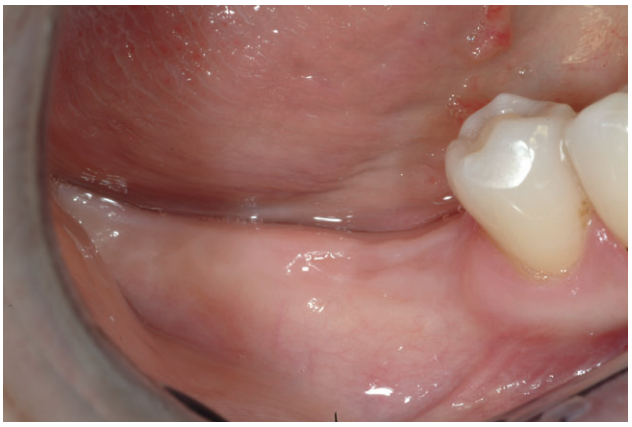

Figure 2 Edentulous space in the lower posterior arch.

As previously mentioned, a baseline threshold value of 50 ISQ was scheduled as a minimum stability quotient in order to perform the procedure of immediate function.

Implant Survival Criteria

An implant was considered surviving if it is clinically stable and if it complies with the function of supporting the prosthesis and is causing no discomfort to the patient. Failure was defined as removal of an implant due to any reason.

RESULTS

Twenty of the patients were followed up for a period of 18 months and only one patient discontinued the treatment. Figures 2 to 6 show a clinical case of partial

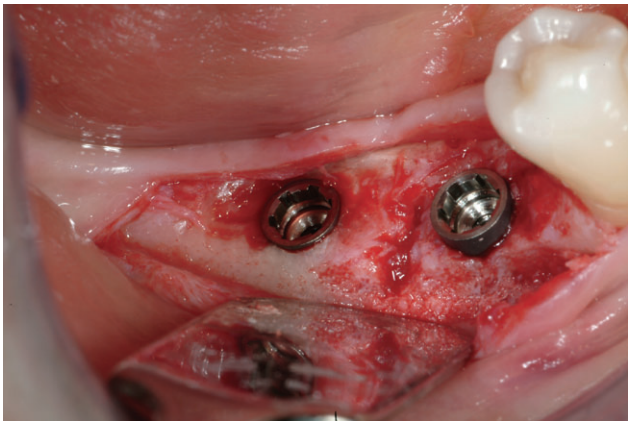

Figure 3 Two implants positioned with a full thickness flap.

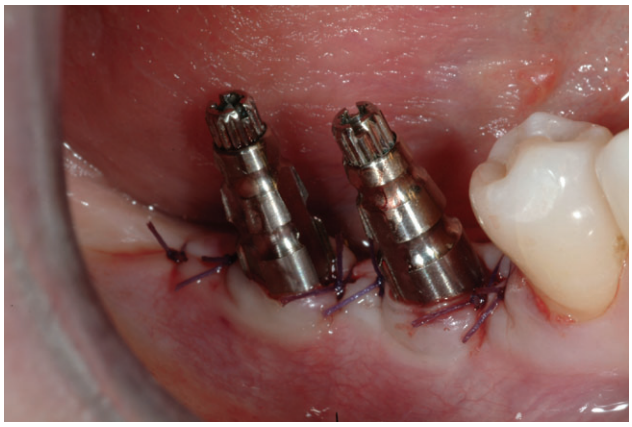

Figure 4 After connecting the transfers to the implants, the flaps were sutured and an impression taken.

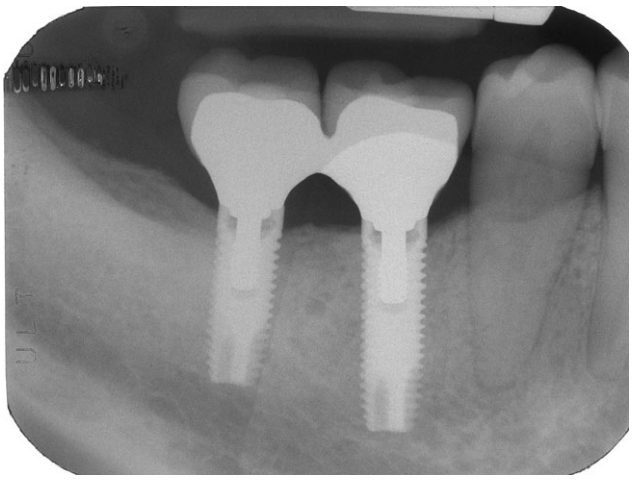

Figure 6 The follow-up after 18 months shows an optimal maintenance of the bone marginal level.

edentulism in the posterior lower arch. Figures 7 to 11 show a case of partial edentulism in the maxilla with the presence of a high bone deficiency.

Clinical Examination

One of the 69 implants was diagnosed as a failure, giving a survival rate of 98.5% after 18 months. The failure occurred 4 weeks after placement in an immediate postextraction site in the anterior maxilla in a patient affected by serious periodontitis.

Sixteen implants were inserted in immediate postextraction sites (Table 1). In nine cases, the implant diameter was equal or larger than that of the postextraction socket and filled the receiving site completely (ESDN group). In seven cases, a "gap" remained between bone and implant and regenerative therapy was performed. In six of these cases, the defects were of the "closed" type (ESCD group) and they were filled with some particulate autologous bone. One case presented an "open" defect with no walls (ESOD group) and was treated with bone grafts and a resorbable membrane (Figure 7).

Radiographic Examination

The radiographic measurements showed that the baseline bone level was situated 0.8 mm (SD 0.2) ($n = 58$) from the top of the collar and 1.7 mm (SD 0.3) ($n = 47$) and 1.4 mm (SD 0.6) ($n = 57$) after 6 and 18 months, respectively (Table 2). Thus, a marginal bone resorption of 0.9 mm (SD 0.3) ($n = 47$) after 6 months and 0.7 mm (SD 0.7) ($n = 53$) after 18 months were seen (Table 3). The proportion of implants showing more than 2-mm bone resorption was 13.2% and no implant showed more than 3-mm bone loss over 18 months (Table 4).

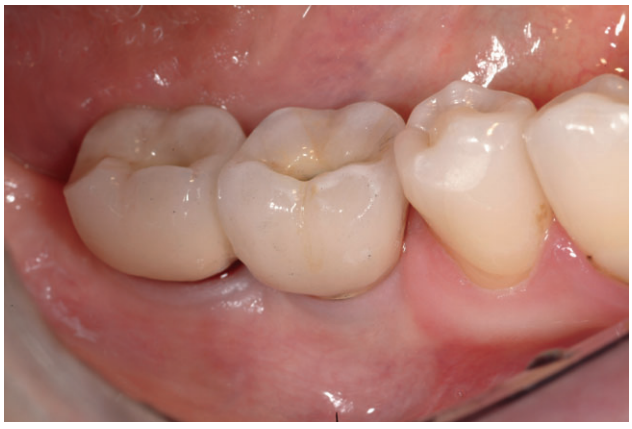

Figure 5 The final gold-ceramic prosthesis after 3 months.

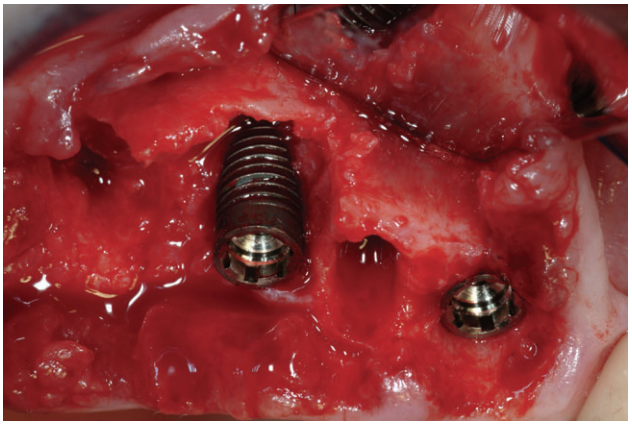

Figure 7 Two implants positioned in the superior maxilla, in immediate postextraction sites. The distal implant shows a large surface and exposed implant threads.

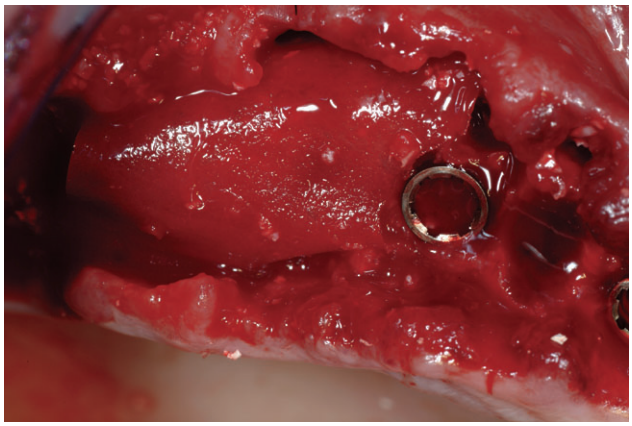

Figure 8 The bone defect has been filled with a mixture of autologous bone/bovine bone deproteinized and then covered with a reabsorbable membrane.

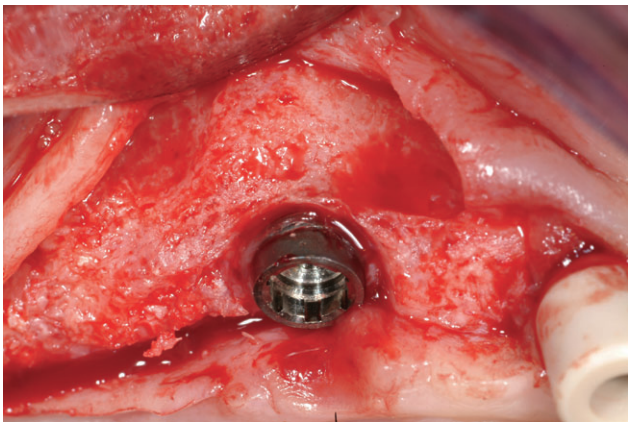

Figure 11 After 6 months, the surgical reentry shows complete coverage with new bone of the previously exposed implant area. The resonance frequency reveals a significant increase (implant stability quotient [ISQ] 61), compared with the baseline (ISQ 51).

RFA

A total of 59 implants were systematically analyzed with RFA measurements. The mean ISQ values were 68.1 (SD 8.8), 66.0 (SD 8.5), 69.1 (SD 6.9), and 73.6 (SD 5.7) at baseline and after 1, 2, and 6 months, respectively.

There was no major difference in stability between the maxilla, although mandibular implants showed slightly higher values with time (Figure 12).

The implants positioned in the postextraction sites with "closed" defects ($n = 6$) showed an average ISQ of 65.8 (SD 7.5) at baseline, which increased to 67.5 (SD 6.9) after 6 months (Figure 13).

The only implant associated with an "open" defect showed a rather low starting value, ISQ 51, which

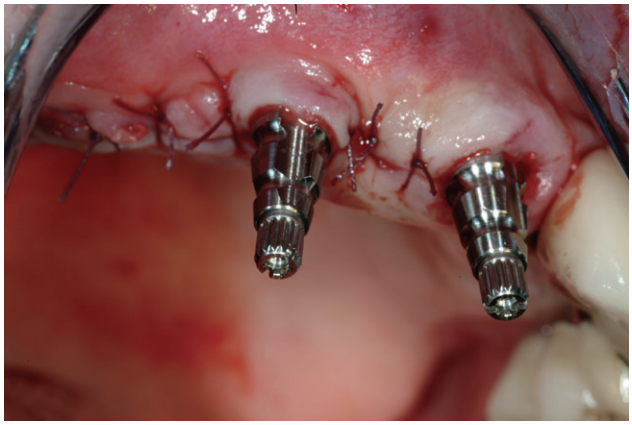

Figure 9 The flaps were sutured around the transfers and an impression was taken.

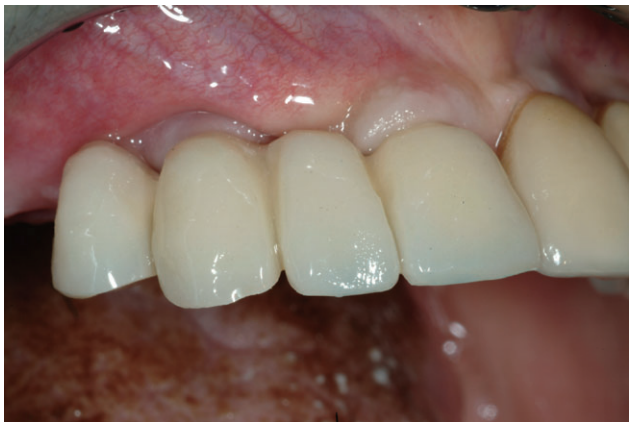

Figure 10 After 4 days, the temporary prosthesis was applied.

TABLE 3 Results from Radiographic Measurements Based on Mean Values of Distal and Mesial Aspects

Time Point	Bone Level	Bone Loss
Baseline	0.8 (SD 0.2) ($n = 58$)	
6 months	1.7 (SD 0.3) ($n = 47$)	0.9 (SD 0.3) ($n = 47$)
18 months	1.4 (SD 0.6) ($n = 57$)	0.7 (SD 0.7) ($n = 53$)

TABLE 4 Distribution of Marginal Bone Loss after 18 months in Function

Interval (mm bone loss)	Number of Implants	Proportion of Implants (%)
<0	11	20.8
0–1	22	41.5
1–2	13	24.5
2–3	7	13.2
>3	0	0

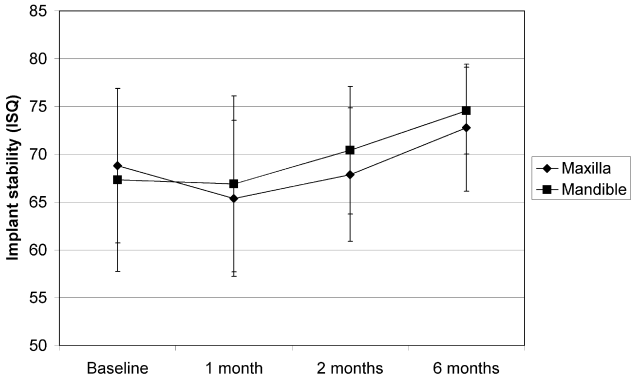

Figure 12 Graph showing the stability of maxillary and mandibular implants with time. ISQ = implant stability quotient.

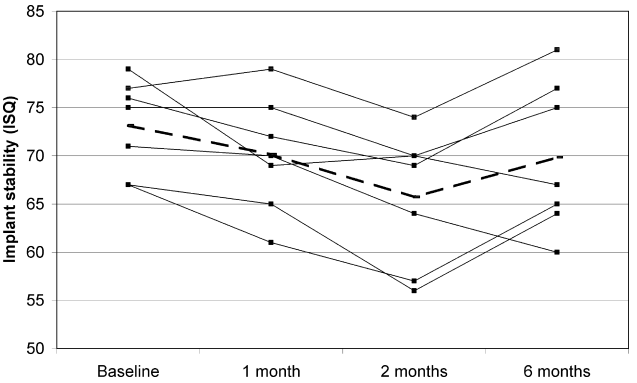

Figure 14 Graph showing the development of seven implants showing falling stability from baseline to 1 month. Hatched line showing the mean stability of the seven implants. ISQ = implant stability quotient.

remained unchanged during 4 weeks (ISQ 52) and then significantly increased after 8 weeks to 56 and finally 64 after 6 months (Figure 13).

The implant that failed (position 12) was installed in an immediate postextractive site and, at the moment of the insertion, it had an ISQ 74. After 4 weeks, the patient reported pain in that area and the analysis with the resonance frequency showed a value of ISQ 42 associated with an initial mobility of the implant and the appearance of bone peri-implant rarefaction. With these clinical conditions, it was impossible to save the implant, and a decision was reached to remove it.

Some implants ($n = 7$) showed a significant decrease of their stability at 1 ($n = 3$) and after 2 months ($n = 4$), maintaining, however, the anchoring in the bone and showing even a significant recovering after 6 months ($n = 5$) (Figure 14). Only two implants showed a continuous decrease of stability up to 6 months.

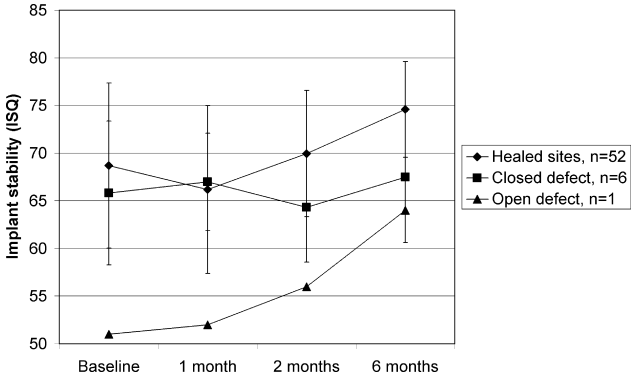

Figure 13 Graph showing development of stability for implants in healed sites, in closed extraction defects, and in one case with an open extraction defect. ISQ = implant stability quotient.

DISCUSSION

The present study confirms the results from previous clinical investigations that good outcomes can be obtained with early loading of implants positioned in the upper arch and in the posterior lower arch, regions which often are characterized by poor quality bone.[9,10,11,17–19,21] There are many advantages with this method such as (1) preservation of the aesthetics; (2) early occlusion loading, even if often reduced; (3) very rapid procedure and therefore less discomfort for the patient; (4) lower number of operating stages for the dentist; (5) probable less bone marginal resorption;[22] and (6) possible advantages for the peri-implant bone generation. Concerning the latter, it has been observed that cylindrical implants with machined surface subjected to immediate function have a positive effect on the osteogenesis.[2] When implants are loaded for 12 weeks, the presence of peri-implant osteoid tissue and the BIC increase significantly. Another study on primates confirmed that immediately loaded implants show a greater BIC (62.4%) compared with that of not loaded implants (56.3%).[3]

According to our protocol, immediate postextraction sites ($n = 16$) were included with the purpose to preserve the bone ridge level as much as possible. It has been observed that after the extraction of the tooth, a bone ridge resorption of even 50% takes place after 1 year, with 2/3 of this process occurring during the first 3 months.[23] Maintenance of the ridge is particularly important in those situations where the height of the available bone is limited and the implant can help to maintain the existing bone. Even more important is the need to maintain the marginal bone level and,

consequently, the soft tissue level too, in the front areas of the arches where the aesthetics play a fundamental role. It has been demonstrated that the positioning of an implant in a fresh extraction site can prevent the resorption, especially on the buccal side where the bone is generally thinner.[24–25]

In a study using immediate function in the front areas of the maxilla, implants were positioned also in immediate postextractive sites.[26] The authors observed that all implant failures occurred in the postextractive sites and concluded that such sites represented a risk factor for the immediate function protocol. On the contrary, an 18-month perspective clinical study demonstrated the possibility to carry out an immediate function protocol with success also in postextractive sites, provided the respect for a rigorous clinical protocol.[21] The authors positioned 50 implants in 22 edentulous areas in the maxilla or in the posterior mandible, classifying the defects according to the preservation or not of the surrounding bone walls. The peri-implant defects were treated with particulate autologous bone grafts or grafts associated with resorbable membranes. All the implants had to have a sufficient primary stability as evaluated by the resonance frequency. At the end of the follow-up period, all the implants resulted to be stable, with a total survival rate of 100%.

The healing of peri-implant defects, following the implant insertion in postextractive sites, depends also on the dimension of the residual "gap." Wilson and colleagues[27] evaluated the bone healing around implants inserted just after the tooth extraction and retrieved after 6 months for histological analysis. The BIC was 72% on the control side (not postextractive areas), 50% for implants with an initial defect equal or less than 1.5 mm, and 17% for implants with an initial defect of 4 mm. Therefore, the bigger the initial defect, the smaller the BIC.

In the present study, 16 implants were inserted in fresh postextractive sites. Nine of these implants completely filled the sockets (ESND group), and did not require a regenerative therapy. Near to six implants, there were defects with preserved walls (ESCD group), and a regenerative treatment was executed with particulate autologous bone taken from the neighboring areas with a "scraper." Only one implant presented a serious defect with the lack of walls (ESOD group), and this area was treated with autologous bone covered with a resorbable membrane (Figure 8). In this last case, it was interesting to observe the progressive increase of the implant stability (Figure 12), probably proportional to the bone regeneration. The second surgical phase after 6 months (Figure 11) showed an almost total coverage of the implant surface, which was previously exposed, demonstrating that the guided bone regeneration can take place also in case of implants subjected to immediate function.[21]

A noninvasive method for the evaluation of the implant stability has been proposed by Meredith and colleagues[28] Such device measures the resonance frequency of a transducer tied to the implant or to the abutment. The transducer transmits the vibrations of sinusoidal type which are received by a second frequency analysis element. The stability values are expressed in ISQ. According to the authors, the resonance frequency is determined by the rigidity of the implant/tissues interface and by the distance between the transducer and the first bone contact. In following studies, the same researchers have been able to confirm the correlation between the measurements with the resonance frequency and the rigidity of the implant inside the bone tissue.[29–30] Glauser and colleagues[31] carried out a study on 23 patients subjected to the procedure of immediate function, monitoring for 1 year the stability of the implant by means of the resonance frequency. The authors observed that the implants subjected to a successive failure showed a continuous drop of stability up to the loss of the implant. Moreover, low stability values after 1–2 months seemed to indicate an increased risk of failure. In another experimental study, some implants with machined and rough surface were positioned in dog mandible.[32] Around the implants, in subgingival position, some ligatures were applied for 3 months with the purpose to cause an experimental peri-implantitis. Afterward, a regenerative therapy was started, including debridement and cleaning of the implant surface. For the monitoring of the implant stability, the resonance frequency was used. During the peri-implantitis phase, it has been possible to observe a loss of bone associated to the drop of implant stability. Later, such stability tended to increase during the healing phase and it was more pronounced in the case of implants with rough surface. The authors concluded that there is a direct correlation between the marginal bone level and the resonance frequency values.

According to some authors, a significant drop of stability occurs after some weeks from the implant

insertion. According to some authors, this period can be quantified in 2 to 4 weeks[12–33] and according to others up to 2 months.[31] The reason for such decrease could be attributed to the bone relaxation after the compression due to the insertion and to the bone adaptation during the healing phase. Other authors[30–34] have instead noticed a maintaining of the bone stability during the first weeks or even a small increase.[34] In the present study, the mean ISQ values at baseline remained unchanged at 1 and 2 months. This behavior could indicate that the initial stability of the Neoss implants (Neoss Ltd.) is not tied to the excessive compression of the bone tissue at the moment of the implant insertion. The mean resonance frequency values, registered at baseline (mean ISQ 68.1) indicate that the implants utilized a sufficient level of primary stability also in the maxillary regions where the bone quality is less favorable. No significant differences were observed between the upper arch (mean ISQ 68.8) and the lower arch (mean ISQ 67.3). These values are higher than those reported for Straumann implants[34] (mean ISQ 57.4) and comparable with those reported for Branemark[35] implants (mean ISQ 67.4). In the present work, the analysis at 6 months evidenced a consistent increase of stability (mean ISQ 73.6), indicating a successful process of implant osseointegration. It has been noticed that the lower the initial value of ISQ, the larger the growth registered at 6 months.

In the immediate postextraction sites ESCD, even though there was a residual defect, stability at baseline of ISQ 65.8 was obtained, which is comparable to that of implants positioned in healthy bone. Only, at the level of the implant positioned in a site ESOD, the initial value was rather low (ISQ 51), probably because of the extensive lack of the surrounding bone. After 8 weeks, the resonance frequency was already giving a significantly increased value (ISQ 56), indicating that a regenerative process was taking place. After 6 months, the value was further increased (ISQ 64), and the second surgical intervention confirmed that the bone regeneration had occurred (Figure 10).

Sometimes, the resonance frequency enables to discover a dangerous drop of stability before having an implant failure. In a perspective clinical study, Vanden Bogaerde and colleagues,[21] with the resonance frequency, evidenced a significant and progressive loss of stability of an implant. Such decrease of stability progressed up to the sixth week, after which a decision was made to remove the implant from the occlusion. The successive control after 6 months showed a recovery of stability with an ISQ value greater than the initial one. In the present study, the implant that failed had an extremely rapid drop of stability and it has been impossible to intervene before losing the integration. After 4 weeks, the patient reported pain, swelling, and a bone rarefaction in the interested area. This was probably due to an infection that occurred because of bacteria trapped during the implant insertion; as a matter of fact, it concerned an immediate postextractive site in a patient affected by a serious form of periodontitis. However, as observed also in a precedent study,[21] a drop of stability during the first weeks does not necessarily signify an imminent risk of implant loss. In the present study, on some implants ($n = 7$) a decrease of stability was observed after 4 weeks ($n = 3$) and 8 weeks ($n = 4$), without any clinical signs from the implants regarding a loss of anchorage. Some of them ($n = 5$), after 6 months, showed a significant increase of the resonance value (Figure 13).

The marginal bone level measurements showed an average bone loss of 0.7 mm over 18 months, which is similar to the value that have been reported from our group for other implant designs[10,17,21] The bone level after 18 months was on average still situated on the collar, ie, 1.4 mm below the reference point on the 1.9-mm-high collar. More than 20% of the implants showed an increase of the bone level, which may be explained by the fact that many implants were placed in extraction sockets. About 13% of the implants showed more than 2-mm bone loss, but no implants lost 3 mm or more over 18 months in function.

CONCLUSION

Within the limitations of the present study, it is concluded that immediate/early function with Neoss implants (Neoss Ltd.) is a reliable method, with an implant survival rate comparable with that of the traditional two-stage protocol.

CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to declare. [Correction added after online publication 24 May 2010: Conflict of Interest Statement added.]

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