

Surgical and Prosthetic Concepts for Predictable Immediate Loading of Oral Implants

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ABSTRACT

Immediate loading of oral implants is an established concept for lower jaw restoration using four intraforaminal implants splinted together with a bar. There is a lot of misunderstanding in the literature and not exact definition of the term "immediate loading."

Moreover, the number of implants to restore edentulous jaws is relatively high to compensate for the loading forces and dependent on the bone quality and quantity. This report presents the different surgical and prosthetic concepts for immediate loading to get long-term success in the upper and lower jaw. When the primary stability is adequate, only six implants may be loaded immediately after surgery, if the implants are splinted using a provisional fixed restoration. Using a number of six primary stable implants, it is possible to restore edentulous jaws independent on the clinical situation. This concept may be used successfully in the posterior part of the mandible when three implants are splinted with provisional crowns and loaded immediately. The biomechanical aspects, the implant design and surface seem to be of great importance for the long-term success in compromised and advanced surgical cases. In conclusion, immediate loading of oral implants may be successful if a primary stability as well as immobilization (splinting) immediately after surgery are taken care.

loading free period of three months in the mandible and six months in the maxilla is a condition sine qua non according to the traditional Brånemark concept presented in 1983.¹ Excessive micromotions larger than 100 µm during this healing period can have a negative effect on the osseous integration of oral implants because fibrous tissue may form at the bone-implant interface disturbing the remodelling processes, which leads to implant mobility.²⁻⁴ A short healing period following implant placement, as well as immediate loading of implants can have very positive social and psychological effects for the patient.⁵

A direct immobilization of the inserted implants using a curved U-shaped bar showed cumulative success



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rates of more than 88 percent.⁶⁻⁷ Furthermore, indirect immobilization using telescopic prefabricated abutments connected with a full denture immediately after surgery (for the first 10 days of healing) has been reported with success rates of about 97 percent.⁸

Fixed implant-supported reconstructions may load implants immediately after surgery without implant failures if certain requirements are met. Some authors recommended a high number of implants with a length higher than 10 mm as well as a rigid provisional splinting, and that cantilevers should be avoided especially in the provisional prosthesis. In addition, excellent implant stabilization should be attained, and sufficient bone quantity as well as quality should be available.^{5, 9-11}

There are many open questions today concerning the treatment protocol of immediate loading:

- What does “immediate loading” mean?
- How many implants are mandatory in each edentulous jaw in order to get osseointegration, when implants are loaded immediately after surgery?
- Is immediate loading possible in cases with bone augmentation in resorbed alveolar ridges?
- Are there any high risks, such as contraindications for immediate loading?
- The present report will try to answer these questions based on the recent literature and the presentation of different clinical case reports.

What Is “Immediate Loading”?

There is no general agreement in the literature about the term “immediate loading.” There is no doubt that “immediate” should be better clarified and “loading” should be defined for the purpose of facilitating the critical analysis of the data published by different authors in the recent literature. Some

papers refer to an installation of the implant-supported overdenture in the first three to four days of healing some others recommended loading 10 days after surgery using bicortical fixation of six Brånemark implants in the symphysis and present high success rates after six months of loading.^{6-7, 12-13} The author considers that the term “early loading” should be used in the later case, because the implants were loaded 10 days after their insertion and this

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should not be considered as “immediate.” The main reason for the use of the immediate loading concept is to significantly reduce the total treatment period, which has positive social and psychological effects for the patient and increase significantly the patient comfort avoiding the use for a long time a removable prosthesis.⁵

Immediate loading of single tooth implants has been demonstrated using provisional crowns without any or with minimal occlusal contacts.¹⁴⁻¹⁶ In order to use the term “immediate loading” in such cases, the implants should have occlusal contacts in the

centric in the first days of healing. In cases of immediate restorations, i.e. in the single tooth implants or small implant-supported restorations without occlusal contacts, which will be replaced later with the final restorations in a physiologic occlusion, the term of “immediate supply” (or temporalization) and not “loading” should be used. Only the study published by Glauser, et al. reported full contacts of the immediately loaded single tooth Brånemark implants in centric occlusion and showed cumulative success rates of 82.7 percent after one year of loading.¹⁷

In partially edentulous free-end clinical cases there are not sufficient data showing the prognosis of immediately loaded implants. Definitely, there is a biomechanical risk in the free-end restorations because of the applied bending moments around the implants especially when these implants are immediately loaded. Some authors suggest early loading (two to six weeks after surgery) in the posterior mandible using implants with rough, sandblasted, large grid acid-etched surfaces.¹⁸ One year after loading the implant survival was 100 percent. The authors recommend careful selection the patients, as well as the implant sites in order to use the early loading concept successfully. In contrast to these findings, the authors were able to evaluate immediately loaded implants with a progressive thread design in 12 patients. In a recent prospective well-controlled randomized clinical study, the immediate loading concept was compared with delayed loaded implants (split-mouth) in the posterior part of the mandible. The clinical and radiological examination after two years of loading did not present any statistically significant difference in the two study groups (immediate vs. delayed).¹⁹

In fully edentulous cases there are few studies showing the long-term prognosis of immediately loaded implants. Different authors immediately loaded non-submerged implants using a provisional restoration and connected them later with submerged healed implants. In their evaluation, the authors reported increased success rates for this immediate loading concept. They also connected such implants together with completely healed (osseointegrated) implants to better compensate the loading forces.²⁰ The implant primary stability is extremely important and the occlusal scheme should have symmetrical contacts keeping the vertical dimension immediately after installation of the provisional bridges.^{6,11,21} Lateral eccentric contacts should be eliminated in the provisional prosthesis and the patient should use a soft diet for the first four to six weeks of healing.²²

Implant Number for Immediate Loading to Restore Edentulous Jaws

Recent literature suggests a minimum of four implants when they are immediately loaded using a removable prosthesis. This number is higher when a fixed reconstruction will be fabricated. At least six to eight implants in the upper jaw and a minimum number of five to six implants in the lower jaw has been previously recommended because of the different bone quality in the different anatomic regions.^{11,22} The implant design seems to be of great importance in association with the implant length and may influence primary stability. Furthermore, rough surfaces (TPS-coated, SLA, acid etched, acid etched-sandblasted or HA-coated) increase the microgrooves and the cell attachment, and positively affect the implant integration.²³⁻²⁷ The

removal torque was higher on implants with rough surfaces compared to those with smooth surfaces in miniature pigs.²⁷ Therefore, rough surfaces were considered to be more suitable than machined surfaces and have been recommended for early or immediate loading.²¹ Implants with machined surfaces are not recommended for immediate loading especially in the maxilla or in areas with poor bone quality.²¹

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Using a new concept of treatment in Sweden, it was possible to place three transmucosal Brånemark-implants in the anterior part of the lower jaw and to load them immediately using a fixed bridge. This "Same-day-teeth"-protocol may not be suited for use in a private practice however, because of the highly precise surgical procedure. According to the first publication based on the Brånemark-Novum-concept, the success rate after one year of loading was 98 percent.²⁸

A recent series of clinical cases have documented that indirect immobilization of four primary stable

Ankylos implants (placed in the anterior region of the mandible) can be immediately loaded successfully using an implant-supported overdenture. According to this treatment protocol the implants were not splinted together with a bar, but were connected with prefabricated conical abutments (SynCone). These prefabricated abutments have a very precise fit with the secondary copings, which are inserted into the overdenture. The denture should not be removed for a period of 10 days and the patient should be placed on a soft diet program. This treatment protocol has been used in a total of 204 implants in a mean observation period of two years and presented a cumulative survival rate of 97.54 percent.⁸ The SynCone-prefabricated abutments have many benefits. They significantly reduce the costs associated with the fabrication of customized castings and allow for better oral hygiene performance in comparison to the bar-retained dentures.

A similar concept but using early functional loading (the implants were functionally loaded within five days after surgery) was recently published using the Brånemark implant system. After two years of loading a cumulative survival rate of 96.3 percent has been observed.²⁹

Edentulous upper and lower jaws have been restored with only six Ankylos implants (in each jaw) and immediately loaded implants after implant placement surgery using temporary resin restorations (immediate functional/occlusal loading). The final restorations were placed and cemented provisionally approximately six weeks after placement surgery. No bone loss was presented two years after loading using this concept. The complete treatment protocol has been recently published in a clinical case report.³⁰

The present results document a high success rate (97.72 percent) in 15 patients with 132 implants (78 placed in the maxilla and 54 in the mandible) after a loading period of 22.37(±12.62) months. The two implants, which failed before healing and were removed, were maxillary implants placed in a patient with bruxism. All implants exhibited healthy peri-implant soft and hard tissue in contact with the implants (data not shown).

In cases of large peri-implant dehiscences and fenestrations after implant insertion, where a coverage of an exposed implant by bone grafting or guided bone regeneration may be indicated, a traditional healing protocol with a delayed loading concept has been recommended.⁷ In contrast to these suggestions, Glauser et al. reported a better prognosis of immediately loaded implants in comparison to the traditional protocol when GBR-technique was performed, because the implants in the augmented regions would be expected to be in contact with the cortical bony plates and not with trabecular bone, presenting a higher stability.¹⁷ There is no data at the moment showing if the augmented areas will be stable over time or if implant exposure may be observed.

Histological Observations of Immediately Loaded Implants

Animal studies have demonstrated that successful osseointegration of implants with a progressive thread design can occur when implants were placed and loaded immediately if some specific conditions are present. Comparison of the histological and histomorphometrical findings of the peri-implant hard and soft tissues on immediately loaded implants and for delayed loaded implants did not show any statistically significant differences in specimens

from *M. fascicularis* monkeys.³¹⁻³³ The mineralized bone at the interface of immediately loaded implants appeared to exhibit higher density when compared to the bone tissue around the delayed-loaded implants.³² Higher bone density has been demonstrated at the interface around both immediately- or delayed-loaded implants when compared with unloaded implants in monkeys.³⁴ This explains that loading in general, seems to promote the formation of dense bone as has been shown elsewhere.³⁵

The histological findings involving implants that were placed in humans and immediately loaded showed no fibrous tissue formation (encapsulation). The bone-to-implant contact (osseointegration) was found to be excellent between the immediately loaded implants and the surrounding alveolar bone. These implants had blade or screw thread designs, which were removed because of implant fractures.³⁶⁻³⁸ Similar findings were recorded after a histological examination of en bloc human biopsy specimen from a patient who died because of a bronchial carcinoma. A total of 12 Ankylos implants (six in the maxilla and six in the mandible) were examined and the authors were able to observe an implant-bone integration without epithelial proliferation and pocket formation. The histomorphometrical evaluation of bone-to-implant contact within the threads demonstrated a mean of about 51 percent and a mean bone volume of about 52 percent with a tendency toward higher percentages around the implants in the upper jaw seven months after loading.³⁹ The implants had a progressive thread geometry and sandblasted surface.

Histological specimens obtained in a clinical study conducted by Rocci, et



Figure 1a. Bilateral edentulous free-end in the mandible.

al. with oxidized implants TiUnite (surface) that were subjected to either early or immediate loading and followed for a period of five to nine months showed normal healing around all of the implants.⁴⁰ In this study, the implants for only one patient were subjected to immediate functional loading the same day of surgery. The implants in four other patients involved early loading (two months after surgery the implants had occlusal contacts). The investigators performed additional studies to determine the success rate of machined and TiUnite (surfaced) implants. Of the implants placed and followed in this study, 14.4 percent of the implants with machined surfaces failed compared with 4.7 percent failures for the oxidized implants in the first year of loading. The higher failures for the machined surface implants occurred more frequently in smokers and poor (Type IV) bone qualities.⁴¹

Immediate Implants and Immediate Loading

The possibility of restoring upper and lower jaws using implants that are placed immediately following extraction of periodontally involved natural teeth and subjecting them to immediate functional loading represents a very interesting treatment concept

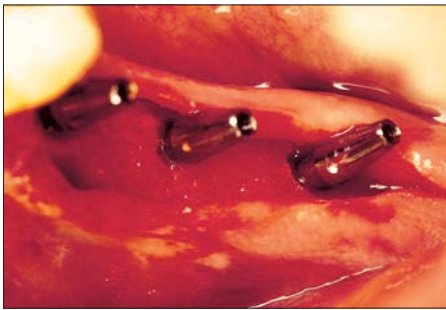


Figure 1b. Placement of three Ankylos implants in the posterior part of the lower jaw for immediate loading.



Figure 1c. Installation of the provisional splinted crowns presenting occlusal contacts.



Figure 1d. Occlusal aspect of the provisional restorations immediately after surgery of the test and control side.

with a lot of possibilities in the future. This treatment protocol may be indicated especially in patients, who may not be able to tolerate a full denture.³⁰ The excellent primary stability of implants with rough surfaces as well as screwed tapered design provides excellent anchorage in the alveolar socket immediately after tooth extraction.

Results have been reported on immediate loaded single tooth implants placed in fresh extraction sockets compared to immediately loaded implants placed in completely healed bony sites. The survival rates were only 82.4 percent and 100 percent for immediate vs. nonimmediate implants, respectively. In an additional pilot study, Ericsson, et al. were able to follow up 14 immediately loaded single tooth implants in 14 patients, which loaded within 24 hours after surgery with temporary crowns. These preliminary data showed also 14 percent failures after a five-month loading period.¹⁵

In contrast to the data from the single tooth immediately loaded implants, the authors were able to get a high success rate when restoring complete jaws using six to eight immediate implants splinted together with temporary cross-arch jaw restorations immediately after placement. The main criteria of success was the excellent primary stability and

the immobilization using a stable temporary bridge.

The present clinical data shows an impressively high success rate using this treatment protocol after clinical loading of the implant for a period of two years. This treatment concept has been used to date in 16 patients with 138 immediate implants (78 in the maxilla and 40 in the mandible) loaded immediately after surgery. After a loading period of 16.18 ± 9.34 months, three immediate implants and immediately loaded were lost (data not shown). This represents a success rate of 97.82 percent using an implant system with a progressive thread design and sandblasted rough surface. The failed immediate implants were placed in combination with simultaneous sinus lift procedure and loaded immediately.

There is no doubt, that special training in advanced periodontal and implant surgery as well as implant prosthodontics will help the dentist to reach high success rate and long-term prognosis in such treatment protocols. A high number of clinical studies are necessary, before these techniques may be used on a routine basis. The excellent primary stability of the selected implant system is a *conditio sine qua non* in order to get in the future scientific data with more evidence.

High Risks for Immediate Loading Treatment Concepts

General contraindications for immediate loading seem to be patients with inadequate compliance for recall visits, and patients with parafunctional habits. This is relevant when patients do not adhere to a soft diet in the first period of healing. Patients with parafunctional habits such as bruxism also should be considered as a high-risk group for immediate loading since it was shown that overloading may change the bone-to-implant interface dramatically.⁴² It has been shown that the failure rate in patients with bruxism with immediately loaded implants was about 37 percent.⁹ There were more failures (41 percent) in comparison to nonbruxers (12 percent) have been reported by Glauser et al.¹⁷ Since it has been considered that bruxism reduces the success rate of implant therapy, bruxers should be treated using the conventional loading protocol.⁴³

Rigid splinting and minimal force applications are critical factors for the success in immediately loaded implants, according to Tarnow et al.¹⁰ The authors recommend avoiding the removal of the provisional prosthesis in the first four to six months of healing if these restorations are cemented. This view



Figure 1e. Radiological examination at the left side (immediately loaded implants) and right side shows no bone loss with the provisional restorations.

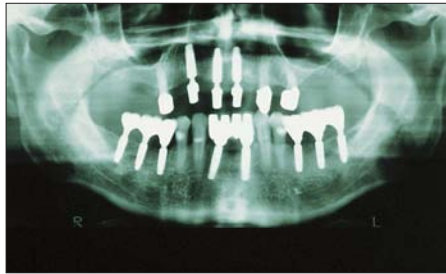
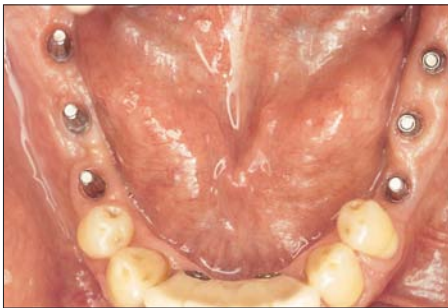


Figure 1f. No bone loss on the immediately and delayed loaded implants.



Figures 1g and h Peri-implant healthy soft tissue condition three years after loading as well as excellent esthetics.



Figure 1h.

corresponds with additional studies performed by Horiuchi et al.¹¹ Moreover, most failures are reported in the posterior part of the mandible.

This is probably because of the poor bone quality in this area and the lack of contact of the implant with the opposing cortex.^{10-11,22} Systemic factors, like heavy smoking and local anatomical factors, such as extensive augmentations in areas of poor bone quality in the maxilla have been discussed as critical factors lead to complications during immediate loading.

The following clinical case reports present a concept of immediate loading in three patients in order to demonstrate the applied surgical and prosthetic treatment protocols and provide the clinician the basis for a successful

immediate loading concept with a long-term success.

Case Presentations

Case No. 1

A 59-year-old Caucasian male patient with bilateral free-end edentulism in the lower jaw received six Ankylos implants, three on each side (Figure 1a). One side of the mandible, the implants were loaded after three months of healing. On the contralateral side, three implants were loaded immediately with temporary splinted crowns (Figures 1b-d). The provisional restorations were placed on both sides in the same time and had occlusal contacts. The radiographical examination immediately after installation of the

splinted provisional crowns is presented in Figure 1e showing the marginal bone level. The final restorations placed 5½ weeks after surgery. After three years, the bone level was the same. No bone loss was able to be observed in the delayed and immediately loaded sides (Figure 1f). The clinical peri-implant soft tissue condition around the Ankylos implants was healthy and the occlusal surfaces of the implants had a conventional occlusal shape representing excellent esthetics.

Case No. 2

A 60-year-old Caucasian female edentulous patient was consulted because of insufficient retention of her lower jaw denture. In the prior six months, the patient received new dentures from her home dentist but was unhappy with the retention in the lower jaw. The patient ultimately decided for a fixed implant-supported bridge. A radiological examination showed sufficient bone height. The full dentures were in an acceptable functional and esthetic condition. The vertical and horizontal dimensions were good. An impression of the lower jaw denture was taken in order to fabricate surgical guide splint for the lower jaw.

Surgical Procedure

A crestal incision was performed under local anaesthesia in order to place Ankylos implants (Dentsply-Friadent Co., Mannheim, Germany). Mucoperiosteal flap elevation was performed and the alveolar ridge was exposed. The thin alveolar ridge in the anterior part of the mandible was reshaped using a diamond bur under sterile saline cooling. A bilateral preparation of the N. mentalis was performed in order to avoid surgical damage during implant placement. The plateau of the alveolar ridge in the symphysis was



Figure 2a. Edentulous mandible for immediate loading. Implant placement and abutment connection for immediate loading using a provisional bridge and immediate functional loading. Mucoperiosteal flap elevation in the upper jaw presenting the narrow alveolar ridge.

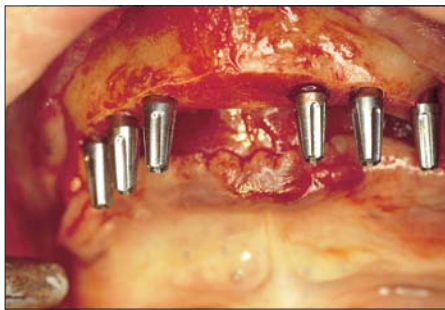


Figure 2b.



Figure 2c.

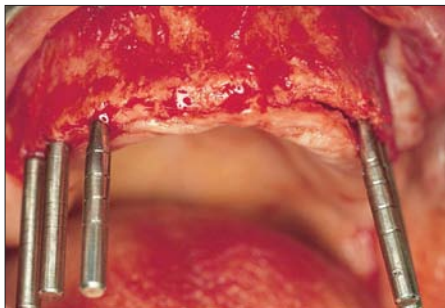


Figure 2d.

sufficient in order to place six implants in the areas Nos. 21-23 and 26-28 without any augmentative surgical procedures. We placed implants with a progressive thread design (Ankylos, Dentsply-Friadent Co., Mannheim, Germany) for a high primary stability using a surgical guide splint during drilling. The implants had a sandblasted surface and a highly polished collar of 2 mm. The length was 14 mm and the diameter 3.5 mm. The implants were connected with their standard straight abutments immediately after surgery (Figure 2a-b). The abutments were fixed with a torque of 20 NCM as has been recommended for this implant system. Periotest values were evaluated to record implant stability immediately

after implant placement and abutment connection (PVo). Temporary caps were placed and fixed in position with Temp-Bond cement material (Kerr Co., Karlsruhe, Germany) and the mucoperiosteal flap was sutured with 4-0 silk suture material (Resorba Co., Nürnberg, Germany).

Postoperative Care and Prosthetic Rehabilitation

Immediately after surgery, a temporary fixed bridge reconstruction was fabricated chairside with Pro-Temp acrylic material (Espe Co., Seefeld, Germany) using an acrylic template and cemented on the abutments having occlusal contacts in centric (Figure 2c). The relining of the template was

performed in centric occlusion, in the correct vertical dimension. An orthopantomograph was performed to evaluate the peri-implant crestal bone level after surgery. The patient was advised to use a soft diet for the first four to six weeks. Rinsing of the oral cavity with chlorhexidine digluconate 0.2 percent solution for chemical plaque control was indicated until the sutures were removed. Ten days after surgery the sutures were removed. Four weeks after implant placement and loading, the peri-implant soft tissue showed a healthy color. Impressions were performed using Impregum (Espe Co, Seefeld, Germany) and special transfer caps using customized trays. An implant-supported metaloceramic reconstruction was fabricated and cemented temporarily with Temp-bond two weeks later. Cantilevers were used for the second premolar and first molar in order to establish a first molar occlusion.

Four months after loading, the patient asked for similar treatment in the upper jaw. Using a similar surgical guide splint for the lower jaw surgical procedure, a mucoperiosteal flap elevation was performed with midcrestal incision under local anesthesia. The alveolar ridge



Figure 2e. Implants placed and connected with their abutment for immediate loading. An additional autogenous bone grafting procedure was necessary as well as a coverage with a Biogide membrane (GBR technique) to cover the implants with bone.



Figures 2f-h. Healthy peri-implant soft tissue around the immediately loaded implants three years after surgery as well as bone stability characterizes the long-term success of the immediate loading concept also in compromised clinical sites.



Figure 2g.



Figure 2h.

was relatively thin (approximately 2 mm to 3 mm width) for the optimal implant placement (**Figure 2d**). The implants were placed using the protocol for the Ankylos implant system in the areas Nos. 4-6 and 11-13. The implants had 14 mm length and 3.5 mm diameter. All implants had excellent primary stability but some of the threads in the buccal aspect were exposed and needed augmentation. Autogenous bone graft was harvested from the two tuberosities using a trephine and milled with a milling machine before augmentation of the exposed implant threads. Temporary resin abutments were placed in order to check the parallelity and then replaced with the definite angulated abutments using controlled torque according to the Ankylos implant protocol (**Figure 2e**). Finally, all implants were covered with one Biogide collagen membrane (Geistlich, Wolhusen, Switzerland), which was fixed in place with titanium pins (Frios, Friadent, Mannheim, Germany). The flap was sutured in place and a temporary arch-shaped fixed bridge without cantilevers was fabricated chairside. Periotest values were evaluated immediately before installation of the bridge and postoperative care instructions were given to the patient as has

been reported previously for the lower jaw. A symmetrical arch-balanced occlusion with the temporary fixed reconstruction was used in centric occlusion without any eccentric contacts in the lateral movements. One week after surgery, the sutures were removed. The impression for the final implant-supported fixed restoration was taken four weeks after surgery using a similar impression technique as in the lower jaw.

The patient was re-examined every three months, the restorations were removed and clinical mobility index (Periotest) evaluated along with the implant soft and hard tissue condition.

The final follow-up examination

three years after surgery in the lower jaw (2.5 years after loading in the upper jaw) showed excellent soft tissue in all of the peri-implant areas as well as an esthetic result (**Figures 2f-g**). A marginal bone loss could not be observed in any of the implants. The Periotest values at the baseline (PVo), at the time of the bridge installation (PV) as well as at the final follow-up examination (PV1) after removal of the prosthetic restorations were as follows:

PVo: 2 ± 3.83 (baseline)

PV: -1.33 ± 2.5 (placement of final restorations)

PV1: -1.41 ± 2.75 (three-year loading period)



Figure 3a. Anterior view.



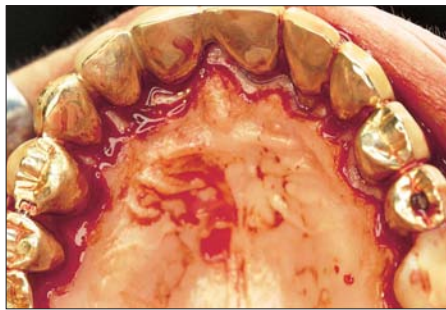
Figure 3b. Radiological examination presenting the advanced periodontal destruction in the upper and lower jaw teeth.

Case No. 3

A 49-year-old female patient was referred because of mobility of the upper and lower jaw teeth. All teeth presented advanced periodontal disease and the patient was informed about the bad tooth prognosis and the possibility of an implant-supported restoration (Figures 3a-b). The patient was unable to accept a full denture for psychological reasons and, therefore immediate implants and immediate functional loading were recommended. A mucoperiosteal flap elevation was performed, and all the periodontally involved teeth were extracted (Figure 3c). Eight immediate implants in the upper and eight in the lower jaw were placed with high primary stability (Figures 3d-e). The implants were connected with their abutments and splinted together with a provisional fixed prosthesis immediately after surgery. Augmentation with autogenous bone grafting materials (GBR technique) was necessary in some areas to increase the stability of the immediate implants (Figures 3f-g). For the initial stages of the healing, the patient used a soft diet. After osseointegration, an impression was done for customized abutments and fabrication of the final restoration.

The dental lab fabricated metal-ceramic fixed implant-supported restorations on customized abutments in order to improve esthetics and

function. The soft tissue peri-implant condition as well as the bone level was stable during the two-year loading period (Figures 3h-i).



Figures 3c and d. Surgical access in order to remove the periodontally involved teeth and inflamed tissues and placement of eight primary stable Ankylos implants in the correct areas.

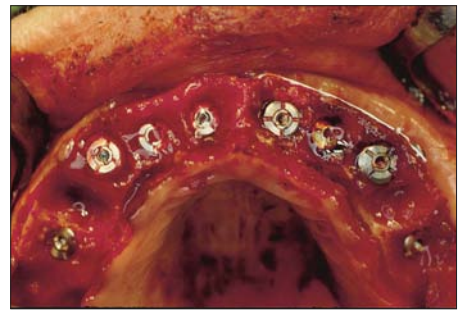


Figure 3d.



Figures 3e and f. Fenestrations and bony defects were grafted with autogenous bone grafting material and covered with a Biogide membrane.



Figure 3f.



Figure 3g. The immediate implants loaded immediately after surgery with provisional fixed implant-supported restorations (functional loading) keeping the vertical dimension.



Figures 3h and i. The peri-implant soft tissue was healthy two years after surgery.



Figure 3i.



Figures 3j and k. An excellent esthetic result was possible using fixed metaloceramic restorations.



Figure 3k.



Figure 3l. The final radiological examination presents stability of the peri-implant bone without any bone loss during the two-year immediate loading period. (Dental technician: M. Funk, MDT, Bad Vilbel, Frankfurt, Germany.)

Discussion and Conclusions

These case reports demonstrate an immediate loading protocol for dental implants in edentulous patients using fixed implant-supported restorations. They also illustrate a treatment protocol and allow a clinician to treat patients using this loading concept with a minimum number of implants (six in each jaw) in edentulous cases.

There are many considerations for successful immediate loading. One of the requirements is the primary stability of the placed implants, which is dependent on the macro- (implant shape, screw geometry) and micro-design (surface pattern) of the implant, the quality of the implant bed preparation, quality and quantity of the bone, as well as the implant length and diameter.

Screw-shaped implants are recommended for immediate loading, because they permit mechanical stability in bone immediately after their placement. Implants placed in poor quality bone should be inserted without tapping for additional initial stabilization or osteoplastic techniques of bone condensing for implant bed preparation should be used.

The primary stability is associated with a high number of bone-to-implant contacts immediately after implant

insertion. An implant is considered as osseointegrated at the histological level when a bone-to-implant contact of more than 60 percent is observed histologically after healing.⁴⁴ Moreover, values of BIC less than 25 percent are associated with clinically stable fixtures.⁴⁵⁻⁴⁶

In the present clinical case reports, the authors used an implant system with progressive thread designed geometry because of the high primary retention.⁴⁷ It had been demonstrated histomorphometrically in cadavers to have high percentages of bone to implant contacts immediately after implant insertion.⁴⁸

By increasing the implant surface area by means of rough surfaces and special thread geometry, it is possible to successfully load small-sized implants (3.5 mm diameter and short implants). Implants with such progressive thread geometry have a total surface similar to multirooted teeth.⁴⁹ Therefore, Ankylos implants were used successfully for single molar replacement.⁵⁰

A further requirement for implant success (when implants are loaded immediately) is immobilization in order to eliminate micromotion in the interface.^{5-6,11,20-21} This immobilization is extremely important in all of the stages of treatment.

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