Periodontology 2000, Vol. 33, 2003, 194–203
Printed in Denmark. All rights reserved

PERIODONTOLOGY 2000
ISSN 0906-6713

Immediate/early loading of oral implants in compromised patients

ULF LEKHOLM

The traditional way to replace lost teeth in edentulous or partially edentulous patients has been to provide these individuals with removable full or partial prostheses – a treatment alternative that is still available today. Since the last decades of the 20th century, the concept of using oral implant supported fixed prostheses has also become an accepted therapy, and several well functioning implant systems are at present available for ''routine'' treatment purposes. However, in many instances implant treatment, when performed according to ''routine'' protocols, means that treated patients still have to use various types of transitional removable prostheses during parts of the clinical handling. For many individuals, this way of working may be a psychologically traumatic experience, as also stated, for example, by Schnitman and coworkers (32). Furthermore, from a functional point of view, treated patients may not be able to cope with the removable prostheses during healing phases, due to bad retention of the provisionals, or may even ask for an immediate treatment solution for socioeconomic reasons. Consequently, there has been a need or at least a wish for the development of ''routine'' implant protocols, decreasing or even eliminating the healing periods before loading inserted implants. As a natural consequence, creation of fixed implant supported prostheses via protocols for either immediate (same day) and early implant loading (within one to a few weeks of healing) have gradually become available during later years as additional concepts, aiming at reducing the treatment time and treatment costs. This is a totally new way of working – a new paradigm – as compared to ''routine'' protocols, but as stated by Ganeles et al. (14), ''once immediately loaded implants have clinically osseointegrated, they appear to take on the long-term predictability characteristics of conventionally healed and loaded implants''. Furthermore, Kinsel & Lamb (22) wrote that ''the new techniques may even offer several advantages, including increased masticatory function, minimised uncontrolled transmucosal loading through cross-arch stabilisation, improvement of psychological well-being, and reduction in treatment time''. Consequently, the new immediate loading approach seems to be a good alternative for treatment of the aforementioned group of patients.

In principle, three different methods can be used when creating implant-supported full fixed bridgework, using a reduced or no healing time:

- provisional constructions based on conventional or extra implants or using transitional implants.
- early (within one to a couple of weeks) permanent loading of conventional implants.
- immediate permanent loading of implants using prefabricated components.

Several reports have been presented on how to work according to the new ''immediate'' protocols, but the mere handling of these will not be discussed in this report. Instead, the first aim of the chapter is to give a review of the literature regarding what is possible to achieve with immediate and early loading protocols when used in edentulous or partially edentulous jaws to support fixed bridgework. No information will be given, though, regarding overdenture and single tooth treatment.

Literature review

Since the difference between immediate, early and delayed loading is not well defined, publication titles can often be very misleading. Several authors confuse a one-stage implant insertion procedure (without

immediate prosthesis installation) with immediate loading. In the current chapter, however, only publications where the implants have been put into functional loading within 3–4 weeks will be reviewed.

Most of the available studies regarding immediate or early implant loading have been carried out in patients who are edentulous in their mandibles (5, 6, 14, 30, 32). In the reports referred to, the implants have in general been placed in the frontal region, between the mental foramina, to support provisional fixed prostheses, whereas posterior areas of the jaws have been avoided due to expected poor bone qualities, higher chewing forces and presumed higher implant failure rates. However, when used in front regions, good long-term follow-up results have been presented by Schnitman et al. (32), who in 10 patients reported a 10-year survival rate of 85% for immediately loaded Brånemark system implants. In that study, only three of the originally inserted implants per jaw were used, placed in a tripod position, for the initial immediate loading to support the provisional construction. The remaining implants were submerged for conventional healing and later use to support the permanent fixed prosthesis. Lost implants were mainly short, posteriorly positioned and placed in poor-bone quality sites. To create a successful outcome of immediate implant loading the authors stated the need for good initial fit, high proportion of implant surface in contact with cortical bone, two-cortical bone stabilization, and elimination of micromovements during the bone remodeling healing period.

Chow et al. (5) provided patients with edentulous mandibles with provisional fixed prostheses, supported by immediately loaded Brånemark system implants. The technique was based on standard components, and used a simple prosthetic design, which has been nicknamed ''the Hong Kong Bridge''. In the report, 27 patients were treated and, in all, 115 implants of various lengths and diameters were inserted. The overall implant survival rate was reported to 98% after 1 year of function.

Recently, a report by Ganeles and coworkers (14), using three different implant systems (ITI, Astra and Frialit-2), reported on the outcome of 27 patients being treated in their edentulous mandibles with immediate provisional constructions and being followed-up for 5 years. The mean number of implants placed for immediate loading was six per jaw. The loss of one implant occurred 3 weeks after placement, whereas 160 out of the 161 immediately loaded implants were successfully integrated (99%). The authors indicated the importance of leaving the implants as immobile as possible during the initial loading period. They therefore suggested a number of clinical factors that may influence the implant's resistance to movement: the number, distribution, length, diameter, and macroscopic stabilising characteristics of the inserted implants; patient bone quality and density; precision of surgical technique; stiffness of the reconstruction; and occlusal force application through function and parafunction. According to the authors, if all factors were adequately balanced, then predictable integration could be anticipated, despite immediate functional loading.

The paper by De Bruyn et al. (6) presented a technique where only three regular platform Brånemark system implants were loaded, within a month after insertion, to support fixed provisional mandibular full arch constructions. A total of 60 implants were used for this purpose in 20 patients. The failure rate for the implants was reported to 10% after a follow-up time of 1–3 years. The authors concluded that the outcome was less favorable than could be expected with a standard four- to six-implant protocol, using a one-stage surgical technique.

Several studies have not only reported on edentulous mandibles but also on immediate loading in edentulous maxillae (17, 20, 22, 37). Tarnow and coworkers (37) inserted a minimum of 10 Brånemark system implants per jaw, of which at least five implants were used for immediate loading. Their 1- to 5-year results revealed a 97% implant survival rate, independent of jaw type. They therefore stated that ''by using a wide anterior-posterior distribution of the implants in order to resist critical micro-movements of the implants, it is possible to achieve the same good success rate in maxillae as in mandibles''. Furthermore, it was pointed out that rigid splinting and minimal lateral force application were critical factors for success.

In a study by Horiuchi et al. (20), as many as 10–12 Brånemark system implants were, whenever possible, placed to support immediate provisional constructions in either jaw. Ninety-four of the originally 96 immediately loaded mandibular implants (98%) remained osseointegrated during a follow-up period of 8–24 months. Similar favorable results were also presented for maxillae, as 42 of 44 immediately loaded implants (96%) remained integrated after the same length of time. The authors gave the following further guidelines for successful immediate implant loading:

- immediate loading may be attempted in selected patients to create bilateral splinting action among

at least five (mandibular) and eight (maxillary) implants distributed optimally.
- the length of immediately loaded implants should probably be at least 8.5 mm (wide platform) or 10 mm (regular platform).
- implants with good primary stabilization (placement torque of more than 40 Ncm) can be immediately loaded.
- implants with a placement torque $<$ 40 Ncm, length $<$ 8.5 mm (wide platform) or $<$ 10 mm (regular platform), or associated with bone grafting, should probably be submerged.
- a screw-retained, passively fitting provisional prosthesis, with a rigid metal casting, will likely be more successful.
- cantilevers should be avoided in the provisional prosthesis.
- the provisional prosthesis should not be removed during the healing period (4 months in the mandible and 6 months in the maxilla).

In a report by Kinsel & Lamb (22), the outcome of 151 immediately loaded ITI implants was reported, being placed in 14 maxillae and 8 mandibles, respectively, and being used to support provisional fixed prostheses from start. At least four implants were used to support the provisional constructions, and implants were followed over a 5–year period. The overall implant survival rate was 98%, independent of type of jaw.

Immediate functional loading of immediate implants in edentulous both mandibles and maxillae, respectively, were also presented by Grunder (17), who reported on five maxillae and five mandibles, respectively. In these, a total of 91 Osseotite implants had been inserted to support immediate provisional fixed prostheses. After a follow-up time of 2 years the overall success rate was reported to 92% (88% in maxillae and 97% in mandibles, respectively). All failed implants were the most distal ones in that particular quadrant, and all failing sites had peroperatively been diagnosed as soft bone sites.

van Steenberghe et al. (36) based the fabrication of the final fixed prosthesis to be installed with abutments on top of the implants at the end of surgery, on 3-dimensional CT scan images. The high precision of this 3-D planning ensures the fit of the final prosthesis on the implants.

Until then, examples of provisional fixed constructions have been presented. However, in the study by Randow et al. (30), the authors presented a prospective protocol based on 16 edentulous mandibles, where early functional loading (within 20 days) of inserted Brånemark system implants was performed using permanent fixed constructions. The technique was built around the use of conventional components and implants, and the bridgework, nicknamed ''the Nordic Bridge'', was individually fabricated, after taking the first impression during surgery. In the report, the 18-month follow-up results were presented, which indicated that no implants had been lost. The same patients were further followed-up by Ericsson et al. (7) for 5 years, during which period no new implants failed.

The first oral implant protocol with which it was possible to provide patients with a successful 1-day permanent treatment result in edentulous mandibles, was the Brånemark Novum concept (3). The technique was based on the principle of using prefabricated prosthetic components and defined surgical guides, when inserting three 5-mm-wide and 13-mm-long (threaded portion) Novum implants. The surgical protocol requires some experience of previous implant surgery, and according to Lekholm (24) it is important to do a proper patient selection, as not all edentulous mandibles are automatically suitable for the procedure. So far, only two follow-up studies of this technique have been presented (3, 35). In the original paper by Brånemark et al. (3), it was shown that three out of 150 inserted implants were lost during the 6-month to 3-year follow-up period (98%). The corresponding prosthetic stability rate was also 98%. In the report by van Steenberghe et al. (35), 50 patients were also treated with this protocol and followed for 12 months. Nine implants in six patients were lost during the follow-up period, resulting in a cumulative survival rate of 94%. The corresponding prosthesis stability rate was 96%. Most of the failures occurred in shape and quality groups C3 and A4 (Lekholm–Zarb index; 25). The authors also reported that extractions in connection with the implant insertion did not have an influence on the outcome. Although the Novum technique has several advantages, e.g. reduced treatment efforts and costs, there may also be some limitations. The bone anatomy in some instances has to be adjusted to correspond to the prefabricated components and there are in principle limited possibilities to individualize the form and extension of the framework.

In the study by Hatano (19), a 1-day technique was presented for edentulous mandibles, which enabled the use of three wide platform Brånemark System implants and the fabrication of individualized permanent fixed bridgework. In the report, 25 patients were treated according to the protocol, using a prefabricated framework, cast in gold–silver–palladium

and primarily sectioned into three parts, one for each implant, but finally soldered together on the day of surgery. A total of 105 implants in 35 patients were followed and reported in the study. Three implants failed during the 2–36 months of follow-up time presented, giving an overall implant survival rate of 97%. The failed implants were distal implants, which were lost within 3 months postinsertion. The advantage with the technique is, first of all, that conventional components and instrumentation can be used and, secondly, that implant lengths and diameters can be individualized for optimal stability via two-cortical stabilization.

Immediate implant loading supporting provisional fixed short-span bridges has also been performed in partially edentulous situations. Maló et al. (26) reported on 49 consecutively treated patients in whom a total of 94 Brånemark system implants were inserted to support 54 fixed prostheses. Of these, 23 were short-span bridges (14 in maxillae and 9 in mandibles) and the remaining ones, single crowns. Clear inclusion and exclusion criteria were used, and the implants were all placed within the esthetic zone, aiming at bicortical stabilization but avoiding marginal countersinking. After 2 years of functional loading, the cumulative survival rate was 96% for all inserted implants. Reported failures mainly occurred in connection with fresh extraction sites, and consequently the authors recommend extra care to avoid situations with persisting inflammation when placing the implants.

Immediate occlusal loading of Brånemark system implants applied in various jawbone regions has also been reported by Glauser et al. (15), who in 41 patients inserted 127 implants being immediately loaded to support provisional fixed partial prostheses. In all, 71% of the patients received their prosthetic constructions the same day and the rest within 11 days. After a follow-up of 1 year, 21 of the immediately loaded implants had failed (17%), a majority of which had been inserted in posterior regions of maxillae, where the success rate *per se* was as low as 66%. Parafunction and soft bone qualities in combination with small bone volumes were considered the main reasons for the higher failure rate in posterior parts of the maxilla.

Finally, a study by Buchs et al. (4) introduced a new implant design – the Altiva Natural Tooth Replacement (NTR) implant. The purpose of the new technique was to minimize patient discomfort, facilitate fabrication of the provisional restoration, and to allow the final impression to be made during surgery. A total of 93 patients were treated with 142 implants, of which 91 (63%) were used to support provisional fixed partial bridgework, attached within 24 h post-implant insertion. The overall implant survival rate was 94%, after a mean follow-up time of 20 months, and was the same for maxillae and mandibles. The authors stated that the factors, which must be combined to minimize initial implant movement, are immediate fixation of the implants and limitation of loading forces to levels that do not stress the implant-to-bone interface.

With the exception of a few studies (7, 14, 22, 32), most of the reviewed reports regarding immediate loading have represented short follow-up periods for the majority of the studied implants. Still, it is interesting to see that, under given conditions, it has been possible to treat edentulous and partially edentulous patients with fixed implant supported prostheses with acceptable results (>90% of survival in most instances), in mandibles as well as maxillae. Consequently, immediate loading protocols seem to give similar good results as the ''routine'' protocols and must therefore be regarded as valuable additions or even substitutes for today's used ''routine'' implant protocols (8).

Compromised conditions

The purpose of this paper is also to present what is known regarding the use of immediate/early implant loading techniques, when applied in compromised patients.

To be able to achieve this aim, it is first of all necessary to identify what is meant with compromised patients. One possible way to define the condition could be ''patients at risk or with specific limitations for going through oral implant surgery''. From the literature (23, 33), as well as the previous chapter, it is known that there are two levels of compromised situations to be considered when working according to ''routine'' oral implant protocols:

- compromised patients (systemic risk factors).
- compromised implant sites (local risk factors).

Systemic risk factors

Regarding systemic risk factors, the same medical contraindications for implant surgery as for delayed loading protocols (23) are of course valid in connection with immediate or early loading techniques. With conditions such as homeostasis defects, blood

dyscrasias, ongoing chemotherapy (39) and any type of uncontrolled disease one should refrain from using either delayed or immediate implant loading techniques. Furthermore, psychological problems and/or alcohol or narcotic abuse are other situations that may contraindicate any type of oral implant treatment. Also patients who have gone through different kinds of bone grafting ought to be excluded from immediate protocols. However, besides these situations, there are other conditions that may be of specific interest in connection with the current topic:

- critical age groups.
- diabetes (unbalanced).
- vitamin D-dependent rickets.
- osteoporosis.
- Sjögren's syndrome.
- smoking habits.

The amount of knowledge is unfortunately very limited concerning these aspects.

In most reports, it is just stated that ''patients were in good medical health or non-contributory''. There is one exception, though; the study by Horiuchi et al. (20), which clearly stated the medical history of included patients. Conditions such as hepatitis C, hypertension, hepatoma, syphilis, and myocardial infarction were included. However, nothing was mentioned in the results about these diseases in relation to lost implants. Other ways to find out what is relevant in connection with the question could therefore be to analyze the inclusion/exclusion criteria used when performing immediate or early loading, as well as to study the reasons for implant failures, occurring in connection with these immediate protocols. In the following, such a method will be utilized to exemplify what is known and can be recommended regarding immediate or early implant loading in connection with compromised situations (Table 1).

Table 1. List of systemic conditions, which may be potential risk factors for immediate oral implant loading, as based on a literature review

Conditions	Risks	References
Osteoporosis	possible risk?	9, 15, 33
Smoking	possible risk?	9, 33
Type II diabetes	possible risk?	26
Rickets	clear risk factor	2
Sjögren's syndrome	clear risk factor	21, 29

Compromised medical conditions in general, as well as alcohol/drug addiction, should be considered clear risk factors (21, 23, 38).

Age and gender

Several reports have indicated that neither age nor gender seems to influence implant failure rates when treatment is performed according to ''routine'' protocols (for review, see 33). However, it is important to remember that with higher ages comes a higher risk of medical complications and slow healing, something to consider independently of the surgical technique used. Furthermore, implant treatment should generally be avoided in still growing individuals (28). Besides these aspects, there is no indication that age and sex may be a problem in relation to immediate or early loading protocols. The results in the reports referred to in the first section of this presentation, which included patients of both sexes as well as of various age groups, were not jeopardized. In fact, in the study by Glauser et al. (15), based on 41 patients being treated with 127 implants, all being immediately loaded and followed 1 year, it was specifically stated that ''the number of failures were evenly distributed between females and males and also among different age groups''.

Diabetes

It was concluded by Shernoff et al. (34) that well-balanced diabetic individuals could be considered for oral implant treatment. This statement was based on 89 type II diabetes patients followed up for 1 year. A similar conclusion was reached by Balshi & Wolfinger (1) based on 227 implants in 34 patients with diabetes. Consequently, diabetes has not been considered a potential risk factor for establishing and maintaining osseointegration of titanium implants when used together with standard protocols. However, in the immediate loading study by Maló et al. (26), patients with diabetes were excluded; whereas Ganeles et al. (14) included such patients in their material. Although evidence from a large number of subjects is lacking concerning diabetes in relation to immediate or early loading, it still appears reasonable to claim that type II diabetes ought not to be an absolute risk factor for direct loading protocols.

Vitamin D-dependent rickets

At a workshop at the Institute for Postgraduate Dental Education in Jönköping, Sweden, the outcome of implant treatment in four patients with X-linked hypophosphatemic rickets was presented. Eight of 10 inserted implants had failed (2). Consequently, rickets should be considered a contraindication for

implant treatment independent of the loading protocol used.

Osteoporosis

It has often been mentioned that patients with diagnosed osteoporosis ought to be viewed as potential risk patients for oral implant treatment due to their soft bone condition. However, there is nothing in the literature supporting such a statement, when osteoporosis is treated according to ''routine'' protocols (for review, see 33). It has, in a retrospective study by Friberg et al. (13), been shown that in a group of osteoporotic patients, the survival rate was 97% after a mean follow-up time of 3.3 years. In that study, an adapted surgical protocol was used, though, to create optimal primary implant stability, which of course is of importance in all sites having soft bone. It seems reasonable to assume that patients with osteoporosis (mainly quality 4 bone; 25) should be regarded as potential risk situations for immediate or early loading, independent of whether an adapted surgical technique can be used or not, due to their impaired bone quality (see below).

Sjögren's syndrome

The systemic disease Sjögren's syndrome may result in xerostomia, which makes it particularly difficult for affected patients to wear conventional removable dentures. Consequently, there has been a need and an interest in treating such patients with oral implant supported prostheses. However, from a limited number of studies (21, 29) it is obvious that, when doing so, the failure rate will become higher than what can normally be expected using standard protocols. Consequently, Sjögren's syndrome ought to be regarded as a potential risk situation also in connection with immediate or early implant loading protocols.

Smoking habits

It has been shown in several studies (for review, see 9, 33) that smoking may have a negative influence on the outcome of oral implant treatment. On average, twice as many implants are lost in smokers as in nonsmokers. Consequently, smoking must also be regarded as a potential risk factor for immediate or early loading protocols, even though several reports have included smokers in their material for immediate implant loading without reporting any negative effects on the outcome (5, 6, 14, 17).

Local risk factors

There are also local risk factors to consider in order to perform successful implant surgery. Some of these can be identified preoperatively, whereas others have to be judged during the implant insertion procedure itself. One of the most important key aspects for success is the need to create an optimal primary implant stability (33). The conditions, which mainly influence the initial stability, are partly related to anatomic conditions and partly to the surgical protocol being used. The two anatomic conditions most commonly mentioned as reasons for implant failures are insufficient jaw volume and poor bone quality (9, 10). Consequently, these two parameters ought to be considered the two major local risk factors also in relation to immediate or early loading protocols. However, other anatomic conditions, such as unfavorable jaw form and inter-jaw relation, should be borne in mind, especially when working with the Brånemark Novum concept (24). With regard to surgical technique aspects, factors related to the surgical handling, as well as who is performing the procedure, may influence the outcome, but independently of the method of loading.

Besides anatomic and surgical aspects, other situations may compromise the implant site/implant treatment, being related to intraoral conditions and certain behaviors of the patient:

- ongoing oral pathology (including active periodontitis).
- parafunctional habits (bruxism).
- irradiation.
- poor patient cooperation.

These conditions have to be considered when planning immediate or early implant loading (Table 2).

Unfavorable jaw shape

In connection with the conventional Brånemark protocol it has been found that short implants, being 7 mm long and 3.75 mm in diameter, can successfully support full fixed mandibular constructions (12). In the study referred to, the 5-year follow-up implant survival rate was 96%, and after 10 years it was 92%. Thus, bone volume *per se* does not seem to be of any major importance in relation to standard protocols, at least not in the frontal region of mandibles, where the bone quality in general is favorable.

In relation to immediate or early loading protocols, different jaw height/implant length requirements have, however, been presented. Some authors considered

Table 2. List of local site related conditions, which may be potential risk factors for immediate oral implant loading, as based on a literature review

Conditions	Potential risks	References
Small bone volume	if only few short implants of standard diameter are inserted	5, 19, 20, 36
Soft bone quality	if not an adapted surgical technique is used	14, 15, 17, 20, 22, 26
Bruxism	a clear risk factor	5, 14, 15, 17, 22, 26
Ongoing pathology	a clear contraindication to any type of implant insertion	6, 15, 18, 23, 26, 31
Irradiated sites	a clear contraindication	9
Non-compliant Patients	a risk factor	5, 15
Bone grafted sites	a clear risk factor	20

that the longer the implants are, the better, at least when using standard diameter implants (6). Others, on the other hand (4, 20, 26, 37), have accepted implants being at least 10 mm long, and some (15) even 7 mm long, but of the widest diameter possible. Consequently, bone volume does not seem to be a major factor for a successful outcome in connection with immediate or early loading, provided good bone quality sites are at hand (15). However, it is important to correlate the length and the diameter with the number of implants being inserted. The more implants are inserted, the shorter their lengths can be (20, 37); whereas the lower the number of inserted implants; the longer and wider they have to be, as indicated by Chow et al. (5) and Hatano (19). Furthermore, when working with few implants, these have to be evenly distributed within the jaw arch, too (32).

The Brånemark Novum technique needs a minimum height of about 12–13 mm and a width of at least 6–7 mm in order to harbor the commercially available Novum implants (3). However, as shown by van Steenberghe et al. (35), too much bone height seems to be a potential risk factor for this protocol. In connection with the protocol it can be mentioned, too, that there is a need also for a certain jaw curvature to fit the prefabricated bars, mainly the U-shaped type of jaw. Another parameter of importance for the Novum protocol is the jaw relation, as only Classes I and III have been regarded suitable for treatment; Class II ought to be treated with some caution (24).

Insufficient bone quality

As already mentioned, soft bone implant sites have by many authors been pointed out as the greatest potential risk situation when working with classic protocols (for review, see 38). In connection with immediate/early loading, quality 4 sites have been excluded in some reports (26). Others have mentioned that most failures have been found in sites where the bone density from the start was low (14, 15, 17, 20, 22, 37), specifically, distal sites, such as over the mandibular canal or under the maxillary sinus, where it can be difficult to obtain two-cortical stabilization. If the implant is not stable from the start, no direct loading should be performed (15). However, if an adapted surgical technique is possible, including no pre-tapping, minimal or no countersinking, reduced drill dimensions, long/wide diameter implants, two-cortical stabilization, etc., favorable implant results can still be obtained in soft bone sites in connection with immediate protocols (5, 15, 32). Besides the necessity of good initial implant stability, authors have stressed the importance of eliminating unfavorable implant movements during healing. This can be achieved by splinting the implants together as quickly as possible via a rigid construction, obtaining a passive fit to the implants (5, 26, 37). The final decision of whether to use the inserted implants for immediate/early loading must be made during implant placement using surgical experience or, preferably, some device to objectively judge implant stability (8). Some reports have measured the insertion torque (11), and stated that, provided there is an initial stability rate of 30–40 Ncm, the implants can be immediately loaded (5, 6, 14, 20, 26). Another objective way to evaluate the initial stability of implants is the ''resonance frequency analysis technique'' (27), by which it is possible to follow the implant over time, without using any invasive procedure. Consequently, soft bone situations do not seem to be an absolute contraindication for immediate implant loading, provided they are evaluated and handled properly.

Signs of parafunctional habits (bruxism)

Parafunctional habits are often considered a potential risk factor for implant treatment. However, there is little clinical evidence that parafunction (bruxism and clenching) is associated with an increased late implant failure rate (9). Still, it would be of great interest to establish the parameters for immediate treatment of potential ''bruxers''. In some studies, patients with signs of bruxism or parafunctional problems have been excluded from the immediately loading protocol (5, 26). In other studies, bruxers were included; however, many failed implants were found in those patients (14, 15, 17, 22). One other report mentioned the importance of avoiding overloading (6) and of creating a well-balanced physiologic occlusion. Consequently, patients with parafunctional problems ought to be viewed as potential risk patients and should be carefully checked postoperatively for signs of possible bruxism, overloading or mechanical problems.

Ongoing infections within the jaws

No ongoing pathology should be accepted in the area for surgery when implants are to be inserted (23). Reports have indicated a negative correlation between the presence of periodontally compromised teeth and the outcome of implant treatment (18). Suggestions have therefore been made to first treat all ongoing periodontitis and to extract compromised teeth, allowing for some time of healing, before inserting any implants (31).

In connection with immediate/early loading concepts, various recommendations have been found, regarding when to insert implants following tooth extraction. One report only included patients if they had been edentulous for at least 6 months before implant placement (6). Other reports used exclusion criteria, stating that patients with ongoing infections at teeth or any infection or inflammation in the oral cavity in general should be excluded from immediate loading (15, 26). Immediate implant placement has been performed directly following tooth extraction (presumably due to periodontitis) and no higher implant failure rate was reported in the follow-up (5, 17, 35). However, when analyzing the reasons for implant failures in connection with the immediate techniques, reports stated that losses occurred more often in connection with fresh extraction sockets (26, 37). Consequently, pretreatment of ongoing pathology within the jaws, including periodontally compromised teeth, should always be taken care of prior to implant placement, independent of loading protocol.

Irradiation

Irradiation of or around the jaws means that there may be a potential risk of osteoradionecrosis in connection with placing implants, or that inserted implants may end up as failures, as shown in a review by Esposito et al. (9). These authors also reported that in the case of irradiation doses above 60 Gy, no treatment should be performed, whereas in situations below 40 Gy, there will be a less risk of problems. At 40–60 Gy, implants may be placed if additional hyperbaric oxygen treatment can be given (16). As irradiation is such a potential risk factor, it is tempting to suggest that no jaw exposed to irradiation should be accepted for immediate or early loading protocols.

Lack of patient cooperation

In connection with immediate or early loading protocols a new category of patients has formed, those who have problems following outlined treatment concepts. They would prefer to decide for themselves ''what'' is going to be done and ''when'' it should be done. However, it has been found, mainly from own experience, that patients who do not follow the treatment concept, e.g. they do not come to agreed appointments but rather come only when problems occur, may be potential risk patients. If so, small problems may have escalated to bigger ones, which could have been prevented had the patients come earlier. If a provisional bridge becomes loose or components start to unscrew, it is important that the construction is checked, the components retightened and the occlusion re-adapted as soon as possible. Otherwise, there is an obvious risk that mechanical complications may worsen or even that the implants may fail to integrate, as also stated by Glauser et al. (15). Inability to attend scheduled follow-up appointments should consequently be used as an exclusion criterion (5). Patients must be cooperative and willing to follow the protocols of the clinic before being accepted for immediate/early implant loading treatment.

Summary

- Immediate/early implant loading via provisional or permanent constructions is possible under certain

conditions, and several different protocols are available showing predictable outcomes of such techniques.

- The advantages with immediate protocols are shortened treatment time, minimized surgical trauma and hopefully less cost.
- Proper patient selection is important as not every edentulous or partially edentulous patient should be a candidate for immediate implant loading.
- Constructions can be based on as few as three implants, if placed in a broad-based tripod position as well as being long and of wide diameters.
- During the entire initial functional period it is important to avoid any removal of the construction, as movements of the implants during the initial functional period may prevent integration of the implants.
- In soft bone sites, an adapted surgical technique should be applied for optimal initial implant stability and methods are currently available to easily evaluate this parameter.
- The inserted implants should be rigidly splinted as soon as possible within a rigid provisional or permanent construction, providing a passive fit to the implants.
- The longer and/or wider the implants are, the better for the outcome. However, short implants can be used for immediate loading purposes, but as many implants as possible should be inserted.
- Contraindications for immediate implant loading include medically compromised patients, alcohol and drug addiction and patients in whom bone grafting protocols have been performed.
- There appears to be a relative contraindication where there is vitamin D-dependent rickets, osteoporosis, Sjögren's syndrome and if the patient is a smoker.
- Potential risks for immediate implant loading seem to be present in connection with soft jaw bone sites, bruxism, ongoing pathology (including infections) within the jaws, irradiation of the surgical region and lack of patient compliance.

References

1. Balshi TJ, Wolfinger GJ. Dental implants in the diabetic patient: a retrospective study. *Implant Dent* 1999: **8**: 355–359.
2. Bergendahl B. The role of prosthodontists in habilitation and rehabilitation of rare disorders: the ectodermal dysplasia experience. *Int J Prosthodont* 2001: **14**: 466–470.
3. Brånemark PI, Engstrand P, Öhrnell LO, Gröndahl K, Nilsson P, Hagberg K, Darle C, Lekholm U. Brånemark Novum: a new treatment concept for rehabilitation of the edentulous mandible. Preliminary results from a prospective clinical follow-up study. *Clin Implant Dent Relat Res* 1999: **1**: 2–16.
4. Buchs AU, Lenine L, Moy P. Preliminary report of immediately loaded Altiva natural tooth replacement dental implants. *Clin Implant Dent Relat Res* 2001: **3**: 97–106.
5. Chow J, Hui E, Liu J, Li D, Wat P, Li W, Ya YK, Law H. The Hong Kong bridge protocol. Immediate loading of mandibular Brånemark fixtures using a fixed provisional prosthesis: preliminary results. *Clin Implant Dent Relat Res* 2001: **3**: 166–174.
6. De Bruyn H, Kisch J, Collaert B, Lindén U, Nilner K, Dvärsäter L. Fixed mandibular restorations on three early-loaded regular platform Brånemark dental implants. *Clin Implant Dent Relat Res* 2001: **3**: 176–184.
7. Ericsson I, Randow K, Nilner K, Peterson A. Early functional loading of Brånemark dental implants: 5-year clinical follow-up study. *Clin Implant Dent Relat Res* 2000: **2**: 70–77.
8. Ericsson I, Nilner K. Early funtional loading using Brånemark dental implants. *Int J Periodontics Restor Dent* 2002: **22**: 9–19.
9. Esposito M, Hirsch JM, Lekholm U, Thomsen P. Biological factors contributing to failures of osseointegrated oral implants (II). Etiopathogenesis. *Eur J Oral Sci* 1998: **106**: 721–764.
10. Friberg B, Jemt T, Lekholm U. Early failures in 4641 consecutively placed Brånemark dental implants: a study from stage 1 surgery to the connection of completed prostheses. *Int J Oral Maxillofac Implants* 1991: **6**: 142–146.
11. Friberg B, Sennerby L, Gröndahl K, Bergström C, Bäck T, Lekholm U. On cutting torque measurements during implant installation. A 3-year prospective study. *Clin Implant Dent Relat Res* 1999: **1**: 75–83.
12. Friberg B, Gröndahl K, Lekholm U, Brånemark PI. Long-term fullow-up of severely atrophic edentulous mandibles reconstructed with short Brånemark implants. *Clin Implant Dent Relat Res* 2000: **2**: 184–189.
13. Friberg B, Ekestubbe A, Mellström D, Sennerby L. Brånemark implants and osteoporosis: a clinical exploratory study. *Clin Implant Dent Relat Res* 2001: **3**: 50–56.
14. Ganeles J, Rosenberg MM, Holt RL, Reichman LH. Immediate loading of implants with fixed restorations in the completely edentulous mandible: report of 27 patients from a privite practice. *Int J Oral Maxillofac Implants* 2002: **16**: 418–426.
15. Glauser R, Rée A, Lundgren AK, Gottlow J, Hämmerle C, Schärer P. Immediate occlusal loading of Brånemark implants applied in various jawbone regions: a prospective, 1-year clinical study. *Clin Implant Dent Relat Res* 2001: **3**: 204–213.
16. Granström G, Tjellström A, Brånemark PI. Bone-anchored reconstructions of the irradiated head and neck cancer patients. *Otolaryngol Head Neck Surg* 1993: **108**: 334–343.
17. Grunder U. Immediate funtional loading of immediate implants in edentulous arches: two-year results. *Int J Periodontics Restorative Dent* 2001: **21**: 545–551.
18. Hardt CRE, Gröndahl K, Lekholm U, Wenndström JL. Outcome of implant therapy in relation to experienced loss of periodontal bone support. A retrospective 5-year study. *Clin Oral Implants Res* 2002: **13**: 488–494.
19. Hatano N. The Maxis New. A novel one-day technique for fixed individualised implant-supported prosthesis in the edentulous mandible using Brånemark system implants. *Appl Osseointegration Res* 2001: **2**: 40–43.

20. Horiuchi K, Uchida H, Yamamoto K, Sugimura M. Immediate loading of Brånemark system implants following placement in edentulous patients: a clinical report. *Int J Oral Maxillofac Implants* 2000: **15**: 824–830.
21. Isidor F, Bröndum K, Hansen HJ, Jensen J, Sindet-Pedersen S. Outcome of treatment with implant-retained dental prostheses in patients with Sjögren's syndrome. *Int J Oral Maxillofac Implants* 1999: **14**: 736–743.
22. Kinsel RP, Lamb RE. Development of gingival esthetics in the edentulous patient with immediately loaded, single-stage, implant-supported fixed prostheses: a clinical report. *Int J Oral Maxillofac Implants* 2000: **15**: 711–721.
23. Lekholm U. The surgical site. Pre-operative examination and principle comments on implant placement. In: Lindhe J, ed. *Clinical periodontology and implant dentistry*. Copenhagen: Munksgaard, 1997: pp. 890–905.
24. Lekholm U. Patient selection for Brånemark Novum Treatment. *Appl Osseointegration Res* 2001: **2**: 36–39.
25. Lekholm U, Zarb GA. Patient selection and preparation. In: Brånemark PI, Zarb GA, Albrektsson T, eds. *Tissue-integrated prostheses: osseointegration in clinical dentistry*. Chicago: Quintessence, 1985:199–209.
26. Maló P, Rangert B, Dvärsäter L. Immediate function of Brånemark implants in the esthetic zone: a retrospective clinical study with 6 months to 4 years of follow-up. *Clin Implant Dent Relat Res* 2000: **2**: 138–146.
27. Meredith N. *On the clinical measurement of implant stability and osseointegration*. Thesis. Göteborg: Göteborg University, 1997.
28. Ödman J. *Implants in orthodontics. An experimental and clinical study*. Thesis. Göteborg: University of Göteborg, 1994.
29. Payne AGT, Lownie JF, Van Der Linden WJ. Implant-supported prostheses in patients with Sjögren's syndrome. A clinical report on three patients. *Int J Oral Maxillofac Implants* 1997: **12**: 679–685.
30. Randow K, Ericsson I, Nilner K, Petersson A, Glantz PO. Immediate functional loading of Brånemark dental implants. An 18-month clinical follow-up study. *Clin Oral Implants Res* 1999: **10**: 8–15.
31. Rosenquist B, Grenthe B. Immediate placement of implants into extraction sockets. Implant survival. *Int J Oral Maxillofac Implants* 1996: **11**: 205–209.
32. Schnitman PA, Wöhrle PS, Rubenstein JE, DaSilva JD, Wand NH. Ten-year results for Brånemark implants immediately loaded with fixed prostheses at implant placement. *Int J Oral Maxillofac Implants* 1997: **12**: 495–503.
33. Sennerby L, Rasmusson L. Osseeointegration surgery: host determinants and outcome criteria. In: Zarb GA, Lekholm U, Albrektsson T, Tenenbaoum H, eds. *Aging, osteoporosis and dental implants*. Chicago: Quintessence, 2001: 55–66.
34. Shernoff AF, Colwell JA, Bingham SF. Implants for type II diabetic patients: interim report. VA implants in diabetes study group. *Implant Dent* 1994: **3**: 183–185.
35. van Steenberghe D, Naert I, Molly L, Vandekerckhove B, De Smet E, Jacobs R. Immediate rehabilitation of edentulous lower jaws with a final fixed prosthesis in 50 consecutive patients. Abstract of the European Association of Osseointegration Meeting, 2002.
36. van Steenberghe D, Malevez C, Van Cleynenbreugel J, Serhal CB, Dhoore E, Schutyser F, Suetens P, Jacobs R. Accuracy of drilling guides for transfer from three-dimensional CT-based planning to placement of zygoma implants in human cadavers. *Clin Oral Implants Res* 2003: **14**: 131–136.
37. Tarnow DP, Emtiaz S, Classi A. Immediate loading of threaded implants at stage-1 surgery in edentulous arches: ten consecutive case reports with 1- to 5-year data. *Int J Oral Maxillofac Implants* 1997: **12**: 319–324.
38. Watzek G, Ulm C. Compromised alveolar bone quality in edentulous patients. In: Zarb GA, Lekholm U, Albrektsson T, Tenenbaum HC, eds. *Aging, osteoporosis and dental implants*. Chicago: Quintessence, 2001: 67–84.
39. Wolfaardt J, Granström G, Friberg B, Naresh JHA, Tjellström A. A retrospective study on the effects of chemotherapy on osseointegration. *J Fac Somato Prosthet* 1996: **2**: 99–107.