Timing of dental implant loading

A Literature Review

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_Osseointegration is the process by which living bone attaches to the artificial surface of an implant by the formation of bony tissue without growth of fibrous tissue at the bone-implant interface.

_Introduction

Osseointegration is a highly dynamic process, which does not only address the formation of bone onto an implant surface after it has been placed, but it also addresses the remodelling or maintenance of bone during the life of the implant.

The long term success of an implant treatment is theoretically determined by factors related to the patient, the implant components and the treating clinicians.[1] Before the introduction of the Prof. Brånemark protocol, dental implants were commonly loaded at placement because immediate bone stimulation was considered to avoid crestal bone loss (Fig.1).[2] The clinician is often faced with the challenge of identifying the successful osseointegration of implant. Clinical success is often determined by a lack of mobility and ability of the implant to resist functional loading.[3]

Radiographically, bone should appear to be closely apposed to the implant surface. The current achievable resolution obtained in medical imaging, however, is about 10 times less than what is required to observe a soft tissue cell. Therefore, radiographic assessment alone is unsuitable to determine with certainty if a soft tissue layer is present. When an implant is exposed to excessive micromotion at the bone-implant interface during healing, fibrous tissue encapsulation of the implant rather than osseointegration may occur. Conventional implant protocols have been based on the achievement of primary stability and prolonged non-loaded healing periods (Fig. 2).[4]

That was achieved by a two stage technique and an unloaded healing period of three to six months. Delayed implant loading was empirically based on the belief that the transfer of any micromotion to the implant surface during healing would result in fibrous encapsulation rather than osseointegration. A perceived psychological, economical and functional advantage of shortened treatment periods has encouraged clinicians to challenge this convention with immediate temporization (Fig. 3) and/or the early and immediate loading of dental implants.

The relative merits of these shortened loading protocols will be discussed with respect to their biologi-

Fig. 1_Direct loading at placement and delayed loading after bone healing.
Fig. 2_Conventional implant protocol without any loading performing the prosthetic in part after bone healing (e.g. Brånemark protocol).

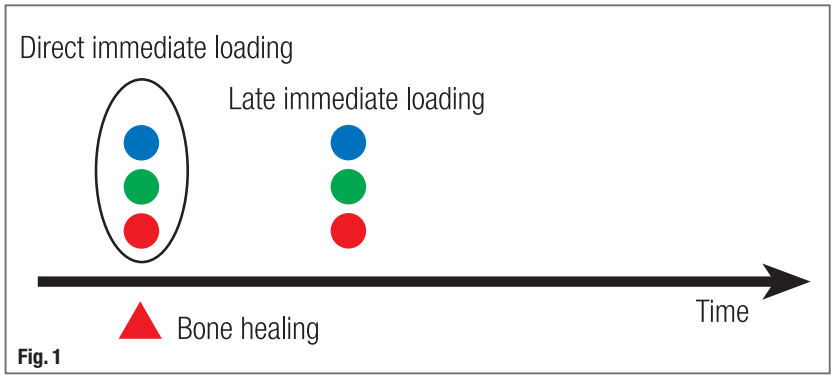

Fig. 1

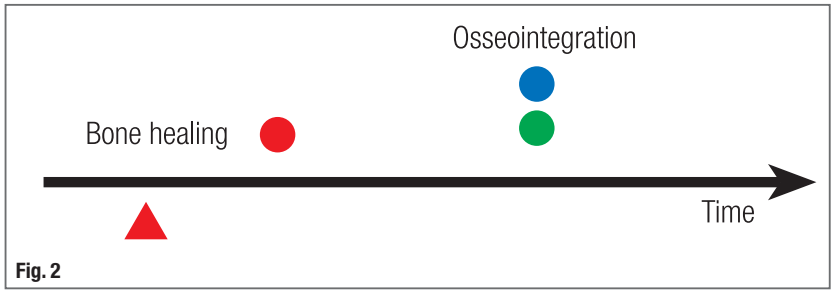

Fig. 2

cal implication, the current evidence based literature and the factors that might influence their outcomes. There is a growing body of published literature supporting reduced implant loading times. Abutment connection and placement of a restoration in occlusion with the opposing dentition of an implant at the time of surgery or within 48 hours of placement is referred to as "immediate loading" The functional restoration of an implant from 48 hours up to 3 months after placement has been defined as "early loading".[5] Both the immediate and early functional loading of implants before lamellar bone formation carry an inherent biological risk. Shortened loading protocols may expose the healing bone to implant interface to mechanical overload as described in Wolffs Law and Frosts Mechanostat theory (Fig. 4).

Interfacial micromotion above the biological threshold can result in the subsequent loss of implant stability. Rough titanium surfaces offer better implant anchorage in bone and more rapid bone deposition.[6] The general applicability of these principles will be considered as to their biological implications, the current evidence base and the factors that influence their results.

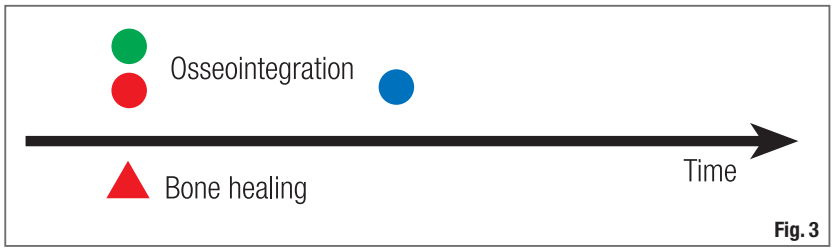

Fig. 3

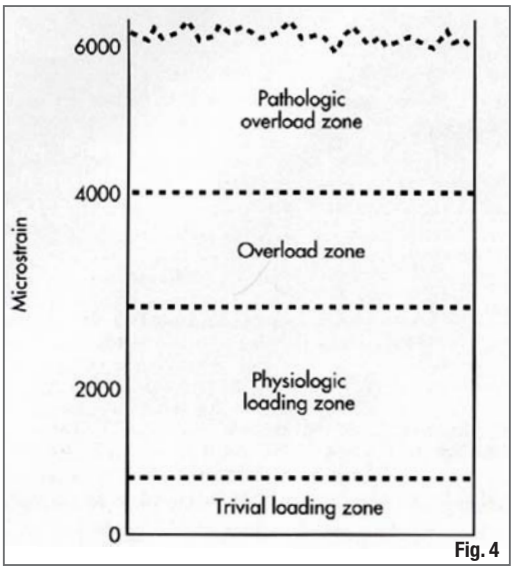

Fig. 4

Fig. 3_Immediate temporization and delayed loading.
Fig.4_Loading zones acc. to H. M. Frost

_Materials and Methods

Clinical reports on dental implants found in major scientific journals and through searching in PUB MED, QUINTESSENZ and MED-LINE, have served as the basis for this review. The following search terms, alone or in combination, were used: implant loading, immediate loading, early loading, delayed loading. After screening the titles and abstracts for possible relevance, they were ordered in full text. We also screened reference list of publications and relevant systematic reviews. To minimise bias, only RCTs of osseointegrated dental implants were considered. To be included, RCTs had to compare the same osseointegrated implants loaded at different times for a period of at least 12 months of loading.

For the purpose of this review immediate loading was defined as an implant put in function within 48 hours after its placement; early loading as those implants put in function from 48 hours up to 3 months after placement, and conventional loading as those implants put in function between 3 to 6 months after insertion. Implant mobility and removal of stable implants dictated by progressive marginal bone loss or infection have been assessed. Implant mobility of individual implants could be assessed manually or with devices such as Periotest® (Siemens, Munich, Germany) or Resonance frequency–Analysis–Osstell® (Integration diagnostics, Göteborg, Sweden). In our search we aimed at including randomized controlled trials. Most clinical reports were on a few implant systems only and threaded commercially pure titanium implants ad modum Brånemark dominated the literature. The quality assessment of the included trials was undertaken independently. The following quality criteria were examined:

Allocation concealment was recorded as adequate (A), unclear (B), or inadequate (C), as described elsewhere [Higgins, Green S. Handbook for systematic reviews of interventions].

Allocation concealment was considered adequate if it was centralized (e.g. Allocation by a central office unaware of subject characteristics). If randomization was pharmacy controlled; if prenumbered or coded identical containers were administered serially to participants.

A score of A was recorded if there was a clear explanation for a withdrawals or dropouts in each treatment group or if there were no dropouts. If clear explanation for any dropouts were given, the risk of bias of the assessment of reasons for dropping out was evaluated. A "strong scientific basis" is required as well. A score of B was recorded if clear explanations for any dropouts or withdrawals were not provided. Articles or authors that stated that allocation concealment procedures were implemented but did not provide details on how this was accomplished were coded as unclear. A score of C was recorded if there

were "insufficient scientific basis" or any procedure that was entirely transparent before allocation, such as an open list of random numbers. Hence, after a thorough reading of the studies included in this review, one of these scores has been qualified according to accuracy and the underlying scientific bases.

_Results

In 2002, a consensus meeting was convened within the World Congress organized by the Spanish Board of Implantology in Barcelona.[5] There was an agreement on terminology for the timing of loading (immediate, early, delayed) and for the implant loading (occlusal loading and nonocclusal loading). According to this consensus meeting the following terminology was described:

Immediate loading
The prosthesis is attached to the implants the same day the implants are placed

Early loading
The prosthesis is attached at a second procedure, earlier than the conventional healing period of 3 to 6 months. The time of loading is started after some days/weeks.

Delayed loading
The prosthesis is attached at a second procedure after a conventional healing period of 3 to 6 months.

Occlusal loading
The crown/bridge is in contact with the opposing dentition in centric occlusion.

Nonocclusal loading
The crown/ bridge is not in contact in centric occlusion with the opposing dentition in natural jaw position.

The available literature demonstrates the possibility of achieving good results with different protocols, especially with immediate loading protocol, at least in good-quality bone, which supports the idea that these concepts may serve as a viable option in implant dentistry. However, the prerequisites for achieving and maintaining acceptable results and the limitations of immediate/early loading are not fully known. Moreover, the terminology used in these protocols is confusing since the difference between different protocols is not well defined, and publication titles can therefore be very misleading. Of 26 potential studies, 7 have been excluded because of insufficient patient selection data or prothesis loading longer than one day (immediate loading), not corresponding to the Barcelona consensus, and 5 have been excluded since the follow up was shorter than 12 months. Fourteen studies have been introduced in this review, the conclusions having been discussed on their basis.

The majority of the studies considered in this review registered a relatively short follow up. In 6 studies the follow up covered a period longer than 24 months.

Daniel Sullivan, Giampaolo Vicenzi, Sylvan Feldman performed a multicenter study: the performance of Osseotite implants after an 1 stage surgery and abbreviated healing period of 2 months in 10 private practice centers. 142 patients, partially or completely edentulous, enrolled in this early loading study, received 526 implants, 65.4 % in mandible and 34.6 % in maxilla. Implants were loaded after a healing period of about two months. The distribution of the prosthesis types included 118 single tooth restoration (118 implants), 134 short-span prosthesis (327 implants) and 16 long-span restoration (81 implants).

Eight of the eleven implant failures occurred during nonsubmerged healing prior to prosthetic loading. Provisional restoration was placed at 2.1 ± 0.5 months, at which time implants were evaluated for mobility, gingival health and radiolucency. The cumulative success rate of these 526 implants was 97.9 % at 5 years.

These results suggest that success can be expected with Osseotite implants after a nonsubmerged reduced healing period of two months in this patient population.[7]

Par-Ölov Östman, Mats Hellman, Lars Sennerby evaluated in a prospective clinical study the radiographic and clinical outcome of immediately loading implants in the partial edentulous mandible over a 4 year follow up period.

96 patients were evaluated and 77 patients who met the inclusion criteria were included. A total of 111 fixed partial dentures supported by 257 Brånemark System implants (77 turned and 180 Ti Unite implants) was delivered. Four (1.16 %) of the 257 implants did not osseointegrate after 4 years. Three turned implants (3.9 %) and one oxidized implant (0.6 %) failed after 4 to 13 months. Immediate loading of implants with firm primary stability in partially edentulous areas of the mandible appears to be a viable procedure with predictable outcome.[8]

Richard P. Kinsel, Mindy Liss evaluated in a retrospective study the effects of implants dimensions, surface treatment, location in the dental arch, numbers of supporting implant abutments, surgical technique, and generally recognized risk factors on the survival of a series of single stage Straumann dental

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implants, placed into edentulous arches using an immediate loading protocol. Data were collected for 344 single-stage implants placed into 56 edentulous arches (39 maxillae and 17 mandibles) of 43 patients and immediate loaded with a one piece provisional fixed prosthesis.

Each patient received between 4 and 18 implants in one or both dental arches. Periapical radiographs were obtained over a 2 to 10 year follow up period to evaluate crestal bone loss following insertion of the definitive metal-ceramic fixed prostheses. A total of 16 implants failed to successfully integrate. Increased rates of failure were associated with reduced implant length, placement in the posterior region of the jaw, increased implant diameter and surface treatment. Implant length emerged as the sole significant predictor of implant failure.

In this prospective analysis, in 56 consecutively treated edentulous arches with multiple single stage dental implants loaded immediately, reduced implant length was the sole significant predictor of failure.[9] George Romanos, Georg Hubertus Nentwig evaluated immediate loading of oral implants on heavy smokers. Nine patients (5 male and 4 female) with a mean age of 52.4 ± 8.3 years who smoked more than 2 packs a day for more than 10 years (heavy smokers) were included in this prospective clinical study. Seventy two implants, 6 implants in each jaw, 6 maxillae and 6 mandibles, made from comercially pure titanium (grade 2), with a progressive thread design and sandblasted surface (Ankylos, Friadent) were used. Provisional fixed prostheses had centric occlusal contacts and group function in the lateral movements of the mandible (immediate occlusal loading). Clinical and radiographic indices were evaluated at the start of loading and at 3 month intervals after loading. After a mean loading period of 33.7 ± 19.0 months (range 6 to 66 months) one implant was mobile. All clinical indices had values in normal ranges. The Periotest values decreased with time, indicated increased security of implants in bone. Crestal bone loss was stable, with only two sites presented minimal vertical bone loss and six presented minimal horizontal bone loss. This study showed that immediate loading of oral implants may be successful in heavy smokers under some circumstances.[10] Gioacchino Cannizzaro, Michele Leone,Ugo Con Solo, Vittorio Ferri, Marco Esposito compared the efficacy of immediae functionally loaded implants placed with a flapless procedure (test group) versus implants placed after flap elevation and conventional load-free healing (control group) in partially edentulous patients. Forty patients were randomized: 20 to the flapless immediate loaded group and 20 to the conventional group. Implants in the immediately loaded group were provided with full acrylic resin temporary restoration in the same day. Implants in the conventional group were submerged (anterior region) or left unsubmerged (posterior region) and left load-free for 3 months (mandibles) or 4 months (maxillae). 52 implants were placed in the in the flapless group and 56 in the conventionally group. After three years no dropouts or failures occurred.

When comparing baseline data with those at the years 1, 2, and 3 within each group, mean Osstell values of the flapless group did not increase, whereas there were statistically significant increases in the Periotest values.

Implants can be successfully placed flapless and loaded immediately without compromising success rates; the procedure decreases treatment time and patient discomfort.[11]

Roberto Crespi, Paolo Cappare, Enricho Gherlone, George E. Romanos performed a study to report a clinical comparative assessement of crestal bone level change around single implants in fresh extraction sockets in the esthetic zone of the maxilla either immediately loaded or loaded after a delay. Forty patients were included in a prospective, randomized study. All patient required 1 tooth extraction. Implants were positioned immediately after tooth extraction and were loaded immediately in the test group (20 implants) and after 3 months in the control group (20 implants). All implants were 13 mm long. Thirty implants had a diameter of 5 mm, and 10 had a diameter of 3.75 mm. Radiographic examination was made at baseline, at 6 months and at 24 months. After a 24-month follow up period, a cumulative survival rate of 100 % was reported for all implants. The success rate and radiographic results of immediate restorations of dental implants placed in fresh extraction sockets were comparable to those obtained in delayed loading group.[12] Two studies registered a 18 month follow up. Joseph Nissan, George E. Romanos, Ofer Mardinger, Gavriel Chaushu assessed the clinical effectiveness of immediate nonfunctional loading for single tooth implants placed in the anterior maxilla following augmentation with cancellous freeze-dried block graft, with clinical outcomes up to 18 months after placement. Implants were immediately restored with unsplinted acrylic resin provisional crowns. Eleven patients received 12 implants in the anterior maxilla, and intraorally radiographs were obtained immediate after implant placement and at 6, 12 and 18 months. Survival rate and radiographic marginal bone loss were evaluated at 0, 6, 12 and 18 months. Marginal bone loss did not extend beyond the first thread up to a 18 month follow-up.

Within the limits of this study, immediate nonfunctional loading for single-tooth implants placed

in the anterior maxilla following augmentation with cancellous freeze-dried block graft seems a promising treatment alternative.[13]

Roberto Crespi, Paolo Cappare, Enricho Gherlone, George E. Romanos evaluated the clinical and radiographic outcome of dental implants immediate placed and loaded into fresh extraction sockets after 18 months. Twenty-seven patients, 15 women and 12 men, received a total of 160 implants. 150 were placed immediately after extraction.The sockets in the study had fully preserved walls, and 10 were placed in healed sites. Immediately after surgical procedure, all patients received the temporary prosthetic reconstruction in occlusion. Five months post surgery, definitive metal-ceramic restorations were cemented on abutments. Intraoral digital radiographic examination were performed 3 and 18 months after implant placement. Mean marginal bone loss 18 months after immediate loading was 0.65 ± 0.58 mm to the mesial side and 0.84 ± 0.69 to the distal side in the maxilla and 1.13 ± 0.51 mm mesially and 1.24 ± 0.60 distally

Tab. 1_Summarized data from the studies /approaches used in this review with reference to immediate loading.

Load time	Splint time	Sit.	Impl. type	Follow up	No.of pac. No.of impl.	Succ. rate	Reference	Lev. of evid
Immediate loading	1 Day	Ed. mand.	Novum Brånemark	12 Months	10 pac. 30 impl.	86.7 %	Els De Smet et al.	B
Immediate loading	1 Day	Max. esthetic zone	Sweden & Martina	24 Months	20 pac. 20 impl.	100 %	Roberto Crespi et al.	C
Immediate loading	< 1 Day	Part. ed. mand.	Ti Unite Brånemark	48 Months	77 pac. 257 impl.	98.4%	Rar-Oslov Ostman et al.	B
Immediate loading	< 1 Day	Ed. max. Ed. mandib.	Ankylos Friadent	12–60 Months	9 pac. 72 impl.	98.6 %	George Romanos et al.	B
Immediate loading	1 Day	Part. Edent.	Zimmer Swiss Plus	36 Months	20 pac. 52 impl.	100 %	Gioacchino Cannizzaro et al.	B
Immediate loading	1 Day	Ed. max. 39 Ed. man. 17	Straumann	2–10 Years	56 pac. 344 impl.	95.6 %	Richard P. Kinsel et al.	B
Immediate loading	1 Day	Ant. maxila	3 I -9 impl. Zimmer-3 impl	18 Months	11 pac. 12 impl.	100 %	Joseph Nissan et al.	B
Immediate loading	< 1 Day	All Edent.	Bicon	12 Months	209 pac. 477 impl.	90.3 %	Mohamed S. Erakat et al.	B
Immediate loading	< 1 Day	Lat ed. mand.	Straumann	12 Months	20 pac. 40 impl.	97.5 %	Roberto Cornelini et al.	B
Immediate loading	< 1 Day	Ed. max. part.	Sweden & Martina	18 Months	27 pac. 160 impl. (150 after extr.)	100 %	Roberto Crespi et al.	C
Immediate loading	< 1 Day	Ed. max.	Zimmer Swiss Plus	12 Months	33 pac. 202 impl.	99 %	Gioacchino Cannizzaro et al.	B
Immediate loading	< 1 Day	Ed. max.	Various	60 Months	44 pac. 338 impl.	99.1 %	Degidi et al.	B
Immediate loading	1 Day	Ed. mandib.	Straumann	24 Months	9 pac. 36 impl.	100 %	Pedro Tortamano et al.	C

in the mandible. Within the limits of this clinical study, the results indicate that immediate loading of implants placed in immediate extraction sites can be carried out successfully.[14] Six studies covered a 12 month follow up. Els de Smet, Joke Duyck, Josvander Sloten, Ignace Naert performed a clinical trial to report on the implant outcome of delayed, early and immediate loading of implants in the edentulous mandible. On a consecutive basis, the first ten patients received an overdenture retained by 2 ball attachments four months after implant insertion (delayed), and the next 10 patients received an overdenture one week after implant surgery (early). The next ten patients were treated with a fixed prosthesis on 3 implants (Brånemark, Novum) either the day of or the day after surgery (immediate). All patients were followed for one year, half were followed for two years. One patient in each OD group lost both implants.

The losses occurred six months after loading in the delayed group and one month after loading in the early group. In the immediate group, one patient lost both distal implants five months after loading. In two other patients, one distal implant failed after one year of loading. Maximal bite forces increased over time for all groups. Marginal bone loss was the highest for the immediate group.

According to this prospective controlled clinical trial, the results achieved with early implant loading were comparable to those achieved with implants loaded after a delay. Distal implants are at higher risk for failure in the immediate loading protocol.[15] Pedro Tortamano, Tadashi Carlos Orii, Julio Yamanochi, Atlas Edson Moleros Nakame, Tatiana de Carvalho Guarnieri presented a new method for fabricating effective definitive prostheses to immediate load implants in edentulous patients.Nine patients received four implants each, and resin metal prostheses were installed less than 48 hours after implant placement. Clinical evaluation of soft peri implant tissues was conducted monthly after the sutures were removed, and radiographs were obtained 6, 12 and 24 months after the surgery. The periotest revealed statistical values that were stable, with no mobility. No signs of inflammation and/or bleeding were observed.The radiographs did not reveal any continuous areas of radiolucency beyond the first thread of the 36 implants after 24 months.

Under immediate load, osseointegration of implants is possible, and the method for the fabrication of resin-metal prostheses has been reliable and predictable.[16] Giuseppe Luongo, Rosario Di Raimondo, Paolo Filippini, Federico Gualini, Cesare Paoleschi evaluated the concept of an immediate loading protocol in the posterior maxilla and mandible through analysis of implant survival at 1 year. Eighty two ITI sandblasted, acid-etched (SLA) implants in 40 patients were loaded between 0 and 11 days after implant placement. The restorations consisted of either 2 splinted crowns or a 3-unit fixed prosthesis. All restorations were put into full functional occlusion. Periapical radiographs were evaluated for changes in crestal bone level from baseline to 1 year postloading. Three patients' implants were not loaded because of lack of primary stability, and a fourth patient was excluded from the study because of a protocol violation (more than 4 implants were used).The mean bone loss at 1 year 0.52 $\pm$ 0.98. The early results from this study indicate that early and immediate loading of two implants in the posterior maxilla and mandible may be suitable in selected patients. On the basis of one year observation, the results appear similar to those achieved with a delayed procedure.[17]

Mohamed S Erakat, Sung-Kiang Chuang Meghan Weed, Thomas B. Dodson estimated the 1-year survival rate of immediate vertical load splinted locking taper implants and identified the risk factors for implant failure. The study cohort was composed of 209 patients who received 477 implants. The overall one year Kaplan Mayer survival estimate was 90.3 %. After controlling other variables, 3 variables-timing of implant placement relative to extraction (delayed implant placement after tooth extraction), coating of implant (uncoated), and increased number of pontics—were associated with an increased risk for implant failure. An overall 1-year survival estimate of 90.3 % (95 % CL: 86.9 %, 93.7 %) was calculated for immediately loaded splinted implants. After controlling other variables, 3 variables-timing of implant placement relative to extraction (delayed implant placement after tooth extraction), coating of implant (uncoated), and increased number of pontics—were associated with an increased risk for implant failure.[18] Roberto Cornelini, Filippo Cangini, Ugo Covani, Antonio Barone, Daniel Buser evaluated the succes rate at 12 months of titanium dental implants placed in the posterior mandible and immediately loaded with 3-unit fixed partial dentures. Patients with missing mandibular premolars and molars were enrolled in this study. Forty implants with a sandblasted, large grit, acid-etched (SLA) surface (Straumann) were placed in 20 patients. Implant stability was measured with resonance frequency analysis using the Osstell device. Implants were included in the study when the stability quotient (ISQ) exceeded 62. At 12 months, only one implant had been lost because of an acute infection. The remaining 39 implants were successful, resulting in a 1-year success rate of 97.5 %. Neither peri-implant bone levels, measured radiographically, nor implant stability changed significantly from baseline to the 12 month follow-up.

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Load time	Splint time	Sit.	Impl. type	Follow up	No.of pac. No.of impl.	Succ. rate	Reference	Lev. of evid
Early loading	2 Months	Ed. max. Ed. mandib.	Osseotite	60 Months	142 pac. 526 impl.	97.9 %	Sullivan et al.	B
Early loading	1-11 Days	Ed. post. mandib. Ed. post. max.	ITI Straumann	12 Months	40 pac. 82 impl.	98.8 %	Giuseppe Luongo et al.	B
Early loading	7 Days	Ed. mandib.	Novum Brånemark	12 Months	10 pac. 20 impl.	90 %	Els De Smet et al.	B

Load time	Splint time	Sit.	Impl. type	Follow up	No.of pac. no.of impl.	Succ. rate	Reference	Lev. of evid
Delayed loading	4 Months	Ed. mandib.	Novum Brånemark	1 Year Half 2 Years	10 pac. 20 impl.	90 %	Els De Smet et al.	C
Delayed loading	3 Months	Max. esthetic zone	Sweden & Martina	24 Months	20 pac. 20 impl.	100 %	Roberto Crespi et al.	B
Delayed loading	4 Months	Part. Edent.	Zimmer Swiss Plus	36 Months	20 pac. 56 impl.	100 %	Gioacchino Cannizzaro et al.	B

Tab. 2_Summarized data from the studies /approaches used in this review with reference to early loading.

Tab. 3_Summarized data from the studies/approaches used in this review with reference to delayed loading.

The findings from this clinical study showed that the placement of SLA transmucosal implants in the mandibular area and their immediate loading with 3-unit fixed partial dentures may be a safe and successful procedure.[19] Gioacchino Cannizzaro, Michele Leone, Marco Esposito have performed a one year follow-up of a single cohort study. Thirty three consecutively treated edentulous patients received 202 implants in the maxila. In 10 patients, 53 implants were immediately inserted in fresh extraction sockets. Three implants in two patients did not reach sufficient stability and were left to heal for 45 to 90 days. All restorations (21 fixed prostheses and 12 overdentures) were delivered the same day of the surgery. No major complication occurred. Five patients experienced biologic complication, e.g. peri-implantitis; ten experienced prosthetic complication. Two implants failed in two patients but were successfully replaced the same day they were removed. No prosthesis failed. Implants placed in the edentulous maxilla with a flapless procedure can be successfully loaded the same day of surgery.[20] The activity around dental implants has been approached by Hiroto Sasaki et al. who performed a study to determine dynamic changes in bone metabolism around osseointegrated titanium implants under mechanical stress. After insertion of implants, the uptake ratio increased during the first week and then decreased gradually. It was significantly higher than baseline on days 4.7 and 10 ($p < 0.01$ Friedman test) and during the second and third week ($p < 0.5$ Steel test). However, it was not significantly higher at 4 weeks and 7 weeks (i.e. metabolic activity had returned to the baseline level). The uptake ratio changed with the loading. With 2.0 and 4.0-N loading, change of activities over the 7 week experimental period was almost the same in terms of magnitude and timing.The ratio reached a maximum during the first week (more than twice that without loading) and then decreased a little. Metabolic activity returned to the baseline level at about 2 to 7 weeks after loading. The ratio from 3 days to 6 weeks after loading was significantly higher than without loading (Friedman and Steel test, $P < 0.05$). There was no significant difference 7 weeks after loading. The results for the 0.5 and 1.0-N loading groups were similar but different from those for the 2.0 and 4.0-N loading groups. With the smaller loadings, the uptake ratio gradually increased after loading and returned to the baseline level at 7 days. It then decreased, reaching baseline level at 2 to 7

weeks after loading. With 1.0-N loading, the uptake ratio did not differ among measurement points (Friedman and Steel tests, P > .05). The uptake ratios with the 2.0 and 4.0 loads were significantly higher than those with the 0.5 and 1.0-N loads (Tukey test, P < 0,5).[21]

_Discussion

Successfully osseointegrated dental implants are anchored directly to the bone. However, in the presence of movement , a soft tissue interface may incapsulate the implant causing its failure.To minimize the risk of soft tissue encapsulation, it has been recommended that implants should be kept load-free by submerging them during the healing period.[24]

Immediatly loaded or early loaded implants after insertion develop special and specific clinical implications with an impact on the treatment time. If it can shortened to a very large extent it involves a significant fact to the benefit of the patients. The main purpose of these studies is actually the achievement of a successful final prothesis. Implant loss is a significant risk factor in this respect.

This review has been intended for gathering data and information available in reference literature in order to achieve a clinical conclusion as to fixed or removable implant-supported prostheses based on time of loading. Attempts to use standard systematic review procedures (application of scientific strategies in ways that limit bias to the assembly, critical appraisal and synthesis of all relevant studies that address a specific clinical question) have not been entirely possible because of report variability, and this limits the ability to draw conclusive comments from the work.

Nowadays, immediate or early dental implants loading with a careful patients' selection is possible. The clinician's experience is an obligatory prerequisite in reaching optimum results with immediate loading. One of the conditions or requirements influencing the procedure success appears to be the high primary stability of the implant at the insertion time. In future, additional and well structured studies are important and necessary to complete a clear protocol for immediate and early loading. No statistic difference for prothesis and implants success rate or marginal bone loss with different time of implant loading has been observed. All known risk factors and contraindications for osseointegration with a standard protocol will be equally or even more important with immediate or early loading protocols. It is thus implied that successful osseointegration with reduced loading protocols requires critical case selection and meticulous surgical and prosthetic management.

A surgical technique that minimizes heat generation and pressure necrosis is of particular importance with both early and immediate implant loading. It is also dependent on the quality and quantity of existing bone at the implant site and the ability to achieve and maintain adequate stability of the implant so that micromotion is kept below the biological threshold. The level of skill and experience of the surgeon play a role in treatment outcomes. The presence of infection in the implant area will affect osseointegration. Untreated periodontitis and periapical pathology must be addressed before implant placement, independent of the loading protocol.

Management of micromotion of the implant is critical for osseointegration and many studies stress the importance of minimizing functional loading in both centric and lateral excursion. Non axial loading is difficult to measure clinically and the ideal occlusal scheme has not been outlined. It is therefore impossible to state that parafunction is an implicit contraindication to immediate or early loading but it is generally considered to be a risk factor.

Relatively few data about the relationship between soft tissue and immediate or early loading are available. Marginal recessions around the immediately loaded implant were comparable to those conventionally loaded.[22, 23]

Smoking has been shown to have a negative impact on osseointegration [25, 26] and, as such, it must be also considered a potential risk factor for immediate and early loading protocols even though some studies showed that immediate loading of oral implants may be successful in heavy smokers under some circumstances.[10, 27, 28]

It is fundamentally necessary for a treatment plan to offer an advantage to the patient. Immediate and early loading benefits reduce surgical steps by eliminating the second procedure, shorten treatment time and provide a functional and psychologic advantage of prosthetic rehabilitation.

Immediate restauration or loading may be particulary attractive to a patient as temporization with a removable appliance is not required after implant fixture placement. The advantage must be carefully considered against a potential increased risk of failure for immediate or early loading times.

An increased success rate was generally stated in the studies; however, two studies [15, 18] have revealed a relatively high failure rate. In one study[15], one patient of each group lost both implants. The loss occurred six months after loading in delayed group and one month after loading in early group. In the immediate group,

one patient lost both distal implants five months after loading. In two other patients, distal implants failed after one year of loading. Marginal bone loss was the highest for the immediate group. In another study[18], there has been reported a success rate of 90.3 %, i.e. 47 lost implants out of 477 inserted implants, respectively. It might be important to specify that Bicon implants were used in the study. It is worth mentioning that, in general, the success rate was high (95.6 % – 100 %), a fact confirming immediate and early loading of dental implants to be a viable treatment option.[7,8,9,10,11,12,13,14,16,17,19,20] Marginal bone loss was observed to be higher with immediately loaded implants.[15] Furtheron, bone loss has not been extended beyond the first implant thread.[13,16] Both implant length reducing and diameter shortening increase the risk of failure.[9] Another important aspect is that immediate loading can be achieved under circumstances of a high primary stability.[8,9,10,11,12,13,14,15,16,17,18,19,20]

_Conclusion and Clinical Relevance

Nowadays, immediate and early loading with outcomes comparable to conventional results is possible. However, a rigurously and thoroughly selected surgical and prothetic management is of utmost importance and necessity in achieving the goal. It is also compulsory for dental implants to show a very good primary stability and bone quantitaty and quality as well as bruxism and parafunctional habits must be correctly assessed. The risk of failure with immediate and early loading is extremely high in the lateral maxillary area due to poor bone quality as well as when one tooth only is replaced. A high success rate has been observed when optimum density bone exists and when the implants are splinted. Biological limits in the immediate and early loading process of dental implants have not been entirely defined yet. Further researches are required and important for a more accurate setting of limits between immediate, early and delayed loading of dental implants.

_Summary

The scope of this review is to find an answer to the questions "when" and "how" implants can be loaded in different time after insertion. For the purpose of this review, immediate loading was defined as an implant put in function within 48 hours after its placement; early loading as those implants put in function from 48 hours up to 3 months after insertion, and conventional loading as those implants put in function between 3 to 6 months after placement. The review has been accomplished on the basis of 14 studies selected out of 26, with a minimum 12 month follow up. The concern for immediate or early loading after insertion determines special and specific clinical implications with an impact on the treatment time since it is shortened to a very large extent, being thus a benefit to the patients.

The main purpose of the studies underlying this review is in fact the success of the final prothesis, since implants loss engenders a great risk for protheses. Immediate or early loading of dental implants is nowadays possible for carefully selected patients. All known risk factors and contraindications for osseointegration with a standard protocol will be equally or even more important with immediate or early loading protocols. It is thus implied that successful osseointegration with reduced loading protocols requires critical case selection and meticulous surgical and prosthetic management. A surgical technique that minimizes heat generation and pressure necrosis is of particular importance with both early and immediate implant loading. It is also dependent on the quality and quantity of existing bone at the implant site and the ability to achieve and maintain adequate stability of the implant so that micromotion is kept below the biological threshold. The level of skill and experience of the surgeon play a role in treatment outcomes. Biological limits in the immediate and early loading process of dental implants have not been entirely defined yet. Further researches are required and important for a more accurate setting of limits between immediate, early and delayed loading of dental implants.

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Cited literature upon request.

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