# Loading Protocols for Dental Implants in Edentulous Patients

German O. Gallucci, DMD, Dr Med Dent[1]/Dean Morton, BDS, MS[2]/Hans-Peter Weber, DMD, Dr Med Dent[3]

***Purpose:*** *The objective of this systematic review was to present the current scientific and clinical evidence related to implant-supported rehabilitations for the edentulous mandible and maxilla.* ***Materials and Methods:*** *An electronic search of several databases covered the period from January 1966 to August 2008. From a total of 2,371 publications identified from this search, 61 articles fulfilled the inclusion criteria set forth by the authors. It should be noted that only studies reporting on implants with rough surfaces were included in the final selection for this review.* ***Results:*** *Selected studies yielded data from 2,278 patients and 9,701 implants. Studies were grouped according to treatment protocol and prosthodontic design, and results on conventional, early, and immediate loading were assessed separately for fixed and removable dental prostheses. Clinical recommendations for implant loading in different edentulous indications were established using a special validation protocol of the published scientific and clinical evidence for different treatment modalities, which was based on the study design, sample size, and outcome homogeneity between studies.* ***Conclusions:*** *The highest level of scientific and clinical validation was found for conventional loading with mandibular overdentures and maxillary fixed dental prostheses. Insufficient scientific or clinical documentation/validation was found for immediate loading of maxillary overdentures, as well as for immediate loading of immediately placed implants combined with fixed or removable dental prostheses in either jaw. All other loading protocols for edentulous arches showed different degrees of clinical documentation.* Int J Oral Maxillofac Implants 2009;24(SUPPL):132–146

**Key words:** *dental implants, edentulism, fixed dental prosthesis, loading protocol, mandible, maxilla, removable prosthesis, systematic review*

Loading protocols for the dental implant treatment of edentulous jaws have been widely discussed in the dental literature. Initial implant stability, implant surface characteristics, bone quality, bone healing, interim prosthesis design, and occlusion pattern during the healing phase have been identified as influential factors in successfully achieving osseointegration with modified loading protocols.[1]

While several randomized controlled trials (RCTs) and reviews have demonstrated clinical efficiency in shortening the time of loading for edentulous patients,[2–5] the related scientific evidence is mostly presented from the perspective of implant survival or success, and with only limited information about the prosthodontic treatment outcome. In order to accurately assess the impact of modified loading protocols in edentulous patients, data should ideally be analyzed separately according to: *(1)* maxillary and mandibular protocols, *(2)* fixed and removable rehabilitations, *(3)* machined and rough-surfaced implants, and *(4)* implant placement into healed sites and extraction sockets that are not yet healed. These factors have often been presented as having a direct influence on the implant and prosthodontic survival rate.

In addition, special consideration should be given to the patient's initial clinical status. Here, two groups can be well differentiated: patients who have been edentulous for a certain period of time, and patients

[1]Lecturer, Department of Restorative Dentistry and Biomaterials Sciences, Harvard School of Dental Medicine, Boston, Massachusetts, USA.
[2]Professor and Interim Chair, Department of Oral Health and Rehabilitation, University of Louisville School of Dentistry, Louisville, Kentucky, USA.
[3]Professor and Chair, Department of Restorative Dentistry and Biomaterials Sciences, Harvard School of Dental Medicine, Boston, Massachusetts, USA.

The authors reported no conflict of interest.

**Correspondence to:** Dr German O. Gallucci, Department of Restorative Dentistry and Biomaterials Sciences, Harvard School of Dental Medicine, 188 Longwood Avenue, Boston, MA 02115, USA. Fax: +1 617-432-0901. Email: german_gallucci@hsdm.harvard.edu

*This review paper is part of the Proceedings of the Fourth ITI Consensus Conference, sponsored by the International Team for Implantology (ITI) and held August 26–28, 2008, in Stuttgart, Germany.*

who will become edentulous due to a failing dentition. These different initial situations will have a direct influence on the treatment sequence.

The objective of this review on loading protocols in edentulous patients was to present well-structured scientific and clinical evidence related to implant-supported rehabilitations for the edentulous mandible and maxilla. The specific aim was to assess the survival outcome of various loading protocols according to their treatment sequence and prosthodontic design.

## MATERIALS AND METHODS

### Search Strategy and Data Analysis

An electronic search for clinical trials on edentulous patients was performed using MEDLINE, PubMed, the Cochrane Controlled Trials Register, and the Cochrane Health Group Specialized Register from 1966 through June 2008. The search terminology included:

- *complete edentulous* AND *implant*
- *complete edentulous* AND *full-arch*
- *complete implant prostheses* OR *complete implant bridge*
- *fixed complete prostheses* AND *implant*
- *edentulous jaws* AND *implant*
- *edentulous jaws* AND *immediate implant loading*
- *edentulous jaws* AND *delayed implant loading*
- *edentulous jaws* AND *early implant loading*
- *edentulous jaws* AND *staged approach*
- *edentulous jaws* AND *loading protocols*
- *complete implant overdentures* OR *complete implant removable prostheses*

Hand-searching of all offline journals and bibliographies of reviewed articles relevant to the topic completed the general search. References appraised in related systematic reviews were also considered.

The search strategy was limited to clinical trials investigating the compatibility of different loading protocols with the achievement of osseointegration. For prospective data, only studies reporting implant and prosthetic survival outcomes after 12 or more months were included. Only clinical trials using endosseous root-shaped implants with rough surfaces were considered for this review. All levels of the hierarchy of evidence, with the exception of expert opinions, were included. For case reports, only studies with a minimum of 10 patients and edentulous arches were accepted.

Selected publications were collected in reference management software, and duplicates were electronically discarded.

After title and abstract screening of 2,371 publications obtained from the electronic search, 295 were selected for full-text reading. Sixty-one articles including data from 2,278 patients and 9,701 implants appeared to fulfill the inclusion criteria. Selected studies on loading protocols for edentulous patients were broken down according to jaw location and prosthodontic design (Table 1).

### Validation Criteria

To formulate conclusions and propose clinical recommendations for various loading protocols in combination with prosthodontic treatment options for the edentulous mandible and maxilla, the included studies were ranked according to their design, sample size, and outcome homogeneity (OH). The outcome homogeneity was considered positive (OH+) when the variation of implant survival rates for the same treatment protocol was 10% or less, and negative (OH–) when the variation was greater than 10%.

Using these criteria, scientific and/or clinical validation was determined as follows:

***Scientifically and Clinically Validated (SCV):***

- Systematic reviews of RCTs or
- Two or more RCTs + ≥ 100 patients + OH+ or
- One RCT and two or more prospective studies + ≥ 150 patients + OH+

***Clinically Well Documented (CWD):***

- One RCT and two or more prospective studies + ≥ 40 patients + OH+ or
- No RCTs but at least three prospective studies + ≥ 60 patients + OH+ or
- No RCTs but two or fewer prospective studies + ≥ 100 patients + OH+

***Clinically Documented (CD):***

- No RCTs, at least two prospective + any retrospective studies + ≤ 40 patients + OH– or
- No RCTs, retrospective studies + ≥ 60 patients + OH–/+

***Clinically Insufficiently Documented (CID):***

- None of the above, expert opinion only, case report only

Each treatment modality described in Table 1 was subsequently categorized according to the above validation criteria and presented in Table 2.

**Table 1 Number of Selected Publications Broken Down by Loading Protocol and Prosthodontic Treatment Modality**

| | Removable | | Fixed | |
|---|---|---|---|---|
| | Maxilla | Mandible | Maxilla | Mandible |
| Conventional loading | 3 studies<br>0 (RCTs)<br>2 (Prosp)<br>1 (Retro)<br>110 Pts/530 Impls<br>94.8%–97.7%<br>OH+ | 10 studies<br>4 (RCTs)<br>4 (Prosp)<br>2 (Retro)<br>671 Pts/1,396 Impls<br>97.1%–100%<br>OH+ | 4 studies<br>1 (RCT)<br>3 (Prosp)<br>0 (Retro)<br>104 Pts/719 Impls<br>95.5%– 97.9%<br>OH+ | 4 studies<br>1 (RCT)<br>2 (Prosp)<br>1 (Retro)<br>207 Pts/1,254 Impls<br>97.2%–98.7%<br>OH+ |
| Early loading | 2 studies<br>0 (RCTs)<br>2 (Prosp)<br>0 (Retro)<br>49 Pts/185 Impls<br>87.2%–95%<br>OH- | 4 studies<br>1 (RCT)<br>3 (Prosp)<br>0 (Retro)<br>68 Pts/136 Impls<br>97.1%–100%<br>OH+ | 4 studies<br>1 (RCT)<br>1 (Prosp)<br>2 (Retro)<br>54 Pts/344 Impls<br>93.4%–99%<br>OH+ | 3 studies<br>0 (RCTs)<br>2 (Prosp)<br>1 (Retro)<br>176 Pts/802 Impls<br>98.6%–100%<br>OH+ |
| Immediate loading | 1 study<br>0 (RCTs)<br>1 (Prosp)<br>0 (Retro)<br>12 Pts/48 Impls<br>95.6%<br>OH N/A | 7 studies<br>0 (RCTs)<br>6 (Prosp)<br>1 (Retro)<br>329 Pts/1,161 Impls<br>96%–100%<br>OH+ | 6 studies<br>0 (RCTs)<br>5 (Prosp)<br>1 (Retro)<br>153 Pts/893 Impls<br>95.4%–100%<br>OH+ | 7 studies<br>0 (RCTs)<br>5 (Prosp)<br>2 (Retro)<br>181 Pts/942 Impls<br>98%–100%<br>OH+ |
| Immediate loading of immediately placed implants | N/A | N/A | 4 studies<br>0 (RCTs)<br>1 (Prosp)<br>3 (Retro)<br>149 Pts/1,194 Impls<br>87.5%–98.4%<br>OH- | 2 studies<br>0 (RCTs)<br>0 (Prosp)<br>2 (Retro)<br>15 Pts/97 Impls<br>97.7%–100%<br>OH+ |
| Total subgroups | 6 | 21 | 18 | 16 |
| Total main groups | 27 | | 34 | |
| Total | 61 | | | |

RCT = randomized controlled trial; Prosp = prospective study; Retro = retrospective study; Pts = patients; Impls = implants; OH = outcome homogeneity (+ [less than 10% variation], – [more than 10% variation]).

**Table 2 Validation of Loading Protocols for Different Prosthodontic Treatments in the Edentulous Mandible or Maxilla**

| | Removable | | Fixed | |
|---|---|---|---|---|
| | Maxilla | Mandible | Maxilla | Mandible |
| Conventional loading | CWD | SCV | SCV | CWD |
| Early loading | CD | CWD | CD | CD |
| Immediate loading | CID | CWD | CWD | CWD |
| Immediate loading of immediately placed implants | CID | CID | CD | CID |

SCV = scientifically and clinically validated; CWD = clinically well documented; CD = clinically documented; CID = clinically insufficiently documented (includes loading protocols that are not documented).

## RESULTS: REMOVABLE IMPLANT PROSTHESES

### Conventional Loading of Mandibular Implant Overdentures

This loading protocol describes the use of two to four implants placed in edentulous mandibles, to be connected to an overdenture after a healing period of 3 to 6 months. Several implant prosthetic designs have been proposed, such as two implants with single ball-shaped or locator attachments,[6–10] two implants splinted with a rigid bar construction,[8–17] four or more implants connected with a rigid bar construction,[12,14–17] and four or more single implants with ball-shaped or locator attachments (Table 3).[8]

Mericske-Stern[6] reported a clinical comparison of bar or single ball-shaped precision attachments placed onto two implants versus three or four

**Table 3 Conventional Loading of Implant-Supported Mandibular Overdentures**

| Study | Study design | Implant type | No. of patients | No. of implants placed | Follow-up (y) | Implant failures | Implant survival rate (%) | Prosthodontic failures | Prosthodontic survival rate (%) |
|---|---|---|---|---|---|---|---|---|---|
| Mericske-Stern (1990)[6] | Retro | Straumann | 62 | 140 | 1 to 5.5 | 2 | 98.6 | NR | NR |
| Naert et al (1999)[11] | RCT | Dyna/ Nobel Biocare | 36 | 72 | 5 | 1 | 98.6 | NR | NR |
| Ferrigno et al (2002)[12] | Prosp | Straumann | 129 | 348 | 10 | 7 | 97.1 | 2 | 97.7 |
| Payne et al (2002)[7] | RCT | Straumann | 12 | 24 | 2 | 0 | 100 | NR | NR |
| Karabuda et al (2002)[8] | Retro | PittEasy Frialit 2 | 36 | 94 | 2-4 | 2 | 97.8 | NR | NR |
| Heydenrijk et al (2002)[13] | Prosp | IMZ | 40 | 80 | 1 | 2 | 97.5 | NR | NR |
| Behneke et al (2002)[17] | Prosp | IMZ | 100 | 340 | 5 | 4 | 98.8 | NR | NR |
| Walton (2003)[9] | RCT | Nobel Biocare | 100 | 200 | 3 | 0 | 100 | 12 | 88 |
| Visser et al (2005)[15] | Prosp | IMZ | 60 | 180 | 5 | 1 | 99.4 | 0 | 100 |
| Stoker et al (2007)[16] | RCT | Straumann | 96 | 258 | 8 | 3 | 98.8 | 6 | 93.7 |

RCT = randomized controlled trial; Prosp = prospective study; Retro = retrospective study; NR = not reported.

**Table 4 Conventional Loading of Implant-Supported Maxillary Overdentures**

| Study | Study design | Implant type | No. of patients | No. of implants placed | Follow-up (y) | Implant failures | Implant survival rate (%) | Prosthodontic failures | Prosthodontic survival rate (%) |
|---|---|---|---|---|---|---|---|---|---|
| Ferrigno et al (2002)[12] | Prosp | Straumann | 35 | 178 | 10 | 9 | 94.9 | 3 | 91.4 |
| Mericske-Stern (2002)[20] | Retro | Straumann | 41 | 173 | 1 to 9 | 9 | 94.8 | NR | NR |
| Krennmair et al (2008)[21] | Prosp | IMZ | 34 | 179 | 5 | 4 | 97.7 | NR | NR |

Prosp = prospective study; Retro = retrospective study; NR = not reported.

implants splinted with a bar. The author suggested that two implants could adequately serve as retention for a mandibular overdenture. Naert et al,[10] Karabuda et al,[8] and Lachmann et al[18] concluded in independent studies that the retention system for mandibular overdentures in splinted versus freestanding implants did not influence the peri-implant tissue outcome when using a conventional loading approach. However, prosthodontic considerations were not reported in these studies.

In a long-term prospective study, Visser and coworkers[15] addressed the question of the number of implants required for ensuring a long-lasting outcome. The authors concluded that there was no difference in the clinical and radiographic status of patients treated with an overdenture on two or four implants during a 5-year evaluation period.

In summary, 10 articles were included in the group of mandibular implant overdentures: 4 RCTs, 4 prospective studies, and 2 retrospective studies indicating a high level of evidence. Results from 671 patients who received 1,396 implants showed an implant survival rate ranging from 97.1% to 100% during a mean follow-up period of 1 to 10 years. The prosthetic survival rate was reported in only 4 of 9 selected articles, and showed a mean survival rate of 95.7% (88% to 100%).

***Conclusions for conventional loading of implant overdentures in the edentulous mandible:***

- Conventional loading of mandibular implant overdentures is scientifically and clinically validated (SCV).
- Implant survival rates (1 to 10 years) range from 97.1% to 100%.
- Prosthodontic survival rates range from 88% to 100%.
- Two implants, single or splinted, will serve as effectively as four splinted implants.

## Conventional Loading of Maxillary Implant Overdentures

This loading protocol describes the use of four to six implants placed in the edentulous maxilla and restored with an overdenture after a healing period of 3 to 6 months. The implant-prosthetic design includes four or more freestanding implants[19] or four to six implants connected by a bar device (Table 4).[12,20,21]

Ferrigno et al[12] conducted a multicenter study with a conventional loading approach and reported a 10-year outcome with a lower survival rate than mandibular implant overdentures.

Mericske-Stern and coworkers[20] stated that optimal survival rates of maxillary implants supporting an overdenture can be enhanced with well-planned

**Table 5 Early Loading of Implant-Supported Mandibular Overdentures**

| Study | Study design | Implant type | No. of patients | No. of implants placed | Follow-up (y) | Time of loading (wk) | Implant failures | Implant survival rate (%) | Prosthodontic failures | Prosthodontic survival rate (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| Roynesdal et al (2001)[22] | Prosp | Straumann | 11 | 22 | 1 | 3 | 0 | 100 | NR | NR |
| Payne et al (2002)[7] | RCT | Straumann | 12 | 24 | 2 | 6 | 0 | 100 | 0 | 100% |
| Attard and Zarb (2005)[4] | Prosp | Nobel Biocare | 35 | 70 | 1 | 1.5 | 2 | 97.1 | 6 | 82.6 |
| Turkyilmaz and Tumer (2007)[23] | Prosp | Nobel Biocare | 10 | 20 | 2 | 1 | 0 | 100 | NR | NR |

RCT = randomized controlled trial; Prosp = prospective study; NR = not reported.

treatment concepts including conventional loading. Recently, Cavallaro and Tarnow[19] proposed using a minimum of four freestanding implants with locator abutments to support palate-free maxillary overdentures. After a conventional healing time, prostheses were attached to the implants, resulting in a 100% survival rate in a 12- to 48-month follow-up time. However, that article reports results from only five consecutive cases/arches, and for that reason was not part of this review.

In summary, three articles were included in the group of maxillary implant overdentures.[12,20,21] The level of evidence was lower than for mandibular overdentures, since only prospective and retrospective studies were available for analysis. Results from 110 patients receiving 530 implants showed a mean implant survival rate ranging from 94.8% to 97.7% during a mean follow-up period of 5 years (range 1 to 10 years). Only one study reported a prosthetic survival rate, which was found to be 91.4%.

***Conclusions for conventional loading of implant overdentures in the edentulous maxilla:***

- Conventional loading of maxillary implant overdentures is clinically well documented (CWD).
- Implant survival rates (1 to 10 years) range from 94.8% to 97.7%.
- Prosthodontic survival rates were described in one prospective study (91.4%, 3-year follow-up).
- More clinical trials are needed to scientifically and clinically validate the use of freestanding implants supporting maxillary overdentures with or without palatal coverage.

## Early Loading of Mandibular Implant Overdentures

This approach describes mandibular implant overdentures that were functionally loaded no earlier than 48 hours after implant placement and no later than 3 months afterward. Two implants combined with an overdenture retained by single ball-shaped or locator abutments[7,22–24] was the only prosthodontic design identified (Table 5).

Roynesdal et al[22] compared conventional and early loading of two solid-screw dental implants supporting a mandibular overdenture. The authors concluded that the survival rate of rough-surfaced implants loaded 3 weeks after implant placement was similar to that of implants loaded in a conventional time frame, on the assumption that primary stability was achieved. Payne and coworkers,[7] in a randomized controlled trial, reported that pairs of unsplinted SLA-surfaced implants can be successfully loaded with mandibular overdentures 6 weeks after surgery. Turkyilmaz and Tumer[23] concluded that the implant survival rate in the anterior mandible was not compromised when using a 1-week functional early loading protocol with unsplinted implants supporting an overdenture.

In summary, for the group of mandibular implant overdentures with an early loading approach, four publications reported results with rough-surfaced implants.[7,22–24] An optimal level of evidence was supported by one RCT and three prospective controlled studies. While promising results were reported in the selected publications, this scientific evidence is based on 68 patients and 136 implants with a 2-year follow-up. The prosthodontic survival rate was reported in only two of the four selected articles.

***Conclusions for early loading of implant overdentures in the edentulous mandible:***

- Early loading (1 to 6 weeks) of mandibular implant overdentures is clinically well documented (CWD).
- Implant survival rates (1 to 2 years) range from 97.1% to 100%.
- Prosthodontic survival rates range from 82.6% to 100%.
- Two freestanding implants in the anterior mandible are sufficient for such a protocol.

**Table 6 Early Loading of Implant-Supported Maxillary Overdentures**

| Study | Study design | Implant type | No. of patients | No. of implants placed | Follow-up (y) | Time of loading (wk) | Implant failures | Implant survival rate (%) | Prosthodontic failures | Prosthodontic survival rate (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| Raghoebar et al (2003)[25] | Prosp | Biomet 3i | 10 | 68 | 1 | 8 | 3 | 95.6 | NR | NR |
| Payne et al (2004)[26] | Prosp | Nobel Biocare | 39 | 117 | 2 | 12 | 15 | 87.2 | NR | NR |

Prosp = prospective study; NR = not reported.

## Early Loading of Maxillary Implant Overdentures

This approach describes maxillary implant overdentures that were functionally loaded no earlier than 48 hours after implant placement and no later than 3 months afterward. Implant-prosthetic designs included four to six implants connected by a bar construction[25] and three freestanding implants with single ball or locator attachments (Table 6).[26]

Raghoebar et al[25] reported on an early loading protocol with overdentures supported by splinted implants. The authors concluded that in selected cases early loading of implants could develop into a predictable treatment modality. In a different approach with early loading, Payne et al[26] investigated the use of freestanding narrow-diameter implants loaded at 12 weeks with maxillary overdentures. The implant survival rate after a 2-year follow-up was 87.2%.

During the 2004 ITI Consensus Meeting on edentulous patients,[1] no publications were available for early loading protocols with maxillary overdentures. Results from the actual search revealed two references with a publication date subsequent to Chiapasco's.[1] These prospective studies describe results from 49 patients who received 185 rough-surfaced implants. The time of loading varied from 8 to 12 weeks, with an implant survival rate ranging from 87.2% to 95.6%. No data related to the prosthodontic survival rate could be retrieved.

***Conclusions for early loading of implant overdentures in the edentulous maxilla:***

- Early loading (8 to 12 weeks) of maxillary implant overdentures is clinically documented (CD).
- Implant survival rates (1 to 2 years) range from 87.2% to 95.6%.
- No prosthodontic survival rates are reported.
- More clinical trials are needed to scientifically and clinically validate the use of freestanding implants supporting maxillary overdentures with or without palatal coverage.

## Immediate Loading of Mandibular Implant Overdentures

Immediate loading with mandibular implant overdentures is a protocol in which implants are connected to the prosthesis and placed in occlusal contact within 48 hours after implant placement. Implant prosthetic designs included immediate prosthetic loading of a single implant in the anterior mandible,[27] two single implants with ball and locator attachments,[28] two immediately loaded and splinted implants,[29] three free-standing implants immediately loaded with a ball or locator attachment,[30] and four or more implants connected with a bar construction (Table 7).[31–33]

Chiapasco and coworkers[31] presented results for immediately loaded implants splinted by a bar construction. The authors concluded that four splinted implants showed survival rates similar to delayed loading. Similar results were later presented by Gatti et al[32] and Romeo et al.[33] Stephan and coworkers[30] proposed an immediate loading protocol with 3 freestanding implants supporting a mandibular overdenture. It was concluded in this publication that the survival rate of three unsplinted immediately loaded implants with a mandibular overdenture was similar to rates of conventionally loaded implants. However, such a protocol is supported by a single publication reporting on 17 patients with no implant lost after a 2-year follow-up. Stricker et al[29] proposed a similar approach to Chiapasco et al,[31] but using two splinted implants. The conclusions suggested that two splinted implants can be successfully used. Marzola et al[28] proposed the immediate loading of two implants by means of a ball attachment–retained mandibular complete denture and concluded that this approach may become a predictable treatment option. Liddelow and Henry[27] reported the use of immediate loading with a single implant supporting a mandibular overdenture. Based on a single publication, this protocol showed lower survival rates for both implants (89.3%) and prostheses (89.3%).

In summary, the use of mandibular overdentures in combination with an immediate loading approach

**Table 7 Immediate Loading of Implant-Supported Mandibular Overdentures**

| Study | Study design | Implant type | No. of patients | No. of implants placed | Follow-up (y) | Time of loading (d) | Implant failures | Implant survival rate (%) | Prosthodontic failures | Prosthodontic survival rate (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| Chiapasco et al (1997)[31] | Retro | Straumann | 226 | 904 | 2–13 | 1 | 24 | 96.9 | 3 | 98.5% |
| Gatti et al (2000)[32] | Prosp | Straumann | 21 | 84 | 2–5 | 1 | 3 | 96.0 | NR | NR |
| Romeo et al (2002)[33] | Prosp | Straumann | 10 | 40 | 2 | 2 | 1 | 97.5 | 0 | 100% |
| Stricker et al (2004)[29] | Prosp | Straumann | 10 | 20 | 2 | 1 | 0 | 100 | 1 | 90% |
| Stephan et al (2007)[30] | Prosp | Nobel Biocare | 17 | 51 | 2 | 2 | 0 | 100 | NR | NR |
| Liddelow and Henry (2007)[27] | Prosp | Nobel Biocare | 28 | 28 | 1 | 1 | 3 | 89.3 | 3 | 89.3 |
| Marzola et al (2007)[28] | Prosp | Nobel Biocare | 17 | 34 | 1 | 1 | 0 | 100 | 2 | 88.3 |

Prosp = prospective study; Retro = retrospective study; NR = not reported.

**Table 8 Immediate Loading of Implant-Supported Maxillary Overdentures**

| Study | Study design | Implant type | No. of patients | No. of implants placed | Follow-up (y) | Time of loading (d) | Implant failures | Implant survival rate (%) | Prosthodontic failures | Prosthodontic survival rate (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| Cannizzaro et al (2007)[34] | Prosp | Zimmer | 12 | 48 | 1 | 1 | 1 | 95.6 | 0 | 100 |

Prosp = prospective study.

on rough-surfaced implants was supported in seven publications. Six were prospective studies, and one was retrospective. Data were extracted from 329 patients receiving 1,161 implants. The scientific evidence can be divided between the well-documented immediate loading protocol using four splinted implants and the more recent proposals with immediate loading using fewer than four implants.

***Conclusions for immediate loading of implant overdentures in the edentulous mandible:***

- Immediate loading (1 to 2 days) of mandibular implant overdentures is scientifically and clinically validated (SCV).
- Implant survival rates (1 to 13 years) range from 96% to 100%.
- Prosthodontic survival rates range from 88.3% to 100%.
- The number of implants (two to four) and whether they are single or splinted has no effect on the implant survival.

### Immediate Loading of Maxillary Implant Overdentures

Immediate loading with maxillary implant overdentures describes a protocol in which a removable prosthesis is attached to the implants and placed in occlusal contact within 48 hours after implant placement (Table 8).

Use of four implants splinted by a bar construction and immediate loading was supported by one single publication.[34] Although the selected article for this category fulfilled the inclusion criteria, the small sample of the patient population and the number of implants precluded the drawing of any conclusions.

***Conclusions for immediate loading of implant overdentures in the edentulous maxilla:***

- Immediate loading (1 to 2 days) of maxillary implant overdentures is clinically insufficiently documented (CID).

## RESULTS: FIXED IMPLANT PROSTHESES

### Conventional Loading of Mandibular Fixed Implant Prostheses

This loading protocol describes the use of dental implants placed in an edentulous mandible to support a fixed dental prosthesis after a healing period of 3 to 6 months. Implant prosthetic designs included four to six implants with a one-piece full-arch fixed prosthesis[35–37] and eight implants with a one-piece full-arch fixed prosthesis (Table 9).[12]

**Table 9 Conventional Loading of Implant-Supported Fixed Prostheses in the Edentulous Mandible**

| Study | Study design | Implant type | No. of patients | No. of implants placed | No. of implants per patient | Follow-up (y) | Implant failures | Implant survival rate (%) | Prosthodontic failures | Prosthodontic survival rate (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| Arvidson et al (1998)[35] | Retro | Astra Tech | 107 | 618 | 4–6 | 5 | 8 | 98.7 | 0 | 100 |
| Ferrigno et al (2002)[12] | Prosp | Straumann | 40 | 320 | 8 | 10 | 5 | 98.5 | 0 | 100 |
| Moberg et al (2001)[36] | RCT | Straumann/ Nobel Biocare | 40 | 208 | 4–6 | 3 | 5 | 97.5 | 0 | 100 |
| Rasmusson et al (2005)[37] | Prosp | Astra Tech | 20 | 108 | 4–6 | 10 | 3 | 97.2 | 0 | 100 |

RCT = randomized controlled trial; Prosp = prospective study; Retro = retrospective study.

**Table 10 Conventional Loading of Implant-Supported Fixed Prostheses in the Edentulous Maxilla**

| Study | Study design | Implant type | No. of patients | No. of implants placed | No. of implants per patient | Follow-up (y) | Implant failures | Implant survival rate (%) | Prosthodontic failures | Prosthodontic survival rate (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| Ferrigno et al (2002)[12] | Prosp | Straumann | 55 | 440 | 8 | 10 | 9 | 97.9 | 2 | 96.3 |
| Bergkvist et al (2004)[38] | Prosp | Straumann | 25 | 146 | 5–7 | 2 | 5 | 96.6 | 0 | 100 |
| Rasmusson et al (2005)[37] | Prosp | Astra Tech | 16 | 88 | 4–6 | 10 | 3 | 96.6 | 0 | 100 |
| Fischer et al (2008)[2] | RCT | Straumann | 8* | 45 | 5-6 | 3 | 2 | 95.5 | NR | NR |

*Patients belonging to a larger sample population of 32 patients with a different loading protocol.
RCT = randomized controlled trial; Prosp = prospective study; NR = not reported.

Arvidson et al,[35] Ferrigno et al,[12] Moberg et al,[36] and Rasmussen et al[37] concluded in similar clinical trials that the long-term clinical results of mandibular implant-supported fixed rehabilitations were highly successful in terms of prosthetic function and implant stability.

In summary, scientific evidence on fixed implant rehabilitations for the edentulous mandible with conventional loading and rough-surfaced implants was supported by one RCT, two prospective studies, and one retrospective study with follow-ups of 3 to 10 years. These clinical trials reported data from 207 patients and 1,254 rough-surfaced implants. The implant survival rate ranged from 97.2% to 98.7% and the prosthodontic survival rate was 100% for all four clinical trials.

***Conclusions for conventional loading of fixed implant prostheses in the edentulous mandible:***

- Conventional loading of mandibular fixed implant prostheses is scientifically and clinically validated (SCV).
- Implant survival rates (3 to 10 years) range from 97.2% to 98.7%.
- The prosthodontic survival rate is 100%.
- The prosthesis design was full arch, one piece, supported by four to eight implants.

## Conventional Loading of Maxillary Fixed Implant Prostheses

This loading protocol describes implant-supported rehabilitations in edentulous maxillae that have been in occlusal function after a healing period of 3 to 6 months. Implant prosthetic designs included four to seven implants supporting a one-piece prosthesis[2,37,38] and eight implants with a fixed full-arch rehabilitation (Table 10).[12]

In a longitudinal study, Ferrigno et al[12] concluded that a maxillary fixed full-arch prosthesis supported by eight implants with an anterior-posterior distribution allows for an optimal long-term implant survival rate. Accordingly, Bergkvist et al,[38] Rasmusson et al,[37] and Fischer et al[2] reported successful survival rates and concluded that rough-surfaced solid-screw implants in combination with fixed prostheses represent a viable treatment alternative in the edentulous maxilla.

In summary, scientific evidence on fixed implant rehabilitations in the edentulous maxilla was supported by three prospective studies and one RCT, with follow-up of up to 10 years. Implant survival rates were similar for all four independent publications, ranging from 95.5% to 97.9%, and included 719 rough-surfaced implants placed in 104 patients. Implant-prosthetic designs were exclusively found in

**Table 11 Early Loading of Implant-Supported Fixed Prostheses in the Edentulous Mandible**

| Study | Study design | Implant type | No. of patients | No. of implants placed | No. of implants per patient | Follow-up (y) | Time of loading (wk) | Implant failures | Implant survival rate (%) | Prostho-dontic failures | Prosthodontic survival rate (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Collaert and De Bruyn (2002)[41] | Retro | Astra Tech | 25 | 108 | 4–5 | 2 | 4 | 0 | 100 | 0 | 100 |
| Friberg and Jemt (2008)[40] | Prosp | Nobel Biocare | 90 | 450 | 5 | 1 | 1 | 0 | 100 | 2 | 97.8 |
| Arvidson et al (2008)[39] | Prosp | Straumann | 61 | 244 | 4–5 | 3 | 1 | 3 | 98.6 | 0 | 100 |

Prosp = prospective study; Retro = retrospective study.

one-piece full-arch rehabilitations and varied in the number of implants and their distribution.

***Conclusions for conventional loading of fixed implant prostheses in the edentulous maxilla:***

- Conventional loading of maxillary fixed implant prostheses is scientifically and clinically validated (SCV).
- Implant survival rates (3 to 10 years) range from 95.5% to 97.9%.
- Prosthodontic survival rates range from 96.3% to 100%.
- The prosthesis design was generally full arch, one piece, and supported by four to eight implants.

## Early Loading of Fixed Implant-Supported Prostheses in the Edentulous Mandible

This loading protocol describes mandibular fixed implant rehabilitations that have been in functional loading 48 hours after implant placement, but no longer than 3 months. Implant prosthetic protocols were described as four to five implants supporting a fixed one-piece rehabilitation (Table 11).[39–41]

In a 3-year follow-up, Collaert and De Bruyn[41] reported that early loading of four to five implants in the edentulous mandible with cross-arch fixed prostheses was a predictable procedure. Friberg and Jemt[40] compared the outcomes of early loading with rough- and machined-surface implants. In this 1-year follow-up study the authors concluded that the implant survival rate was significantly higher for rough-surfaced implants. In a similar clinical trial, Arvidson et al[39] reported that treatment outcomes for early loading in the edentulous mandible with fixed prostheses are comparable with conventional protocols. In addition, no increase in the incidence of implant–prosthetic complications was reported when compared to conventional protocols. Patient benefits included reduced treatment time and improved quality of life.

In summary, one retrospective and two prospective studies supported the scientific evidence on early loading of implants in the edentulous mandible with fixed implant rehabilitations. They included data from 176 patients and 802 rough-surfaced implants with a 1- to 3-year follow-up. The time of loading varied from 1 to 4 weeks and the implant survival rate ranged from 98.6% to 100%.

***Conclusions for early loading of mandibular fixed implant-supported rehabilitations:***

- Early loading of mandibular fixed implant prostheses is clinically documented (CD).
- Implant survival rates (1 to 3 years) range from 98.6% to 100%.
- Prosthodontic survival rates range from 97.8% to 100%.
- Prosthesis design was full arch, one piece, supported by four to five implants.

## Early Loading of Fixed Implant-Supported Prostheses in the Edentulous Maxilla

Early implant loading with fixed rehabilitations describes a protocol in which implants have been in occlusal contact no earlier than 48 hours and no later than 3 months. Implant prosthetic protocols included five to eight implants supporting maxillary fixed implant rehabilitations (Table 12).[2,42–44]

Olsson et al[44] and Nordin et al[43] concluded that early loading protocols can be applied with predictable results using rough-surfaced implants for the rehabilitation of the edentulous maxilla with fixed prostheses. In an RCT, Fischer at al[2] showed no important differences between early and delayed loading of implants in the edentulous maxilla after 5 years of function.

In summary, the sample population for early loading with fixed implant-supported rehabilitation in the edentulous maxilla included 54 patients and 344 rough-surfaced implants. One RCT, one prospective,

**Table 12 Early Loading of Implant-Supported Fixed Prostheses in the Edentulous Maxilla**

| Study | Study design | Implant type | No. of patients | No. of implants placed | No. of implants per patient | Follow-up (y) | Time of loading (wk) | Implant failures | Implant survival rate (%) | Prostho-dontic failures | Prosthodontic survival rate (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Olsson et al (2003)[44] | Retro | Nobel Biocare | 10 | 61 | 6–8 | 1 | 2 | 4 | 93.4 | NR | NR |
| Nordin et al (2004)[43] | Retro | Straumann | 16 | 98 | 6 | 1 | 2 | 1 | 99.0 | NR | NR |
| Fischer et al (2008)[2] | RCT | Straumann | 16 | 94 | 5–6 | 5 | 2 | 5 | 94.7 | NR | NR |
| Lai et al (2008)[42] | Prosp | Straumann | 12 | 91 | 6–8 | 3 | 6 | 1 | 98.9 | 0 | 100% |

RCT = randomized controlled trial; Prosp = prospective study; Retro = retrospective study; NR = not reported.

**Table 13 Immediate Loading of Implant-Supported Fixed Prostheses in the Edentulous Mandible**

| Study | Study design | Implant type | No. of patients | No. of implants placed | No. of implants per patient | Follow-up (y) | Time of loading (wk) | Implant failures | Implant survival rate (%) | Prostho-dontic failures | Prosthodontic survival rate (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ganeles et al (2001)[45] | Retro | Straumann, Astra, Frialit-2 | 27 | 161 | 5–8 | 2 | 1 | 1 | 99.4 | NR | NR |
| Gallucci et al (2004)[47] | Prosp | Straumann | 6* | 34 | 6 | 1 | 1 | 0 | 100 | 0 | 100 |
| Testori et al (2004[48] | Prosp | Biomet 3i | 62 | 325 | 5–6 | 1 | 2 | 2 | 99.4 | NR | NR |
| Drago and Lazzara (2006)[46] | Prosp | Biomet 3i | 27 | 151 | 5–6 | 1 | 1 | 3 | 98 | 0 | 100 |
| Degidi et al (2006)[51] | Retro | Nobel Biocare | 9 | 50 | 4–5 | 3 | 1 | 0 | 100 | ? | ? |
| Capelli et al (2007)[49] | Prosp | Biomet 3i | 24 | 96 | 4 | 3 | 2 | 0 | 100 | 0 | 100 |
| De Bruyn et al (2008)[50] | Prosp | Astra Tech | 25 | 125 | 5 | 3 | 1 | 0 | 100 | 0 | 100 |

*Patients belonging to a larger sample population of 11 edentulous arches.
Prosp = prospective study; Retro = retrospective study; NR = not reported.

and two retrospective studies with a follow-up time of 1 to 5 years yielded implant survival rates ranging from 93% to 99%.

***Conclusions for early loading of maxillary fixed implant-supported rehabilitations:***

- Early loading of maxillary fixed implant prostheses is clinically documented (CD).
- Implant survival rates (1 to 3 years) range from 93.4% to 99%.
- Prosthodontic survival rates are not reported.
- The prosthesis designs were full-arch one-piece or segmented supported by five to eight implants.

## Immediate Loading of Fixed Implant-Supported Prostheses in the Edentulous Mandible

Immediate loading with mandibular implant overdentures describes a protocol in which a fixed provisional contact is attached to the implants and placed in occlusal function within 48 hours after implant placement. Implant-prosthetic protocols were described as cross-arch fixed rehabilitations with anterior-posterior distribution of five to eight implants,[45,46] segmented rehabilitations with anterior-posterior distribution of six implants,[47] and full-arch prostheses with anterior implants and distal cantilevers (Table 13).[48–51]

Ganeles and coworkers[45] reported that with appropriate stabilization and distribution of occlusal load, mandibular implants can be immediately loaded in a complete-arch configuration with no apparent detrimental effect on the rate of osseointegration. In a similar clinical trial but with a smaller sample population, Gallucci et al[47] concluded that osseointegration with immediate implant loading via fixed provisional restorations can be successfully achieved. Furthermore, the authors suggested that neither the metal-free design of the provisional prostheses nor the removal of the provisional prostheses during the healing phase adversely affected osseointegration. Testori et al,[48] Drago and Lazzara,[46] Degidi et al,[51] and De Bruyn et al,[50] each using different implant systems, stated that the rehabilitation of the

**Table 14 Immediate Loading of Implant-Supported Fixed Prostheses in the Edentulous Maxilla**

| Study | Study design | Implant type | No. of patients | No. of implants placed | No. of implants per patient | Follow-up (y) | Time of loading (d) | Implant failures | Implant survival rate (%) | Prostho-dontic failures | Prosthodontic survival rate (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Gallucci et al (2004)[47] | Prosp | Straumann | 5* | 40 | 8 | 1 | 1 | 2 | 95.4 | 0 | 100 |
| Malo et al (2005)[52] | Retro | Nobel Biocare | 32 | 128 | 4 | 1 | 1 | 3 | 97.6 | 4 | 87.5 |
| Ostman et al (2005)[53] | Prosp | Nobel Biocare | 20 | 123 | 6–7 | 1 | 1 | 1 | 99.2 | NR | NR |
| van Steenberghe et al (2005)[54] | Prosp | Nobel Biocare | 27 | 184 | 6–8 | 1 | 1 | 0 | 100 | 0 | 100 |
| Capelli et al (2007)[49] | Prosp | Biomet 3i | 41 | 246 | 4–6 | 3 | 2 | 5 | 97.9 | 0 | 100 |
| Bergkvist et al (2009)[55] | Prosp | Straumann | 28 | 168 | 6 | 2 | 1 | 3 | 98.2 | NR | NR |

*Patients belonging to a larger sample population of 11 edentulous arches.
Prosp = prospective study; Retro = retrospective study; NR = not reported.

edentulous mandible with an immediate, occlusally loaded provisional hybrid prosthesis is a viable treatment alternative to the classical delayed protocols. Capelli and coworkers[49] presented similar results for immediate loading using only four implants (two straight and two tilted).

In summary, immediate loading of rough-surfaced implants with a fixed provisional restoration was well supported by seven publications, mostly prospective studies. With a sample population of 181 patients and 942 implants and a follow-up of 1 to 3 years, the implant survival rate ranged from 99.4% to 100%. One interesting finding with this protocol is that there were no prosthetic failures during the follow-up period.

***Conclusions for immediate loading of fixed mandibular implant-supported rehabilitations:***

- Immediate loading of mandibular fixed implant prostheses is scientifically and clinically validated (SCV).
- Implant survival rates (1 to 3 years) range from 98% to 100%.
- The prosthodontic survival rate is 100%.
- Prosthesis designs were full-arch one-piece or segmented supported by four to eight implants.

## Immediate Loading of Fixed Implant-Supported Prostheses in the Edentulous Maxilla

This loading protocol describes maxillary implants that have been placed in occlusal function via fixed prostheses no later than 48 hours after surgery. Implant prosthetic designs have been proposed as four to six implants with full-arch prostheses and distal cantilevers,[49–52] five to eight implants with a one-piece full-arch prosthesis,[53–55] and eight implants distributed along the edentulous maxilla to support a segmented rehabilitation (Table 14).[47]

Various implant-prosthetic protocols have been proposed for immediate implant loading in the edentulous maxilla. Gallucci and coworkers[47] loaded maxillary implants immediately via a full-arch fixed interim prosthesis that was later replaced by a segmented final rehabilitation, as first described by Belser et al.[56] The authors concluded that this approach was compatible with the achievement of osseointegration, although the sample population was considered small. In a similar clinical trial, Ostman et al[53] and Bergkvist et al[55] concluded that six to seven implants for immediate loading of a fixed provisional prosthesis is a viable option for implant treatment of the edentulous maxilla, at least when good primary implant stability can be ensured. Malo et al,[52] using a protocol of four immediately loaded implants and some rescue ones left unloaded, presented comparable implant survival rates. Similar results were found by Capelli et al[49] when using four to six implants. Van Steenberghe et al[54] reported on immediate loading using models derived from three-dimensional oral implant planning software. The authors concluded that this protocol is a reliable treatment option. On the other hand, this was the sole publication yielded by the search on such a protocol.

In summary, scientific background for immediate loading with fixed interim prostheses in the edentulous maxilla was supported by one retrospective and five prospective studies. No RCTs were available at the time of the search. Only one study had a follow-up of 3 years, one had a 2-year follow-up, and four had 1-year follow-ups. The sample population included 153 patients receiving 893 immediately loaded rough-surfaced implants. The implant survival rate ranged from 95.4% to 100%, and the prosthodontic survival rate ranged from 87.5% to 100%. One notable finding

**Table 15 Immediate Implant Placement and Loading with Fixed Prostheses in the Mandible**

| Study | Study design | Implant type | No. of patients | No. of implants placed | No. of implants per patient | Mean follow-up (y) | Time of loading (d) | Implant failures | Implant survival rate (%) | Prostho-dontic failures | Prosthodontic survival rate (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Grunder (2001)[58] | Retro | Biomet 3i | 5* | 43 | 8–10 | 2 | 1 | 1 | 97.7 | NR | NR |
| Cooper et al (2002)[57] | Retro | Astra Tech | 10 | 54 | 4–6 | 1.5 | 1 | 0 | 100 | 0 | 100 |

*Patients belonging to a larger sample population of 10 edentulous patients.
Retro = retrospective study; NR = not reported.

was that most of the failed implants were located in the posterior maxilla.

***Conclusions for immediate loading of maxillary implant-supported rehabilitations:***

- Immediate loading of maxillary fixed implant prostheses is scientifically and clinically validated (SCV).
- Implant survival rates (1 to 3 years) range from 95.4% to 100%.
- Prosthodontic survival rates range from 87.5% to 100%.
- Prosthesis designs were full-arch one-piece or segmented supported by four to eight implants.

### Immediate Loading of Immediately Placed Implants with Fixed Prostheses in the Edentulous Mandible

This loading protocol describes maxillary implants that have been immediately placed into extraction sockets and into occlusal function with fixed prostheses no later than 48 hours after surgery. The implant-prosthetic protocol included 4 to 6 immediately placed implants supporting fixed prostheses with distal cantilevers[57] and 8 to 10 implants splinted by a one-piece full-arch fixed rehabilitation (Table 15).[58]

Grunder[58] reported on the immediate placement and loading of rough-surfaced implants supporting a fixed rehabilitation. The authors showed that the immediate functional loading of immediate implants without the use of any bone substitutes or barrier membranes for fixed full-arch reconstructions can be successful over a 2-year period. In a similar loading protocol but with a different prosthetic design, Cooper et al[57] concluded that in selected healthy patients, significant time and clinical visits may be saved by simultaneous extraction, implant placement, and restoration with a simple acrylic-resin provisional prosthesis.

In summary, two retrospective studies were identified from the electronic search. They reported data from 15 patients and 97 immediately placed and loaded implants with a follow-up ranging from 1.5 to 2 years. The implant survival rate ranged from 97.7% to 100%. One article reported no prosthodontic failures.

***Conclusions for immediate loading of immediately placed implants with fixed prostheses in the edentulous mandible:***

- Immediate loading of immediately placed implants with fixed implant prostheses is clinically insufficiently documented (CID).
- Implant survival rates (1.5 to 2 years) range from 97.7% to 100% (15 patients only).
- The prosthodontic survival rate is 100%.
- The prosthesis design was full-arch one-piece supported by 4 to 10 implants.

### Immediate Loading of Immediately Placed Implants with Fixed Prostheses in the Edentulous Maxilla

This protocol describes maxillary implants that have been inserted immediately into extraction sockets and placed in occlusal function no later than 48 hours with a fixed prostheses. Implant-prosthetic designs were described as 6 to 8 implants splinted by a full-arch prosthesis[59] and 8 to 12 implants splinted by a one-piece full-arch fixed rehabilitation (Table 16).[58,60,61]

The reliability of this loading protocol has been supported by Degidi et al[60] with the conclusion that wider implants had a higher risk of failure. Grunder[58] and Jaffin et al[59] reported similar results, concluding that immediate loading of immediately placed implants in the edentulous maxilla was a viable treatment alternative. Balshi et al,[61] in a prospective study of full-arch maxillary immediate loading, suggested that this protocol was suitable for most patients in need of full maxillary implant reconstruction to provide long-term stability of screw-retained fixed prostheses.

In summary, data for immediate placement and loading of rough-surfaced implants in the edentulous maxilla were supported by one prospective and three retrospective studies. In 2 to 5 years of follow-up, the sample population consisted of 149 patients receiving

**Table 16 Immediate Implant Placement and Loading with Fixed Prostheses in the Maxilla**

| Study | Study design | Implant type | No. of patients | No. of implants placed | No. of implants per patient | Mean follow-up (y) | Time of loading (d) | Implant failures | Implant survival rate (%) | Prostho-dontic failures | Prosthodontic survival rate (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Grunder (2001)[58] | Retro | Biomet 3i | 5* | 48 | 8–11 | 2 | 1 | 6 | 87.5 | NR | NR |
| Jaffin et al (2004)[59] | Retro | Straumann | 34 | 236 | 6–8 | 2 | 2 | 16 | 93.2 | NR | NR |
| Degidi et al (2005)[60] | Retro | Several | 55 | 388 | 6–12 | 5 | 2 | 6 | 98.4 | NR | NR |
| Balshi et al (2005)[61] | Prosp | Nobel Biocare | 55 | 522 | 8–11 | 3 | 1 | 8 | 98.4 | 0 | 100 |

*Patients belonging to a larger sample population of 10 edentulous patients.
Prosp = prospective study; Retro = retrospective study; NR = not reported.

1,194 implants. Thirty-six failures were recorded, yielding an implant survival rate ranging from 87.5% to 98.3%. Implant-prosthetic designs were diverse, particularly in terms of the number of implants per patient (8 to 12). The prosthodontic outcomes were rarely described.

***Conclusions for immediate loading of immediately placed implants with fixed prostheses in the edentulous maxilla:***

- Immediate loading of immediately placed implants with fixed prostheses is clinically documented (CD).
- Implant survival rates (2 to 5 years) range from 87.5% to 98.4%.
- The prosthodontic survival rate, reported in only one study, is 100%.
- The prosthesis design was full-arch one-piece supported by 6 to 12 implants.

### Staged Approach for Fixed Implant Rehabilitations in Edentulous Jaws

This approach describes a treatment sequence for patients who present a failing dentition and are receiving fixed implant rehabilitation. According to Cordaro et al,[62] the main advantage of this protocol is the avoidance of a removable provisional phase. In addition, the protocol was presented as an alternative to immediate implant placement and loading.[62,63]

The electronic search performed for this review failed to show any relevant clinical trials for this treatment modality.

***Conclusions for staged approach for fixed implant rehabilitations in edentulous jaws:***

- More clinical trials are needed to scientifically and clinically validate this protocol.

## ACKNOWLEDGMENTS

The authors wish to express their gratitude to all participants of Consensus Group 3 for their scientific and intellectual contributions.

## REFERENCES

1. Chiapasco M. Early and immediate restoration and loading of implants in completely edentulous patients. Int J Oral Maxillofac Implants 2004;19(suppl):76–91.
2. Fischer K, Stenberg T, Hedin M, Sennerby L. Five-year results from a randomized, controlled trial on early and delayed loading of implants supporting full-arch prosthesis in the edentulous maxilla. Clin Oral Implants Res 2008;19:433–441.
3. Raghoebar GM, Meijer, HJ, van 't Hof M, Stegenga B, Vissink A. A randomized prospective clinical trial on the effectiveness of three treatment modalities for patients with lower denture problems. A 10 year follow-up study on patient satisfaction. Int J Oral Maxillofac Surg 2003;32:498–503.
4. Attard NJ, Zarb GA. Immediate and early implant loading protocols: A literature review of clinical studies. J Prosthet Dent 2005;94:242–258.
5. Cooper L, De Kok IJ, Reside GJ, Pungpapong P, Rojas-Vizcay F. Immediate fixed restoration of the edentulous maxilla after implant placement. J Oral Maxillofac Surg 2005;63(suppl 2): 97–110.
6. Mericske-Stern R. Clinical evaluation of overdenture restorations supported by osseointegrated titanium implants: A retrospective study. Int J Oral Maxillofac Implants 1990;5:375–383.
7. Payne AG, Tawse-Smith A, Duncan WD, Kumara R. Conventional and early loading of unsplinted ITI implants supporting mandibular overdentures. Clin Oral Implants Res 2002;13: 603–609.
8. Karabuda C, Tosun T, Ermis E, Ozdemir T. Comparison of 2 retentive systems for implant-supported overdentures: Soft tissue management and evaluation of patient satisfaction. J Periodontol 2002;73:1067–1070.
9. Walton JN. A randomized clinical trial comparing two mandibular implant overdenture designs: 3-year prosthetic outcomes using a six-field protocol. Int J Prosthodont 2003;16:255–260.

10. Naert I, Gizani S, Vuylsteke M, van Steenberghe D. A 5-year randomized clinical trial on the influence of splinted and unsplinted oral implants in the mandibular overdenture therapy. Part I: Peri-implant outcome. Clin Oral Implants Res 1998;9:170–177.
11. Naert I, Gizani S, Vuylsteke M, van Steenberghe D. A 5-year prospective randomized clinical trial on the influence of splinted and unsplinted oral implants retaining a mandibular overdenture: Prosthetic aspects and patient satisfaction. J Oral Rehabil 1999;26:195–202.
12. Ferrigno N, Laureti, M, Fanali S, Grippaudo G. A long-term follow-up study of non-submerged ITI implants in the treatment of totally edentulous jaws. Part I: Ten-year life table analysis of a prospective multicenter study with 1286 implants. Clin Oral Implants Res 2002;13:260–273.
13. Heydenrijk, K, Raghoebar GM, Meijer HJ, Van Der Reijden WA, Van Winkelhoff AJ, Stegenga B. Two-part implants inserted in a one-stage or a two-stage procedure. A prospective comparative study. J Clin Periodontol 2002;29:901–909.
14. Mau J, Behneke A, Behneke N, et al. Randomized multicenter comparison of 2 IMZ and 4 TPS screw implants supporting bar-retained overdentures in 425 edentulous mandibles. Int J Oral Maxillofac Implants 2003;18:835–847.
15. Visser A, Raghoebar GM, Meijer HJ, Batenburg RH, Vissink A. Mandibular overdentures supported by two or four endosseous implants. A 5-year prospective study. Clin Oral Implants Res 2005;16:19–25.
16. Stoker GT, Wismeijer D, van Waas MA. An eight-year follow-up to a randomized clinical trial of aftercare and cost-analysis with three types of mandibular implant-retained overdentures. J Dent Res 2007;86:276–280.
17. Behneke A, Behneke N, d'Hoedt B. A 5-year longitudinal study of the clinical effectiveness of ITI solid-screw implants in the treatment of mandibular edentulism. Int J Oral Maxillofac Implants 2002;17:799–810.
18. Lachmann S, Kimmerle-Muller E, Gehring K, et al. A comparison of implant-supported, bar- or ball-retained mandibular overdentures: A retrospective clinical, microbiologic, and immunologic study of 10 edentulous patients attending a recall visit. Int J Prosthodont 2007;20:37–42.
19. Cavallaro JS Jr, Tarnow DP. Unsplinted implants retaining maxillary overdentures with partial palatal coverage: Report of 5 consecutive cases. Int J Oral Maxillofac Implants 2007;22:808–814.
20. Mericske-Stern R, Oetterli M, Kiener P, et al. A follow-up study of maxillary implants supporting an overdenture: Clinical and radiographic results. Int J Oral Maxillofac Implants 2002;17:678–686.
21. Krennmair G, Krainhofner M, Piehslinger E. Implant-supported maxillary overdentures retained with milled bars: Maxillary anterior versus maxillary posterior concept—A retrospective study. Int J Oral Maxillofac Implants 2008;23:343–352.
22. Roynesdal AK, Amundrud B, Hannaes HR. A comparative clinical investigation of 2 early loaded ITI dental implants supporting an overdenture in the mandible. Int J Oral Maxillofac Implants 2001;16:246–251.
23. Turkyilmaz I, Tumer C. Early versus late loading of unsplinted TiUnite surface implants supporting mandibular overdentures: A 2-year report from a prospective study. J Oral Rehabil 2007; 34:773–780.
24. Attard NJ, David LA, Zarb GA. Immediate loading of implants with mandibular overdentures: One-year clinical results of a prospective study. Int J Prosthodont 2005;18:463–470.
25. Raghoebar GM, Schoen P, Meijer HJ, Stellingsma K, Vissink A. Early loading of endosseous implants in the augmented maxilla: A 1-year prospective study. Clin Oral Implants Res 2003;14: 697–702.
26. Payne AG, Tawse-Smith A, Thomson WM, Duncan WD, Kumara R. One-stage surgery and early loading of three implants for maxillary overdentures: A 1-year report. Clin Implant Dent Relat Res 2004;6:61–74.
27. Liddelow GJ, Henry PJ. A prospective study of immediately loaded single implant-retained mandibular overdentures: Preliminary one-year results. J Prosthet Dent 2007;97(suppl 6): S126–S137.
28. Marzola R, Scotti R, Fazi G, Schincaglia GP. Immediate loading of two implants supporting a ball attachment-retained mandibular overdenture: A prospective clinical study. Clin Implant Dent Relat Res 2007;9:136–143.
29. Stricker A, Gutwald R, Schmelzeisen R, Gellrich NG. Immediate loading of 2 interforaminal dental implants supporting an overdenture: Clinical and radiographic results after 24 months. Int J Oral Maxillofac Implants 2004;19:868–872.
30. Stephan G, Vidot F, Noharet R, Mariani P. Implant-retained mandibular overdentures: A comparative pilot study of immediate loading versus delayed loading after two years. J Prosthet Dent 2007;97(suppl 6):S138–S145.
31. Chiapasco M, Gatti C, Rossi E, Haefliger W, Markwalder TH. Implant-retained mandibular overdentures with immediate loading. A retrospective multicenter study on 226 consecutive cases. Clin Oral Implants Res 1997;8:48–57.
32. Gatti C, Haefliger W, Chiapasco M. Implant-retained mandibular overdentures with immediate loading: A prospective study of ITI implants. Int J Oral Maxillofac Implants 2000;15:383–388.
33. Romeo E, Chiapasco M, Lazza A, et al. Implant-retained mandibular overdentures with ITI implants. Clin Oral Implants Res 2002;13:495–501.
34. Cannizzaro G, Leone M, Esposito M. Immediate functional loading of implants placed with flapless surgery in the edentulous maxilla: 1-year follow-up of a single cohort study. Int J Oral Maxillofac Implants 2007;22:87–95.
35. Arvidson K, Bystedt H, Frykholm A, von Konow L, Lothigius E. Five-year prospective follow-up report of the Astra Tech Dental Implant System in the treatment of edentulous mandibles. Clin Oral Implants Res 1998;9:225–234.
36. Moberg LE, Kondell PA, Sagulin GB, Bolin A, Heimdahl A, Gynther GW. Brånemark System and ITI Dental Implant System for treatment of mandibular edentulism. A comparative randomized study: 3-year follow-up. Clin Oral Implants Res 2001;12:450–461.
37. Rasmusson L, Roos J, Bystedt H. A 10-year follow-up study of titanium dioxide-blasted implants. Clin Implant Dent Relat Res 2005;7:36–42.
38. Bergkvist G, Sahlholm S, Nilner K, Lindh C. Implant-supported fixed prostheses in the edentulous maxilla. A 2-year clinical and radiological follow-up of treatment with non-submerged ITI implants. Clin Oral Implants Res 2004;15:351–359.
39. Arvidson K, Esselin O, Felle-Persson E, Jonsson G, Smedberg JI, Soderstrom U. Early loading of mandibular full-arch bridges screw retained after 1 week to four to five Monotype implants: 3-year results from a prospective multicentre study. Clin Oral Implants Res 2008;19:693–703.
40. Friberg B, Jemt T. Rehabilitation of edentulous mandibles by means of five TiUnite implants after one-stage surgery: A 1-year retrospective study of 90 patients. Clin Implant Dent Relat Res 2008;10:47–54.
41. Collaert B, De Bruyn H. Early loading of four or five Astra Tech fixtures with a fixed cross-arch restoration in the mandible. Clin Implant Dent Relat Res 2002;4:133–135.
42. Lai HC, Zhang ZY, Zhuang LF, Wang F, Liu X, Pu YP. Early loading of ITI implants supporting maxillary fixed full-arch prostheses. Clin Oral Implants Res 2008;19:1129–1134.

43. Nordin T, Nilsson, R, Frykholm A, Hallman M. A 3-arm study of early loading of rough-surfaced implants in the completely edentulous maxilla and in the edentulous posterior maxilla and mandible: Results after 1 year of loading. Int J Oral Maxillofac Implants 2004;19:880–886.
44. Olsson M, Urde G, Andersen JB, Sennerby L. Early loading of maxillary fixed cross-arch dental prostheses supported by six or eight oxidized titanium implants: Results after 1 year of loading, case series. Clin Implant Dent Relat Res 2003;5(suppl 1):81–87.
45. 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 private practice. Int J Oral Maxillofac Implants 2001;16:418–426.
46. Drago CJ, Lazzara RJ. Immediate occlusal loading of Osseotite implants in mandibular edentulous patients: A prospective observational report with 18-month data. J Prosthodont 2006;15:187–194.
47. Gallucci GO, Bernard JP, Bertosa M, Belser UC. Immediate loading with fixed screw-retained provisional restorations in edentulous jaws: The pickup technique. Int J Oral Maxillofac Implants 2004;19:524–533.
48. Testori T, Meltzer A, Del Fabbro M, et al. Immediate occlusal loading of Osseotite implants in the lower edentulous jaw. A multicenter prospective study. Clin Oral Implants Res 2004;15: 278–284.
49. Capelli M, Zuffetti F, Del Fabbro M, Testori T. Immediate rehabilitation of the completely edentulous jaw with fixed prostheses supported by either upright or tilted implants: A multicenter clinical study. Int J Oral Maxillofac Implants 2007;22:639–644.
50. De Bruyn H, Van de Velde T, Collaert B. Immediate functional loading of TiOblast dental implants in full-arch edentulous mandibles: A 3-year prospective study. Clin Oral Implants Res 2008;19:717–723.
51. Degidi M, Perrotti V, Piattelli A. Immediately loaded titanium implants with a porous anodized surface with at least 36 months of follow-up. Clin Implant Dent Relat Res 2006;8: 169–177.
52. Malo P, Rangert B, Nobre M. All-on-4 immediate-function concept with Brånemark System implants for completely edentulous maxillae: A 1-year retrospective clinical study. Clin Implant Dent Relat Res 2005;7(suppl 1):S88–S94.
53. Ostman PO, Hellman M, Sennerby L. Direct implant loading in the edentulous maxilla using a bone density-adapted surgical protocol and primary implant stability criteria for inclusion. Clin Implant Dent Relat Res 2005;7(suppl 1):S60–S69.
54. van Steenberghe D, Glauser R, Blomback U, et al. A computed tomographic scan-derived customized surgical template and fixed prosthesis for flapless surgery and immediate loading of implants in fully edentulous maxillae: A prospective multicenter study. Clin Implant Dent Relat Res 2005;7(suppl 1):S111–S120.
55. Bergkvist G, Nilner K, Sahlholm S, Karlsson U, Lindh C. Immediate loading of implants in the edentulous maxilla: Use of an interim fixed prosthesis followed by a permanent fixed prosthesis: A 32-month prospective radiological and clinical study. Clin Implant Dent Relat Res 2009;11:1–10.
56. Belser UC, Bernard JP, Buser D. Implant placement in the esthetic zone. In: Lindhe J, Lang NP, Karring T (eds). Clinical Periodontology and Implant Dentistry, ed 5. Hoboken, NJ: Wiley-Blackwell, 2008:915–945.
57. Cooper LF, Rahman A, Moriarty J, Chaffee N, Sacco D. Immediate mandibular rehabilitation with endosseous implants: Simultaneous extraction, implant placement, and loading. Int J Oral Maxillofac Implants 2002;17:517–525.
58. Grunder U. Immediate functional loading of immediate implants in edentulous arches: Two-year results. Int J Periodontics Restorative Dent 2001;21:545–551.
59. Jaffin RA, Kumar A, Berman CL. Immediate loading of dental implants in the completely edentulous maxilla: A clinical report. Int J Oral Maxillofac Implants 2004;19:721–730.
60. Degidi M, Piattelli A, Felice P, Carinci F. Immediate functional loading of edentulous maxilla: A 5-year retrospective study of 388 titanium implants. J Periodontol 2005;76:1016–1024.
61. Balshi SF, Wolfinger GJ, Balshi TJ. A prospective study of immediate functional loading, following the Teeth in a Day protocol: A case series of 55 consecutive edentulous maxillas. Clin Implant Dent Relat Res 2005;7:24–31.
62. Cordaro, L, Torsello F, Ercoli C, Gallucci G. Transition from failing dentition to a fixed implant-supported restoration: A staged approach. Int J Periodontics Restorative Dent 2007;27:481–487.
63. Chaimattayompol N, Emtiaz S, Woloch MM. Transforming an existing fixed provisional prosthesis into an implant-supported fixed provisional prosthesis with the use of healing abutments. J Prosthet Dent 2002;88:96–99.