Success of Immediate Functional Loading of Implants

Immediate loading, defined as implant loading within the first 24–48 hours after implant placement, has been an increasingly active field of interest in implant dentistry. Results of a Cochrane systematic review evaluating the timing of loading suggested that immediately loading mandibular implants can be as effective as conventional loading protocols, leading clinicians to inquire whether the same might be true for maxillary implants. This issue of Report on Prosthodontics reviews a series of articles related to the success of immediate loading of implants.

Maxillary Functional Loading: A 5-year Retrospective Study

As immediate functional loading of the edentulous mandible came into vogue, many clinicians questioned whether this technique could be applied to the edentulous maxilla. Degidi et al from the University of Bologna, Italy, evaluated the outcomes (implant survival) for 43 consecutively enrolled patients treated with immediately loaded cross-arch fixed provisional restorations in the edentulous maxilla.

Researchers placed 388 implants, with a mean of 9 implants per patient; 213 implants were placed in healed bone, while 175 implants were placed postextraction. Mesial and distal peri-implant crestal bone was measured by calibrated examination of periapical radiographs following surgery (baseline) and at 12-month intervals. Implant survival rate was evaluated based on:

- absence of pain or dysesthesia,
- absence of infection with suppuration,
- absence of mobility,
- crestal bone loss <1.5 mm during the first year of loading and
- crestal bone loss <0.2 mm/year during the following years.

Six implants failed within the first 6 months. The probability of an implant surviving 5 years after surgery was 97.08% and 99.54% for men and
women, respectively ($p < .05$). Survival rates based on implant diameter were 99.37% and 93.75% ($p = .0009$) for implant diameters ≤5.25 mm and >5.25 mm, respectively. The 5-year implant survival rate was 99.29% in patients who had ≤10 implants, 96.30% in those with >10 implants ($p = .0332$). Life-table analysis for crestal bone loss (after eliminating the 6 failed implants) produced a survival rate at 5 years of 99.7%.

Implant length, implant surface, patient bone quality and placement in extraction sites vs healed sites did not show statistically significant differences. However, a multivariate analysis (Cox regression) demonstrated that implant diameter and patient age significantly affected survival rate. Larger-diameter implants ($p = .042$) and older patient age ($p = .041$) were associated with a poorer outcome, while female patients had a lower risk of failure ($p = .066$). Four of the 6 implants that failed had a diameter 25.25 mm; 5 of the 6 implants that failed were placed in men.

This case series clearly demonstrated the success of immediately loaded maxillary implants. The authors recommended a balanced distribution of implants over the maxilla, maximizing the anterior–posterior distance between implants in immediately loaded situations. Their case series suggests treating patients with 8–9 implants distributed from second molar to second molar. However, concerns arise regarding the placement of implants too close together because of insufficient space or insufficient quantity of bone, creating high drilling stress on the bone, and increased cost of treatment due to the number of implants.


**Functional Loading in the Maxilla Using Flapless Surgery**

Although no randomized controlled clinical trials have evaluated the use of immediately loaded implants in the edentulous maxilla, several uncontrolled investigations have been reported. Cannizzaro et al from the University of Modena and Reggio Emilia, Italy, reported their 1-year findings of a prospective single-cohort clinical trial using a flapless surgery protocol.

Thirty-three consecutively treated patients (202 implants) were enrolled; excluded were patients with systemic diseases that would interfere with osseointegration, including typical contraindications to implant surgery. Fifty-three implants were placed in extraction sites;

- 18 implants were placed in “soft” bone,
- 148 in “normal” bone and
- 36 in “dense” bone.

Patients were treated with a flapless implant surgery technique utilizing a surgical template for implant placement. Implant stability of 45 Ncm was required for immediate loading; all but 3 implants reached this goal. Within 4–8 hours after implant placement, implants were rigidly connected with acrylic resin provisional prostheses, screw-retained metal/resin Toronto-type restoration, or bars for supporting overdentures. Patients were placed on a soft-food diet for 7 days. Definitive prostheses were inserted approximately 45 days after the initial loading.

Outcome measures of prosthesis and implant success, intraoperative and postoperative complications, implant stability using resonance frequency analysis (RFA) values, pain and edema were recorded. No prosthesis failed; however, 2 implants failed. The mean implant stability quotient (ISQ) at implant placement was 68.9 ± 2.05; 1 year later, the mean ISQ was 71.4 ± 1.6. Eight patients experienced no postoperative pain, 18 had slight pain, 6 had moderate pain and 1 experienced severe pain. The surgeon scored 11 patients as having no visible edema, 8 as having slight edema, 10 as having moderate edema, and 4 as having severe edema and/or visible hematoma and ecchymosis.

Five patients had biologic complications: 1 patient had intermittent pain around the implant that lasted 3 months; 1 patient had hyperplastic tissue under an overdenture bar 10 months after placement; 1 patient suffering from depression and poor oral hygiene had peri-implant mucositis 1 month after placement; and 2 patients each had 1 implant affected with peri-implantitis. Ten patients had prosthetic complications, consisting of 2 loose prostheses requiring recementation, 2 loose prostheses requiring replacement, 2 overdentures requiring adjustment because of excessive pressing on the mucosa, 1 patient with 2 los-
Table 1. Summary of findings from recent investigations on immediately loaded implants in the edentulous maxillae

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of patients (failed)*</th>
<th>No. of implants (failed)</th>
<th>No. of failed prostheses</th>
<th>Follow-up</th>
<th>Implant system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cannizzaro et al (2007)</td>
<td>33 (2)</td>
<td>202 (2)</td>
<td>0</td>
<td>1 year</td>
<td>Zimmer Spline</td>
</tr>
<tr>
<td>Bergkvist et al (2005)</td>
<td>28 (2)</td>
<td>168 (3)</td>
<td>0</td>
<td>8 months</td>
<td>Straumann sand-blasted, large-grit, acid-etched</td>
</tr>
<tr>
<td>Degidi et al (2005)</td>
<td>44 (5)</td>
<td>338 (3)†</td>
<td>0</td>
<td>5 years</td>
<td>Various</td>
</tr>
<tr>
<td>Maló et al (2005)</td>
<td>32 (2)</td>
<td>128 (3)†</td>
<td>0</td>
<td>1 year</td>
<td>Nobel Biocare TiUnite</td>
</tr>
<tr>
<td>Östman et al (2005)</td>
<td>20 (1)</td>
<td>123 (1)</td>
<td>0</td>
<td>1 year</td>
<td>Nobel Biocare TiUnite</td>
</tr>
<tr>
<td>van Steenberghe et al (2005)</td>
<td>27 (1)</td>
<td>184 (0)</td>
<td>0</td>
<td>1 year</td>
<td>Nobel Biocare TiUnite</td>
</tr>
<tr>
<td>Total</td>
<td>184 (13)</td>
<td>1143 (15)</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The number of patients who had at least 1 implant failure is shown in parentheses; †implants were not individually tested for stability; therefore, the number of implant failures may be underestimated.

A Meta-analysis of Loading Time

Although evidence suggests that immediate loading of dental implants may be a successful treatment modality in the edentulous mandible, skeptics remain. Further controversy exists with regard to the use of immediately loaded implants in the maxilla. In their 2005 meta-analysis, Ioannidou and Doufexi from the University of Connecticut evaluated the impact of different implant-loading protocols on implant survival.

Included in the meta-analysis were 13 prospective trials (including 6 randomized controlled trials) reporting implant failure rates for early or immediate implant loading compared with conventional loading. The combined studies totaled 1266 dental implants and included dental implants in both jaws. The overall implant failure rate was 4.4%, with no statistically significant difference in the failure rate between conventional and nonconventional loading. The implant failure rate was 4.2% for the immediate or early loading group, 4.8% for the conventional loading group.

Eight clinical trials (871 implants) compared immediate loading with conventional loading protocols. The dental implants evaluated were placed in both the mandible and the maxilla. When the studies comparing conventional vs immediate loading were adjusted for the effect size, the immediately loading implants showed a slightly worse (but not statistically significant) outcome. However, when only the randomized clinical trials were analyzed, there was no difference between the 2 groups.

It should be noted that there were only 2 randomized clinical trials comparing immediate loading with conventional loading protocols, comprising 160 implants. Therefore, the randomized clinical trials alone lack statistical power. Since these 2 studies evaluated mandibular implants, they cannot be used to answer the question regarding immediate loading of maxillary implants. Despite the limitations of this analysis, the data suggest there is no difference between the conventional and nonconventional loading protocols. However, further evaluations are needed to confirm these findings.

Clinical Outcomes of Immediate and Early Loading in the Maxilla: A Review

During the last decade, interest in 1-stage implants with reduced healing times has grown, and in the last 5 years interest has escalated with the advent of immediate loading protocols. One valid criticism has been the lack of controlled clinical trials to evaluate their efficacy. Sennerby and Gottlow from Gothenburg University, Sweden, reviewed the literature published since 2005 describing controlled prospective clinical studies of immediate and/or early loading of dental implants. Inclusion criteria consisted of studies with ≥10 patients in each group and a clinical follow-up of ≥1 year.

Although 3 studies compared immediate loading to delayed loading, only 1 evaluated loading times in the edentulous maxilla. In the study by Östman et al (Clin Implant Dent Relat Res 2005), 123 implants were placed and loaded within 12 hours with a screw-retained temporary prosthesis. The control group was treated with a conventional 2-stage protocol. No statistically significant differences were found between the groups. The study group lost 1 implant, while the control group lost none. The mean marginal bone loss was 0.8 ± 0.9 mm and 0.9 ± 1.0 mm for the study and control groups, respectively. The authors concluded that the use of 6–7 implants for immediately loading a fixed provisional prosthesis was a viable treatment option for the edentulous maxilla.

In a randomized clinical trial, Fischer et al (Clin Oral Implants Res 2008) compared early loading (within 2 weeks of implant placement) with delayed loading. This 5-year study of 142 implants showed no difference in the failure rates of the 2 groups. Although the mean marginal bone loss was higher in the test group (0.8 mm, compared with 0.3 mm), the marginal bone level of the test group was situated more coronally. This difference was attributed to the difference in the timing of the baseline measurement of the 2 groups; remodeling and bone loss may have occurred in the delayed group between surgery and prosthesis placement (baseline).

Other studies were mentioned in this review, but the above 2, summarized in Table 2, were the only ones pertinent to the edentulous maxilla. The authors concluded that implants in the maxilla loaded with an immediate or early protocol have a high survival rate accompanied by minimal bone loss, but this review highlights the need for further controlled clinical trials.


Table 2. Prospective cohort studies comparing loading protocols in the edentulous maxilla

<table>
<thead>
<tr>
<th>Author</th>
<th>Implant/surface</th>
<th>Group</th>
<th>Patients</th>
<th>Implants</th>
<th>Time of load</th>
<th>Follow-up</th>
<th>Implant failures</th>
<th>Survival (%)</th>
<th>Bone loss (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Östnian et al (2005)</td>
<td>Bränemark MkIII, MkIV Replace Select Tapered (TiUnite), all oxidized</td>
<td>Test</td>
<td>20</td>
<td>123</td>
<td>12 hours</td>
<td>1 year</td>
<td>0</td>
<td>100.0</td>
<td>0.8 ± 0.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control</td>
<td>20</td>
<td>120</td>
<td>6 months</td>
<td></td>
<td>1</td>
<td>99.2</td>
<td>0.9 ± 1.0</td>
</tr>
<tr>
<td>Fischer et al (2008)</td>
<td>ITI sand-blasted, large-grit, acid-etched (SLA)</td>
<td>Test</td>
<td>16</td>
<td>95</td>
<td>9–18 days</td>
<td>5 years</td>
<td>5</td>
<td>94.7</td>
<td>0.8 ± 1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control</td>
<td>8</td>
<td>47</td>
<td>3–4 months</td>
<td></td>
<td>2</td>
<td>95.7</td>
<td>0.3 ± 1.0</td>
</tr>
</tbody>
</table>

In the Next Issue:
- CAD/CAM-guided prosthesis for immediate loading of bone-grafted maxilla
- Interim implant-supported, cement-retained prosthesis: clinical technique
- Implant-supported metal-ceramic restoration

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