Luc Gillot, Renaud Noharet, Jacopo Buti, Bernard Cannas

A retrospective cohort study of 105 patients rehabilitated with immediately loaded mandibular cross-arch bridges in combination with immediate implant placement

Key words: cross-arch bridge, full rehabilitation, immediate implant placement, immediate loading, mandibular edentulous patients, provisional screw-retained prostheses

Purpose: To evaluate the outcome of immediately loaded cross-arch bridges 4 months after loading. A second aim was to compare survival rates of implants placed in healed versus fresh extraction sites.

Materials and methods: In total, 105 consecutive patients about to have their mandibles rendered fully edentulous (mean extractions per patient: 6.1 teeth) received four to six implants each (total number = 448), which were immediately placed in healed sites (266 implants, 59%) or fresh sockets (182 implants: 41%). Immediate loading of provisional prostheses was performed and all patients were followed-up for 4 months. The success criteria included prosthesis success, assessment of individual implant stability and complications.

Results: No patient dropped out and all 105 patients received definitive fixed prostheses after four months of loading. The overall implant survival rate after four months was 98.2%. Eight implants were lost in eight patients (8%). Four of them were inserted in fresh extraction sockets (2.2%) and four in healed sites (1.5%). No significant difference ($P = 0.4990$) was found for implants placed into healed sites versus fresh extraction sites. No complications were reported.

Conclusions: Immediate implant placement and loading resulted in high implant as well as prosthetic survival rates. Placement in healed or fresh extraction bone sites did not influence implant survival.

Conflict-of-interest statement: All materials used in this study were purchased by the authors and it is therefore free of any conflict of interest.

Introduction

Treatment of completely edentulous patients with immediate implant loading has been scientifically documented and validated during the last decade. Protocols for immediate implant placement following tooth extraction have also been presented with high implant survival rates. Benefits include reduction of the number of treatment steps required and shorter treatment periods. Therefore, this technique seems a reliable therapeutic alternative. Few studies are available on immediate implant placement with immediate loading for patients about to become edentulous. Reported data are scarce and contradictory; while some authors report lower implant survival rates in extraction sites, others do not.
The aim of this study was to evaluate implant and prosthetic survival rates after 4 months of loading prior to definitive prosthesis delivery when using an immediate implant insertion procedure after extraction and direct implant loading. A second aim was to compare the survival rates of implants placed in healed versus fresh extraction sites. The study is reported following the STROBE Statement (http://www.strobe-statement.org/).

Materials and methods

A systematic and reproducible protocol was followed for 105 consecutive patients who were about to have edentulous mandibles. Patients were treated from February 2004 to September 2010.

To be eligible for the protocol, the candidates had to have remaining teeth to be extracted and replaced by implants. Only compliant patients with no psychological disorders were treated. Smoking was tolerated if the number of cigarettes smoked per day was less than 15. Exclusion criteria were: alcohol addiction, drug addiction, and a history of radiotherapy of the head and neck area.

Patients, treated by two different teams at two private clinics, received a total of 448 implants in their mandibles: 50 patients received 225 implants at clinic A and 55 patients received 223 implants at clinic B.

The outcome measures were prosthetic and implant survival rates after 4 months of loading, and complications. During the first appointment, a prosthetic treatment plan was discussed based on the clinical evaluation and panoramic radiograph analysis of remaining teeth and the decision to eventually extract them (Fig 1). Patients then underwent a conventional computerised tomography scan. The possibility of placing a sufficient number of implants at the same stage as teeth extraction was evaluated (Fig 2). It was decided which implants could be placed into fresh extraction sites by considering the likelihood of obtaining sufficient stability. The planning phase aimed at avoiding fresh extraction sites as much as possible since proper primary implant stability is more difficult to achieve (Fig 3). After the patient’s consent, impressions were taken and the teeth to be extracted were removed on the plaster model and a waxup of the final prosthesis was prepared and discussed with the patient.

Prophylactic antibiotics were administered to all patients as follows: amoxicillin, 2 g per day for 6 days starting the day before surgery. Precautions were made during the extraction/implant insertion procedures to preserve the alveolar bone in the best possible way and to meticulously clean the alveolar sockets from granulation tissue. Thus, thin periodontal, which enabled gentle tooth luxation, were used during the extraction phase. An overall mean of 6.1 teeth per patient were extracted.

Implants were inserted starting with a 20 Ncm torque. The torque was increased gradually to engage the implant up to its final location. The final torque used was a maximum of 50 Ncm (Fig 4). Of the 448 inserted implants, 372 were cylindrical with parallel walls (MkIII®, Nobel Biocare, Gothenburg, Sweden) and 76 were cylindrical with tapered walls (Speedy®, Nobel Biocare). This decision was based on stability and was made with regard to the bone quality at each site. All of the implants used were 4 mm in diameter with moderately rough surfaces (TiUnite®). Almost all implants (99.3%) were longer than 10 mm; 82% were 13 mm in length or longer (Table 1). The shortest length used was 8.5 mm.

Then, abutments were placed followed by impression coping placement. After suturing the flap around the copings, an impression was taken at the same session using a customised pre-made impression tray and a polyvinylsiloxane rigid impression material (Clinibite Fast Clinix®, CFPM, Tremblay, France).

The impression tray was then placed on the presurgical plaster model from which all the remaining teeth planned to be extracted were removed (Fig 5). A dental laboratory processed the impression by placing abutment replicas and remodelling a modi-
Fig 2  Three-dimensional analysis and planning with NobelProcera® software of an implant placed in a future extraction socket near the mental foramina.

Table 1  Length of implants.

<table>
<thead>
<tr>
<th>Length</th>
<th>8.5</th>
<th>10</th>
<th>11.5</th>
<th>13</th>
<th>15</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>3</td>
<td>34</td>
<td>43</td>
<td>327</td>
<td>41</td>
<td>448</td>
</tr>
<tr>
<td>%</td>
<td>0.7</td>
<td>7.6</td>
<td>9.6</td>
<td>73.0</td>
<td>9.2</td>
<td>100</td>
</tr>
</tbody>
</table>

Fig 3  Panoramic view of the global planning.

Fig 4  Clinical view after implant insertion in a healed site (left) or in a fresh socket (right).

Fig 5  The pre-surgical plaster model from which all the remaining teeth planned to be extracted were removed.

Fig 6  The impression tray placed on the pre-surgical plaster model.

Fig 7  Modified plaster model including abutment replicas.
fied plaster model (Figs 6 and 7). Provisional metal-reinforced full resin screw-retained restorations were prepared in less than 9 hours and placed on provisional titanium cylinders (Figs 8 and 9). The screw-retained option avoids the risk of cement debris getting trapped in fresh surgical sites. After 4 months, each patient received a screw-retained permanent titanium framework with resin teeth (Procera® Implant Bridge, Nobelbiocare) (Fig 11).

Outcome measures checked at 4 months by the surgeons were:

- success of the prosthesis
- success of the implants (Fig 10) assessed as stability of the implant when re-screwing the screw abutment with a 35 Ncm torque for straight abutments or 15 Ncm for angulated abutments, and absence of clinical and radiographic peri-implant infection
- any complication.

Then, different prosthodontists, referring to both clinics, delivered the definitive restorations to the patient. The statistical analyses compared implant survival rates in healed and fresh extraction sites. A logistic multilevel model was created for the binomial outcome variable ‘success-failure’ at implant level. The explicative variable used was ‘fresh socket’. This variable was 1 for implants placed in fresh sockets and 0 for implants placed in healed sockets.

### Results

The study included 53 males and 52 females. The overall mean age of patients was 58.7 years (males: 58.6; females: 58.8) at implant placement. In total, 78 patients (74%) received 4 implants, 26 patients (25%) received 5 implants and 1 patient received 6 implants (1%). The two or three central implants were standing upright, whereas the two distal ones

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**Fig 8** Provisional metal-reinforced full resin screw-retained bridge.

**Fig 9** Postoperative orthopantomograph. Notice the assumed proximity of implant tips with mental foramen due to the 2-dimensional nature of this radiograph, which needs to be compared with Figure 2.

**Fig 10** Clinical view during final control 4 months after loading.

**Fig 11** Orthopantomograph of the definitive fixed dental prosthesis with a follow-up of 6 years.
were tilted to pass superior, distal to and lingual to the mental foramina. The total number of extracted teeth was 642, which corresponded to a mean of 6.1 teeth per patient. These were mainly anterior teeth, and 182 implants were inserted into sockets of severely diseased end-stage teeth. Thus, a total of 40.6% of the implants were placed into an extraction socket (Table 2).

No prosthesis failed. Eight of the 448 implants placed were lost in eight patients. The implant survival rate after 4 months of loading, based upon the implant survival criteria defined above, was 98.2% (Table 3). The success at patient level was 92.4%. Six failures were diagnosed at follow-up after 4 months, without any clinical signs. The two remaining failures were detected due to pain reported by the patients. Of the 8 failures, 5 concerned distal implants, 4 were in healed sites and 1 in a fresh socket. Three failures occurred for intermediate implants, all placed in fresh sockets. In cases of failure, the failed implant was removed after removing the provisional prosthesis. The prosthesis was placed on remaining implants and the bridge shortened. As soon as possible, a new implant was placed and connected. It was re-evaluated after 4 more months of healing. Five failures occurred among the 225 implants placed at clinic A, and three failures among the 223 implants at the clinic B. The implant survival rate was 97.8% in fresh extraction sockets and 98.5% in healed sites.

The multilevel model did not show any statistically significant differences for failures in ‘fresh socket’ at implant level (P value = 0.4990). The odds ratio was 1.62 with a 95% confidence interval ranging from 0.40 to 6.55. Odds ratio values >1 indicate an increased risk for implant failure in fresh extraction sockets and odds ratio values <1 indicate an increased risk for implant failure in healed sockets.

At the 4-month follow-up, no peri-implant infection was found during the clinical or radiological evaluation. At the same time, possible paraesthesia was assessed and no patient reported it.

**Discussion**

Antibiotic prophylaxis has been shown to be effective in reducing implant failures. This may be even more important when extracting compromised teeth during the same session. As bacterial activity is present in fresh extraction sites, sometimes for long periods, it may be difficult to avoid potential bacterial contamination. Antibiotics were combined with meticulous cleaning of the surgical site by excising all granulation tissue. The survival rate of implants in the present study was 98.2% when executing extractions, immediate placement of implants and delivery of screw-retained prosthetic reconstructions within 9 hours of surgery. The outcome is in agreement with Pieri et al. who presented a treatment protocol in which the definitive restoration was made and placed within 48 to 72 hours. They reported a cumulative survival rate of 98.6%.

The statistical comparison of survival rates for implants placed into healed sites versus fresh extraction sites revealed no significant difference (P = 0.5). Thus, the type of bone site had no influence in the present investigation.

All implants were placed with a torque higher than 20 Ncm. Long implants were used, the majority being equal to or longer than 13 mm (Table 1) to achieve osseous anchorage beyond the alveolar socket for high primary implant stability. Such stability reduces the risk for micro-movements, thus facilitating bone healing. Underpreparation of the osteotomy sites and bicortical anchorage

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**Table 2** Type of implant sites.

<table>
<thead>
<tr>
<th>Number of implants</th>
<th>In fresh socket</th>
<th>In healed site</th>
<th>Total</th>
</tr>
</thead>
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<tr>
<td>%</td>
<td>40.6%</td>
<td>59.4%</td>
<td>100%</td>
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**Table 3** Implant survival rates.

<table>
<thead>
<tr>
<th>Number</th>
<th>Success</th>
<th>Failure</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>98.2</td>
<td>1.8</td>
<td>100</td>
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<table>
<thead>
<tr>
<th>Healed sites</th>
<th>Success</th>
<th>Failure</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>98.5</td>
<td>1.5</td>
<td>100</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Socket sites</th>
<th>Success</th>
<th>Failure</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>97.8</td>
<td>2.2</td>
<td>100</td>
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</table>
made it easier to obtain good primary implant stability. In addition, immediate splinting of implants may decrease the risk for failures30, and the maximal use of healed sites might enable better stability for the whole prosthetic construction.

The bone–implant gap in fresh extraction sockets was of little concern in patients with completely edentulous mandibles since there are fewer aesthetic considerations.

Treatment with provisional prostheses seems to be more advantageous in this context, since the soft tissue will heal and become more stable, thus enabling the permanent prosthesis to fit the new gingival morphology. In a previous study on permanent Procera prostheses inserted a few days after implant placement in completely edentulous mandibles31, some patients reported discomfort due to space formation between the prosthesis and the gingiva. This space appeared after healing and maturation of the soft tissues, i.e. a few months after surgery. In comparison to a cemented solution, the screw-retained option facilitates the removal of the construction and avoids the ingress of cement debris into fresh surgical sites.

Different success rates are reported in the literature regarding implants immediately placed in fresh sockets. Most of published studies involved single tooth replacement and described higher failure rates13. From a biomechanical point of view, single implants may be more sensitive to overloading. The present authors speculate that the connection of four to six implants provide a safer transfer of load on each implant.

Comparing these results with similar studies, the present authors suggest that the higher survival rates observed both in healed sites and in fresh sockets could be influenced by the very strict protocol used for impression taking at the end of the surgery22. This technique permits the reduction of errors during laboratory steps and provides a provisional reinforced fixed prosthesis in a few hours.

Due to the retrospective nature of data recording, with a follow-up limited to 4 months after loading, results should be considered with caution. Due to the inclusion of only fully edentulous mandibles, the results of this study cannot be extrapolated to other situations such as partial or single implants. Separate studies need to be conducted to evaluate these situations.

### Conclusions

Within the limits of the retrospective nature of this study, the rehabilitation of mandibles after multiple tooth extractions with immediate implant placement and immediate loading can be highly successful. Placement in healed or fresh extraction bone sites did not influence implant survival. This technique reduces the overall duration of treatment and allows patients to spend only a few hours without teeth.

### References


