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Immediate loading of subcrestally placed dental implants in anterior and premolar sites☆

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ABSTRACT

Purpose: Immediate loading of dental implants has been evolving into an appropriate procedure for the treatment of partially edentulous jaws. The purpose of this study was to evaluate the clinical success and radiological outcome of immediately and delayed loaded dental implants in anterior and premolar sites.
Materials and methods: In this retrospective study, data of 163 individuals requiring tooth removal with subsequent implant placement in anterior and premolar sites were analyzed. Implants were immediately loaded by provisional acrylic resin bridges or loaded with delay. Implants were followed up annually for up to 9 years including intraoral radiographs.
Results: A total of 285 implants in 163 patients were placed. 218 implants were immediately loaded and 67 implants with delay. Fifteen implants failed during the follow-up period resulting in survival rates of 94.5% for immediate loading and 95.5% for delayed loading. After an initial decrease of 0.3 mm in the first 12 months the marginal bone level remained stable. No statistically significant differences were found in marginal bone loss between immediately and delayed loaded implants ($P = 0.518$, 95% CI).
Conclusion: Within the limits of this study, immediate loading of immediately subcrestally placed dental implants in anterior and premolar sites is a reliable treatment option for dental rehabilitation.
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1. Introduction

According to the Brånemark protocol in 1983, a stress-free healing period is one of the most emphasized requirements for predictable implant integration (Branemark, 1983). Due to the long existing doctrine that loading an implant too early could cause fibrous tissue at the bone-implant interface, the conventional treatment method for dental implants was a two-stage procedure (Esposito et al., 2013). Since then, many studies have shown good clinical results achieved by one-stage protocols (Buser et al., 1990; Degidi et al., 2003; Acuña et al., 2006; Chiu et al., 2006; Grandi et al., 2015; Henningsen et al., 2016; Simonpieri et al., 2017).

Loading within physiological limits can stimulate bone formation as a result of bone adaptation to loading. Rocci et al. found higher values regarding bone-to-implant contact (BIC) and resonance frequency analysis in immediately loaded implants with a compaction of bone towards the implant surface and a lamina dura–like structure surrounding the implants placed in trabecular bone in vivo (Rocci et al., 2003). However, strict criteria have to be followed for immediate loading in order to avoid non-osseointegration, such as an appropriate insertion torque to achieve primary implant stability,

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adequate implant length and absence of systemic or local contra-indications (e.g. large bone defects and parafunctional activities) (Gallucci et al., 2014). In a recent study reviewing the survival rates of immediately and delayed placed and loaded implants in posterior jaws, success rates were slightly higher when implants were loaded with delay (Moy et al., 2016). A number of case reports and studies indicate that immediately loaded implants have a longitudinal marginal bone loss and soft tissue stability comparable to those of conventionally loaded implants (Ganeles et al., 2004; Lang et al., 2012; Mura, 2012). However, it is not possible to stop the loss of crestal bone by immediate loading. Results of several prospective studies show comparable results of marginal bone loss for immediate and delayed loading protocols (Prosper et al., 2010; Koirala et al., 2016). Therefore, a more recent approach is to place implants subcrestally. In a recent study, Calvo-Guirado et al. found a reduced crestal bone resorption and increased BIC in immediately subcrestally placed implants compared to immediately crestally placed implants in vivo (Calvo-Guirado et al., 2015). Besides that, they also found a lower resorption of the lingual and buccal crest when immediate implants were placed subcrestally (Calvo-Guirado et al., 2014). Several studies reported a lack of evidence for implant position (maxillary/mandibular/anterior/posterior) or type of loading as predictors for marginal bone loss or implant failure (Lang et al., 2012; Busenlechner et al., 2014). On the contrary, some studies found higher failure rates for implants placed posteriorly compared to anteriorly placed implants and higher failure rates in implants inserted in the maxilla compared to mandibular implants (Carr, 2012; Schwarz et al., 2016). A possible reason could be that it may be more difficult to achieve primary stability in the posterior regions of the jaws, especially in the spongious maxilla.

Therefore the objective of this retrospective study was to evaluate long-term outcomes regarding survival and success of immediately subcrestally placed implants in anterior and premolar sites that were either immediately or delayed loaded. Our main hypothesis was that the survival and success rates of immediately subcrestally placed and immediately loaded implants are comparable to the survival and success rates of immediately subcrestally placed and delayed loaded implants in anterior and premolar sites.

2. Material and methods

2.1. Case selection

In this single-centre retrospective cohort study, a total of 163 patients underwent immediate dental implant placement in anterior and premolar sites immediately after tooth removal in a private clinic between November 2003 and April 2015. All implants were placed subcrestally, and all patients were at least 18 years of age and able to provide informed consent. Implants were divided into immediate loading (classified as study group) and delayed loading (classified as control group).

Inclusion criteria were: (1) dentition requiring extraction in anterior and/or premolar sites of the mandible and/or maxilla; (2) preservation of the buccal bony wall after tooth removal tested by probing; (3) receiving at least one immediately subcrestally placed XIVE® implant (Dentsply Friadent, York, PA, USA) and (4) available follow-up data including dental radiographs.

Exclusion criteria were: (1) irradiated bone; (2) severe diabetes mellitus, haemorrhagic conditions, immuno-compromising or other severe systemic diseases; (3) heavy smoking (at least 20 cigarettes per day); (4) intravenous bisphosphonate treatment; (5) drug abuse and (6) uncooperative patients.

A total of 163 patients (77 males, 86 females) aged between 18 and 85 years (average 56.8 years) were included in this retrospective study. No dropouts or exclusions occurred. A total of 285 implants were inserted and either immediately loaded or healed submerged. Immediately loaded implants met the following requirements: (1) insertion torque of $\geq$25 N/cm; (2) no clinical signs of inflammation and (3) receiving chair-side provisional resin crowns or bridges. Final prosthetic restoration was performed 5 months after implant placement. Regularly scheduled recalls were done at least annually after final restoration including intraoral radiographs. Additional follow-ups were carried out according to specific risk factors, local conditions or anomalies.

2.2. Surgical procedure

All patients underwent the same surgical protocol. After careful tooth removal by luxators and preservation of the buccal bony wall, a bone cavity was extended gradually according to the intended implant diameter. Inserted implants were placed clinically 0.5 mm subcrestally. Infected sockets were debrided surgically. If necessary, bone augmentations with autologous particulated bone or bone substitutes (Geistlich BioOss®, Geistlich Biomaterials, Wolhusen, Switzerland or FRIOS Algipore®, Dentsply, York, PA, USA) were performed. In some cases, a resorbable membrane was used (Geistlich BioGide®, Geistlich Biomaterials, Wolhusen, Switzerland). The mucoperiosteal flaps were sutured with monofilament non-resorbable sutures (Ethilon 5-0, Ethicon, Norderstedt, Germany). Analgesics (Ibuprofen 600 mg) were given on demand. Antibiotics (amoxicillin 1000 mg, three times a day, or clindamycin 600 mg, three times a day in case of penicillin allergy) were given for 5 days. Final wound inspection, suture removal and occlusal adjustments were performed 7–10 days after surgery.

2.3. Prosthetic protocol

The prosthetic procedure depended on the time of loading. Patients which were treated by the immediate loading protocol had to meet the following conditions according to Romanos et al. (Romanos, 2004):

- Sufficient bone availability and quality (between D1 and D3) to reach primary stability
- Immediate loading in bone quality D4 only in cases with strong cortical bone
- A minimum insertion torque of 25 N/cm

All immediately loaded implants were initially loaded with provisional acrylic resin bridges fixed by temporary cement (Tempbond®, Kerr Dental, Rastatt, Germany). To avoid shear forces, occlusal contacts were reduced to a minimum in habitual occlusion only. A soft diet was recommended for the first 12 weeks. The provisional acrylic resin bridges were replaced five months after surgery and the final restoration was applied.

All patients who were treated by the delayed loading protocol had an insertion torque of less than 25 N/cm. In these cases, a submerged healing was preferred to achieve successful osseointegration. Implants were uncovered 5 months after implant placement and the final restoration was applied.

2.4. Data extraction and outcome measurements

All study data were retrieved from medical records and anonymized in accordance with the World Medical Association Declaration of Helsinki (64th WMA General Assembly, October 2013). Since survival defines the presence of implants in the mouth only at the time of clinical or radiographic control, neither the condition of the implant nor of the prosthesis is taken into consideration. Therefore, clinical success was assessed by

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