Resonance frequency evaluation on immediate loading implants with angled abutments: case series

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Summary

***Aim*: Immediate loading of implant-supported prosthesis is a predictable and standardised therapy for rehabilitation of partially and totally edentulous patients. The present case series evaluate implant success rates by measuring resonance frequency on immediate loading implants with angled abutments.**
***Materials and methods*: A prospective study was performed on five partially edentulous patients. Twenty-six *Neoss ProActive Tapered*® (Neoss Ltd. Harrogate, UK) implants were inserted: 22 in the maxillary bone and 4 in the mandibular bone. The *Osstell* ISQ® (Osstell; Integration Diagnostics, Göteborg, Sweden) was used to evaluate implant stability. Implant Stability Quotient (ISQ) measurements were performed in three stages: at time of implant insertion (t0), after three (t1) and 12 (t2) months. The ISQ values were recorded after implant installation of *Access*® (Neoss Ltd. Harrogate, UK) during the different stages.**
***Results*: A six month- follow-up showed implant survival of 96%. Twenty-four implants were osseointegrated, a maxillary implant was lost and one other implant was excluded from the study. The values of ISQ ranged between 53-88 ISQ (average 66 ± 6.1 ISQ, median 67 ISQ) at t0, 51-80 ISQ (average 70 ± 5.8 ISQ, median 70 ISQ) at t1 and 53-80 ISQ (average 70.8 ± 5.7 ISQ, median 72 ISQ) at t2.**
***Conclusions*: The 24 successful implants out of 25 in 5 patients demonstrate how using 4-6 implants guarantees sufficient anchorage for a fixed prosthesis and adequate distribution of the prosthetic load on the maxillary and mandible bones, without causing implants failures.**

Key words: resonance frequency, immediate loading implants, angled abutments.

Introduction

Immediate loading of implant-supported prosthesis is a predictable and standardized therapy for rehabilitation of partially and totally edentulous patients; it shows high rates of survival and success, both for the implants and for the prosthesis.
In a 2003 paper, Aparicio et al. analyzed advantages and disadvantages of immediate load technique. They considered the various factors that could affect outcomes (patients' selection criteria, quality of bones, fixture length, surface and shape features, surgeon skillfulness, implant primary stability, occlusal load) and recognized primary stability as the main goal (1).
Also in 2003, Malò et al. described a surgical protocol, the "*All on Four*" method, for rehabilitation of four-implant mandibular arches: two in the frontal side and two in the backside. This method showed a reduction in treatment times, patient discomfort and biological costs (2). Subsequently, the "*All on four*" has been extended to the maxillary bone, resulting in 98% of implant survival after a 5 years follow-up (3).
According to a photoelastic analysis on the peri-implant stress levels *in vitro*, bone around 45° angled implants is more exposed to an occlusal overload in comparison to bone around smaller angulations implants. Small stress differences have been reported around fixtures angles of 0°, 15° and 30°; the regions around the fixtures 'coronal third emerged as the most stressed (4).

Angled abutments mediate prosthetic rehabilitation of angled implants so that abutments axes of the same arch result as parallel as possible.
The most used angled abutments in literature are *Multi Unit Abutment (MUA®)* (Neoss Ltd. Harrogate, UK), *Access*® (Neoss Ltd. Harrogate, UK) and *Low Profile*® (Neoss Ltd. Harrogate, UK).
According to a literary review, the clinical performances of the angled abutments are equal to those of the straight abutments. The stress produced by extra-axial load increases with abutment angulation, yet no consensus has been reached about the precise inclination that leads to implant failure.
During implant success evaluation, it is essential to distinguish between mandibular and maxillary bone. Indeed, a retrospective study on early load with full-arches prosthesis resulted in no implant loss in the mandible, even using only 4 implants, against a 10.6% implant loss in the maxillary bone (5). Another study on full load arch prostheses shows a success rate of 97% for mandibular implants and 87.5% for maxillary ones two years after surgery (6).
The successful installation of immediate loading prosthesis with a full-arch in the maxillary bone depends on the observation of adequate criteria: patient selection, implant choice, correct surgical technique and correct prosthesis realization (7).
Given the limited number of existing studies on the topic (8), the present case series aims to evaluate the success of immediate-loading implants with angled abutments by measuring resonance frequencies.

Clinical series

Study design

The study was a case series designed to evaluate the success of immediate-loading of twenty-six post-extractive implants: 22 in the maxillary bone and 4 in the mandibular bone. A mandibular implant was excluded from the study because angled abutment was unnecessary. Twenty out of twenty-five implants were inserted in post-extraction alveolus while the remaining five in native bone. The inserted implants, *Neoss ProActive Tapered*® (Neoss Ltd. Harrogate, UK), consist of commercially pure titanium grade 4.
The *Osstell* ISQ® (Osstell; Integration Diagnostics, Göteborg, Sweden) device was used to evaluate implant stability. The *SmartPeg™ (Osstell)* is a small, high-precision disposable aluminium bar screwed onto the implant (or angled abutment) during measurements. The ISQ measurements were performed at the time of implant insertion (t0), after 3 (t1) and 12 (t2) months.
Cone-beam CT and OPT were employed for patients' clinical, prosthetic and radiographic assessments.
All patients underwent oral hygiene sessions; they were further instructed to perform oral hygiene during pre-surgical phase.

Study population

The participants were 5 partially edentulous patients: 2 males and 3 females aged between 58 and 74 years (average of 66 ± 8 years). They were selected according to the following exclusion criteria:

- Systemic disorders (thrombocytopenia, coagulopathy, hepatopathy, immunosuppression, diabetes, prolonged cortisone therapy, chemotherapy, iv bisphosphonate treatment, radiotherapy, myocardiopathy)
- Smoking habits
- Bruxism
- Temporomandibular disorders
- Severe dental or skeletal malocclusions.

And the following inclusion criteria:

- need for a full-arch bridge maxillary and/or mandibular supported by 4 or 6 implants
- minimum implant length of 10 mm
- torque of insertion equal to or greater than 35 Ncm
- prosthesis connected to all the implants
- occlusion with long and wide centric.

All the examined patients were healthy; 4 of them took antihypertensive drugs.

Surgical and prosthetic procedures

In order to assemble the articulator-mounted plaster models and construct the surgical template, the intermaxillary connections must be transferred. A facebow has to be employed if an occlusal vertical dimension (OVD) increment is required or if the connections between the two maxillary arches are absent.
In patients with stable occlusion (at least 4 pairs of antagonist teeth) alginate impressions were taken and intermazillary relationship was recorded by occlusion wax. Gypsum models were placed in the articulator; the resulting surgical template guided implants insertion in the correct prosthetic position and aided the choice of the correct *Access*®.
In patients with unstable occlusion (less than 4 pairs of antagonist teeth), intermaxillary relationship and vertical occlusion dimension (OVD) were registered using a facebow.
Avulsion of every compromised dental element was performed; in the same session, 4 or 6 implants were inserted both in native bone and in post-extraction sites. The implant insertion sites were planned based on TC assessment. The chosen areas were the ones with greater bone volume, which did not require a preventive bone regenerative surgery.
The maxillary implants have been placed in 1.2, 2.2, 1.4 / 1.5, 2.4 / 2.5 regions; the mandibular ones in 3.2 / 3.3, 4.2 / 4.3, 3.4 / 3.5, 4.4 / 4.5 regions. The two posterior implants had a mesio-distal inclination of 25-30°, while the two anterior ones inserted in the premaxilla and in the parasymphysis region were straight.
The protocols suggested by Neoss served as a reference for implant sites preparation. The surgical template guided the implants' position and inclination. The implants were inserted using a torque of 35 N/cm