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Research article

Immediately loaded mini dental implants as overdenture retainers: 1-Year cohort study of implant stability and peri-implant marginal bone level

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ABSTRACT

Aim: This 1-year cohort study investigated stability and peri-implant marginal bone level of immediately loaded mini dental implants used to retain overdentures.
Materials and methods: Each of 30 edentulous patients received 4 mini dental implants (1.8 mm × 13 mm) in the interforaminal mandibular region. The implants were immediately loaded with pre-made overdentures. Outcome measures included implant stability and bone resorption. Implant stability was measured using the Periotest Classic® device immediately after placement and on the 3rd and 6th weeks and the 4th, 6th and 12th months postoperatively. The peri-implant marginal bone level (PIBL) was evaluated at the implant's mesial and distal sides from the polished platform to the marginal crest. Radiographs were taken using a tailored film holder to reproducibly position the X-ray tube at the 6th week, 4th and 12th months postoperatively.
Results: The primary stability (Periotest value, PTV) measured -0.27 ± 3.41 on a scale of −8 to + 50 (lower PTV reflects higher stability). The secondary stability decreased significantly until week 6 (mean PTV = 7.61 ± 7.05) then increased significantly reaching (PTV = 6.17 ± 6.15) at 12 months. The mean PIBL measured −0.40 mm after 1 year of functional loading, with no statistically significant differences at the various follow-ups ($p = 0.218$).
Conclusions: Mini dental implants placed into the interforaminal region could achieve a favorable primary stability for immediate loading. The follow-up Periotest values fluctuated, apparently reflecting the dynamics of bone remodeling, with the implants remaining clinically stable (98.3%) after 1 year of function. The 1-year bone resorption around immediately loaded MDIs is within the clinically acceptable range for standard implants.

1. Introduction

Implant-retained dentures have become a successful, increasingly popular treatment option to enhance the stability and retention of complete dentures over resorbed ridges (Das et al., 2012). However, this option is challenged by a number of factors including bone volume and available finances. Mini dental implants are considered to be a good alternative to standard dental implants due to their small diameter, low primary costs, and avoidance of additional surgical procedures such as bone augmentation (Griffitts et al., 2005; Preoteasa et al., 2010).

In a recent systematic review, the calculated mean of one-year survival rate for mini dental implants used for definitive prosthodontic treatment in the mandible was 94.7% (Bidra and Almas, 2013). Middle-term survival rates for mini dental implants used for immediate stabilization of mandibular prostheses ranged between 91% and 97% (Bidra and Almas, 2013; Bulard and Vance, 2005; Elsyad et al., 2011; Mundt et al., 2013; Shatkin et al., 2007), whereas sound long term data are not available.

The clinical outcomes of immediately loaded mini dental implants used as retainers for mandibular overdenture were recently investigated (Scepanovic et al., 2012). The authors reported a 98.3% implant success rate at the 1-year follow-up and a 1-year overdenture success rate of 100%. Patients reported a

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significant improvement in quality of life, overdenture stability, comfort, speaking and chewing ability following implant rehabilitation. Apart from the dentures retention and patients' satisfaction, little is known regarding the effects of immediate loading of mini dental implants on implant stability or the ability of peri-implant bone to withstand this load (Elsyad et al., 2011; Jofre et al., 2010; Jofré et al., 2010). The present study reports data on these clinical measures from the same cohort (Scepanovic et al., 2012).

Different methods are available to measure implant stability. The Periotest value of an oral implant is an objective and easily applied measure of stability that may assist the clinician in deciding whether to extend the healing period before loading fixtures (Olive and Aparicio, 1990). PTV's range on a scale of −8 to +50, with the negative range presenting better stability. Researchers reported different ranges of PTVs for successfully osseointegrated standard-diameter implants (−9 to +9; −5 to +5; −7 to 0; −4 to −2; −4 to +2) (Aparicio, 1997; Eitner et al., 2008; Morris et al., 2003; Olive and Aparicio, 1990; Teerlinck et al., 1991). Data regarding these PTV values for mini dental implants are scarce. In a 3-year prospective study on mini dental implants supporting a mandibular overdenture, PTV from -3.7 ± 1.1 to -4.2 ± 1.2 were recorded for successfully osseointegrated implants (Elsyad et al., 2011). Experimental data from nonviable bovine femoral bone, have shown that mini dental implants, designed for immediate loading, can only be loaded immediately if their Periotest values are measured to be between the range of −8 to +9 (Dilek et al., 2008). Further clinical research is needed to be performed in order to draw more definite conclusions about immediate loading of the mini dental implants (Dilek et al., 2008). There is no defined PTV that would allow immediate loading of standard-diameter implants, but an insertion torque of at least 32 Ncm is mandatory (Ottoni et al., 2005; Payer et al., 2010).

Bone resorption around the implant naturally occurs as part of the bone tissue maturation and reaction to loading forces. Studies have suggested criteria for the expected "physiologic" resorption of crestal bone around dental implants (Buser et al., 1997). On the other hand, pathologic peri-implant crestal bone loss can compromise implant treatment (Hermann et al., 2001). Therefore, measuring PIBR is one of the important outcome measures in implantology, and an indication of success of the implant (Hermann et al., 2001).

The aim of this 1-year cohort study was to investigate primary and secondary implant stability as well as changes in peri-implant marginal bone level of immediately loaded mini dental implants used to retain mandibular overdentures. Our first hypothesis was, that, despite their narrow diameter, mini dental implants could achieve primary stability within the accepted range for immediately loaded standard diameter implants. The second hypothesis was that secondary stability and peri-implant bone resorption of mini dental implants immediately loaded by mandibular overdenture are not different from standard diameter implant's accepted values.

2. Materials and methods

After obtaining the Ethics Committee's approval (no. 36/5), this cohort study was conducted at the Clinic of Prosthodontics and Clinic of Oral Surgery, School of Dentistry, University of Belgrade from January 2010 to June 2011. Patient selection as well as surgical and prosthetic protocols have been previously reported in detail (Scepanovic et al., 2012). A total of 120 mini dental implants (MDI; 3M ESPE, St. Paul, MN, USA) with a length of 13 mm, diameter of 1.8 mm and with polished collar were used for the rehabilitation of mandibular edentulism of 30 patients (16 female and 14 male) aged from 45 to 63. Twelve patients presented with sound medical history, whereas 10 had hypertension, 2 had asthma, 2 had controlled diabetes mellitus type 2, and 3 had thyroid dysfunction. Each patient received 4 mini dental implants (MDI; 3M ESPE, St. Paul, MN, USA) in the interforamine region, which were immediately loaded with overdentures. A flap surgical approach was required in 7 patients due to narrow alveolar ridge in order to prevent accidental perforation of the lingual cortical plate and subsequent risk of sublingual hematoma. All patients were treated by the same oral surgeon, prosthodontist and dental technician in order to provide uniform conditions.

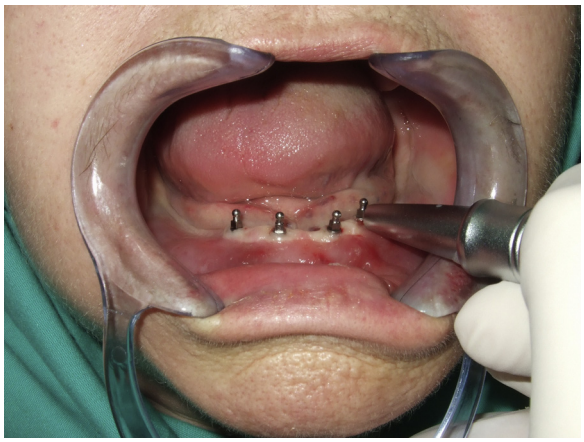

Fig. 1. Measurement of implant stability. The rod of the Periotest Classic® device approaching the square point at the collar part of the implant used as a reference point.

Outcome measurements in this study were primary and secondary implant stability as well as peri-implant bone loss.

2.1. Implant stability measurements

Primary implant stability was measured immediately after implant placement using the Periotest Classic® device (Medizintechnik Gulden, SiemensAG, Germany). In order to achieve reproducible measurement of implant stability, the square point at the collar part of the implant was chosen as a reference (Fig. 1). The Periotest rod was positioned perpendicularly to the implant axis and alveolar ridge. The device produces 16 hits in 4 s. Contact time of the rod and implant surface is measured in milliseconds. The test values are measured on a numeric scale from −8 to +50, where negative values present better implant stability.

After measuring primary stability, the metal housings were incorporated into the dentures. The recently made dentures were drilled on the inner surface in order to make a proper space for the metal housing. When passive fit was achieved, cold curing acrylic was used to underline and retain the metal housings into the denture. To avoid the acrylic penetration into the undercut spaces of the implant, block-out shims were placed.

Secondary implant stability was measured postoperatively on the 3rd and 6th weeks and on the 4th, 6th and 12th months in the same way used to measure primary stability.

2.2. Peri-implant marginal bone level assessment

Peri-implant marginal bone level was evaluated by means of a special film holder that was made from a commercial X-ray film holder (Dentsply® film holder) using a silicone key (Zeta plus Zhermack®) to reproducibly position the X-rays tube in the different follow-up points (Fig. 2). The film holder was retained in place using a snap connection to the implant-retained denture. All radiographs were taken by the long cone technique. A plastic ring,

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