# RADIOLOGICAL EVALUATION OF DENTAL IMPLANT TREATMENT SUCCESS RATE

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**Abstract:** *Measurement of marginal bone is one of the most reliable criteria for establishing dental implant treatment success rate. If an implant is still in function but is not tested with respect of success criteria is considered as surviving. The aim of the present retrospective study was to evaluate long term treatment success with mandibular two-implant overdenture in fully edentulous patients by measuring the marginal bone loss on radiographs. Methods: Panoramic radiographs of 47 patients, three for each (after surgery, one week after implants loading and at 5-year follow-up) were analysed. Marginal bone loss was measured according to baseline, set at one week after implants loading. Results: 94 implants measured a marginal bone loss between 0.30 and 1.71 mm with a mean value of 0.73 (±0.19) mm, below the limit of 1.80 mm proposed according to different success criteria. Conclusions: All implants retrospectivelly evaluated are considered successful, despite of the type of retention system used for mandibular overdenture.*

## INTRODUCTION

To be considered successful, a restored dental implant should fulfil several criteria related to functionality (especially chewing), tissue physiology (osseointegration), absence of pain and patient satisfaction.(1)

Albrektsson et al.(2), after performing an extensive literature review including all major implant systems used in the 98s, proposed some criteria to evaluate the *success* of treatment with dental implants.

Those criteria, revised by a great number of researchers (3,4), are currently accepted and include: lack of mobility, peri-implant radiolucency, pain, infection and less than 0.2 mm peri-implant bone resorption per year except the first year after prosthetic loading. In the first year of functioning, maximum allowed bone resorption is 1.0 mm (5) to 1.5 mm.(4)

An implant can be called a *failure* if osseointegration is failing, if there is clinical mobility, if normal use gives pain or if there is peri-implant radiolucency owing to infection or if it is removed, irrespective of the reason.

The implants that are still in function but were not tested with respect of success criteria or neither the criteria of success or failure are met are considered as *surviving*. Therefore, radiological measurement of the distance from an established landmark of the implant to the alveolar bone crest represents one of the most reliable criteria in assessing dental implants treatment *success*, in conjunction with other clinical parameters evaluation (e.g., peri-implant probing depth, bleeding on probing, implant stabilility).(6)

## PURPOSE

The aim of this study was to evaluate long term treatment success with mandibular two-implant overdenture in fully edentulous patients by measuring the marginal bone loss on radiographs.

## MATERIALS AND METHODS

In the present study, the panoramic radiographs of the fully mandibular edentulous patients treated at Concordia Dent Clinic Bucharest between September 2004 and March 2012 in a project granted by the ITI Foundation for the Promotion of Oral Implantology, Switzerland (ClinicalTrials.gov Identifier: NCT01034930), were retrospectively analyzed.

The initial study included 69 patients (48 women and 21 men) aged between 42 and 84 years old at the time of surgery. All patients had been wearing conventional complete dentures with fitting problems due to extensive ridge atrophy. They received two screw type standard Soft Tissue Level (STL) Straumann implants (Institute Straumann AG, Switzerland) with 4,1 mm diameter and 10 or 12 mm length in the anterior region of the mandible, between the two mental foramen, following a one stage non-submerged protocol. After a 6-week-healing period, implants were loaded and each patient was randomly assigned to one of the following overdenture retention system: Magnet (23 patients), Retentive anchor (23 patients) and Locator (23 patients).(7)

Out of the 138 implants placed, four failed to osseointegrate, were replaced and all patients could be treated as previously planned with two-implant retained overdenture.

At 5-year-evaluation period, patients were satisfied with the treatment carried out both functionally and aesthetically and no other implant was lost, considering 100% *survival* rate after loading. But to evaluate the success, a rigorous radiographic analysis and the measurements of bone loss was mandatory.

Therefore, panoramic radiographs of the patients from surgery to the last follow-up were retrospectively evaluated. To be included in the present study, several requirements for the accuracy of measurements were imposed:
- At least three panoramic radiographs (after surgery, one

week after implants loading and at 5-year follow-up);
- All three radiographs to be performed at the same radiographic centre, using the same technique;
- Sufficient radiographic quality with no scratches or discoloration.

22 patients were excluded due to missing radiographs (8 patients), not the same radiographic centre (12 patients) and compromised radiographic quality (2 patients).

141 conventional radiographs were scanned at 300 dots per inch (dpi) using a table scanner (Epson Perfection 2450) and cropped around the part of the mandible containing the implants and the abutments, for ease of evaluation.(1)

The cropped radiographs were analyzed by a dentist specialized in maxillofacial radiology with over 12 years of experience in interpreting dental radiograph and measurements were made with the use of Image J software, version 1.49n (imagej.nih.gov), regardless of the type of abutment inserted on the implant.

In order to evaluate bone resorption, the following landmarks were considered:
- A – top of implant neck,
- B – apex of implant body,
- C – distal bone level,
- D – mesial bone level,
- x – distal marginal bone with respect to the top of implant body,
- y – mesial marginal bone with respect to the top of the implant body (figure no. 1).

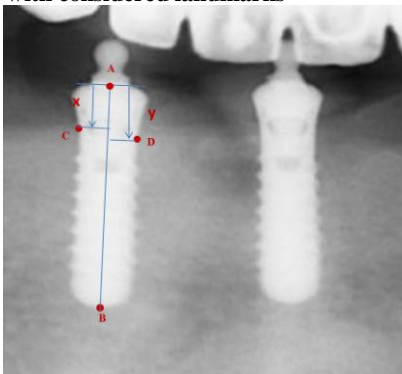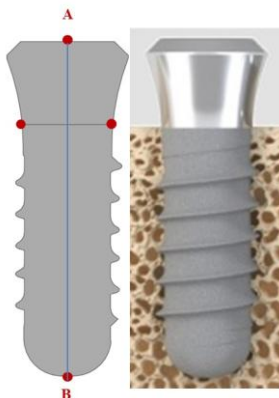**Figure no. 1. Cropped radiograph of the implants and abutments with considered landmarks**



**Figure no. 2. The length of the implant body (AB) is known (10 or 12 mm)**



Each radiograph was measured four times and a mean value was calculated. The most pronounced bone loss for each implant was chosen to represent the respective implant: z =

maximum value between x and y. In our example z = y.

The z segment in pixels (ImageJ software) was converted in millimetres using the *rule of three* and knowing implant length (figure no. 2).

Bone loss after five years (Δz) was calculated by subtracting z` value measured at 5 years from z value measured at loading (considered baseline) according to the formula:

$$\Delta z = z - z`.$$

Success of the implant was evaluated according to the maximum bone loss alowed in five years:

**Less than 1 mm (first year) + 4 (years) x 0,2 (maximum loss per year) mm = 1,8 mm after 5 years of functioning.**(1)

For each implant, if a maximum bone loss either mesially or distally measured was less than 1,8 mm, it was considered *successful*.

Similarly, for monitoring osseointegration, z value at loading (considered baseline) was subtracted from bone level measured after implants insertion (zch):

$$\Delta zos = z - zch.$$

Statistical analysis was performed using Microsoft Excel 2013.

## RESULTS

Panoramic radiographs of 47 patients (35 woman and 12 men) out of 69 patients met the selection criteria. A total of 141 conventional radiographs were scanned, 3 for each patient: after surgery (n=47), after loading (n=47) and at 5-year follow-up (n=47). A number of 94 implants were evaluated and maximum bone loss (Δz), from mesial and distal measurements, was calculated. Results of mean values, standard deviation, maximum and minimum bone loss in mm are presented in table no. 1.

**Table no. 1. Radiological evaluation of dental implant treatment success rate and bone healing during osseointegration**

| | Marginal bone loss in 5 years (Δz) | Bone healing during osseointegration (Δzos) |
|---|---|---|
| **Mean** | 0.73 | -0.21 |
| **Standard Deviation (SD)** | 0.19 | 0.17 |
| **Max. bone loss (mm)** | 1.71 | -0.67 |
| **Min. bone loss (mm)** | 0.30 | 0 |

**Figure no. 3. Marginal bone loss compared to baseline measured after 5 years of functioning for the 94 implants included in this retrospective study**
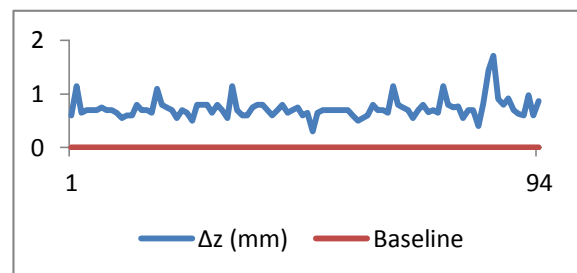


The 94 implants measured a marginal bone loss between 0.30 and 1.71 mm with a mean value of 0.73 mm (table no. 1), less than maximum 1.80 mm allowed, therefore all implants evaluated were considered successful. Figure no. 3 gives an overview on bone remodelling around implants during

the 5 years of functioning.

Bone remodeling at loading compared to the implant insertion registered mostly negative values with a mean of -0.21 and a maximum resorption of -0.67 mm (table no. 1). 24 implants (out of 94) registered no bone loss during osseointegration (figure no. 4).

**Figure no. 4. Bone healing during osseointegration compared to baseline for the 94 implants included in this retrospective study**
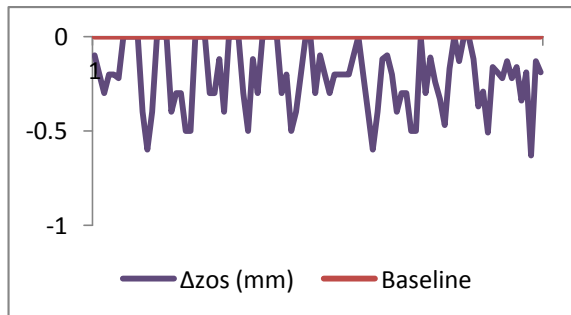


## DISCUSSIONS

The definition of osseointegration of endosseous implants implies "an intimate bone to implant contact around the entire contour with continuous remodeling of the supporting bone and the maintenance over the years of a stable marginal bone height under functional levels and types of loading for the entire life of the patient".(8) A noteworthy systematic review (9) considers marginal bone loss as a decisive factor in distinguishing between implant success and survival. Therefore, the measurement of marginal bone is mandatory for establishing dental implant treatment success rate. A drawback of this study is the use of panoramic radiographs, with possible distortions in the symphysial area of the mandible, instead of standardized periapical radiographs with parallel x-ray beams and film holders mounted directly on the implants.(10) Moreover, experiments on human cadavers advocated that the measuring error for marginal bone levels was 0.14 mm on intraoral radiographs and 0.21 mm for panoramic radiographs (11), close to 0.2, the maximum annual bone loss allowed. Due to severely resorbed alveolar process in the mandibles with high floor of the mouth, the panoramic radiograph was the only X-ray technique which could be applied in these situations, as intraoral films could not be positioned parallel to the implant axis without causing considerable discomfort to the patient. To overcome this drawback in the present study, the radiographs were taken with reproducibility and, for the accuracy of the evaluation, panoramic radiographs performed at different centres during the follow-up period were excluded. Moreover, bone loss was measured according to baseline, set as reference point. Similar techniques are considered to offer an acceptable accuracy (12) for peri-implant bone level measurements and were used to assess bone loss in a great number of studies with implant overdentures.(1) Baseline for bone resorption was set at one week after implant loading to allow an accurate evaluation.(5) Bone healing during osseointegration was evaluated separately as it could be a prognostic determinant in implant dentistry and it should not influence the value of marginal bone loss in the first year, 1 mm maximum allowed in this study.(5) Mean bone loss measured after 5 years of functioning was 0.73 mm ±0.19 (table no. 1), similar to Cehreli's (13) study (0.73 +/- 0.06) but lower than Meijer's (14) findings (0.9 mm) for the same implant brand. Maximum marginal bone resorption for the 94 implants evaluated is 1.71 mm, below the limits suggested by different

success criteria (2,4) therefore, all evaluated implants could be considered successful.

## CONCLUSIONS

Within the limits of this study, all implants evaluated were considered successful, despite of the type of retention system used for mandibular overdenture.

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