

# RETROSPECTIVE ANALYSIS OF 2,244 IMPLANTS AND THE IMPORTANCE OF FOLLOW-UP IN IMPLANTOLOGY

## ABSTRACT

**AIM:** A retrospective clinical analysis evaluated the clinical behavior of the prosthetic restorations, screw joint stability, peri-implant bone level and soft tissues, implant survival rate and patient satisfaction. **MATERIAL AND METHODS:** Data was collected from follow-up visits of 444 patients, aged from 26 to 88 years, that were rehabilitated with 2,244 implants placed between 2005 and 2010. **RESULTS:** The implant survival rate was 99.73%, 94.78% for prosthetic screws, and 96.70% for abutment screws. Peri-implant bone levels remained stable (bone loss equal or less than 1 mm) in 96.21% of the implants. Plaque accumulation was present in 275 patients and was associated with gingival bleeding in 66 patients. Three hundred and thirty patients were satisfied, 103 were somewhat satisfied, 7 patients expected more from their restorative treatment, and 4 patients were dissatisfied. **CONCLUSION:** Continuous follow-up of patients with implant restorations provides essential information on the behavior of implants and prosthetic components, enabling the early intervention in minor prosthetic complications (e.g. screw loosening) to avoid future major complications (e.g. implant failure).

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## KEYWORDS

Dental implants. Dental prosthesis. Retrospective studies.  
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## INTRODUCTION

The criteria for successful osseointegration have been established and well-documented since 1981.<sup>1,2</sup> It has been previously established that during the healing period of up to one year after installation of the prosthetic restoration, a bone loss of approximately 1.0 mm is considered normal, followed by less than 0.2 mm in the following years; the soft tissues should also remain healthy over the years.<sup>3</sup> Another criteria for success of dental implants was proposed based on the difficulties that implants in less than ideal positions present for the placement of the prosthetic restoration.<sup>4</sup>

Current criteria for success depends on an interrelationship between functional, biological, and mechanical aspects.<sup>3,4</sup> The tissues surrounding the implants should be healthy, the bone level around the fixtures should be within normal limits and screw joint stability is required. The follow-up of clinical cases have supported the restorative techniques that were proposed and changes that were needed over the years.<sup>5-8</sup> New indications for implant placement technique<sup>9</sup> and the outcomes that patients are looking for in restorations supported by dental implants have changed over the years.<sup>10</sup>

Data that assess techniques used in implant training courses are important to enable the continuance or modification of the concepts applied at an educational institution.

The aim of this study is to present the data collected in follow-ups of cases treated during training programs at the Latin American Institute for Dental Research and Education (ILAPEO). This study assessed the basic survival rates of the implants, the bone level around the implants, condition of the soft tissues surrounding the implants, stability of the prosthetic screws, and the levels of patient satisfaction related to the treatment and the prostheses.

## MATERIAL AND METHODS

The research protocol for this study was approved by the ethics board of the Pontifícia Universidade Católica do Paraná (PUC-PR) (CAAE protocol number 13426313.0.0000.0100; PUC-PR report number 244.722). All patients who were rehabilitated with dental implants during training programs at the ILAPEO, from 2005 to 2010, were instructed and invited to return for clinical maintenance and follow-up at 6-month intervals for the first 2 years. This study collected data available from the completed forms and from the patient's follow-up returns.

After installation of the implant-supported rehabilitations, all patients were trained and motivated to proper hygiene the prosthetic restorations. The implant survival rate was assessed according to the criteria for successful osseointegration proposed by Smith and Zarb (1989).<sup>3</sup> All clinical assessments

during the follow-up visits were made by one experienced calibrated clinician that also administered a 25-item structured multiple response questionnaire. The questionnaire evaluated complications related with the prosthetic restoration, the implants, the peri-implant bone levels, and also evaluated the overall patient satisfaction with the implant treatment. Patient satisfaction was determined as satisfied, somewhat satisfied, and dissatisfied. A total of 444 forms were filled out, 55 (12.4%) of which were follow-ups of three- to five-unit splinted partial prostheses (screw-retained metal-ceramic prosthesis) and 389 (87.6%) were full-arch prostheses (screw-retained hybrid fixed prosthesis), to a total of 2,244 implants (Neodent, Curitiba, PR, Brazil).

Peri-implant bone level was assessed on undistorted radiographs. Digital intraoral radiographs were obtained on the day of the follow-up visit using the paralleling technique and a universal sensor holder (Rinn® XCP-DS FIT™, Dentsply Rinn, Elgin, IL, USA). The radiographs were performed using the same x-ray equipment (7 mA and 85 kVp, Heliodont Vario, Sirona Dental GmbH, Salzburg, Austria) and intraoral sensor (Xios Plus, Sirona Dental GmbH). Specialized software (Sidexis XG, Dental GmbH) was used to measure the vertical bone level. The peri-implant bone levels were determined as less or equal to 1 mm and higher than 2 mm by one calibrated operator. The measurements were made from

the prosthesis/implant-abutment interface up to the most apical radiolucency (Figures 1 and 2).

Figure 1. Evaluation of the peri-implant bone level - X-ray of External Hexagon implant. d = measured vertical bone loss.

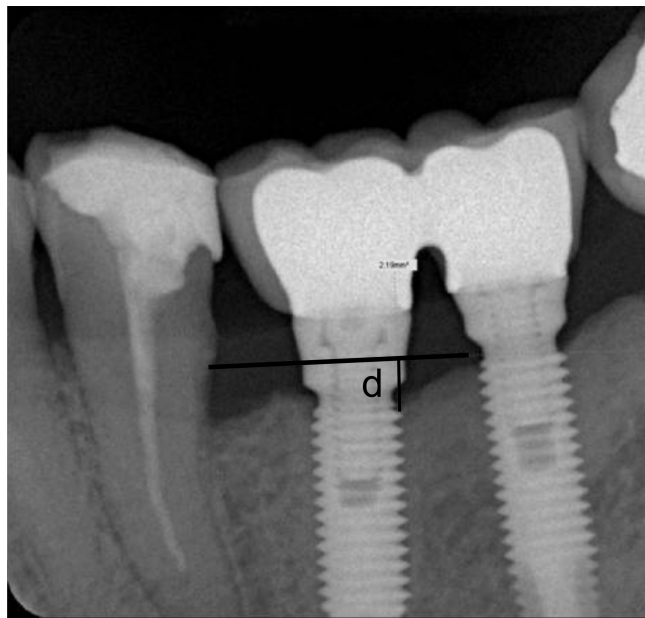
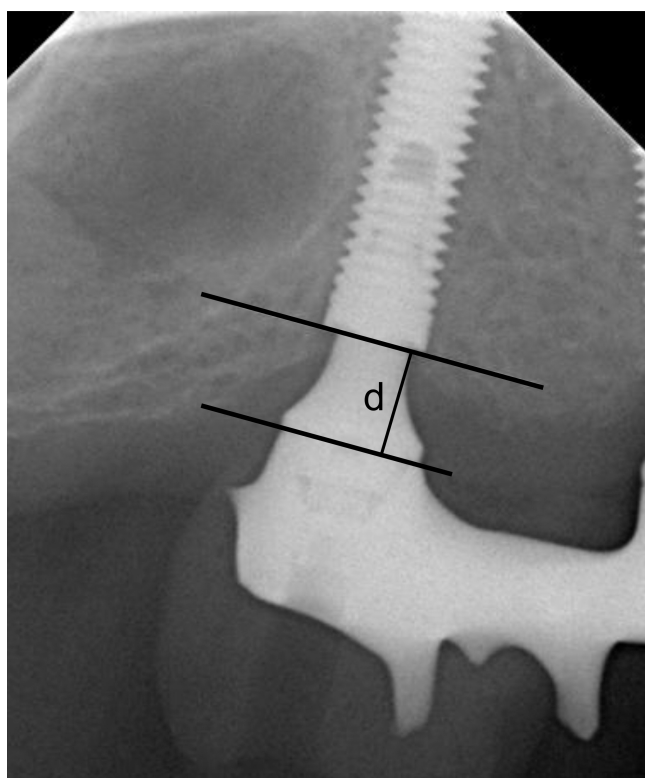


Figure 2. Evaluation of the peri-implant bone level - X-ray of Morse taper implant. d=measured vertical bone loss.



Screw joint stability was evaluated by checking the torque of the prosthetic and prosthetic-abutment screws using a torque gauge (Neodent). The criterion used was that screws with less than 10 N-cm were considered loosen. The presence or absence of mobility was manually checked with the aid of clinical instruments trying to move the restorations. When mobility was detected, all components were disassembled to understand whether the connection between restoration and prosthetic-abutment or the connection between prosthetic-abutment and implant or the implant was loose.<sup>11</sup>

The presence of clinical complications in the prosthetic restorations was performed according to settings from a previous study.<sup>12</sup>

Presence of mechanical complication and the type of complications were assessed (polishing of chipped-off porcelain, retightening of loose screw, and need for a new restoration). The prosthetic misfit of the restorations with the abutments was also evaluated in the x-rays. Simplified Gingival and Plaque Indexes were used to assess the presence/absence of inflammation or plaque and were performed only on the implant-supported restorations. Bleeding from the gingival margin and visible plaque scored 1, while absence of bleeding and no visible plaque scored 0.<sup>13-15</sup>

## RESULTS

Data from 2,244 implants were analyzed. Two hundred and thirty-five implants supported screw-retained metal-ceramic partial dental prostheses (10.5%) and 2009 supported screw-retained hybrid full-arch dental prostheses (89.5%). One thousand four hundred and thirty-seven implants were placed in the mandible (64%) and 807 in the maxilla (36%). The survival success rate of the 2,244 implants was 99.73%; five implants were lost and one was submerged after a period from 6 months to 5 years in function. Ten of the 444 (2.2%) prosthetic restorations were considered non-passive; three of the five implants that failed were supporting these restorations.

The full-arch restorations in the maxilla were supported by 4, 6 or more than 6 implants; in the mandible, the restorations were supported by 4 or 5 implants being that 85.38% were supported by 5 implants. Some implants were in an angled position whereas others were axially straight, arranged between the two maxillary sinuses or between the mental foramens. The success rate did not differ between different implant positions.

The stability rate was 94.78% for prosthetic screws and 96.70% for prosthetic-abutment screws. Two prosthetic-abutment screws were fractured. The overall patient satisfaction found that 330 patients (74.09%) were satisfied, 103 (23.44%) were somewhat

satisfied, 7 (1.57%) expected more from their restorative treatment, and 4 patients (0.9%) were dissatisfied. The complaints were related to difficult hygiene (43 patients; 13%), aesthetics (24 patients; 7.3%), occlusal discomfort (16 patients; 5%), phonetics (13 patients; 4%), pain (6 patients; 1.8%), and 2 patients did not report any specific complaint. From the 114 patients who had some dissatisfaction, 99 were restored with a full-arch hybrid implant-fixed dental prosthesis and 15 with implant-fixed metal-ceramic partial dental prosthesis; 48 prosthetic restorations were located in the maxilla and 66 in the mandible.

Peri-implant bone loss was less than or equal to 1 mm in 96.21% of the implants and higher than 2 mm in 3.78% of the implants. Plaque was present in 275 patients and gingival bleeding was present in 66 of the 275 patients (24% of the patients that had plaque accumulation).

## DISCUSSION

The overall success evaluation of the implants used for this study was based in previously published studies that suggested criteria for implant success.<sup>3,4</sup> Some of the factors include healthy tissues surrounding the implants, presence of screw joint stability, and bone level around the fixtures within normal values with the implant in function (vertical bone loss less than 0.2 mm annually after the

first year of service).<sup>3</sup>

The overall implant survival rate of the implants was 99.73%. This is in agreement with other studies that found similar implant survival rates ranging from 98.1 to 100%<sup>2,6,16-21</sup> and higher than other studies that found survival rates ranging from 80.3 to 92.4%.<sup>22-24</sup> Some studies<sup>25,26</sup> found that early loss of the implant fixtures is the most common finding. No early loss of implant fixtures was found in this study. The five failed implants that were lost were replaced and a new prosthetic restoration was fabricated. When implant failure is detected, the clinician should solve it immediately and replace it when needed. Faster response on failures might lead to higher patient satisfaction levels, since complications with the implant-treatment are among the factors that significantly influences patient satisfaction.<sup>27</sup> Other factors include implant position, definitive restoration shape, appearance, effect on speech, and chewing capacity.<sup>27</sup>

It can be stated that the amount of implants used for the full-arch restorations (4 to 6 or more in the maxilla and 4 or 5 in the mandible) are adequate considering the overall survival rate of the implants (99.73%). This is in agreement with other studies that suggested a number of 4 or 6 implants in the maxilla to restore a full-arch restoration and found high predictability rates.<sup>22,28</sup> Implant

inclination also had no effect for the implant survival rate and agrees with other studies that found similar outcome.<sup>18,29</sup> For implant-fixed mandibular restorations, the minimum number of implants varies from 4 to 6 between the mental foramina with high rates of success and predictability.<sup>2</sup> For the maxilla, the initial indication of 6 parallel implants has presented lower rates of success,<sup>30-33</sup> which may be explained by the complex anatomy, the presence of complex anatomical structures such as the maxillary sinuses and nasal cavities, and poor bone quality. This fact makes it a challenge to treat atrophic maxillae and has led to the development of new surgical techniques, such as reconstruction with large autogenous bone grafts from extraoral donor areas and the use of zygomatic fixtures.<sup>34-36</sup>

Screw joint stability found in this study was comparable to previously published studies that used similar methodology.<sup>37,38</sup> The routine use of a torque gauge to tighten the screws of implant-supported restorations is recommended and helped maintaining screw joint stability. The passive fitting of implant-supported restorations is another factor that influences screw stability.<sup>17,39,40</sup> The follow-ups made possible the identification of loose screws so that they could be adjusted for proper functioning of the restoration. Screws were changed when necessary. No further complication or pain was associated with screw loosening. This confirms the

observations of another study that recommended careful tightening of the screws using torque gauges to minimize the risk of long-term mechanical problems such as fracture of the prosthetic-abutment or the implants.<sup>41</sup> Other studies found implant fractures that were preceded by loosening of the screws.<sup>42</sup>

Prosthesis passive fitting is a complex clinical step because it relies on many technical procedures. Adding small errors when taking the impression, pouring the cast, and waxing and casting can easily result in frameworks misfit.<sup>37</sup> Clinical follow-ups may help in solving problems in an early stage, preventing worst-case scenarios. However, the need for additional clinical sessions to care for the mobility of the prosthesis can be frustrating to the patient, possibly affecting the level of satisfaction with the treatment.<sup>37</sup>

The level of satisfied patients was 74.09%. This is higher than a study that reported a satisfaction rate of 50%<sup>36</sup> and lower than another study that found 88.2% of satisfied patients.<sup>43</sup> For this study, full mouth and partial restorations were mixed together, with a higher trend for treating edentulous lower jaws. All complications with the implant rehabilitation were addressed. The overall satisfaction of the patients was lower than the success rate of the implant restorations. This is in agreement with findings from other studies<sup>25,36</sup> that found that despite the high

success rate of the implant restorations, the level of satisfaction is not as high. It has been previously suggested that the patients that attend the dental office more frequently do so because of complications with the implant therapy rather than for supportive treatment or routine check-up.<sup>25</sup> Most of the issues reported by the patients in the present study were related with prosthesis hygiene. The patients do not always notice problems related with the prosthetic restoration, and dentists should routinely follow-up their clinical cases to avoid further complications.

The aesthetic demands of patients needing implant rehabilitation have significantly increased in recent years.<sup>44</sup> The 7 patients that expected more from their treatment were rehabilitated with full-arch hybrid fixed prosthesis and their main complaint was related with the appearance, the time it took to complete the treatment, and unsatisfactory lip support. The aesthetic limitations of full-arch hybrid fixed prosthesis should not be overlooked. Exchanging a removable complete denture that replaces the gingival contours and provides extra lip support by a hybrid fixed prosthesis with extension limitations and more difficult to hygiene maintenance might contribute to the problem.<sup>23</sup>

Since this study was conducted in a training environment, the time to complete the treatment is expected to be higher compared

to a private practice. A previous study<sup>27</sup> reported that the communication between dentist and patient is important to achieve optimal esthetic results and is indicated that the information received prior to treatment was related to patient overall satisfaction. It has also been previously reported that patients with high or unrealistic expectations are the most difficult patients to treat,<sup>45</sup> thus further emphasizing the importance of the communication between dentist and patient.<sup>27</sup>

The peri-implant bone level around the implants remained stable with up to 1 mm bone loss in 96.21% of the fixtures. This agrees with the recommended levels of bone loss for successful osseointegration.<sup>1,2,4</sup> The results are similar to those found by another study that reported bone loss around the implants of up to 1 mm in 95.1% and in 4.9% bone loss higher than 2 mm.<sup>46</sup> Patients rehabilitated with osseointegrated implants should be advised of the importance of regular maintenance to avoid complications and should accept the possibility that technical complications leading to additional maintenance cost can occur with implant-supported restorations.<sup>12</sup> Screw-retained restorations are easier to maintain because of its retrievability. Multiple and complex restorations are therefore recommended to follow such characteristics.

## CONCLUSION

The results found in this study indicate that the long-term success of implant-supported restorations could be improved by continuous follow-ups. The early intervention in cases of prosthetic screw loosening and implant loss can minimize higher trauma, maintain the bone levels surrounding the implants, and positively influence the patient's levels of satisfaction. A limitation of this study is that implants of different sizes, designs, and connections were evaluated. Different implant position, number of implants and types of restorations were also present in the clinical cases. A more homogeneous sample can be used in future prospective clinical trials.

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