Immediate loading over lower prosthesis in edentulous mandibles: comparison between two types of prosthetic connection

Carga imediata sobre protocolos inferiores: comparação entre dois tipos de conexões protéticas

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INTRODUCTION

Dental implants have been widely used due to their high success rates. However, several factors interfere with the maintenance of the perimplant bone tissue, such as: surgical trauma, load conditions, degree of precision and adjustment between components, resistance and stability of the implant/abutment interface when subjected

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INTRODUCTION

Dental implants have been widely used due to their high success rates. However, several factors interfere with the maintenance of the perimplant bone tissue, such as: surgical trauma, load conditions, degree of precision and adjustment between components, resistance and stability of the implant/abutment interface when subjected
Comparison between two types of prosthetic connection

The patients underwent clinical and imaging examination through panoramic radiographs. The patients who met the following criteria were selected: a) total lower edentulism; b) good bone availability of residual ridge (highest height of 11 mm and thickness greater than 5 mm); c) type I and II bone tissue; and d) no systemic contraindications. Patients who followed the criteria previously established by Chiapasco et al. were excluded from the study.

Each patient was treated with four implants of regular diameter (3.75 x 11 mm) for lower protocol-type rehabilitation with functional immediate loading in the immediate postoperative period. The implants were distributed between the mental foramens, so that the two implants on the left side of each patient had Morse cone connections, while the two implants on the right side had external hexagon prosthetic connections, following a split mouth design (Figure 1).

Figure 1. Dental implants installed between mentuals foramen.

Surgical and prosthetic procedures

All surgical procedures were performed under local anesthesia by the same surgeon. The implants were placed following a standardized surgical protocol and using previously prepared surgical guides. After installation of the implants, mini-abutments were adapted over them, and then transferred by molding with open molders (Figure 2).

Figure 2. Adaptation of mini-piers on implants and molding with open molders.

The analogs were positioned on the transfer dies and sent to the laboratory phase. Within 72 hours,
A protocol-type hybrid prosthesis made with metal and acrylic superstructure were installed with the appropriate occlusal adjustment. All patients received also complete upper dentures (Figure 3).

![Figure 3. Postoperative of 2 days, metallic superstructure and hybrid prosthesis type protocol installed.](image)

**Evaluation**

The parameters evaluated included probing depth, stability of the implants and perimplant bone loss, which were measured at the baseline (immediately after installing the prosthesis) and after 3 and 6 months postoperatively. All examinations were performed by a previously trained professional.

1. **Probing depth**: Evaluation of the probing depth was based on the previous clinical study by Gerber et al. (2009), and it was performed with a plastic millimetric periodontal probe (Colorvue® Hu-Friedy®, Rotterdam, Belgium) which was positioned perpendicular to the long axis of the implant on the buccal, lingual and proximal surfaces, measuring the distance from the gingival margin to the base of the sulcus. For each implant, probing depth (mm) was calculated based on the average of the 4 values obtained. For reproducibility and standardization of probe positions two devices were prepared, one for the right side and one for the left side, made from acrylic, which were adapted to the mini-abutments and contained perforations in the buccal, lingual, mesial and distal regions.

2. **Perimplant bone levels**: Each implant received a periapical radiograph using the parallelism technique with modified positioners and with the aid of an individualized bite block made of condensation silicone. The radiographs were scanned and the images were imported into the Adobe Photoshop C5-3 software. Brightness and contrast were standardized based on the values of the histogram of each image, which provides uniformity in shades of gray, making it easier to visualize the contours of the anatomical structures present. The images were opened one by one in the Vixwin Pro 1.2c software (Gendex-Dentsply) and enlarged on the monitor screen until they occupied the largest space possible. The tool “shades of gray” was selected in order to enable the evaluation of the numerical values of the pixels around the uppermost spirals of the implants. Analysis of spirals 1-2 was chosen as standard, in their mesial and distal surfaces, where the numerical values of the pixels for the bone tissue immediately next to each spiral were checked and recorded. The tool “shades of gray” provides the values of each pixel present in the images, ranging from 0 to 255. Near zero values are representative of bone loss areas (radiolucent image) and values close to 255 are radiopaque and represent the presence of bone tissue. Therefore, values from 0-40 were considered representative of areas without bone.

3. **Stability of the implants**: Implant stability was measured by resonance frequency analysis (RFA) by magnetic transduction, using Osstell® ISQ (Osstell AB, Göteborg, Sweden). For measuring, except for the baseline, the prosthesis was removed and SmartPeg A3 was adapted to the prosthetic component. The Osstell® sensor was positioned perpendicular to the long axis of the implant in the buccolingual and mesiodistal directions. All measurements were taken in triplicate and an overall average of both axis was calculated.

The data obtained received T-Test for comparison between the two groups of prosthetic connections and analysis of variance (ANOVA) to compare the results of the periods for each prosthetic connection. The significance level used in both tests was 5%.

**RESULTS**

The sample consisted of 18 patients (12 female and 6 male), totaling 72 implants inserted (36 with Morse cone and 36 with external hexagon connection). The average age of patients was 59 years. No implants were lost and no prosthetic complications were observed during the study.

**Probing depth**

A total of 876 measurements of probing depth were obtained, 292 for each evaluation period. In general, there was an increase in probing depth values for the two prosthetic connections according to the period, and the implants with Morse cone connections had statistically significant lower values of probing depth for all periods (0.68/1.19/1.31) when compared to implants with external
hexagon connections (1.08/1.52/1.64) (Table 1).

As for the analysis comparing the periods for the same type of prosthetic connection, a statistically significant difference among baseline, 3 months (p<0.01 for Morse cone and p<0.001 for external hexagon) and 6 months (p<0.001 for Morse cone and external hexagon) was observed (Table 2).

**Table 1.** Average of the parameters evaluated according to the type of prosthetic connection: T-Test at the 5% significance level.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Prosthetic connection</th>
<th>P</th>
<th>Number of analyses</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISQ</td>
<td>CM</td>
<td>EH</td>
<td>0.38</td>
</tr>
<tr>
<td>Baseline</td>
<td>71.94</td>
<td>71.08</td>
<td></td>
</tr>
<tr>
<td>3 months</td>
<td>70.73</td>
<td>69.05</td>
<td>0.08</td>
</tr>
<tr>
<td>6 months</td>
<td>69.0</td>
<td>68.23</td>
<td>0.038</td>
</tr>
<tr>
<td>PD</td>
<td>MC</td>
<td>EH</td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>0.68</td>
<td>1.08</td>
<td>0.0015*</td>
</tr>
<tr>
<td>3 months</td>
<td>1.19</td>
<td>1.52</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>6 months</td>
<td>1.31</td>
<td>1.64</td>
<td>&lt; 0.001*</td>
</tr>
<tr>
<td>PBL</td>
<td>MC</td>
<td>EH</td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>15</td>
<td>16</td>
<td>0.61</td>
</tr>
<tr>
<td>without loss</td>
<td>120</td>
<td>121</td>
<td>0.61</td>
</tr>
<tr>
<td>3 months</td>
<td>29</td>
<td>33</td>
<td>0.61</td>
</tr>
<tr>
<td>without loss</td>
<td>107</td>
<td>103</td>
<td>0.61</td>
</tr>
<tr>
<td>6 months</td>
<td>37</td>
<td>50</td>
<td>0.61</td>
</tr>
<tr>
<td>without loss</td>
<td>99</td>
<td>86</td>
<td>0.61</td>
</tr>
</tbody>
</table>

Note: MC: Morse Cone; EH: External Hexagon; ISQ: Implant Stability Quotient; PD: Probing Depth; PBL: Peri-implant bone loss; *: this indicates a statistically significant difference.

**Table 2.** Average of the parameters evaluated comparing the periods for each prosthetic connection: ANOVA at the 5% significance level.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Periods</th>
<th>p</th>
<th>Number of analyses</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISQ</td>
<td>Baseline 3 months 6 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MC</td>
<td>71.94a</td>
<td>70.73</td>
<td>69.0b</td>
</tr>
<tr>
<td>EH</td>
<td>71.08a</td>
<td>69.05</td>
<td>68.23&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>PD</td>
<td>MC</td>
<td>0.68a</td>
<td>1.19b</td>
</tr>
<tr>
<td></td>
<td>EH</td>
<td>1.08a</td>
<td>1.52&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>PBL</td>
<td>MC</td>
<td>15</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>EH</td>
<td>16</td>
<td>33</td>
</tr>
</tbody>
</table>

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**Perimplant marginal bone levels**

A total of 136 measurements per period for each one of the prosthetic connections was obtained. In the group with Morse cone connections, bone loss around the first and/or second spirals was detected in 15, 29 and 37 evaluations at the baseline, 3-month and 6-month periods, respectively. In the group with external hexagon connections bone loss was detected in 16, 33 and 50 evaluations at the baseline, 3-month and 6-month periods, respectively. However, when comparing the groups there were no statistical differences (p<0.61) (table 1). Similarly, it was also not observed any statistically significant difference in the perimplant bone loss between the periods considered for either of the prosthetic connection types (table 2).

**Stability**

A total of 1296 measurements of implant stability were obtained, 432 per evaluation period and 216 for each type of connection. Considering the three study periods, there was a reduction in the ISQ values for both types of prosthetic connection. No statistical difference was observed between groups, so that for implants with Morse cone connections the values were 71.94, 70.73 and 69 for the baseline, 3-month and 6-month periods, respectively. For implants with external hexagon connection the values were 71.08, 69.05 and 68.23 (Table 1).

In the comparative analysis of the study periods for each prosthetic connection, statistically significant differences occurred between baseline and 6 months for both types of prosthetic connection (Table 2).

**DISCUSSION**

The type of prosthetic connection may interfere with the results of implant-supported rehabilitation<sup>3,12</sup>. The different types of connection have their specific characteristics and it is worth noting that the greater the gap between the implant and the abutment, the greater the bacterial colonization, fatigue and risk of fracture. Those factors directly affect the surrounding bone tissue, causing resorption and even leading to the loss of the implant. Some studies show that the internal connections have a smaller space between the implant and the abutment and thus lower risk of biological and mechanical problems<sup>7,16-18</sup>. As in this study, in order to determine which implant system causes less damage to the perimplant tissues, some studies compared the different types of prosthetic connections<sup>7,19</sup>.

D’ercole et al.<sup>19</sup> compared Morse cone and
internal hexagon connections for bacterial infiltration at the implant/abutment interface and found no statistical differences between them. However, numerically lower bacterial infiltration was observed in the Morse cone group. In the present study, statistical difference was only observed between the groups for the parameter probing depth, with lower values for the Morse cone connection. For the other parameters assessed no statistical differences were observed between the two types of prosthetic connections.

The internal connections, especially the Morse cone, have shown better performance over the external connections in some experimental studies. Goiato et al. showed better distribution of loads on implants with Morse cone connections when compared to external hexagon connections. The superior results of internal over external connections may be primarily due to the lower vertical force transmitted from the bottom of the implant to the abutment, distribution of the lateral load into the implant and large contact surface between the implant and the abutment present in the internal connections. In accordance, the present results showed lower probing values for implants with Morse cone connection when compared to the external hexagon.

Maintenance of perimplant bone crest height is very important for the success of dental implants. For Albrektsson et al., a bone loss of up to 1.5 mm in the first year followed by 0.2 mm every year is acceptable for a successful implant. Assuming that the type of prosthetic connection interferes with the dispersion of loads around the implant, it also influences the perimplant bone loss. Therefore, several authors evaluate the perimplant bone loss in different types of prosthetic connections. In this study, the largest amount of bone loss was observed for the external hexagon group in comparison to the Morse cone group, but without statistically significant difference between them. Similarly, Lin et al. evaluated the marginal bone loss on radiographs of implants with external hexagon, internal hexagon and Morse cone prosthetic connections and no statistically significant difference was observed. These results indicate that there seems to be no difference in marginal bone loss around implants with different prosthetic connections in a short period of follow-up.

In contrast, Koo et al. evaluated the linear bone change, dimensional bone change and the angle between the implant and the adjacent bone through radiographs and found significantly higher bone loss in implants with external connections over those with internal connections. Galindo-Moreno et al. also found significantly higher marginal bone loss in implants with external connection (0.714 mm/year) as compared to implants with internal connection (0.516 mm/year) installed in the mandible after 6 and 18 months. However, as in the present study, other authors found no statistical difference in bone loss around implants with internal and external connections. Thus, it is observed that the action of different types of connections on the perimplant bone resorption is a controversial subject in the literature and requires further studies and longer follow-ups for better clarification.

With regard to the load conditions, according to Ghanavati et al., success rate of implants under early loading is approximately 93.7%. Li et al., followed for 12 months implants installed in fully edentulous jaws subjected to immediate loading and found a higher success rate (98.7%). In this study, we observed a 100% success rate for the short follow-up, since no loss or failure was observed. However, in the systematic literature review by Sanz-Sánchez et al., the authors reported a higher chance of failure (p<0.036), higher bone loss (p<0.000) and lower increase in the ISQ values (p<0.001) for implants with immediate loading over implants with conventional loading.

In contrast, Rismanchian et al. evaluated the stability quotient (ISQ), bleeding on probing, pocket depth and histomorphometric assessment after 3 months of follow-up of implants inserted into dog mandibles. Regarding the amount of bone in contact with the implant, they observed larger areas for implants with early loading (46.17% ± 12.89%), without statistical difference when compared to implants with late loading (44.4% ± 10.45%). With regard to ISQ values, statistical difference was observed between implants with early loading (71 ± 6.35) compared to late loading (66.75 ± 11.86), and the highest values were observed for the implants with early loading. Rocci et al., in turn, compared the bone/implant contact in implants with immediate loading and early loading. The bone area in the immediate loading group (92.9%) was higher than in the early loading group (81.4%), but no statistical difference was observed. Similarly, Pontes et al., compared the bone area in contact with implants placed in different positions undergoing early or late loading and observed no significant differences. In the present
study, the implants were subjected to immediate loading and the two types of connection presented similar ISQ values. A statistical difference in ISQ values was only found when comparing baseline and 6-month periods in both groups.

CONCLUSIONS

The results suggest that immediate loading is a viable option for rehabilitation of edentulous mandibles and the type of connection did not interfere with the success of the implants in the short-term follow-up.

REFERENCES


Collaborators

The nature and level of contribution where each of the authors was involved were as follows. MR OLIVEIRA and AS OLIVEIRA: collect of data; literature review, writing and submission of the manuscript. MAC GABRIELLI and R SPIN NETO, statistical analysis and assisted in the preparation of the manuscript. VA LEITE, assisted in the surgical procedures and of the documentation of the cases. OEB PAGANELLI, critical review of the writing of the manuscript and of the English version. VA PEREIRA FILHO, surgical procedure and the documentation of the cases.


Received on: 22/2/2017
Final version resubmitted on: 16/5/2017
Approved on: 22/8/2017