BIOMECHANICS AND OVERDENTURES
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ABSTRACT
The purposes of this paper are to discuss the importance of implant number, distribution, and occlusion for rehabilitation longevity, even as to compare splinted and unsplinted implants. Implant overdentures were clinically analysed and, the success and survival rates were related to the attachment system. Four implants splinted with a bar was the option more frequently used but revealed more mechanical complications. Further experimental tests and clinical studies should be performed in order to clarify the number and most appropriate distribution of implants, as well as the most favorable prosthetic designs for overdentures

Keywords: biomechanics, implant overdentures, prosthesis.

INTRODUCTION
Dental implants are used successfully as abutments on total and partially edentulous patients, supporting fixed or removable restorations. An implant-assisted overdenture consists on a removable dental prosthesis that covers and rests on one or more dental implants (The glossary of prosthodontics terms, 2005) and it is retained by an attachment system (namely, bar and ball attachments). An implant-supported overdenture is completely supported by the implants and an implant-retained overdenture is supported by the mucosa too (Misch, 2009). Depending on the dental arch to rehabilitate, some authors advise different infrastructure designs considering independent or splinted implants, as a means for improving retention and stability of conventional dentures.

Due to lack of the periodontal ligament, osseointegrated implants, unlike natural teeth, react biomechanically in a different fashion to occlusal force. It is therefore believed that dental implants may be more prone to occlusal overloading, which is often regarded as one of the potential causes for peri-implant bone loss and failure of the implant/prosthesis (Kim, 2005). So, the malposition of the implants and overloading factors may negatively influence the biomechanical behaviour of the restauration. Screw loosening and fracture, and fracture of the metallic infrastructure or prosthetic components are frequent mechanical complications. A study review concluded that the overdentures present higher technical complications rates, in comparison with other prosthodontic options (Berglundh, 2002).

Today, two-implant overdenture is a well-documented and established treatment modality for edentulous mandible. Unlike mandibular overdentures, treatment of the edentulous maxilla by implant-supported overdentures is challenging and complicated by inherent problems (Çehreli, 2010).
Apart from clinical reports, some parameters have been investigated by using Finite Elements (FE) methods, such as, the effects of mucosal thickness or resiliency and the influence of the retention mechanism on stress distribution; and the effects of implant positions on peri-implant bone stress (Bilhan, 2015).

The purposes of this paper are to discuss the importance of implant number, distribution, and occlusion for rehabilitation longevity, even as to compare splinted and unsplinted implants, regarding clinical outcomes.

**MATERIAL AND METHODS**

Patients rehabilitated with an implant-supported overdenture were called for a clinical examination of the implants and assessment of the prosthesis. Thirty-six implant-supported overdentures were clinically analysed and, the success and survival rates of dental implants were related to the jaw and to the attachment system. The number of supporting implants varied between a minimum of two and a maximum of four, splinted with a bar or unsplinted (independent retainers). At the time of the observation, the overdentures had been in situ for at least 2 and up to 12 years, with a mean of 6.5 years. Radiographs were taken and peri-implant parameters were recorded.

This study included 17 maxillary overdentures, 15 retained by a bar system and 2 supported by independent abutments (Locator); and 19 mandibular overdentures, 9 retained by a bar system and 10 connected to single abutments, either ball or Locator.

Descriptive statistics were used to calculate the frequency of complications and to understand how the success and survival rates of dental implants were related to the jaw and to the attachment system. Non-parametric tests were performed at IBM SPSS Statistics 22 to compare different groups.

**RESULTS**

A total of 143 dental implants were placed in edentulous jaws to be the support of implant overdentures. Thirteen out of these (9.1%) did not osseointegrated and were lost early. Other 7 implants (5.4%, related to the number of loaded implants) were lost during function, 5 supporting bar-maxillary overdentures (7.1%) and 2 retaining ball-abutments at the mandible (3.3%). There were no significant differences in early and late implant losses (p>0.05) between maxilla and mandible.

At the moment of observation, 123 implants were analysed (65 in maxilla and 58 in mandible), which means that 86.0% of all implants originally placed and 94.6% of all implants placed in function were still in situ. The survival rate of dental implants in this study was 92.9% for the maxilla and 96.7% for the mandible.
The overdentures included in this study were divided in groups depending on the dental arch, the retention system and the number or supporting implants, at the observation time (Table 1).

At the maxilla, 8 unsplinted and 57 splinted implants were clinically analysed, and 6 and 19 presented marginal bone loss, respectively. There was significant difference in number of implants with marginal bone loss between splinted and unsplinted dental implants (p=0.044). At the mandible, 4 out of 27 independent implants and 11 out of 31 splinted implants presented signs of marginal bone loss. There was no significant difference in number of implants with marginal bone loss between splinted and unsplinted dental implants (p=0.801) that support mandibular overdentures (Figure 1).

Regardless the complication occurrence, the survival rate of the rehabilitation was 100%. All overdentures remained in function. The occurrence of bone loss seems to be more frequent at the anterior maxilla (38.5%) than in the mandible (25.9%), but there was no statistical differences between the maxilla and the mandible (p=0.060).

Four implants splinted with a bar was the option more frequently used and revealed more biomechanical complications than ball attachment systems, such as implant loss, peri-implant bone loss, fracture of clips, need for relining and screw loosening. Fracture of the infrastructure occurred only one time, at a maxillary bar-retained overdenture.

Table 1 - Classification of the overdentures (n=36) according to the dental arch and the retention system.

<table>
<thead>
<tr>
<th>Retention system</th>
<th>Unsplinted</th>
<th>Splinted</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2 implants</td>
<td>3 implants</td>
<td>4 implants</td>
</tr>
<tr>
<td>Maxilla</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Mandible</td>
<td>6</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1 - Number of implants exhibiting marginal bone loss within each overdenture group.
DISCUSSION

The implant loss occurred more times in the maxilla (Berglundh, 2002), which could be explained by the reduced bone quality and quantity, divergent implant axes, the inclination of the implant relative to the occlusal plane, and offset positioning of denture teeth. On this study, the implant loss occurred in 5.4% of implants, near to the incidence calculated for a 5-year period (Berglundh, 2002). However there were no significant differences in the implant loss between both jaws, as well as in the early implant loss.

Marginal bone loss was evaluated at radiographs but it was not possible to quantify it. Despite the higher frequency of implant bone loss at the maxilla, there were no significant differences among the maxillary and mandibular implants. Within the maxillary overdentures, there was a significant difference between retention systems, probably because few cases of unsplinted implants were clinically analysed. According to a systematic review where 4200 implants were examined, no significant difference was observed in the marginal bone loss of implants retaining or supporting mandibular overdentures, relative to implant type or attachment designs (Çehreli, 2010).

The design of overdenture attachments should provide optimum force distribution around supporting implants to allow bone loading within physiologic levels (Çehreli, 2010). In vitro experiments and numeric analyses have suggested that overdenture attachment design may influence stress/strain magnitudes around implants and that lower stresses occur around unsplinted implants (Çehreli, 2010). Within the limitations of Finite Element Analysis, a study with an edentulous mandible model (Barão, 2013) concludes that the use of fixed implant dentures and removable dentures retained by 2, 3 or 4 unsplinted implants reduced the stresses in both implant/prosthetic components and supporting tissues (cortical bone, trabecular bone and mucosa). In addition, cantilevered bar-clip overdenture displayed highest stresses values within components and the bar-clip overdenture highest stress in the tissues. On the other hand, Bilhan et al. (Bilhan, 2015) concluded that the increase in number of implants and the use of a splinted attachment could be preferred in order to reduce forces emerging around the implants. This slightly lower stress values for the bar attachment could be particularly important in cases with reduced implant size and/or bone quality (Bilhan, 2015). In vivo, however, it has been shown that bar retainers contribute to force partitioning (load sharing) between implants, higher forces are exerted on unsplinted implants, and loading on distal cantilever bar extensions does not lead to excessive bone loss around implants (Çehreli, 2010). In addition, the height of magnet and ball attachments usually does not exceed the cervico-occlusal level of bars; therefore, their use probably does not lead to bending moments that exceed the physiologic tolerance of bone tissue (Çehreli, 2010).

Information about the influence of different attachment types on the frequency of prosthetic complications is also controversy.
CONCLUSION

Implant overloading attributes clinical complications such as screw loosing or fractures, prosthesis fractures, continuing marginal bone loss, implant fractures and implant loss (Kim, 2005). At the present time, for the maxilla there are no studies that concluded how many implants should support an overdenture (Rocuzzo, 2012). For the mandible, it cannot be concluded that bone loss, patient satisfaction or number of complications is significantly related to the number of implants supporting the overdenture (Rocuzzo, 2012). Controversy persists regarding the design and indications for different attachment systems for overdentures (Çehreli, 2010).

The biomechanical behavior of implant overdentures depends on the number and distribution of the supporting implants, their characteristics and angulations. Moreover, biological and anatomic conditions should also be considered on the treatment outcome. Further experimental tests and clinical studies should be performed in order to clarify the number and most appropriate distribution of implants, as well as the most favorable prosthetic designs for overdentures.

REFERENCES


