Implant stability is one of the principal factors in the clinical success of implant therapy. Research has shown that one of the major causes of failures in osseointegration is excessive micro-movements, although to date, there is no clinical available method for measuring micro-movements.

In this study 32 endosseous implants (Camlog Biotechnologies®, Wimsheim, Germany) inserted in rehabilitated patients with two or more adjacent dental implants in the lower posterior jaw [Fig.1]. Implants were restored using unit crowns over two different prosthetic abutments 5D (N=14) and PS (N=14), were used [Fig. 2].

Clinical stability was also measured clinically in ISQ (Implant Stability Quotient) using the Osstell® ISQ (Osstell® ISQ Integration Diagnostic, Sweden) [Fig.5]. The results were statistically analyzed with the software IBM SPSS® Statistics 20.0 [SPSS Inc., Chicago, Illinois, USA].

The results obtained show correlation with the RFA system, and Prosthetic abutment geometry did not interfere in the ISQ readings [Fig.6].

Micro-movement measurements were performed by 3D DIC with two high speed photographic cameras [Fig.3] [Point Grey GRAS-20454C, PENTAX TV Lens 75mm, 1:2.8, with 1624x1224 resolution] and the video correlation system Vic 3D 2010 (Correlated Solutions®, Columbus, USA), after the application of a bite load of more than 30N, measured with a miniature compression loading cell (Applied Measurements Ltd., Berkshire, UK) and the system design software LabVIEW 2010 (National Instruments®, Texas, USA) [Fig.4].

In order to measure micro-movements, the system required a heterogeneous pattern which was handled with a software: Evolution Silverline (Harder & Steenbeck, Nordenstedt, Germany) over a sticker paper and placed on the buccal side of both the crown over the implant and the neighboring natural tooth [Fig.6]. After images acquisition, micro-movements analysis was done with a post processing application from Vic-3D 2010, in order to remove the rigid body motion. For each patient, a stero system calibration was performed using a standardized calibration target sized 14,929mm, with a pitch of 1,780mm (9x9), before acquiring images.

The results obtained for maximum micro-movements values [μm] with digital image correlation in the three space directions U, V and W [Mesio-Distal, Occlusal-Apical and Buccal-Lingual, respectively] and the Resultant displacement (R) were:

<table>
<thead>
<tr>
<th>Displacement</th>
<th>U</th>
<th>V</th>
<th>W</th>
<th>R</th>
</tr>
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</table>

The results obtained seem to be correlated with the ISQ values indirectly measured by RFA (Resonance Frequency Analysis) with the Osstell® ISQ, for each space direction considered (U and W), U: (26)=0.412, p=0.036, W: (26)=0.417, p=0.034. For direction V (Apical) results weren’t compared because the Osstell® ISQ doesn’t work in this direction, which is a limitation of this method.

Conclusions

Within the limitations of this study, 3D DIC method is capable to measure dental implants micro-movements, although not being a clinical system. The results obtained show correlation with the RFA system, and Prosthetic abutment geometry did not influence the occurrence of micro-movements.

Acknowledgments