MEASUREMENT OF LOOSENING TORQUE OF PROSTHETIC COMPONENTS IN MORSE TAPER CONNECTION IMPLANTS

ABSTRACT

AIM: The aim of this study was to verify two different types of interfaces in Morse taper connection implants, relating the mechanical resistance to a loosening torque that is required to separate or move the prosthetic abutment. MATERIAL AND METHODS: Ten Morse taper connection implants and their respective abutments were divided into two groups (n = 5), DH (double hexagon) interface and OI (octagonal implant) interface. A standard insertion of implants was performed in a stainless steel base, where each abutment received a sequence of two consecutive tightening torques at a 10-minute interval, followed by a loosening torque, which was measured using a digital torque gauge. The Student's t-test with a 5% significance level was used for data analysis. RESULTS: The results showed a statistically significant difference in the loosening torque values compared with DH torque values (p < 0.05). However, the difference between tightening and loosening torque values was not statistically significant in the OI group (p = 0.465). CONCLUSION: The study concluded that there was a difference in the torque required to loosen the abutment screws between the DH group and the OI group, with the latter showing better results.

KEYWORDS

Dental implants. Morse taper connection. Implant-abutment connection.

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INTRODUCTION

Dental implants are designed to restore function and aesthetics of partially and fully edentulous patients. Osteo-integration is described as the close contact between implant and bone, which has shown to be successful in the implant systems\textsuperscript{1-2}. These approaches have led to the emergence of new implant-abutment connection systems and their components, allowing a larger number of studies and solutions for more effective and aesthetic results in rehabilitative treatment\textsuperscript{3-4}.

Morse taper connection implants have been studied to examine their advantages over systems using internal or external hexagon, in which there is a fit improvement between the implant and the prosthetic abutment system, according to the literature\textsuperscript{5}. Alkan et al.\textsuperscript{6} (2004) report that the preload is the strength produced on the implant screw by the torque applied. In the hexagon implant system, preload is the only force that resists to functional occlusal forces, preventing abutment displacement. If the preload is exceeded by the occlusal force, the screw will loosen\textsuperscript{7}. Morse taper connections improve the fit between the different implant components and help prevent loosening\textsuperscript{8-9}.

When the loosening torque values are close to or greater than the fastening torque, it indicates that there is a good prognosis regarding the loosening of prosthetic components\textsuperscript{10}. If a torque is applied on a Morse taper connection, the abutment cone is pulled against the inner wall of the implant, which generates friction between the parts, and a close contact occurred between the internal and external surfaces of the abutment implant\textsuperscript{11}. Morse taper coupling is characterized by the need for a loosening torque greater than a tightening torque to loosen the abutment\textsuperscript{12-13-14}. Different types of adaptation to the prosthetic implant abutment have been developed, such as indexed components aimed at facilitating abutment positioning and manufacturing of the dental prosthesis\textsuperscript{15-16-17-18}.

The mechanical stability of the implant-abutment connection is crucial to the success of implant-supported restorations. Therefore, understanding torque tightening and loosening values is essential. According to some authors, the implant stability can be improved by using indexed interfaces\textsuperscript{18}. For an adequate fit at the abutment-implant interface to occur, in addition to the torque values recommended by the manufacturer, passive adaptation is vital to prevent micro motions and instability, generating a significant screw torque loss\textsuperscript{19}.

Given the above, the aim of present study was to examine two different types of interfaces for Morse taper connections regarding the mechanical resistance to loosening torque that is required to move or
separate the prosthetic abutment from the implant. The null hypothesis was that there were no statistically significant differences between the two groups.

**MATERIAL AND METHODS**

Ten Morse taper implants (Titaniumfix®, São José dos Campos, Brazil) were used for this study. The sample was randomly divided into two groups (n = 5), according to the abutment-implant interface design.

The double hexagon (DH) group comprised five 11-degree Morse taper implants (B-fix, Titaniumfix®, São José dos Campos, Brasil) for dual locking with antirotation cone, dual internal hexagon, micro threads in the coronal portion, regular platform 4.0, 10mm in length, and aesthetic abutment (Ref: 406801) with a torque of 20 Ncm (Titaniumfix®, São José dos Campos, Brazil). The octagonal interface (OI) group comprised five octagonal design implants (C-fixTitaniumfix®, São José dos Campos, Brasil) with transgingival collar of 1.8 mm and 45-degree shoulder, associated with an 8-degree internal tapered fitting, regular platform 4.0, 10mm in length and solid abutment (Ref: CMAC4.0) with a torque of 32 Ncm (Titaniumfix®, São José dos Campos, Brasil).

To prepare the specimens, a standardized insertion of implants was performed in a stainless steel base and secured with a cross bolt. Then, the prosthetic component was manually coupled using a specific wrench\(^\text{17}\) (Figure 1).

After the specimens and their bases were secured, tightening and loosening torques were applied. The torque in each group was applied according to the manufacturer’s guidelines. For that purpose, a digital torque gauge with a nominal axial range between 15 and 150 Ncm, 0.1 Ncm resolution (Tohnichi®i, STC50CN model, manufacturing Nº 703224S, Japan) previously calibrated was used (Figure 2).

Before attachment of the abutment, a solution of 1 mL of sterile saline was applied to the internal threads of the implant using a pipette to simulate the environment of the oral cavity prior to insertion of the implant screw\(^\text{19}\). For each set of abutment-implant connections, the screw was set under the torque recommended by the manufacturer. The proper wrench provided was attached to the digital torque gauge following the manufacturer’s protocol to insert all screws. After 10 minutes, the screw was re-tightened to the same torque load to minimize displacements between the mating threads and to achieve optimum preload. Five minutes later, the loosening torque was measured using a digital torque gauge. Each loosening torque was recorded for each abutment-implant connection (Figure 3).
RESULTS

The Student’s t-test was used for statistical data analysis. Given that each group was subjected to an initial torque, the results of the initial torque entered the statistical analysis to obtain the means of loosening torque. Analysis of the results between groups showed a statistically significant difference in the DH group (p < 0.05). However, there was no statistically significant difference in the OI group (p = 0.465) (Table 1). Regarding the torque loss, there was a statistically significant loss in the DH group compared with the OI group (p < 0.001). (Table 2).

DISCUSSION

The results of this study rejected the null hypothesis, because there were statistically significant differences between DH and OI groups when a loosening torque was applied to the abutment-implant systems (p < 0.001), which demonstrated that the OI group had a greater resistance to a loosening torque than the DH interfaces.

A comparison between the groups revealed that there was a significant torque loss in the DH interfaces, showing an increased tendency towards loosening of these components. In the OI group, the torque loss was only 1.28%, which was not significant, being very close to the torque load value applied. In a study by Sutter et al.14 (1993), the loosening torque value in Morse taper...
connection and 8-degree internal angle implants was approximately 24% higher than the tightening torque, at 25 Ncm, which characterizes a good prognosis for the making of the future prosthesis, given that the loosening torque values are close to or higher than the tightening torque values.

### Table 1. Comparison of the tightening and loosening torque values between the groups (Ncm).

<table>
<thead>
<tr>
<th>Groups</th>
<th>Tightening torque Mean (SD)</th>
<th>Loosening torque Mean (SD)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DH (N=5)</td>
<td>20.09±0.02</td>
<td>13.77±1.06</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>OI (N=5)</td>
<td>32.17±0.03</td>
<td>31.76±1.79</td>
<td>0.465</td>
</tr>
</tbody>
</table>

Student’s t-test. *DH = Double hexagon; *OI = Octagonal interface.

### Table 2. Absolute and relative differences between tightening and loosening torque values.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Absolute/relative means - SD</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DH (N=5)</td>
<td>6.32/31.45% - 1.80</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>OI (N=5)</td>
<td>0.41/1.27% - 1.08</td>
<td>-</td>
</tr>
</tbody>
</table>

Student’s t-test. *DH = Double Hexagonal; *OI = Octagonal Interface.

An analysis of the tightening and loosening torque results of the DH group interface (31.45%) and OI system (1.27%) suggests, as did Binon (2000), that since there is a bonding between two independent metallic structures, micro motions between the connections may occur, thus influencing loosening torque values.

According to results from the literature, indexed prosthetic components somehow influence the frictional resistance of the abutment, which alters somewhat the loosening torque values of these components. Ceruti et al.\(^\text{16}\) (2014) compared the tightening and loosening torque values between indexed and non-indexed abutments, and concluded that the indexed abutment group demonstrated a torque loss of 15.3%, which supports the findings by Villarinho et al.\(^\text{18}\) (2013) who also compared indexed vs. non-indexed abutments and found a torque loss of 14.81% in the indexed abutment group.

Weiss et al.\(^\text{10}\) (2000) tested several connection models of abutment-implant systems by performing tightening and loosening torque cycles on screw implants in Morse taper connections. They demonstrated that there was a loss of initial torque caused by poor quality or possible lack of accuracy in manufacturing the parts involved in the abutment-implant connections, which could affect the desired contact precision at the time of placement and final tightening of the implant. In the present study, both groups
showed a decrease in the loosening torque values compared with their tightening torque values. The minimum torque loss of only 0.41 Ncm observed in the OI group was not considered statistically significant.

In their study, Rodrigues Neto et al.\textsuperscript{17} (2014) tested components with octagonal and hexagonal dual interfaces, using 10 implants divided into two groups, and found no significant differences in the loosening torque values between the groups (p = 0.12). Given that no differences were found by comparing tightening torque and loosening torque between groups, the authors suggested that further studies should be conducted with a larger number of specimens and mechanical cycling for future comparisons. Using the same method as that used by Rodrigues Neto et al. for the comparison of the torque values, the present study found statistically significant differences between the groups (p <0.05). Due to the conflicting results, new methods and a larger number of specimens should be used in future studies.

Cerutti et al.\textsuperscript{8} (2013) evaluated the loosening torque values in indexed abutments of Morse taper systems and found a significant difference within the groups by comparing the loosening torque with tightening torque in the internal DH connection group. In that study, the loosening torque values of the abutment were not higher than the tightening torque values of the indexed abutments. A possible interference of devices with rotational features in the indexed components may be the cause that prevented the occurrence of high loosening torque values, since they do not allow a close contact that is characteristic of components with a conical interface. In the present study, no difference was found between the tightening torque and loosening torque values in the groups assessed by applying the same method as that mentioned in study above. Since that there were anti-rotation components in the implants, the result may also be explained by the absence of mechanical cycling.

Given that this study was conducted in vitro, further studies that use axial loads are needed to analyze the behavior of different indexed forms of Morse taper abutments.

**CONCLUSION**

Within the limitations of in vitro studies, this study concluded that there was a significant reduction in the loosening torque values compared with the tightening torque values in the DH group (p < 0.05). Moreover, there was a significant torque loss in the DH group compared with the OI group (p < 0.05), which demonstrated better results for the octagonal group interface.
REFERENCES


