An *In Vitro* study to compare the insertion torque and the removal torque of two screw type dental implants with different thread designs on three different materials. Final Report. Ref. A-27- JCT-08

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AIM

This study aims to determine the influence of macroscopic design of dental implants on the insertion and removal torque in wood conglomerate, epoxy resin and bovine bone ribs.

SPECIFIC AIMS

- To compare the insertion torque values of Euroteknika Universal and Euroteknika Natura implants in conglomerate wood, epoxy resin and bovine bone.

- To compare the removal torque values of Euroteknika Universal and Euroteknika Natura implants in conglomerate wood, epoxy resin and bovine bone.
METODOLOGY

Materials:

Two squares of wood conglomerate with dimensions 12 x 13 x 1,5 cm, 20 cubes of epoxy resin (Epoxicure™ hardener) with dimensions 2 x 2 x 2 cm and two bovine ribs without soft tissues were prepared to insert the two studied implant types.

Work sequence:

- Twenty 4*10mm Euroteknika Universal implants were inserted in conglomerate wood.
  - The position of the 20 implants was marked on the conglomerate wood allowing a distance of 1cm between implants.
  - The following sequence of drills of Euroteknika Universal quirurgical kit was used under saline irrigation:
    - 2,2 drill until 10mm
    - 2,9 drill until 10mm
    - 3,15 drill until 10mm
    - 3,4 drill until 10mm

- Twenty 4*10mm Euroteknika Natura implants were inserted in conglomerate wood.
  - The position of the 20 implants was marked on the conglomerate wood allowing a distance of 1cm between implants.
  - The following sequence of drills of Euroteknika Natura quirurgical kit was used under saline irrigation:
    - 2,2 x10 drill
    - 2,6 drill until 10mm
    - Cortical drill for Ø 4 until its stop
    - Conical drill with stop until 10mm
o Twenty 4*10mm Euroteknika Universal implants were inserted in epoxy resin.

- The following sequence of drills of Euroteknika Universal quirurgical kit was used under saline irrigation:
  - 2,2 drill until 10mm
  - 2,90 drill until 10mm
  - 3,15 drill until 10mm
  - 3,40 drill until 10mm
  - 3,75 drill until 10mm because the epoxy resin is considered as bone type D2-D1 (hard)

o Twenty 4*10mm Euroteknika Natura implants were inserted in epoxy resin.

- The following sequence of drill of Euroteknika Natura quirurgical kit was used under saline irrigation:
  - 2,2 x10 drill
  - 2,6 until 10mm
  - Cortical drill for Ø 4 until its stop
  - Conical drill without stop until 10mm

o Twenty-two 4*10mm Euroteknika Universal implants were inserted in type 2-3 bovine rib.

- The position of the 20 implants was marked on the surface of bone simulator allowing a distance of 1cm between implants.
- The following sequence of drills of Euroteknika Universal quirurgical kit was used under saline irrigation:
  - 2,2 drill until 10mm
  - 2,9 drill until 10mm
  - 3,15 drill until 10mm
  - 3,4 drill until 10mm
Twenty-two 4*10mm Euroteknika Natura implants were inserted in type 2-3 bovine rib.

- The position of the 20 implants was marked on the conglomerate wood allowing a distance of 1cm between implants.
- The following sequence of drills of Euroteknika Natura quirurgical kit was used under saline irrigation:
  - 2,2 x10 drill
  - 2,6 drill until 10mm
  - Cortical drill for Ø 4 until its stop
  - Conical drill with stop until 10mm

Once the implants beds were all prepared, implants were placed and removed manually with a digital torque controller (Force and Torque™, Mecmesin, England). The maximum insertion and removal torque value was registered.

**Statistical Analysis**

To study differences in torque of insertion or removal torque between Universal and Natura implants and among different insertion materials multifactor ANOVA analysis of variance was used (Statgraphics Plus 5.1). Factors were type of implant and material where implants were placed in.

To study the relation of insertion torque and removal torque of Universal and Natura implants simple regression analysis was used (Statgraphics Plus 5.1)
RESULTS

Study of insertion torque values

Descriptive values of torque of insertion depending on type of implants are shown in table 1.

<table>
<thead>
<tr>
<th>INSERTION TORQUE (N*cm)</th>
<th>UNIVERSAL IMPLANTS</th>
<th>NATURA IMPLANTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEAN</td>
<td>60,72</td>
<td>72,17</td>
</tr>
<tr>
<td>STANDARD DEVIATION</td>
<td>22,26</td>
<td>22,17</td>
</tr>
<tr>
<td>MAXIMUM</td>
<td>97,6</td>
<td>121</td>
</tr>
<tr>
<td>MINIMUM</td>
<td>15,2</td>
<td>15,8</td>
</tr>
</tbody>
</table>

*TABLE 1. Descriptive analysis of torque of insertion values (N*cm) for Universal and Natura implants*

Mean values of torque of insertion depending on type of implant and material used to insert implants are represented in figure 1.

![Insertion Torque](image)

*FIGURE 1. Insertion torque (N*cm) depending on material used and type of implant*

Mean torque of insertion measured in Natura implants was statistically greater than in Universal implants (<0,0001) (Figure 2). Mean torque of insertion measured in different materials was statistically different (p<0,0001). Mean torque of insertion measured on epoxy resin was significantly the greatest measured value. Mean torque measured in conglomerate wood was significantly greater than that measured bovine ribs (Figure 3). Interaction of type of implant and material of insertion was not statistically significant (p=0,52). Mean torque measured in Natura implants was greater than that measured in Universal implants in all materials (Figure 4).
FIGURE 2. Mean table of torque of insertion depending on type of implant used

FIGURE 3. Mean table of torque of insertion depending on the material used for implant insertion
FIGURE 4. Interaction of material used and type of implant in the registered torque of insertion values

Study of removal torque values

Descriptive values of removal torque depending on type of implants are shown in table 2.

<table>
<thead>
<tr>
<th>REMOVAL TORQUE (N*cm)</th>
<th>UNIVERSAL IMPLANTS</th>
<th>NATURA IMPLANTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>61,10</td>
<td>69,23</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>18,38</td>
<td>16,28</td>
</tr>
<tr>
<td>Maximum</td>
<td>90,8</td>
<td>108,8</td>
</tr>
<tr>
<td>Minimum</td>
<td>12,4</td>
<td>11,2</td>
</tr>
</tbody>
</table>

TABLE 2. Descriptive analysis of removal torque values (N*cm) for Universal and Natura implants

Mean values of removal torque of insertion depending on type of implant and material used to insert implants are represented in figure 5.
Mean removal torque values measured in Natura implants were significantly greater than those measured in Universal implants (p=0.0016) (Figure 6). Mean removal torque measured on different materials was statistically different (p<0.001). Mean removal torque measured in epoxy resin was significantly the greatest measured value. No significant differences were stated between removal torque values measured in conglomerate wood and bovine bone (Figure 7). Interaction of type of implant and material of insertion was statistically significant (p=0.0079). In conglomerate wood and bovine bone removal torque values were greater in Natura implants than in Universal implants. In epoxy resin removal torque measured in Universal implants was slightly superior to that measured in epoxy resin (Figure 8).
FIGURE 6. Removal torque measured in Universal implants and Natura Implants

FIGURE 7. Removal torque measured when epoxy resin and conglomerate wood was used
Study of relationship between insertion torque values and removal torque values

It exists a strong correlation between insertion torque values and removal torque values in Universal implants ($r=0.90$) (Figure 9 and 10) and in Natura Implants ($r=0.77$) (Figure 11 and 12).

FIGURE 8. Interaction in removal torque of sort of implant and material used for its insertion

FIGURE 9. Correlation between Insertion Torque and Removal Torque values in Universal Implants
**FIGURE 10.** Insertion and Removal Torque Values in different materials with Universal Implants

**FIGURE 11.** Correlation between Insertion Torque and Removal Torque values in Natura Implants

<table>
<thead>
<tr>
<th>Material</th>
<th>Insertion Torque</th>
<th>Removal Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epoxy Resin</td>
<td>88,7</td>
<td>80,865</td>
</tr>
<tr>
<td>Wood</td>
<td>54,4053</td>
<td>51,6211</td>
</tr>
<tr>
<td>Bovine Bone</td>
<td>40,73</td>
<td>51,33</td>
</tr>
</tbody>
</table>
FIGURE 12. Insertion and Removal Torque Values in different materials with Natura Implants
DISCUSSION

Two types of implants were tested. Natura implants have a conical shape and Universal type of implants have a cylindrical shape. Both, torque of insertion values and removal torque values, were significantly superior for Natura implants, indicating that conical shape may induce more primary stability than a cylindrical shape, which is also stated in the dental literature\(^1\).

Maximum values of insertion torque were always seen at the end of the insertion of the implant. All implants were placed at the same depth of the material used, so no greater values of insertion torque were measured because of increasing insertion depth. Maximum removal torque values were always seen at the first unthreading, so removal torque values are more consistent than insertion torque values. Removal torque values in epoxy resin were slightly greater in Universal implants than in Natura implants. Epoxy resin is a very hard material so it may be considered that friction had a very important role in the higher value observed in Universal implants, which have more contact surface material-implant than Natura implants.

A strong correlation was observed for torque of insertion values and removal torque, which indicate that both values are related and are consistent. This indicates a positive quality control of the performance of this study.

Both types of implants were tested in three different implantation materials. Bovine bone is considered as an equivalent of human bone\(^2\). Epoxy resin is a very strong material that is used for mechanical studies, but it may not be the best material for studying torque of insertion and removal. Conglomerate wood gives similar properties than bovine bone. Conglomerate wood properties depend in an important degree on its composition, which is not constant in all conglomerate woods available in the market. Finally, bovine bone density is not very constant. In this study we alternated the placement of Universal implants and Natura implants, so the difference observed with the bone density did not have a direct effect on the registered values. In bovine ribs, torque of insertion depended very much on the depth the implant was placed, which may be the explanation of the high removal torque values measured in this material in comparison with the insertion torque values.