**Implants with original and non-original abutment connections**

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**Introduction**

The economic pressure to produce and deliver implant-supported reconstructions at a reduced material price, when at the same time investments in the dental laboratory are reduced and access to equipment is limited, may lead to the use of non-original abutments for the restoration of implants. Small-diameter implants that are made of a titanium-zirconium alloy and have a higher mechanical strength allow implant-supported reconstructions in smaller spaces and narrower ridges. Using these small-diameter implants avoids the use of augmentation procedures and orthodontic treatment.

**Aim of this study**

1) Test in vitro mechanical resistance of three original abutments on original implants and two non-original abutments on original implants.
2) Measure rotational misfit between original abutments on original implants and non-original abutments on original implants.
3) Assess and compare failure modes.

**Materials and methods**

Diameter-reduced implants with CADCAM titanium abutments were used with the following implant-abutment combinations (11 or 12 specimens):

- **Group A**: Straumann BL NC 3.3 mm Roxolid® with Straumann® CARES® Titanium abutments
- **Group B**: Straumann BL NC 3.3 mm Roxolid® with Nobel Biocare Procera® Titanium abutments
- **Group C**: Straumann BL NC 3.3 mm Roxolid® with Astra Tech Atlantis™ Titanium abutments
- **Group D**: Nobel Biocare Replace Straight 3.4 NP with Nobel Biocare Procera® Titanium abutments
- **Group E**: Astra Tech OsseoSpeed™ TX 3.5 S with Astra Tech Atlantis® Titanium abutment

The rotational misfit was measured with a rotation measurement tool. The critical bending moment was measured with a set up according to ISO 14801.

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<table>
<thead>
<tr>
<th>Group</th>
<th>Number of specimen</th>
<th>Mean rotational misfit</th>
<th>Standard deviation</th>
<th>Minimum rotational misfit</th>
<th>Maximum rotational misfit</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Straumann® Implant, Straumann® Abutment</td>
<td>11</td>
<td>1.21°</td>
<td>0.236°</td>
<td>0.83°</td>
</tr>
<tr>
<td>B</td>
<td>Straumann® Implant, Nobel Biocare® Abutment</td>
<td>12</td>
<td>n.a.</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
<tr>
<td>C</td>
<td>Straumann® Implant, Astra Tech® Abutment</td>
<td>12</td>
<td>2.01°</td>
<td>0.446°</td>
<td>0.83°</td>
</tr>
<tr>
<td>D</td>
<td>Nobel Biocare® Implant, Nobel Biocare® Abutment</td>
<td>12</td>
<td>3.50°</td>
<td>0.285°</td>
<td>3.00°</td>
</tr>
<tr>
<td>E</td>
<td>Astra Tech® Implant, Astra Tech® Abutment</td>
<td>11</td>
<td>2.50°</td>
<td>0.208°</td>
<td>2.33°</td>
</tr>
</tbody>
</table>

Tab. 1: Rotational misfit
All pairwise comparisons (A–C, A–D, A–E, C–D, C–E, D–E) were statistically significantly different. The interface with the original Straumann abutment on the original Straumann implant was the most precise connection.

The forces measured with non-original abutments on original implants (Groups B and C) were significantly higher compared to the original abutments on original implants (Groups A, D and E). This is due to the different abutment materials used: Straumann uses titanium Grade 4, and Nobel Biocare and Astra Tech use titanium Grade 5 abutment material, which altered the mechanical stiffness of those specimens.

Conclusions

On the basis of the study results it should be recommended to use abutments from the original implant manufacturer when restoring implants.

Non-original abutments differed in the design of the connecting surfaces, shape, dimensions and material and have a higher rotational misfit. All these differences may result in unexpected failure modes and may have an effect on clinical handling as demonstrated by the rotational misfit in Group B. There are no known clinical studies evaluating the influence of non-original abutments on implants and their use may result in a potentially increased risk.

Only the interface with the original Straumann abutment on the original Straumann implant showed a smooth displacement curve. In all other groups an uneven force and release was noted, which is known as the stick-slip effect. Additionally, the interface with the original Straumann abutment on the original Straumann implant showed the most consistent measurements, indicated by the smallest box plots.

<table>
<thead>
<tr>
<th>Group</th>
<th>Maximal force to fracture</th>
<th>Force at 0.2% strain offset</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Straumann® Implant, Straumann® Abutment</td>
<td>553 N ± 30 N</td>
<td>487 N ± 41 N</td>
</tr>
<tr>
<td>B: Straumann® Implant, Nobel Biocare® Abutment</td>
<td>700 N ± 32 N</td>
<td>538 N ± 40 N</td>
</tr>
<tr>
<td>C: Straumann® Implant, Astra Tech® Abutment</td>
<td>690 N ± 24 N</td>
<td>587 N ± 43 N</td>
</tr>
<tr>
<td>D: Nobel Biocare® Implant, Nobel Biocare® Abutment</td>
<td>555 N ± 25 N</td>
<td>453 N ± 44 N</td>
</tr>
<tr>
<td>E: Astra Tech® Implant, Astra Tech® Abutment</td>
<td>508 N ± 43 N</td>
<td>439 N ± 49 N</td>
</tr>
</tbody>
</table>

Tab. 2: Mechanical resistance

1 One abutment was used as a sample to run a pre-test for the entire series, which reduced the number of specimen to 11.

2 One abutment could not be used to run the test as the fit with the stainless steel cylinder could not be obtained, which reduced the number of specimen to 11.

3 No measurements were possible since the non-original abutments were oversized and manual adjustments were necessary to connect the abutments to the implants. Three out of 12 abutments could not be removed after testing.

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