Screw-retained implant-supported restoration in the edentulous maxilla

A working document for the production of a milled zirconium dioxide framework

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When veneering zirconium dioxide frameworks, manual dexterity and a profound knowledge of the materials is required. The correct use of the materials is decisive for success. A screw-retained and therefore conditionally removable restoration is a proven concept for the implant prosthetic treatment of an edentulous maxilla. Zirconium dioxide is a framework material that can support a long-lasting result. A state-of-the-art zirconium dioxide material such as Zenostar T (Wieland Dental) and innovative ceramic veneering systems (such as IPS e.max Ceram, Ivoclar Vivadent) enable natural-looking prosthetic restorations to be achieved in an efficient manner. In principle, zirconium dioxide is a sophisticated material that requires correct and skilled application.

Introduction to a patient case

An implant-supported, screw-retained bridge was planned for the edentulous maxilla. Based on defined backward planning, six implants were inserted into the patient’s jaw. After the healing phase, the implants in the visible region were provided with transversal screw-retained abutments. In the molar region, the final bridge restoration would be occlusally screw-retained.

Important parameter for framework production

A set-up of the planned restoration was used as a basis for the CAD/CAM-supported production (Zenotec, Wieland Dental) of the zirconium dioxide framework. After digitisation in the design software, the framework shape was reduced according to the cut-back technique. This method created sufficient space for the veneer. The digital structure was first milled in wax so that the fit and precision could be checked (Fig. 1). Subsequently, the framework was milled from a Zenostar T disc. During framework construction, it was necessary to include sintering drops as an occlusal support for the restoration so that distortion would be prevented during sintering in the Zenotec sintering furnace. In doing so, the restoration was not to be separated from the occlusal tongue (Fig. 2). Sintering distortion was avoided with this method. The sintering process was carried out in the compact, high-temperature Zenotec Fire P1 sintering furnace, which is supplied with pre-installed programmes. This sintering furnace can also be freely programmed so that other sintering programmes can be used. We selected the “long programme”. The heating-up and cooling-down phases
were set as long as possible in order to achieve an exact result. It should be noted that the sintering time should not be shortened. After sintering, the framework had the required fitting accuracy. The restoration was perfectly supported with the occlusally positioned sintering drops (Fig. 3). The titanium sleeves could be easily inserted into the framework (Figs. 4 & 5).

The recommended sintering programme:
- 20–900 °C for 1.5 h (600 °C/h)
- Holding time: 900 °C for 30 min
- 900–1,450 °C for 2.75 h (200 °C/h)
- 1,450 °C for 2 h
- Cooling: 600 °C/h; from 1,450 to 900 °C
- 900–300 °C for 1.2 h

Preparing for veneering

The next working steps require not only manual dexterity but also knowledge of the material firing parameters and furnace settings. This is the only way to ensure a balanced temperature distribution in the bonding area between the framework and the veneer. This in turn results in a sound bond and uniform shrinkage of the ceramic layer. Slow cooling of the restoration prevents the risk of tension in the fired restoration, which therefore minimises the risk of

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Fig. 3: Sintering the framework. Small sintering drops supported the framework during sintering. – Fig. 4: Checking the fit of the titanium sleeves after sintering. – Fig. 5: Comparison between the wax structure and the sintered framework. – Fig. 6: The fired framework with IPS e.max Ceram ZirLiner ready for veneering. – Fig. 7: Preparing for the wash bake. Both the gingival and the tooth areas were covered with the relevant materials. – Fig. 8: Selection of the required dentine materials (IPS e.max Ceram).
Case report: restoration of the edentulous maxilla

Delamination. The exact fit of the restoration justifies the long firing time.

It should be noted that the programmes must be adjusted accordingly before the ZirLiner bake (IPS e.max Ceram ZirLiner, Ivoclar Vivadent):
- long heating-up time
- long cooling-down time

Ceramic system and framework

Our preferred veneering material (IPS e.max Ceram) consists of low-fusing nano-fluorapatite. The material has a crystal structure similar to that of natural dentition and allows a specifically adjustable combination of translucency, brightness and opalescence. The framework (Zenostar T) is an ideal base for the ceramic veneer. The defined cut-back enables the framework to be veneered efficiently. The reduced tooth shape allows the veneering ceramic to be applied in an even thickness. This ensures that the layered ceramic is heated uniformly during firing. For the fabrication of the prosthetic gingiva, we chose IPS e.max Ceram Gingiva materials, with which we achieved a gingival area with a lifelike appearance. The materials were applied and fired in a similar manner to the dentine and enamel materials.

Liner bake

First, the ZirLiner bake was carried out using the IPS e.max Ceram ZirLiner, a material with multiple functions. On the one hand, the ZirLiner creates a strong bond between the veneer and the framework. On the other hand, it gives the restoration depth of shade and fluorescence. We do not recommend omitting the ZirLiner, as this can increase the risk of cracks and delamination. Before the ZirLiner is applied, the framework must be free from dust and dirt. Contamination must be avoided. The IPS e.max Ceram Liner should cover the framework completely; we recommend applying the material in uneven layers. After a short drying time, it can be fired (Fig. 6).
Wash bake
Owing to the low thermal conductivity of zirconium dioxide, the wash bake is indispensable. The veneering ceramic sinters directly on to the framework surface, and a homogeneous bond to the fired ZirLiner is achieved. First, a wash bake was carried out in the pink aesthetic zone. The restoration was placed on to a firing tray and then fired (Fig. 7). Then the IPS e.max Ceram Transpa clear wash bake was carried out.

The recommended firing programme for the wash bake:

<table>
<thead>
<tr>
<th>Start temp.</th>
<th>Drying time</th>
</tr>
</thead>
<tbody>
<tr>
<td>403°C</td>
<td>8 min</td>
</tr>
</tbody>
</table>

Temp. increase | End temp. |
25°C/min | 980°C |

Holding time
1 min
Vacuum
450–959°C

Individual build-up of the white aesthetics
The basic tooth shade for this restoration was A2. In order to achieve a unique and characteristic result, we individualised the ceramic materials and used other effects, such as Deep Dentin and Impulse, Intensive and opalescent materials (Fig. 8). We built up the ceramic on the prepared framework according to the layering diagram (Fig. 9), using Build-up Liquids to mix the IPS e.max Ceram. We worked as closely as possible to the final tooth shape (Figs. 10 & 11) and then fired the restoration.

The recommended firing programme for the first dentine bake:

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>403°C</td>
<td>8 min</td>
</tr>
</tbody>
</table>

Temp. increase | End temp. |
25°C/min | 450–749°C |

Holding time
1 min
Vacuum
450–749°C

After firing, the bridge was trimmed and cleaned. This is ideally carried out in an ultrasound water bath or using a steam cleaner. The shape was then completed using ceramic and a second dentine bake was carried out. The firing parameters were based on the first dentine bake.

Individual build-up of the pink aesthetics
There are 13 IPS e.max Ceram shades available for the prosthetic gingiva design. With this variety, it is...
The recommended firing programme for the first gingiva bake:

<table>
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<table>
<thead>
<tr>
<th>Temp. increase</th>
<th>End temp.</th>
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<tbody>
<tr>
<td>25 °C/min</td>
<td>745 °C</td>
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<table>
<thead>
<tr>
<th>Holding time</th>
<th>Vacuum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 min</td>
<td>450–744 °C</td>
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For the second gingiva bake, the shape was completed and the furnace temperature lowered again by 5 °C (Fig. 13). After this bake, the restoration had a distinct 3-D shape and a very natural appearance. The teeth had a good depth of colour and a warm translucency.

Conclusion

In dental technology, manual skills and optimal materials are essential, but also a profound knowledge of materials science and material-specific characteristics is of fundamental value. In particular, when dealing with a complex restoration on a zirconium dioxide framework, correct handling is a major criterion for success. In the case presented, the framework (Zenostar T) and the ceramic veneer (IPS e.max Ceram) successfully harmonised with one another, creating a vibrant interplay of colours. Owing to accurately selected firing parameters, no delamination or late cracks are to be expected.

contact

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