Clinical Review

Straumann® CARES® Abutment

Zirconium Dioxide

straumann
simply doing more

CASE REPORT: STRAUMANN® CARES® ABUTMENT ZIRCONIUM DIOXIDE

A. Clinical close-up view of a 27-year-old female patient who had lost her two maxillary central incisors in an accident. Two Straumann® Bone Level 4.1 RC implants were placed and subsequently restored with directly screw-retained provisional crowns for peri-implant soft tissue conditioning. Note the resulting harmoniously scalloped course of the mucosa. – **B.** Two CAD-CAM generated CARES® zirconia abutments were produced and veneered with pressable ceramics. Particular emphasis was placed on a flat cervical emergence profile. – **C.** During crown insertion, the distinctly distal eccentricity of the triangular neck configuration is apparent, ensuring a natural line of mucosal emergence with the zenith located distally to the longitudinal tooth axis. – **D.** Frontal view taken at the five-year follow-up confirming that the soft tissue continues to be stable and healthy. **E.** The corresponding radiograph reveals favorable bone conditions, especially between the implants. – **F.** Patient is satisfied with esthetic and function. Case Courtesy of Dr. U. Belser and Dr. D. Buser.

Precise functionality

Low bacterial colonization

Superior esthetics

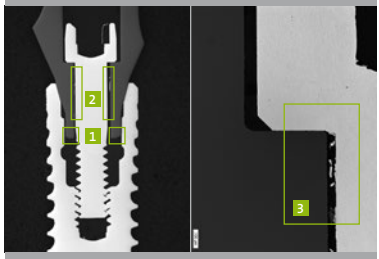
Long-term performance

Zirconia (zirconium dioxide, ZrO_2) is a popular material in restorative dentistry for implant abutments due to its superior mechanical properties compared to other ceramics **(Manicone et al., 2007)**. The whitish color allows for highly esthetic dental restorations especially in the anterior maxilla and for patients with thin mucosal biotype. An increasing number of third-party manufacturers now offer all-zirconia abutments. However, all-zirconia abutments are not all alike – quality and manufacturing expertise make a difference **(Figs. 1, 2)**.

DID YOU KNOW?

- 1789 – Zirconia is discovered by German chemist Martin Heinrich Klaproth
- 1969 – Zirconia is proposed as a new material for hip head replacement
- 1990s – Introduction of Zirconia as an implant abutment material

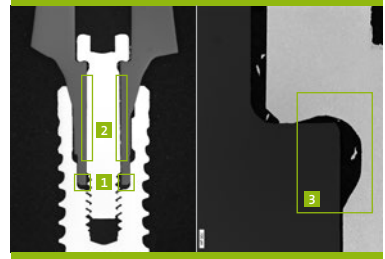
Non-original abutment (claimed to be compatible)



Third-party abutment on Straumann® Bone Level RC Implant

1. No additional support below the Crossfit® connection: the engagement of the abutment inside the implant is substantially lowered
2. Less precise guidance: more space between the screw body and the abutment inside the implant
3. Enhanced risk of screw loosening: rectangular screw head, no undercut design

Original Straumann components



Straumann® CARES® all-zirconia abutment on Straumann® Bone Level RC Implant

1. Additional support below the Crossfit® connection for high stability: very deep engagement of the abutment inside the Straumann implant
2. Precise guidance: screw body and abutment inside the implant are very well aligned
3. Prevention of screw loosening: optimized abutment-screw undercut design with rounded edges for higher screw pretension

Fig. 1: Obvious difference: micrograph comparing precision of fit of a Straumann® CARES® all-zirconia abutment and a non-Straumann third-party all-zirconia abutment. Section cuts from randomly chosen samples. Straumann® inernal report MAT-13-526.

PRECISE FUNCTIONALITY

When it comes to implant therapy, most patients look for functionality, i.e. stable clinical outcomes of the implants and high esthetics of the prosthetic suprastructures. For Straumann, however, functionality is a by-product of precision. The precise fit of the interface between the implant and the all-zirconia abutment has a positive influence on implant-abutment stability **(Saidin et al., 2012)**, stress load transfer **(Nascimento and Albuquerque, 2011)**, as well as the biological response of the peri-implant tissue **(Quirynen and van Steenberghe, 1993)**. Micro-gaps as small as 10 µm and resulting micromovements at the implant–abutment interface are gateways for bacterial colonization and plaque formation **(Broggini et al., 2003)**, which can even lead to implant failure **(Dhir, 2013)**. Therefore, every manufacturer defines exact dimensions and tolerances for the manufacture of abutments and implant-abutment connections. The precise fit of **original Straumann implants and abutments** has been clearly shown to be technically superior to results achieved by third-party abutments **(Gigandet M. et al., 2012; Keilig L et al., 2013; Kim et al., 2012)**. In addition, Straumann has optimized the implant-abutment connection geometry to take into account the special material properties of zirconia: zirconia is more than five times harder than titanium **(Vagkopoulou et al., 2009)** but, like other ceramics, is sensitive to tensile stress. This difference in hardness, together with small, sharp-edged flaws or cracks at the implant-abutment interface can lead to wear and damage of the titanium implant **(Klotz et al.,**

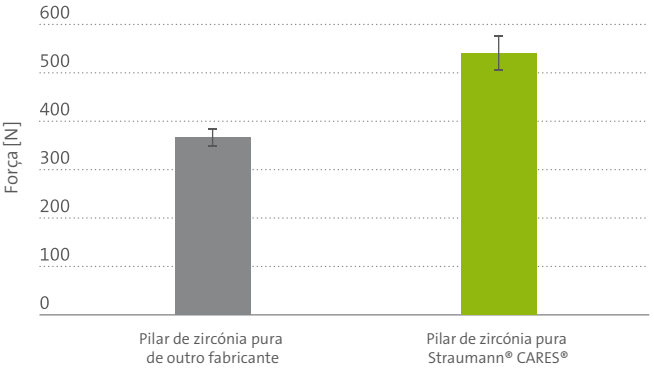


Fig. 2: Straumann® CARES® zirconia abutments demonstrated 32.3 % higher strength (statistically significant) compared to a non-Straumann third-party all-zirconia abutment **(adapted from Joda et al., 2015)**.

2011; Stimmelmayr et al., 2012). Therefore, sharp angles have been removed from the **Straumann® CARES® all-zirconia abutment** screw connection for a higher screw preload. The rotation protection of the **CrossFit®** connection and the precise matching dimensions of the screw body and the abutment provides the best prerequisites to prevent the screw from loosening, and thus, providing patients with the desired long-term functionality.

DID YOU KNOW?

The mouth is a dynamic and complex ecosystem with:

- a virtually constant temperature of 36.6 °C
- a buccal flora with more than 500 bacterial species able to constitute thick biofilms on teeth, crowns, fixed partial dentures or endosseous implants
- biofilms are the main source of gingivitis, periodontitis, peri-implantitis, and may also contribute to implant failure

LOW BACTERIAL COLONIZATION

All-zirconia shows lower bacterial colonization on its surface compared to titanium **(Rimondini et al., 2002; Scarano et al., 2004)**. Degidi et al. compared all-zirconia and titanium in permucosal applications. The biopsy of soft tissue from the study participants showed fewer inflammation processes around all-zirconia versus titanium healing abutments after six months **(Degidi et al., 2006)**. Nitric oxide (NO) is an indicator of inflammatory processes, and bacterial infection generally results in the production of large quantities of NO. Lower activity of NO synthesis was observed in tissues around all-zirconia healing abutments **(Degidi et al., 2006)**. This is an important observation, since bacterial infections can even lead to peri-implant infections and subsequently implant loss **(Lindquist et al., 1996)**. In addition, a pre-clinical study showed that the proportion of pro-inflammatory leucocytes in the epithelium is lower around all-zirconia than titanium abutments **(Welander et al., 2008)**, suggesting superiority of the gingival seal of zirconia.

SUPERIOR ESTHETICS

The use of **Straumann® CARES® all-zirconia abutments** is highly recommended in the esthetic zone and for patients with thin gingiva biotype due to their light color, favorable peri-implant soft tissue integration and resulting well-documented esthetic benefit **(Cosgarea et al., 2015; de Medeiros et al., 2013; Jung et al., 2008)**. In addition, blood flow – an indicator of the health of the soft tissue around implants – is similar between all-zirconia abutments and natural teeth, and more favorable compared with titanium abutments **(Kajiwara et al., 2015)**.

PROVEN LONG-TERM PERFORMANCE

All-zirconia abutments offer sufficient stability and clinical long-term success in dental applications, which has been confirmed in several clinical trials. A recent review reported that all-zirconia abutments are reliable in the anterior region from both biological and mechanical points of view **(Nakamura et al., 2010)**. Another study showed that all-zirconia abutments (anterior and premolar single crowns) survived in 100 % of the cases after four years of functional loading **(Glauser et al., 2004)** and performed well even after evaluation up to twelve years in anterior areas **(Passos et al., 2014)**. Two systematic reviews compared zirconia abutments (all-zirconia abutments and zirconia abutments with a metallic insert at the implant-abutment interface) with metal abutments and found no differences regarding survival rates as well as technical and biological outcomes after five years of clinical use **(Sailer et al., 2009; Zembic et al., 2014)**. Currently, there are both HIP (hot isostatic pressing) zirconia and pre-sintered zirconia on the market. HIP zirconia has a more homogeneous quality paired with a higher compressive strength. Therefore, some manufacturers opt to do the trimming and shaping at the pre-sintered state (known as the "green state"), where the material still has a lower strength. But the following sintering process induces a ~20% sintering shrinkage, which can reduce the precision of fit of the abutment design when pre-milled. In addition, if flaws are already present at the green stage, they are incorporated into the sintered product. Straumann uses HIP zirconia which is CAD-milled at its final high strength. This process requires more time and expensive equipment, but the zirconia can be milled immediately to the final desired dimensions because no further sintering is required. Compared to pre-sintered zirconia, HIP zirconia has a more homogeneous quality, translating clinically into improved resistance to hydrothermal aging and long-term performance.

DID YOU KNOW?

- Straumann® CARES abutments are made from 100 % metal-free yttria-stabilized tetragonal zirconia (Y-TZP)
- Yttrium oxide retains the zirconia crystals in a stable shape at room temperature
- Y-TZP abutments on the market differ between manufacturers. The chemical composition is similar, but there are differences in physical and mechanical properties that affect their clinical performance

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