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Introduction

Since the early 1980s, all-ceramic restorations experienced a constantly and consequently expanded indication. New ceramic materials with an improved long-term stability as well as innovations in cementation were the driving forces for the rapid development and spreading of all-ceramic restorations.

Reflecting on the development in prosthetics, all-ceramic restorations are – apart from implant prosthetics – the fastest growing area of dental treatment. Zirconia, quickened by the development of CAD/CAM technologies, paved the way for new indications in all-ceramic restorations.

Since the introduction of Cercon high-performance ceramics 15 years ago, numerous developments in CAD/CAM and dental materials have led to a constantly expanding indication for zirconia restorations. In the meantime, the range of indications not only covers single crowns and fixed partial dentures, but also implant-prosthetic superstructures and attachments for removable restorations.

More than 25 international publications confirm that the Cercon ceramic materials are among the best-documented and evaluated zirconia ceramic materials worldwide. The consequent analysis of these data led to numerous improvements in clinical safety, the development of a new highly translucent variation (Cercon ht) did not only improve the optical properties of restorations, but it moreover allows the fabrication of full-contour monolithic zirconia restorations. After polishing, monolithic restorations made of Cercon ht show a very limited antagonist abrasion. Due to their high mechanic loading capacity, these restorations can be fabricated with a wall thickness that up to now could only be achieved in metal full-cast restorations. Nowadays, zirconia restorations are available fully veneered, partially veneered or non-veneered with their range of processing and indications approaching the properties of conventional metal-ceramic restorations.

However, not only the materials and processing technologies were improved, but also the clinical recommendations regarding every step from the preparation to the cementation of the restoration were constantly updated.

The present clinical manual covers specific aspects of different material variations, new findings in clinical procedures (preparation, impression-taking, cementation) as well as the available evidence on the clinical performance of zirconia restorations. We trust that it will facilitate the daily routine in both, the dental office and the dental lab.

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At a glance – Cercon®

Material competence from a single source: Research and development, compositions, and production.

- 2001 Launch of Cercon base (white)
- 2003 Launch of Cercon base colored
- 2011 Launch of Cercon base light, medium, colored
- 2011 Launch of Cercon ht white high-translucent
- 2012 Launch of Cercon ht light and medium
- 2015 Launch of Cercon ht 16 Vita shades and concept

Material

- Zirconia, Y-TZP
- Fine-grained
- High sintering activity, stability about 1,200 MPa

In different in vitro and in vivo studies, zirconia Y-TZP revealed no mutagenic or carcinogenic effects in chromosome aberration or Ames tests. The results of these studies document that no local toxic effects are to be expected due to a contact of zirconia with bones or soft tissues.

Biocompatibility

Color concept

The intended launch (September 2015) of pre-colored Cercon ht disks in 16 Vita shades sets a new standard. A quick and simple reproduction of zirconia restorations in all 16 Vita shades in the dental lab is the top priority – either with one of the 16 pre-colored disks or with just a selection.

The lab can choose the most effective process:

- Dipping (white disk and dipping colors)
- Milling from a blank in one of the colors (16 Vita shades + bleach)
- Easy staining concept with a special selection
- Veneering concept for all colors
Cercon does not only impress with its stability, but also with the superior translucency of the material. The high light transmission allows a near-nature restoration design, while at the same time the semi-opacity of the material approves its application on colored tooth stumps.

The new color concept of Cercon ht covers 5 different quality levels:

- Glazed
- Stained / Glazed
- Cutback-technique
- Partially veneered
- Fully veneered

Based on the customers’ requests, all Cercon ht restorations can be fabricated with varying effort and return.

The static fracture and fatigue strength of zirconia veneered crowns and fixed partial dentures are increased by a factor of 2 to 5 in comparison with other all-ceramic systems (glass-ceramics, alumina).

The long-term clinical success of Cercon restorations is based on a combination of high flexural strength and fracture toughness.

The combination of positive properties such as biocompatibility, stability, translucency, low thermal conductivity make zirconia the ideal material for fixed prosthetic restorations with numerous clinical advantages such as:

- Broad range of indications in the anterior and posterior region
- Try-in with checking of occlusion
- Temporary cementation
- Conventional cementation
Indications for veneered and full-contour
Cercon base and Cercon ht restorations

Since the introduction of the Cercon high-performance ceramics 15 years ago, numerous developments in dental materials have led to a constantly expanding indication for zirconia restorations.

While the material introduced first (Cercon base) was only suitable for the fabrication of veneered restorations, implant abutments, and double-crowns, the development of a new, highly translucent zirconia material (Cercon ht) leads to improved optical properties of the frameworks. Moreover, this variation stands out for a reduced antagonist abrasion after polishing. Now veneered as well as full-contour Cercon restorations are available for the following indications:

Veneered restorations
- Fully or partially veneered anterior and posterior crowns
- Fully or partially veneered anterior and posterior fixed partial dentures with a maximum of two adjacent pontics
- Fully or partially veneered cantilever fixed partial dentures (maximum width of the extension: one premolar)
- Partially veneered adhesive fixed partial dentures in the anterior region for the replacement of a missing tooth

Additional ranges of application
- Customized and pre-fabricated implant abutments
- Ceramic double-crowns

15 years of consequent innovation

Two variations – many indications

Veneered restorations

Implant abutments
Double-crowns
Indications for veneered and full-contour Cercon base and Cercon ht restorations

**Monolithic restorations**

- Full-contour (monolithic) restorations that are only individualized by a staining process are suitable for the following range of indications:
  - Full-contour posterior crowns
  - Full-contour posterior fixed partial dentures with a maximum of two adjacent pontics
  - Full-contour cantilever fixed partial dentures with a maximum extension width of one premolar in the posterior region

Veneered and full-contour Cercon restorations (except resin-bonded fixed partial dentures) can be applied on natural teeth as well as on implants.

**Contraindications**

- The following situations represent a contraindication for veneered restorations:
  - Bruxism
  - Insufficient space

- Moreover, it should be considered that implant-prosthetic superstructures bear an increased inbuilt technical complication risk (fractures of the veneering ceramics). Multi-unit implant-supported fixed partial dentures should thus be designed as full-contour restorations.

**Not approved restoration designs**

- The following indications are not yet sufficiently supported by clinical data and are not approved by the manufacturer:
  - Inlay fixed partial dentures
  - Customized root posts
  - Customized intraosseous implants
General recommendations for the preparation of Cercon restorations

All-ceramic Cercon base and Cercon ht restorations can also be produced as ceramic-veneered or full-contour (monolithic) restorations. Independent from the type of execution, the preparation design must be appropriate for the material involved to ensure that the following design parameters are observed in the dental lab:

The preparation limit of zirconia restorations should be designed as a chamfer preparation or a shoulder with rounded internal line angle. Bevel preparations are not recommended.

Additional directions:
- Preparation angle 6 - 8°
- Rounded line and edge angles
- Bevelled cusp-fossa relief

The minimum wall thickness of the restoration varies depending on the indication. In the anterior and posterior region, a minimum wall thickness of 0.4 mm should be maintained for veneered crowns. For fixed partial dentures and monolithic crowns, a minimum wall thickness of 0.5 mm is required.

When planning the preparation of all-ceramic fixed partial dentures, the necessary connector area must be considered, too. The minimum connector areas for zirconia fixed partial dentures are:
- 7 mm² for 3-unit anterior fixed partial dentures
- 9 mm² for 4-unit anterior fixed partial dentures
- 9 mm² for 3-unit posterior fixed partial dentures
- 12 mm² for posterior 4-unit fixed partial dentures

In 4-unit fixed partial dentures, the wall thickness should be increased to 0.6 to 0.7 mm in the occlusal area and in the area facing the pontic.
Cercon restorations can either be produced as fully veneered or partially veneered crowns and fixed partial dentures.

For the preparation of fully veneered anterior restorations, a minimum circular cutting depth of 1.0 mm as well as a cone angle of 6° to 8° are required at the axial preparation surfaces. The transitions between the axial and the palatal/incisal surfaces must be rounded (minimum radius: 0.4 mm). For an optimum esthetic result, an incisal reduction of 2.0 mm is required. For CAD/CAM-fabricated restorations, the minimum width of the incisal edge in the vestibulo-oral direction should be at least 0.8 mm to guarantee an exact reproduction of the internal surfaces of the structure by the milling unit.

The palatal design of upper anterior and canine teeth should be contoured with a rhombic instrument (e.g. palatal grinder according to Marxkors). This instrument is also suitable for rounding the transitions between the axial walls and the incisal edge.

In partially veneered restorations, the palatal reduction can be limited to 0.5 mm if these areas are designed in zirconia only. This procedure is recommended for restorations with a considerably reduced space (e.g. a deep bite or a tooth tilting in the palatal direction). A minimum cutting depth of 1.0 mm is required for the veneered vestibular parts of the restoration, the preparation limit should be designed as a chamfer or shoulder preparation.

Rotating instruments with a medium grain size are recommended for finishing the preparation.
Recommendations for preparation of Cercon restorations with dental-ceramic veneering

A minimum occlusal layer thickness of 1.0 mm is required for fully veneered posterior restorations. Due to this, a tooth substance removal of at least 1.5 mm at the occlusal surfaces is recommended. The tapering of the axial preparation surfaces should range from 6° to 8°. The transitions between the axial walls and the occlusal surface need to be rounded, whereas the occlusal relief should be designed as a simplified masticatory surface.

An aperture angle of the occlusal surfaces between 120° and 140° guarantees an exact reproduction of the interior restoration surfaces during the milling process and thus leads to a good internal fit.

The aforementioned rhombic instrument is suitable for the preparation of the occlusal parts, too. It should be applied vertical to the tooth axis. If applied parallel to the tooth axis and if the transitions are rounded with the conical instrument tip, it can also be used for rounding the transitions of the axial to the occlusal surfaces.

Depending on the expansion of the veneer, the substance removal can be reduced accordingly in partially veneered restorations. In cases with a vestibular veneering, an occlusal and palatal reduction of 0.6 to 0.8 mm is sufficient. In the vestibular region, a reduction of at least 1.0 mm is required.
The zirconia material Cercon is offered in various colors and translucencies. The classic variation Cercon base, which was launched more than 10 years ago, is a semi-opaque material. It is especially suitable for the restoration of discolored tooth stumps. These classic yttria partially-stabilized ZrO2 ceramic materials stand out for a high stability. As the structure can be colored in the established dentin shades, this material avoids the well-known dark rims of metal-ceramic restorations, even in cases with gingival recession.

In comparison, the varieties Cercon ht and Cercon ht light offer a significantly increased translucency – the perfect materials for the restoration of non-colored tooth stumps. An optimum esthetic result will be achieved if the material chosen meets the degree of discoloration of the prepared tooth. Moreover, these translucent materials facilitate the combination of different restoration types. Especially in complex situations with a combination of veneers and crowns or fixed partial dentures, translucent zirconia materials in combination with glass-ceramics used for veneering lead to superior esthetic results.

The downright flexibility in cementation is yet another advantage. An adhesive cementation is not mandatory. If suitable materials are used, a temporary cementation is possible.
Material selection for anterior restorations

By a variation in translucency, the esthetic results can be improved without the necessity of adhesive cementation. Although this is a chance, it is also challenging for the communication between the dental practice and the dental lab. When working with the classic zirconia variations, the degree of discoloration of the prepared tooth was negligible, information on the tooth stump color is essential when using translucent zirconia materials. If a highly translucent structure is applied to a discolored tooth stump, the preparation will gleam greyish. This phenomenon is well-known from the application of transparent glass-ceramic materials. However, this problem can be avoided if the dental lab is provided with information on the degree of discoloration of the prepared tooth. The dental technician will then be able to choose the optimum degree of translucency for the structure (Rinke and Fischer 2012). A digital photography of the preparation with a color chart indicating the desired result is the easiest way to communicate this information.
Material selection for anterior restorations

Although the translucent zirconia materials – due to their long-term stability – do not generally require adhesive cementation, the importance of choosing a suitable cementing material must not be neglected. As far as the classic zirconia variations are concerned, the esthetic result of the restoration was only marginally influenced by the cement. Visible differences only occurred in the cervical region. The introduction of translucent zirconia materials increases the significance of optical properties for cementing materials. As translucent structures can only be applied on not resp. lightly discolored tooth stumps, a stump-covering effect of the cement is not reasonable. For a temporary as well as for the final cementation, translucent cements should be used.
Recommendations for the preparation of full-contour (monolithic) Cercon ht restorations

The minimum-invasive preparation is an advantage of full-contour zirconia restorations; the required substance removal is comparable with that of a classic full-cast crown. The minimum occlusal thickness is 0.5 to 0.7 mm, while the substance removal near the preparation limit should be 0.5 mm at least.

A chamfer preparation or a shoulder with rounded internal line angle is recommended for full-contour zirconia restorations. Due to the reduced cutting depth in the preparation, instruments with a reduced diameter can be used. The remaining parameters for preparation (preparation angle 6° to 8°, simplified design of the occlusal relief) focus on the well-known recommendations for veneered zirconia restorations.

By a minimally invasive preparation, a reduction of possible biological complications (endodontic treatment) is expected. Moreover, especially the reduced occlusal reduction in comparison to a veneered restoration leads to an improved retention in crowns and fixed partial dentures due to an increased preparation height. Accordingly, a conventional cementation of the restoration is possible more frequently. This is advantageous, especially for restorations with an increased risk of retention loss (3- to 4-unit mandibular posterior fixed partial dentures).
Polished zirconia surfaces show only a low abrasion on antagonistic tooth surfaces. Therefore, a smooth and highly polished surface is required for the clinical application of monolithic zirconia restorations.

Considering practical aspects, it is recommended to finish the occlusal adjustment prior to cementation. The intraoral grinding of monolithic zirconia restorations should be performed with special diamond instruments (e.g. ZR grinders, Gebr. Brasseler GmbH, Lemgo; or K-Diamonds, Edenta AG, Au, Switzerland) for optimum ablation. Static and dynamic adjustments in occlusion are followed by an extraoral multi-level polishing procedure. First, diamond-layered silicone polishers are used, followed by a diamond polishing paste. If additional occlusal adjustments are necessary after cementation, the following instruments are recommended for intraoral use:

- **Occlusal adjustment**: ZR grinders (Gebr. Brasseler), and K-Diamonds (Edenta);
- **First polishing (silicone polisher)**: StarGloss (Edenta), EVE DiaCera (EVE Ernst Vetter GmbH, Pforzheim, Germany), and 94000 C/M/F (Gebr. Brasseler);
- **Mirror finish**: OptraFine HP Polishing Paste (Ivoclar Vivadent AG, Schaan, Liechtenstein), and DirectDia Paste (Shofu Dental GmbH, Ratingen, Germany).

The final polishing is performed with diamond polishing paste and a nylon brush without water.
Impression-taking for all-ceramic Cercon base and Cercon ht restorations

Impressions can be taken conventionally with all materials and procedures for common prosthetic applications (hydrocolloid, polysiloxane, polyether, corrective, double-mix, and monophase technique) erfolgen.

For a good reproduction of the preparation limit, the use of braided retraction cords (e.g. Ultrapak, Ultradent Products GmbH, Cologne, Germany) in combination with the double-cord technique is recommended:

First, a thin cord is applied to the sulcus. It remains in situ during the whole process of impression-taking. This first cord is blocking possible bleeding from the sulcus and prevents a flapping back of the gingiva on the preparation limit. On top, a second, thicker cord is applied that is removed immediately prior to impression-taking. This cord leads to a pronounced lateral displacement of the gingiva, thus allowing a 0.5 mm overlap of the impression material on the preparation limit.

In the correction technique as well as in the double-mix technique, the distribution of the low viscosity material by airflow is recommended. The airflow should be directed into the sulcus, thus leading to a good adaptation of the impression material to the surface of the prepared tooth.

Temporary restorations can be cemented with commercially available materials. If an adhesive cementation is intended later, the temporary restorations should be fixed with a eugenol-free temporary cement.
Cementation of all-ceramic Cercon base and Cercon ht restorations

Due to the high bending and fatigue strength of yttria-stabilized zirconia structures, a temporary cementation (e.g. Integrity Temp Grip, Dentsply DeTrey, Konstanz, Germany) as in metal-ceramic restorations is possible. Clinical studies (Rinke and Jenatschke 2003, Rödiger et al. 2010) show that zirconia restorations without ceramic shoulders can be cemented temporarily for a limited period.

However, the removal of temporarily cemented zirconia restorations bears the risk of damage, especially in case of critical load peaks. It is therefore recommended to cement fixed partial dentures with ceramic shoulders finally (conventionally or adhesive), as the ceramic shoulders of these restorations have an increased fracture risk during removal.

A temporary cementation for zirconia restorations should be limited to 2 to 3 weeks, as damage might occur while chewing due to unnoticed loss of retention or a loosening of the restoration. When removing the restoration for final cementation, the possible clinical advantages of a temporary restoration should be weighed up against the risk of damage.

The removal of temporarily cemented restorations requires special tools with rubber working tips (e.g. crown remover, Stoma GmbH, Emmingen, Germany) to prevent from a damage of the veneering ceramics. A direct contact of metallic instruments with the ceramic must be avoided.

A transparent temporary cement (e.g. TempBond clear, Kerr Hawe, Karlsruhe, Germany) is recommended for the temporary cementation of highly translucent Cercon ht restorations.
Cementation of all-ceramic Cercon base and Cercon ht restorations

Basically, all conventional cements are suitable for the fixation of Cercon restorations. A conventional cementation is recommended in the following situations:

- Preparations with a sufficient stump height of 4 mm
- Preparation angle of 3° – 5°

However, phosphate and glass-ionomer cements hardly possess any adhesive properties to the tooth structure and the restoration materials. They should therefore not be applied in indications with an increased risk of retention loss like e.g. fixed partial dentures in the mandibular molar region.

Several in vitro studies and clinical studies (Ortrop et al. 2012, Rinke et al. 2013) demonstrated that the retention of zirconia crowns cemented with resin-modified glass-ionomer cements (e.g. Permacem 2.0, DMG GmbH, Hamburg, Germany; FujiCEM Plus, GC Germany GmbH, Bad Homburg, Germany; Meronplus, Voco GmbH, Cuxhaven, Germany) is significantly higher than in conventional zink-phosphate cements or pure glass-ionomer cements. Moreover, resin-modified glass-ionomer cements are available in different colors and translucencies; they offer improved retention and more favorable optical properties and should thus be preferred to pure zinc-phospate or glass-ionomer cements.

A conditioning of the prepared tooth is not necessary. However, the cementation surfaces of the restoration should be air-abraded (Al2O3, 50 µm, 1-2 bar) to provide improved retention.
Cementation of all-ceramic Cercon base and Cercon ht restorations

Zirconia restorations can also be cemented adhesively to improve their retention in risk indications (e.g. short or extremely cone-shaped tooth stumps, multi-unit fixed partial dentures). Self-adhesive cements (e.g. SmartCem2, Dentsply DeTrey, Konstanz) (Piwowarczyk et al. 2005) or composite cements with a reactive phosphate monomer or a zirconia primer that build a chemical compound with zirconia can be used.

Numerous in vitro studies and clinical evaluations support the application of composite cements with reactive monomers (e.g. Panavia 21 TC or Panavia f 2.0, Kuraray Europe GmbH, Hattersheim, Germany).

The use of self-adhesive cements does not require a special conditioning of the tooth structure; it can be applied under relative moisture control. The cementation surfaces of the restoration should be air-abraded (Al2O3, 50 µm, 1-2 bar) to improve the retention.

The self-adhesive cement is applied to the restoration prior to placing it on the dried tooth stump. For an easy removal of the excess cement, these areas are treated with a polymerization lamp for 3 to 5 seconds. The restoration is then fixed; the excess can easily be removed with a dental probe.

**Self-adhesive cements offer the following clinical advantages:**
1. Increased retention in comparison with conventional cements
2. Available in various colors and translucencies
3. Easy handling and safe excess removal
Cementation of all-ceramic Cercon base and Cercon ht restorations

Maximum retention will be achieved by using composite cements with separate bondings. Material-related as well as clinical aspects should be considered when choosing an appropriate cement.

- A chemical bond is required, created either by the components of the cementation material (e.g., a reactive phosphor monomer [Panavia, Kuraray]) or by application of a special primer (Monobond Plus, Ivoclar Vivadent/Primer A-Z, Shofu Dental).

- The tooth structure must be conditioned. It has to be considered that in prepared teeth, bonding can almost only be carried out to dentin. Moreover, absolute moisture control is difficult to achieve.

Considering these aspects, the use of bonding systems with self-etching primers is recommended. In contrast to the total-etch technique with phosphoric acid, here no rinsing of the acid compound is necessary. Therefore, these systems can be applied under relative moisture control. The following cementation systems with self-etching primer/bonding systems are available:

- Panavia 21, Panavia F2.0, Kuraray
- ResiCem, Shofu Dental
- Multilink, Ivoclar Vivadent

When using self-adhesive bonding systems, the application of a special bonding substance is required for conditioning. After a material-specific residence time, the tooth stump is carefully dried and ready for cementation. The crowns are air-abraded (see conventional cementation), then conditioned by application of an additional bonding substance. In cases of subgingival crown margins, a thin retraction cord (e.g., Ultrapak size 00 or 0) should be applied to avoid resin residues in the sulcus and a contamination with sulcus fluid.
Preparation of endodontic access cavity and removal of Cercon restorations

With appropriate instruments, the preparation of an endodontic access cavity can be performed quickly and without clinical difficulties. When preparing the access cavity, a two-step procedure is recommended. First, the veneering ceramic material is removed with a diamond instrument without perforating the structure.

For the preparation of an access cavity, special coated diamond instruments are recommended (e.g. ZR grinders, Gebr. Brasseler GmbH, or K-Diamonds, Edenta AG). They stand out for a considerably higher reduction performance than conventional diamond instruments.

In a second step, a diamond instrument is used to perforate the ceramic material of the structure. A distance of 0.5 mm to the veneering ceramic material must be maintained to avoid chipping.

The structural stability of the Cercon crowns is maintained after having opened the access cavity. Thus, the restoration can remain in situ. The access cavity can easily be closed with an adhesively bonded composite filling.

By the way: The x-ray opacity of Cercon restorations meets that of metal-ceramic restorations. For the removal of a Cercon restoration, it must be split at the axial wall to the middle of the occlusal area or to the incisal edge. The restoration is then bent up with an appropriate instrument until fracture occurs. In adhesively cemented restorations, cement residues on the surface of the tooth stump can be removed with an ultrasonic instrument.
Three different designs for all-ceramic zirconia abutments are available:

- Pre-fabricated pure zirconia abutments with a central retention screw being the only metallic component
- Customized CAD/CAM-fabricated pure zirconia abutments
- Two-piece zirconia abutments – the implant abutment consists of a metallic abutment base, adhesively joint with a customized zirconia abutment.

Based on clinical evaluations with observational periods of up to 5 years, one- and two-piece zirconia abutments are suitable for implant-supported fixed single-tooth restorations in the anterior and posterior region.

In cases with a reduced thickness of the periimplant soft tissue (< 3mm), a restoration with all-ceramic abutments for anterior single-tooth abutments offers esthetic benefits, as a shining-through of any metallic components is avoided. Pre-fabricated all-ceramic abutments are fit for clinical situations where only minor corrections of the abutments are required. Re-working must be minimized, a minimum wall thickness of the zirconia structures (0.5 to 0.7 mm) is essential.
As the available sizes of pre-fabricated abutments cannot always be adapted to the individual emergence profile of the peri-implant soft tissues, these abutments are limited in their indication. Moreover, the position of the preparation limit for the superstructure cannot always be adapted to the course of the marginal gingival rim.

Focussing on good esthetics with invisible crown restorations and an easy removal of cement residues, the preparation limit should run approximately 1 mm below the marginal gingiva rim. Regarding a support of the soft tissue and considering the slightly subgingival preparation limit, customized abutments can be adapted to the soft tissue situation. The shape of pre-fabricated abutments differs considerably from the shape of a prepared natural tooth and the emergence profile, especially in posterior restorations. Therefore, individually fabricated all-ceramic abutments should be preferred.

Due to the complex implant-abutment connection geometry, a sufficient precision of customized one-piece zirconia abutments can only be achieved in a centralized CAD/CAM production unit. Today, most CAD/CAM systems allow the fabrication of two-piece zirconia abutments directly in the dental lab. After scanning the master model, a titanium base matching the implant system is selected. The customized zirconia abutment that is constructed on this base can be milled from pre-sintered zirconia blanks. The densely sintered abutment is then glued to the titanium base, finalized, and polished.

Advantages of customized abutments
Cercon base and Cercon ht
all-ceramic superstructures

In patients with a reduced thickness of perimplant soft tissues (< 2mm), all-ceramic single crowns on all-ceramic abutments lead to better esthetic results than metal-supported restorations. In this indication, all-ceramic crowns showed no increased technical failure rate (fractures of the structure, chipping). Based on the available clinical data, this type of restoration is widely accepted.

However, when combined with implants on prefabricated abutments in the posterior region, veneered all-ceramic single crowns with zirconia structures showed an increased complication rate (extended fractures of the veneering ceramic material). The available clinical data indicate that the technical complication rate of all-ceramic superstructures can be reduced by using customized all-ceramic abutments.

Alternatively, fixed superstructures can be fabricated as monolithic Cercon ht restorations. This avoids the risk of fractures in the veneering ceramic. The use of customized abutments is also recommended for the fabrication of monolithic restorations (reduced risk of potential technical complications). Moreover, a routine use of customized abutments for implant-supported posterior restorations is recommended for the following reasons:

Due to their larger surface, customized abutments offer an improved retention of the superstructure. In certain circumstances, a temporary cementation is possible without an increased risk of retention loss. Furthermore, the cement gap can be relocated to the equi- resp. subgingival region, and excess cement can easily be removed.
The safe removal of excess cement is essential because cement residues can lead to an iatrogenic periimplantitis. Therefore, the cementation material must be selected carefully – conventional or self-adhesive cements (e.g. SmartCem 2, Dentsply DeTrey) should be preferred to dual-hardening composite cements.

Today, only limited clinical data on all-ceramic superstructures for fixed partial dentures are available. However, existing data show that short-span fixed partial dentures (especially in the anterior region) only bear a limited risk of technical complications (Kim et al. 2012).

In contrast, an increased technical complication rate (extended fractures of the veneering ceramics) was documented for long-span veneered all-ceramic fixed partial denture constructions with up to 10 units (Larsson et al. 2012). Therefore, the use of veneered superstructures should be limited to short-span fixed partial dentures (3 units) until additional clinical data are available. For multi-unit fixed partial dentures in the posterior region, monolithic constructions are recommended.
Clinical performance of Cercon restorations

Since 2000, more than 45 clinical studies on the clinical performance of zirconia crowns and fixed partial dentures have been published. The available data confirm the high structure stability of crowns and 3-unit fixed partial dentures with observational periods of 3 to 5 years (Raigrodski et al. 2012, Tritawana et al. 2012, Layton & Wennerberg 2014, Takeichi et al. 2014).

Today, the structure stability of anterior and posterior single crowns and 3-unit fixed partial dentures made of zirconia is valued equal to metal-supported restorations. However, these studies prove that all-ceramic zirconia restorations show an increased complication rate for fractures of the veneering ceramic. The exact source of this increased incidence of ceramic fractures in zirconia restorations was unknown for quite some time, however, an accumulation in the posterior region was documented (Raigrodski et al. 2012, Tritawana et al. 2012). Several in vitro studies proved that especially a pronounced anatomical framework design, and a long-term cooling process after veneering can minimize the failure risk (Chaar et al. 2012, Tan et al. 2012).

In a prospective study, these approaches for improvement (pronounced anatomical framework design, and long-term cooling process) were clinically evaluated for molar crowns: After a 3-year observational period, no statistically significant difference in the fracture rates of veneering ceramics for metal-ceramic and all-ceramic single crowns was observed (Rinke et al. 2012).
Clinical performance of Cercon restorations

Other approaches were a press-on technique of the veneering ceramics, or the fabrication of CAD/CAM veneers which were then luted or glass-soldered to the zirconia structure (Chaar et al. 2012, Guess et al. 2012, Schmitter et al. 2012).

In both indications, single crowns as well as 3-unit tooth-supported fixed partial dentures, the technical complications seem to be limited to fractures of the veneering ceramic. However, if steps for a reduced chipping risk are taken (pronounced anatomical framework design, and ceramic veneering with long-term cooling), the performance should equal the results of metal-ceramic fixed partial dentures.

The situation for multi-unit and multi-span fixed partial dentures is slightly different: Within an observational period of 5 years, fracture rates of the structure between 9 and 17% are reported for long-span constructions (Salido et al. 2012 Schmitt et al. 2012, Schmitter et al.2012). It was documented that the technical complication rates strongly depend on the position and size of the fixed partial denture reconstruction. Anterior fixed partial dentures were less likely to suffer fractures of the structure or of the veneering ceramics (Schmitter et al. 2012). Therefore, at the moment an application of multi-span veneered zirconia fixed partial dentures should be limited to anterior restorations. To avoid technical complications (fractures of structure and veneering ceramics), posterior multi-span fixed partial dentures should be designed as full-contour (monolithic) restorations.
In clinical studies with observational periods of 2 to 4 years, zirconia cantilever fixed partial dentures provided a sufficient structure stability (Wolfart et al. 2009, Ohlmann et al. 2012). Appropriate measures can reduce the well-known challenge of chipping in ceramic veneering.

Zirconia materials are appropriate for structures of adhesively cemented resin-bonded fixed partial dentures in combination with a minimum invasive preparation (Sasse et al. 2012). One-arm resin-bonded fixed partial dentures should be seen as a promising alternative to the conventional two-arm design.

Zirconia-based inlay fixed partial dentures show an increased initial complication risk, even with adhesive cementation (Ohlmann et al. 2008). Therefore, their indication is critical until additional data are available. First clinical results with a modified preparation design to expand the adhesive surface around the inlay retainer showed a reduction of technical complications (Abou-Tara et al. 2011). In 23 adhesively cemented inlay fixed partial dentures with a zirconia structure, one retention loss and two fractures of the veneering ceramic were documented after a mean observational period of 20 months.

Based on the available clinical studies with observational periods of up to 5 years, one- and two-piece zirconia abutments are suitable for implant-supported fixed single tooth restorations in the anterior and posterior region.

Moreover, first results from a retrospective study indicated that all-ceramic abutments can be used for the support of short-span fixed partial dentures (Kim et al. 2012).
Clinical performance of Cercon restorations

Under clinical conditions, all-ceramic single crowns on all-ceramic abutments lead to better esthetic results than metal-supported restorations. No increased technical complication rate (fractures of the structure, chipping) for all-ceramic crowns was documented for this indication (Hosseini et al. 2012). When placed on prefabricated implant abutments in the posterior region, cemented all-ceramic single crowns showed an increased complication rate (extended fractures of the veneering ceramic) (Schwarz et al. 2012). At the same time, a prospective 5-year study documented that all-ceramic posterior single crowns cemented on customized all-ceramic abutments showed a performance comparable with metalceramic crowns on customized titanium abutments (Zembic et al. 2012).

Thus, the following preconditions are required for all-ceramic posterior zirconia superstructures:

- Customized contoured abutment design, preferably fabricated from a ceramic material
- Contoured Modelling of the crown structure
- Reduction of the chipping risk

If these preconditions are met, cemented all-ceramic crowns are suitable for posterior single-tooth restorations, careful indication provided.
Clinical performance of Cercon restorations

In comparison with tooth-supported restorations, implant-supported metal- and all-ceramic fixed partial dentures bear an increased risk for technical complications (Pjetursson et al. 2012, Larsson et al. 2012). Therefore, removable short-span constructions are preferred (Kim et al. 2012). For the time being, the indication for implantsupported fixed partial dentures should be restricted to 3-unit constructions due to the limited clinical data available. To avoid technical complications, posterior fixed partial dentures should be fabricated on customized abutments, the recommendations for all-ceramic posterior single crowns apply accordingly.

Especially for molar restorations, full-contour (monolithic) restorations should be considered.
Due to the well-known difficulties of veneered restorations, the risk of technical complications was approached by so-called monolithic restorations, i.e. restorations made of one material only (Rinke and Fischer 2012). Potential advantages:

- Avoidance of technical complications
- Substance-preserving preparation
- Cost reduction (saving of veneering)
Clinical performance of Cercon restorations

At present, only very limited data on full-contour zirconia restorations are available from studies with a maximum observational period of 2 years (Marchak et al. 2011, Rojas et al. 2011). So far, no increased risk for technical or biological complications has been documented. Extensive in vitro studies evaluated potential risks of clinical application and possible advantages for this type of restoration.

In vitro studies revealed that full-contour crowns showed a higher translucency and fracture resistance than veneered zirconia crowns (Beuer et al. 2011). Moreover, the abrasion properties of zirconia surfaces are essential for a clinical application.

In the initial stage of application, a complete covering of the zirconia structure with veneering ceramics was requested because an exposition of the structure might cause an increased antagonist abrasion. However, a study of Jung et al. (2010) demonstrated that polished and glazed zirconia surfaces show a reduced antagonist abrasion in comparison with conventional veneering ceramics. These findings have in the meantime been supported (Preis et al. 2011, Rosentritt et al. 2011, Mitov et al. 2012, Stawarczyk et al. 2013).

Therefore, no increased risk of antagonist abrasion is expected for the clinical application of polished or glazed full-contour restorations. This is the first procedure ever to allow the fabrication of conventionally cemented all-ceramic crowns and fixed partial dentures with a substance abrasion that could up to now only be achieved with metallic full-cast restorations. When considering that a coloring/staining of the structure allows an individual color characterization, interesting areas of application in an all-ceramic treatment concept arise.
For a successful treatment, the following products from the Dentsply group are recommended:

<table>
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<th>Process</th>
<th>Product Description</th>
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<tr>
<td>Impression taking</td>
<td>Aquasil Ultra</td>
<td>Dentsply DeTrey, Konstanz</td>
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<tr>
<td>Veneering</td>
<td>Cercon® ceram Kiss &amp; Cercon® ceram love</td>
<td>DeguDent, Hanau, Germany</td>
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<td>Temporary cementation</td>
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<tr>
<td>Final cementation conventional</td>
<td>Aquacem®</td>
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<td>Final cementation self-adhesive</td>
<td>SmartCem®2</td>
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<td>Final cementation adhesive</td>
<td>Dentsply Cementation System</td>
<td>Dentsply DeTrey, Konstanz, Germany</td>
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References


