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Summary of Safety and Clinical Performance (SSCP) Ceramir Crown & Bridge and Ceramir Bioceramic Implant Cement

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This Summary of Safety and Clinical performance (SSCP) is intended to provide public access to an updated summary of the main aspects of the safety and clinical performance of the device.

The SSCP is not intended to replace the Instruction for Use as the main document to ensure the safe use of the device, nor is it intended to provide diagnostic or therapeutic suggestions to intended users or patients.

The following information is intended for users/healthcare providers. In section 11 of this document a summary intended for the patient is provided.

1 DEVICE IDENTIFICATION AND GENERAL INFORMATION

Device trade name	Ceramir® Crown & Bridge[1] Ceramir® Bioceramic Implant Cement
Manufacturer name	Doxa Dental AB
Manufacturer address	Axel Johanssons gata 4–6, SE-754 50 Uppsala, Sweden
Manufacturer's single registration number (SRN)	SE-MF-000021129
Basic UDI-DI	7350052434007Z
Medical device nomenclature description / text	Dental restorative cements, temporary and permanent
Class of device	Class IIa, rule 8 (Annex VIII, MDR)
Year when the first certificate (CE) was issued covering the device	Ceramir Crown & Bridge: 2008
Authorized representative if applicable	N/A
Name of Notified Body and identification number	DNV Product Assurance AS 2460

[1]Device variants: Ceramir® Crown & Bridge is available both as a capsule for mixing and direct application (QuikCap) and as a powder for manual mixing and application (QuikMix)

2 INTENDED USE OF THE DEVICE

2.1 Intended purpose

The intended purpose and applications of Ceramir Crown & Bridge (Ceramir CB) and Ceramir Bioceramic Implant Cement (Ceramir BIC) are summarized in **Table 1.**

	Ceramir Crown & Bridge[1]	**Ceramir Bioceramic Implant Cement**
Intended use	Ceramir Crown & Bridge is intended for permanent cementation of: • Metal and porcelain fused to metal crowns and bridges • Gold inlays and onlays • Cast or prefabricated metal posts • High-strength ceramic crowns and bridges suitable for conventional cementation (e. g. zirconia, alumina, and lithium disilicate)	Ceramir Bioceramic Implant Cement is intended for permanent cementation on implant abutments of: •Metal and porcelain fused to metal restorations •High-strength ceramic restorations suitable for conventional cementation (e. g. zirconia, alumina, and lithium disilicate)
Indication	Patients with indication of conventional permanent cementation of prosthetics on natural teeth or implant abutments	Patients with indication for permanent cementation of prosthetics on implant abutments
Patient populations	Provided that indications and contraindications are followed, there are no additional restrictions as to patient populations	Provided that indications are followed, there are no additional restrictions as to patient populations
Contraindications	Do not use as a direct pulp-capping agent. In case of close proximity to the pulp, use accepted standard clinical procedures.	No contraindications
Precautions required by the manufacturer	• Ceramir Crown & Bridge contains polyacrylic acid, which may be irritating to eyes and skin. Avoid contact with eyes. In case of skin contact, rinse with plenty of water. In case of contact with eyes, rinse immediately with plenty of water and seek medical care. • Do not use on patients with known allergy to polyacrylic acid. In rare cases, the product may cause sensitivity to some persons. If such reactions are observed, discontinue the use of the product and consult a physician.	• Ceramir Bioceramic Implant Cement contains polyacrylic acid, which may be irritating to eyes and skin. Avoid contact with eyes. In case of skin contact, rinse with plenty of water. In case of contact with eyes, rinse immediately with plenty of water and seek medical care. • Do not use on patients with known allergy to polyacrylic acid. In rare cases, the product may cause sensitivity to some persons. If such reactions are observed, discontinue the use of the product and consult a physician.

Table 1. *Intended use and application.*[1]*Note that Ceramir Crown & Bridge is the name of the cement included in Ceramir Crown & Bridge QuikCap and Ceramir Crown &Bridge Quikmix*

3 DEVICE DESCRIPTION

3.1 Description of the device

3.1.1 Overview

Ceramir CB and Ceramir BIC have the same chemical formulation, but Ceramir CB is provided in two different primary packaging systems, as capsulated cement where powder and liquid are mixed in the capsule, or as a hand mixed version where the user mixes powder and liquid on a mixing pad. Ceramir BIC is only delivered as a capsulated cement.

3.1.1.1 Principal composition and function

Ceramir cement is a powder/liquid system. The powder consists of:

- a glass ionomer cement,
- a ceramic cement (i.e., calcium aluminate (CA)), and
- a radio-opacifying agent; strontium fluoride (SrF_2).

The main component in the powder is calcium aluminate and, in the liquid, water. The cement, which hardens as a result of a chemical reaction, is self-setting. Ceramir CB and CBIC do not incorporate a medicinal substance, tissues or blood products.

The glass ionomer part of the cement functions as a dispersion agent for the calcium aluminate particles as well as giving the cement its early (< 1h) properties i.e., mixing properties, viscosity, setting time, initial acidic pH and initial strength. It also gives the cement the ability of fluoride release over time.
The CA part of the cement gives the material some of its final properties, such as an alkaline pH and a high resistance to acid erosion. The CA also contributes to a release of calcium ions to the surrounding environment. The calcium aluminate part of the cement provides the second reaction which is a dissolution – precipitation process. During the process the dissolved calcium aluminate is hydrated, which is creating a dual product of an aluminium hydroxide gel, which transforms into crystalline gibbsite ($Al(OH)_3$), and a crystalline calcium aluminate hydrate, katoite ($Ca_3Al_2(OH)_{12}$). The products from the calcium aluminate hydration become chemically bonded with the glass ionomer as the cations; calcium, strontium, and aluminium, are present in both systems.
The calcium aluminate reaction consumes water and proceeds as long as there is both unreacted calcium aluminate and water provided in the structure, and/or until the porosity of the structure is so low that no more hydrate growth can take place. The hardened material is composed of fully dispersed radio-opacifying particles (SrF_2), partially un-dissolved glass ionomer glass particles, crosslinked poly(acrylic acid) salt, the hydrated calcium aluminate material and if water availability is low, un-reacted calcium aluminate particles.

3.1.1.2 Use and application

The dental cement composition is identical in Ceramir CB and Ceramir BIC. The devices differ in their use and clinical application and in their respective delivery systems as follows:

- Ceramir Crown & Bridge is a hybrid glass-ionomer calcium-aluminate dental cement, intended to be used for conventional permanent cementation of prosthetics, including high strength ceramic constructions, e.g. lithium disilicate and zirconia.
- Ceramir Bioceramic Implant Cement is a hybrid glass-ionomer calcium-aluminate dental cement, intended to be used for permanent cementation on implant abutments of: Metal and porcelain fused to metal restorations, and high-strength ceramic restorations suitable for conventional cementation (e. g. zirconia, alumina, and lithium disilicate).

Ceramir cement contains ceramic powder and liquid. The cement is delivered in the following primary packaging systems:

1. *C&B QuikCap and CBIC QuikCap*

The liquid and powder are filled in capsule for mixing and delivery. The powder and liquid are separated in different compartments, inside the plastic delivery capsule, Figure 1. Each capsule is packed in an aluminium pouch.

Figure 1. *Ceramir CB and BIC delivery capsule*

The capsule is activated just before use by pressing the (white) plunger into the capsule, allowing the powder and liquid to blend in the capsule. The content is mixed by using a high-frequency oscillating (4,000 to 5,000 rpm) or rotating capsule mixer.
A capsule applicator (e.g., Ceramir Applicator 2, Figure 2) is needed to extrude the mixed material from the capsule. The seating of the crown and finishing of the restoration is performed using conventional methods.

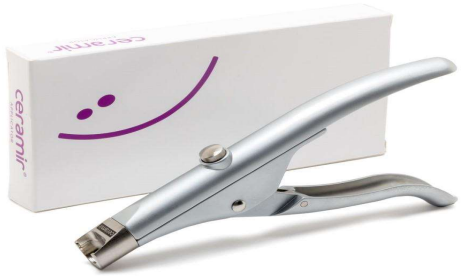

Figure 2. *Ceramir Applicator 2*

2. Ceramir Crown & Bridge QuikMix

When delivered in the QuikMix system, the powder is delivered in a glass jar and the liquid is delivered in a plastic bottle**, Figure 3.**

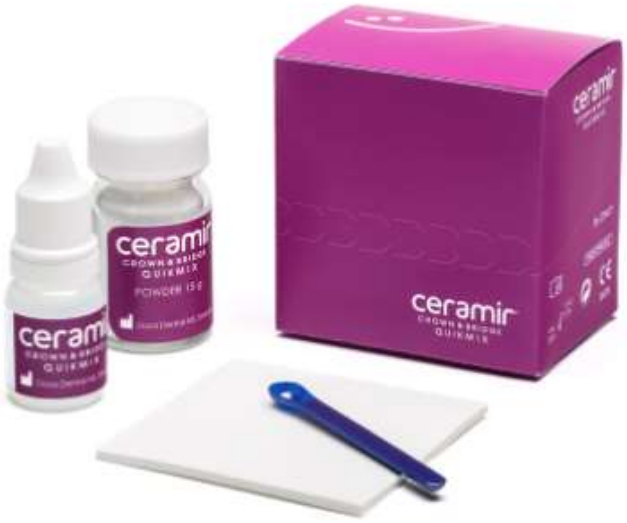

Figure 3. *Ceramir Crown and Bridge QuikMix with accessories*

For the hand-mixed system the powder and liquid are delivered in separate containers. The liquid is dosed by dropping the liquid through the nozzle of the bottle. Each drop is 0.05 g and for one dose two drops are needed (i.e., 0.10 g). To dose the powder, a spoon is included with the powder. A leveled spoon will give 0.18 g powder, resulting in a powder to liquid ratio of 1.8 g/g.
The powder and liquid are mixed on the included mixing pad for 30 seconds using a plastic spatula (not included). The seating of the crown and finishing of the restoration is performed using conventional methods**.**

3.2 Previous generations or variants

3.2.1 Device Market History / Predecessor Devices

Device market history including predecessor devices is summarized in Table 2.

Device	Delivery system	EU	Comment
XeraCem	Hand-mixed	2008	No longer marketed
Ceramir Crown & Bridge (initially XeraCem Capsule)	In Capsule system from VOCO, Germany	2009	No longer marketed
Ceramir Crown & Bridge: Extended indications	In Capsule system from VOCO, Germany[1]	2012	No longer marketed. Indications remain.
Ceramir Crown & Bridge Singlecap	Smaller amount in capsule. Capsule system from VOCO, Germany[1]	2012	No longer marketed. Slightly less extrudable volume compared to Ceramir Crown & Bridge. Capsule system from VOCO, Germany.
Ceramir Crown & Bridge QuikCap	Current version of the product. In capsule system from SDI Ltd., Australia[2]	2016	New capsule system from SDI Ltd, Australia. Acids in the formulation were moved from the powder to the liquid. Only one extruded volume available.
Ceramir Crown & Bridge QuikMix	Hand-mixed version, includes a scoope and a mixing pad.	2016	Same formulation as Ceramir Crown & Bridge QuikCap.
Ceramir Crown & Bridge QuikMix powder refill	Includes a scoope.	2016	-
Ceramir Crown & Bridge Liquid refill	No accessory included.	2016	-
Ceramir Bioceramic Implant Cement QuikCap	Current version of the product. In capsule system from SDI Ltd., Australia[2]	2019	Same product as Ceramir Crown & Bridge QuikCap, slightly more narrow indication for use, targeting implant dentists.

Table 2. *Device market history.*

3.2.1.1 Summary of device changes.

<u>Change of capsule system from VOCO to capsule system from SDI Ltd.</u>

- New supplier of capsule, filling of powder and liquid in the capsule, aluminium foil and packaging of the filled capsule in aluminium foil.
- New capsule design (SDI design). Only one amount of extruded cement available.

New/restructured formulation.
The insignificant change of composition was made to accommodate the formulation to the new capsule system: The polyacrylic and tartaric acids were moved from the powder to the liquid and additional water was added to the liquid. The change to include slightly more water was made in such a way that the ratios between all other ingredients was kept the same.

3.3 Accessories to be used in combination with the device

3.3.1 Accessories for Ceramir CB and BIC QuikCap

- *Mixer*

The cement is mixed using a high-frequency oscillating (4,000 to 5,000 rpm) or rotating capsule mixer. Mixing time is 8s. Mixer is not marketed by Doxa Dental AB.

- *Applicator*

Applicator (see Figure 2) is needed to extrude cement from the capsule. Applicator 2 is marketed by Doxa Dental AB.

3.3.2 Accessories for C&B QuikMix

- *Scoop*

A scoop for powder dosing is included with powder. The scoop is convenient and recommended (but not necessary) to use to obtain the recommended P/L ratio according to the IFU.

- *Mixing pad*

A mixing pad is needed for mixing. A non-absorbing mixing pad or glass slab can be used in accordance with IFU. Mixing pad is delivered with the product for convenience, but different mixing pads can be used.

- *Plastic spatula*

A plastic spatula is recommended for cement mixing. Depending on the type of mixing pads used, a metal spatula can be used, but since this can give a grey cement when used with some types of mixing pads, it is not recommended. Spatula is not delivered with the product.

3.4 Other devices or products to be used in combination with the device

There are no other products to be used in combination with the device except the accessories described in section 3.3.

4 RISKS AND WARNINGS

4.1 Residual risks and undesirable effects

Residual risks and undesirable effects that may occur after cementation with Ceramir CB and Ceramir BIC dental cements are listed below:

- Hypersensitivity
- Allergic reaction
- Infection
- Inflammation
- Caries
- Loss of restoration

These possible adverse reactions are typically associated with the use of dental cements, i.e., they are not specific for Ceramir CB and Ceramir BIC.

Adverse reactions and possible side-effects following the use of Ceramir dental cement are carefully monitored in the post-market surveillance (PMS) process. The incidence of complaints reporting allergic reactions is low: only 3 incidents were registered during the last four years (2018-2021) with over 1.3 million cementations performed during this period.

No complaints reporting other adverse reactions, such as hypersensitivity, inflammation or carries, caused by the use of Ceramir dental cement were received by the manufacturer during the last four years.

4.2 Warnings and precautions

The warnings and precautions to be observed are summarized below:

Ceramir Crown & Bridge QuikMix	**Ceramir Crown & Bridge QuikCap**	**Ceramir Bioceramic Implant Cement (CBIC)**
Warnings		
- For professional dental use in recommended indications only - Keep Ceramir Crown & Bridge QuikMix at temperatures	- For professional dental use in recommended indications only - Keep Ceramir Crown & Bridge QuikCap at temperatures between 4°C/39°F and 20° C/68° F.	- For professional dental use in recommended indications only - Keep Ceramir Bioceramic

between 4°C/39°F and 20° C/68° F. - Store with jar caps securely tightened and away from high humidity. - Do not use Ceramir Crown & Bridge QuikMix after the expiry date - Do not use any pre-treatment agents, e.g. silanes, primers or bonding agents when cementing with Ceramir Crown & Bridge. Use of any such pre-treatments will destroy the bond between cement and restoration. - Room temperatures above 23°C/73°F will accelerate setting time and reduce working time. Working time can be lengthened by using refrigerated components or by mixing on a cold glass slab.	- Do not open the aluminum pouch until immediately before use. - Do not use Ceramir Crown & Bridge QuikCap capsules after their expiry date. - Do not use any pre-treatment agents, e.g. silanes, primers or bonding agents when cementing with Ceramir Crown & Bridge. Use of any such pre-treatments will destroy the bond between cement and restoration. - Work quickly - Room temperatures above 23 °C/73 °F will accelerate setting and reduce the working time available.	Implant Cement at temperatures between 4°C/39°F and 20° C/68° F. - Do not open the aluminum pouch until immediately before use. - Do not use C Ceramir Bioceramic Implant Cement capsules after their expiry date. - Do not use any pre-treatment agents, e.g. silanes, primers or bonding agents when cementing with Ceramir Bioceramic Implant Cement. Use of any such pre-treatments will destroy the bond between cement and restoration. - Work quickly - Room temperatures above 23 °C/73 °F will accelerate setting and reduce the working time available.
Precautions		
- Ceramir Crown& Bridge contains polyacrylic acid, which may be irritating to eyes and skin. Avoid contact with eyes. In case of skin contact, rinse with plenty of water. In case of contact with eyes, rinse immediately with plenty of water and seek medical care. - Do not use on patients with known allergy to polyacrylic acid. In rare cases, the product may cause sensitivity to some persons. If such reactions are observed, discontinue the use of the product and consult a physician.		- Ceramir Bioceramic Implant Cement contains polyacrylic acid, which may be irritating to eyes and skin. Avoid contact with eyes. In case of skin contact, rinse with plenty of water. In case of contact with eyes, rinse immediately with plenty of water and seek medical care. - Do not use on patients with known allergy to polyacrylic acid. In rare cases, the product may cause sensitivity to some persons. If such reactions are observed, discontinue the use of the product and consult a physician.

Table 3. *List of warnings and precautions for Ceramir CB and Ceramir BIC*

5 SUMMARY OF CLINICAL EVALUATION AND POST-MARKET CLINICAL FOLLOW UP

Dental cements or luting agents (*to lute: glue two structures together*), provide a link or adhesive between a restoration and prepared tooth or implant abutment, bonding them together through surface attachment. The cementing agent's primary requirement is to hold a restoration in place for an indefinite period of time and maintain a seal between the restoration and the tooth.
A broad spectrum of luting agents for permanent cementation are available, such as zinc phosphate, polycarboxylate (a hybrid of zinc phosphate) cement, resins and glass-ionomer cements as well as resin-modified glass-ionomer cement.
Each luting cement has its advantages and disadvantages and no one material is perfect. Selection of luting agent to be used for a given restoration should be based on a basic knowledge of the materials available, the type of restoration to be placed, the requirements of the patient and the expertise & experience of the clinician.

5.1 Summary of clinical data from literature related to equivalent devices

Equivalence is not claimed for Ceramir Crown & Bridge and Ceramir Bioceramic Implant Cement.

5.2 Summary of clinical data from conducted investigation before CE marking

No company driven clinical investigation prior to CE marking of Ceramir Crown & Bridge and Ceramir Bioceramic Implant Cement has been performed. See section 5.3 for clinical data published in scientific literature.

5.3 Summary of clinical data from other sources

5.3.1 Clinical investigation

Clinical safety and performance of Ceramir Crown was studied in a prospective clinical investigation. The results of the investigation including 6-month follow-up are published in [Jefferies et al., 2009]. The following one-, two- and three-year follow-up of the patients are published in [Jefferies et al., 2009b, Jefferies et al., 2011; Jefferies et al., 2013]. The study protocol and informed consent form were approved by the Institutional Review Board at Temple University Kornberg School of dentistry (USA).

The clinical investigation was supported by Doxa Dental AB.

The primary objective was to determine clinical safety and efficacy of Ceramir Crown & Bridge for permanent cementation in fixed prosthodontics.
Cementation of high-gold alloy and porcelain-fused to metal (PFM) single crowns and bridges was performed using Ceramir CB. 38 crowns and bridges were cemented in 17 subjects, of which 31 were on vital and seven on non-vital teeth. The study consisted of six bridges with 13 abutment teeth (12 vital/one non-vital).
23 cementations were done on anterior teeth and 15 were on posterior teeth.
The distribution of patients was nine female and eight male subjects, aged 25 to 79 years.

Baseline data was collected comprising subject pre-cementation baseline parameters including patient response to categorical and visual analog scale (VAS) based measurement of pre-cementation sensitivity, gingival inflammation index (GI), presence, or absence of caries in abutment teeth, notation of preparation parameters as well as pre-cementation seating characteristics. Subject post-cementation baseline parameters included adverse taste, post-cementation tooth reaction, post-cementation soft tissue reaction, marginal integrity and marginal discoloration.
Post-operative sensitivity and any adverse events were assessed first after 7-10 days after cementation and followed up after 30 days, 6 months, 1 year, 2 years and 3 years post cementation. The follow-up included also the assessment of mechanical parameters of the cement.
Table 4 summarizes safety parameters evaluated during the entire study.

	Baseline	30 days	6 months	1 year	2 years	3 years
No. patients	17	17	17	15	13	11
No. of restorations/ abutments	38	38	38	31	27	24
Average VAS Score	7.6 mm	3.1 mm	0.4 mm	0.2 mm	0.0 mm	0.0 mm
Average GI	0.56	0.10	0.11	0.16	0.21	0.07
% Alpha – Categorical, Subjective post-operative Sensitivity	58.8%	88.2%	100%	100%	100%	100%

Table 4. *Clinical safety parameters assessed for Ceramir-luted restorations*

Evaluated clinical performance parameters are summarized in Table 5.

	Baseline	**30 days**	**6 months**	**1 year**	**2 years**	**3 years**
No. pt recalled	17	17	17	15	13	11
No. of restorations/ abutments	38	38	38	31	27	24
% Alpha - Retention	100%	100%	100%	100%	100%	100%

% Alpha – Absence of caries	100%	100%	100%	100%	100%	100%
% Alpha – Marginal integrity	100%	100%	100%	100%	100%	100%
% Alpha – Marginal discoloration	100%	100%	100%	100%	100%	100%

Table 5. *Retention, secondary caries, marginal integrity and discoloration for Ceramir-luted restorations*

In conclusion, clinical investigation including 3-year follow up on the clinical performance and safety of Ceramir CB showed that the cement is clinically acceptable for permanent cementation for all-metal and ceramic-fused to metal crowns and fixed to patient dentures. The favorable consistency and viscosity of the cement appeared to insure complete seating of all castings at cementation. Removal of excess set cement from the margins was also noted to be “easy” for all subjects and restorations. No patients noted any taste, adverse or otherwise, and no patients experienced any immediate post-cementation hypersensitivity. Three-year recall data yielded no loss of retention, no secondary caries, no marginal discolorations and no subjective sensitivity. All restorations rated excellent for marginal integrity. Average Visual Analog Scale (VAS) score for tooth sensitivity decreased from 7.63 mm at baseline to 0.44 mm at six-month recall, 0.20 mm at one-year recall, 0.00 mm at two- and three-year recall. Average Gingival Index (GI) score for gingival inflammation decreased from 0.56 at baseline to 0.11 at six-month recall, 0.16 at one-year recall, 0.21 at two-year recall, and 0.07 at three-year recall. After periodic recalls up to three years, Ceramir CB is concluded to have performed quite favorably as a luting agent for permanent cementation of permanent restorations.
Apart from the clinical studies shown, there is one published case report, [Griffin et al., 2013], on the use of Ceramir CB for cementation of monolithic zirconia crown. This report highlights the importance of favorable cement handling characteristics, such as working time, cement consistency and film formation, and ease of cement excess removal for the overall success of dental restoration.

5.3.2 *In vitro* studies

In addition, to the clinical studies, mechanical properties of Ceramir dental cement were investigated in several published *in vitro* and *ex vivo* studies. Limitations of these studies are that extracted teeth do not account for factors of the complex intraoral environment; salivary content, mastication forces, tooth alignment. Furthermore, greater inconsistency may occur when crown cementation is completed in a clinical setting. Nonetheless, *in vitro* testing is the only possibility to assess mechanical properties of the dental cements and *in vitro* aging models reproducing long-term aging behavior provide relevant data to assist clinical decisions.

5.3.2.1 Mechanical properties

The Table 6 below gives an overview of the published *in vitro* studies on mechanical properties of Ceramir dental cement.

Reference	Mechanical property	Study design	Comparison	Result	
Jefferies et al., 2013b	Retentive strength	Clinically simulated tensile test	-	Cold crowns	38.3 ± 8.5 (Kg f)
				Zirconia crowns	32.1 ± 6.3(Kg f)
				Lithium disilicate	29.48 + 9.99(Kg f)
Streiff et al., 2021	Crown removal stress	Lithium disilicate crowns cemented on 24 extracted molars	Ceramir	Lithium disilicate	1.93 MPa (261.4 N)
			Ketac Cem		1.06 MPa (139.4 N)
	Crown retention	6 months aging/30 000 thermocycles	-	No complete loss of retention due to cement degradation	
Jefferies et al., 2013a	Mean compressive strength	Test according to ISO 9917:2003[1] (≥ 50 MPa)[2]	Ceramir	160 ± 27 MPa	
			RelyX	96 ± 10 MPa	
			Fuji Plus	138 ± 15 MPa	
			RelyX	157 ± 10 MPa	
	Film thickness	Test according to ISO 9917:2003[1]	-	16.8 ± 0.9 µm	
	Net setting time			4.8 ± 0.1 min (1.5-8 min)[2]	
	Microhardness (Vickers hardness)	Test according to ISO 9917:2003[1]	Ceramir	68.3 ± 17.2 HV	
			Fleck's zinc phosphate (Mizzy, Keystone Dental)	51.4 ± 10 HV ($p < 0.05$)	
Dandoulaki et al., 2019	Shear bond strength	Monolithic zirconia ceramic cemented to human dentin	-	2.52 MPa to 5.23 MPa Mixed failure types observed	
Pameijer et al., 2010	Microleakage	Premolars cemented with Ceramir subjected to bacterial microleakage	-	By day 60 88.8 % of molars showed no leakage	

Table 6. *Overview of in vitro studies evaluating mechanical properties of Ceramir Crown & Bridge. [1] ISO 9917:2003 Dentistry — Water-based cements — Part 1: Powder/liquid acid-base cements; [2] Requirements of ISO 9917-2003; requirement is not changed in SS-EN ISO 9917-1:2007*

5.3.2.2 Bioactivity

Bioactivity in the meaning of interaction or response from living tissue of Ceramic was studied in several published studies which are summarised below in Table 7.

Reference	Property	Study design	Result	
Engstrand et al., 2012	Hydroxyapatite (HA) formation	Specimens prepared with Ceramir C&B immersed in human saliva and phosphate buffered saline (PBS; as positive control) for 7 days. Formation of HA formation analysed	Ceramir specimens in saliva	~ 1.5 mg HA deposition
			Ceramir specimens in PBS	~ 7.9 mg HA deposition
Dandoulaki et al., 2019	Hydroxyapatite (HA) formation	Ceramir specimens in simulated body fluid (SBF)1 for 30 days	HA deposition not detected.	
Huang et al., 2020	Dentin mineralization	Specimens were cycled for 30 days between a demineralization solution (pH = 4) and a remineralization solution (pH = 7.0) for 20 hours. Specimens were then sectioned to 100 µm and evaluated with polarized light microscopy	Ceramir	3800 ± 1900 µm2
			Bioactive cement (Activa Bioactive)	1400 ± 700 µm2
			Calcium-releasing self-adhesive resin cement (Theracem)	2100 ± 2600 µm2
			Self-adhesive resin cement (Rely Unicem 2)	−2000 ± 1700 µm2
			RMGI (Rely X Luting Plus)	7700 ± 2500 µm2
Unosson et al., 2012	Antibacterial properties (measured in Colony forming units; CFUs)	Streptococcus mutans bacteria were placed in direct contact with specimens that had been aged for	Ceramir	10 min: ~2 x 105 CFUs ($p < 0.05$ vs. controls) 1 day: ~2.5 x 105 CFUs ($p < 0.05$ vs. all cements exc. CA ctrl) 7 days: ~3 x 105 CFUs

		10min, 1 day, and 7 days	RelyX Unicem	10 min: ~2.5 x 105 CFUs 1 day: ~3 x 105 CFUs 7 days: ~3 x 105 CFUs
			GIC (Ketac Cem)	10 min: ~ 5.5 x 105 CFUs 1 day: ~ 5 x 105 CFUs 7 days: ~ 4 x 105 CFUs
			Zinc Phosphate (Harvard Cement)	10 min: ~ 2.5 x 105 CFUs 1 day: ~ 3.5 x 105 CFUs 7 days: ~ 4 x 105 CFUs
			Control: GIC (no brand name)	10 min: ~ 5 x 105 CFUs 1 day: ~ 6 x 105 CFUs 7 days: ~ 5 x 105 CFUs
			Control: Calcium aluminate (CA ctrl; no brand name)	10 min: ~ 1 x 105 CFUs ($p < 0.05$ vs. all other cements) 1 day: ~ 1 x 105 CFUs ($p < 0.05$ vs. all other cements) 7 days: ~ 0.5 x 105 CFUs ($p < 0.05$ vs. all other cements)
Gallegos et al., 2019	Cell viability %	Disk specimens of dental cement were exposed to host and oral bacterial cells	Ceramir Zinc phosphate (Fleck's) RMGIC (Fuji Cem 2) Self-adhesive resin cement (RelyX Unicem 2)	Murine pre-osteoblasts, presented as Ceramir; Fleck's; Fuji; RelyX Unicem 2 (approx.9: Day 3: ~85%; 20%; 20%; <10%. Day 7: 80%; 70%; <10%; <10%. Human Gingival Fibroblasts, presented as Ceramir; Fleck's; Fuji; RelyX Unicem 2 (approx.): Day 3: ~95%; 100%; 80%; 20%. Day 7: ~95%; 95%; 60%; 30%.
Marvin et al., 2019	Cell vialbility	Direct contact with cells was conducted as per ISO 10993 by	Ceramir	MC3T3-E1 pre-osteoblasts, presented as Ceramir; RelyX

		seeding 6-well plates at 350,000 cells/well and incubating the samples for additional 24 hours. Reported results are for cements alone, not cements applied on commercially pure Titanium; cpTi	Self-adhesive resin cement (RelyX Unicem 2) RMGIC (Fuji Cem) Zinc oxide eugenol (Intermediate Restorative Material; IRM) Zinc Phosphate (Fleck's)	Unicem 2; Fuji Cem; IRM (approx.): 0.5 hours: 90%; < 10%; 50%; <10%; 80%. 24 hours: 80%; <10%; 75%; <10%; 100%. Human Gingival Fibroblasts, presented as Ceramir; RelyX Unicem 2; Fuji Cem; IRM (approx.): 0.5 hours: 90%; 60%; 40%; <10%; 80%. 24 hours: 100%; 80%; 80%; 70%; 100%.

Table 7. *Overview of studies evaluating bioactive properties of Ceramir C&B and CBIC. [1]SBF has a 10 times lower phosphate content than PBS.*

5.3.3 Post-market data

The number of complaints received during the last four years is low. The complaint frequency ("number of complaints for the devices" divided by "all sold cementations at all markets") is in the range of 0.004 – 0.014 % for the years 2018-2021 and there are no indications on any systematic or severe risks with the device.

None of the complaints indicated any new or changed risks for the devices or any information concerning misuse or off-label use of the device.

During the period 2018-2021, no adverse events (serious incidents) have been reported to Competent Authorities, however, risk of underreporting should be considered.

During the period 2018-2021 no Field safety Corrective Actions (FSCA) have been issued.

Post-Market Clinical Follow-up (PMCF) activities have been undertaken for the Ceramir CB and Ceramir BIC.
Data collected though Post-Market Clinical Follow-up (PMCF) activities have not revealed any unknown side effects which were not reflected in the current risk analysis.
No PMCF studies have been conducted by the manufacturer.

5.4 Overall summary of the clinical performance and safety

Ceramir Crown & Bridge and Ceramir Bioceramic Implant Cement are marketed in Europe, USA and Japan. Over 55,000 devices have been distributed to customers with over 1,3 million cementations performed only for the last four years.

The claims made by the manufacturer have support by clinical and *in vitro* testing data. The published studies include clinical use of Ceramir Crown & Bridge with one-, two- and three-years patient follow-up. The clinical applications of Ceramir dental cement have not been evaluated in large series of patients, however, Ceramir CB and BIC are luting agents in line with a wide variety of dental cements with well-described performance characteristics. The clinical performance of dental cements is largely predefined by its technical performance characteristics, which are standardized and compliant with ISO 9917-1, and biocompatibility of cement.
Additionally, extensive use of Ceramir C&B on the market and post-market surveillance data indicating very low complaint rate further support safe and efficient use of Ceramir Crown & Bridge and Ceramir Bioceramic Implant Cement for permanent cementation on tooth or implant abutments with excellent restoration retention rates, minimal postoperative sensitivity and excellent handling properties in line with state of the art.
Post-cementation complications such as hypersensitivity to the components of the dental cement or allergic reactions as well as loss of fixed prosthodontics are common risks associated with the use of dental cements. Such complications are rare and comparable to what is generally accepted for state-of-the-art dental restorative treatment. In addition, there are no indications of systematic device issues causing patient harm. According to current knowledge/ state of the art in the medical field concerned and according to available medical alternatives, the benefit/risk profile for Ceramir Crown & Bridge and Ceramir Bioceramic Implant Cement is considered acceptable.

5.5 Planned and ongoing PMCF

The safety of the Ceramir CB and Ceramir BIC is judged to be sufficiently explored, based on the low complaint rate over the years, its long-term use, and the number of sold devices. Planned PMCF activities (as part of PMS) will take into account the monitoring of the residual risks, any emergent risks, unknown side-effects and off-label use.
A PMCF investigation is not deemed necessary since performance and safety of the devices are already known from previous use of the devices and from transferable experience with similar devices (other dental cements).

6 POSSIBLE DIAGNOSTIC OR THERAPEUTIC ALTERNATIVES

Alternatives to use Ceramir CB and Ceramir BIC would be the use of other dental cements available on the market.
A broad spectrum of luting agents for permanent cementation are available, such as zinc phosphate, polycarboxylate (a hybrid of zinc phosphate) cement, resins and glass-ionomer cements as well as resin-modified glass-ionomer cements.
Each luting cement has its advantages and disadvantages, and no material is perfect. Selection of luting agent to be used for a given restoration should be based on a basic

knowledge of the materials available, the type of restoration to be placed, the requirements of the patient and the expertise & experience of the clinician.

7 SUGGESTED PROFILE AND TRAINING FOR USERS

The intended user of Ceramir Crown & Bridge and Ceramir Bioceramic Implant Cement is a health care professional, i.e. dentist and nurse at a dental clinic. Usually, the nurse prepares for cementation and the dentist performs the cementation. Dental cements are routinely used in dental practice. No product-specific training is required.

8 REFERENCE TO ANY HARMONIZED STANDARDS

The standards and guidance documents listed below are the versions used for documentation, validation and verification of Ceramir Crown & Bridge and Ceramir Bioceramic Implant Cement.

Standards applied	Title
Standards	
EN ISO 13485:2016	Medical devices – Quality management systems – Requirements for regulatory purposes
SS-EN ISO 14971:2020	Application of risk management to medical devices
IEC 62366-1:2015	Medical devices — Part 1: Application of usability engineering to medical devices
SS-EN ISO 10993-1:2020	Biological evaluation of medical devices– Evaluating and testing
SS-EN ISO 7405:2018	Dentistry - Evaluation of biocompatibility of medical devices used in dentistry
SS-EN ISO 9917-1:2007	Dentistry — Water-based cements — Part 1: Powder/liquid acid-base cements
Common specification	
No applicable common specifications currently available.	
Implementing and delegating acts	
No applicable implementing or delegating acts available for fulfilment of the requirements in this GSPR list.	
Guidelines	
MEDDEV 2.7/1 rev 4	Clinical evaluation: Guide for manufacturers and notified bodies
MDCG-2020-6	Regulation (EU) 2017/745: Clinical evidence needed for medical devices previously CE marked under Directives 93/42/EEC or 90/385/EEC. A guide for manufacturers and notified bodies

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10 DOCUMENT REVISION HISTORY

SSCP revision number	Date issued	Change description	Revision validated by notified body
1	2022-12-02	New document	☐ Yes Validation language ☐ No (*only applicable for class IIa and some class IIb devices*

11 SUMMARY OF SAFETY AND CLINICAL PERFORMANCE OF CERAMIR CROWN & BRIDGE AND CERAMIC BIOCERAMIC IMPLANT CEMENT INTENDED FOR PATIENTS

Document revision: 01
Date issued: 20221202

This Summary of Safety and Clinical Performance (SSCP) is intended to provide public access to an updated summary of the main aspects of the safety and clinical performance of Ceramir® Crown & Bridge and Ceramir® Bioceramic Implant Cement (Ceramir CB and BIC). Ceramir Crown & Bridge (CB) is available both as a capsule for mixing and direct application (QuikCap) and as a powder for manual mixing and application (QuikMix). The information presented below is intended for patients or laypersons. A more extensive summary of its safety and clinical performance prepared for healthcare professionals is found in the first part of this document.

The SSCP is not intended to give general advice on the treatment of a medical condition. Please contact your healthcare professional in case you have questions about your medical condition or about the use of the device in your situation. This SSCP is not intended to replace an Implant Card or the Instruction for Use to provide information on the safe use of Ceramir CB and BIC.

11.1 Device identification

Device trade name	Ceramir Crown & Bridge QuikCap Ceramir Crown & Bridge QuikMix Ceramir Bioceramic Implant Cement
Manufacturer's name and address	Doxa Dental AB Axel Johanssons gata 4–6, SE-754 50 Uppsala, Sweden.
Basic UDI-DI	7350052434007Z
Year when the first certificate (CE) was issued covering the device	2008

11.2 Intended use of the device.

Ceramir Crown & Bridge (Ceramir CB) is a dental cement used for permanent cementation of

- Metal and porcelain fused to metal crowns and bridges
- Gold inlays and onlays
- Cast or prefabricated metal posts

- High-strength ceramic crowns and bridges suitable for conventional cementation (e. g. zirconia, alumina, and lithium disilicate)

Ceramir Bioceramic Implant Cement (Ceramir BIC) is intended for permanent cementation on implant abutments of:

- Metal and porcelain fused to metal restorations
- High-strength ceramic restorations suitable for conventional cementation (e. g. zirconia, alumina, and lithium disilicate).

Ceramir CB is indicated for permanent cementation of prosthetics on natural teeth or implant abutments. Ceramir BIC is used only for implant cementations.

Ceramir CB and Ceramir BIC can be used in all patient groups, provided that all indication and contraindications are followed.

Ceramir CB is contraindicated for use as a direct pulp-capping agent and standard clinical procedures should be followed instead in cases when the dentist is working close to the pulp. Ceramir BIC has no contraindications.

Ceramir CB and BIC contain polyacrylic acid, which is rare cases can cause allergic reactions and sensitivity. If such reactions are observed the use of Ceramir CB or Ceramir BIC shall be stopped.
If the reaction occurs after the cementation procedure is performed, contact your healthcare provider.

11.3 Device description

Ceramir CB and Ceramir BIC (further addressed as Ceramir) are dental cements or luting agents (to lute: glue two structures together) used to glue a restoration on a prepared tooth or on an implant. The main purpose of dental cement is to permanently hold a restoration in place and provide a seal between the restoration and the tooth.

Ceramir CB and Ceramir BIC have the same chemical composition. Ceramir CB is provided in two different primary packaging systems, as capsulated cement where powder and liquid are mixed in the capsule (QuikCap), or as a hand mixed version where the user mixes powder and liquid on a mixing pad (QuikMix).
Ceramir BIC is only delivered as a capsulated cement.

Ceramir cement is a powder/liquid system. The powder contains:

- a glass ionomer cement,
- a ceramic cement (i.e., calcium aluminate), and

- a radio-opacifying agent; strontium fluoride (radio-opacifying agent is added to allow the distinction between cement line and recurrent caries on X-ray pictures).

The main component in the powder is calcium aluminate and, in the liquid, water. Powder and water components are mixed prior to application. The powder components dissolve in water and the material hardens due to formation of two compounds: katoite and gibbsite. Katoite is a crystalline calcium aluminate hydrate. Gibbsite is an aluminium-hydroxide and is formed first as an amorphous gel which transforms over time into crystalline gibbsite. The products from the calcium aluminate hydration chemically bond with the glass cement component of the powder since both contain calcium, strontium, and aluminium. The hardened cement contains evenly distributed radio-opacifying particles, partially undissolved glass particles, crosslinked poly(acrylic acid) salt, the hydrated calcium aluminate material.

11.4 Risks and warnings

Contact your healthcare professional if you believe that you are experiencing side-effects related to the device or its use or if you are concerned about risks. This document is not intended to replace a consultation with your healthcare professional if needed.

Well known materials and established manufacturing methods have been used to produce Ceramir dental cement. The product has been designed and tested under controlled conditions to reduce the risk for any device deficiencies or side-effects.
However, individual reaction to the components of the cement or the cementation procedure itself cannot be excluded.
Adverse reactions which can occur when Ceramir or other dental cements are used include:

- Allergic reactions or hypersensitivity to any of the components of the cement
- Infection
- Inflammation
- Caries

Adverse reactions and possible side-effects following the use of Ceramir dental cements are carefully monitored by the manufacturer.
The incidence of adverse reactions is low: only 3 incidents reporting allergic reaction were registered during the last four years (2018-2021) with over 1.3 million cementations performed during this period. The manufacturer is not aware of any cases of inflammation, infection or caries occurring for the last four years.

During the period 2018-2021 no Field safety Corrective Actions (FSCA) have been issued.

11.5 Summary of clinical evaluation and post-market clinical follow-up

Ceramir Crown & Bridge, including the no longer marketed product XeraCem, is marketed both in Europe and in USA since 2008. Ceramir Bioceramic Implant Cement was introduced into both markets in 2019. Only for the last four years (2018-2021) devices corresponding to approximately 1.4 million cementations have been distributed on the market.
A clinical investigation of Ceramir Crown & Bridge with one-, two- and three- years patient follow-up has been performed. The results of this study are summarized in section 11.5.1.

The clinical performance of dental cements is largely determined by its technical performance characteristics. Certain characteristics, such as mechanical properties of cement and cement performance upon aging can only be tested in laboratory conditions. Therefore, data obtained from *in vitro* ("test-tube experiments") and *ex vivo* (tests on extracted teeth) studies are very important and support the results of the clinical investigation.

Ceramir Crown & Bridge and Ceramir Bioceramic Implant cements showed excellent ability to hold restorations on teeth or implants in place with minimal post-cementation sensitivity. Excellent cement consistency, fast cement setting and easy removal of excess cement makes the cementation procedure simple for the dentist and gives the favorable result to the patient.

Use of Ceramir dental cement on the market is carefully followed by the manufacturer. Manufacturer collects and analyses complaints from the users and patients treated with Ceramir dental cements to identify any safety issues or poor performance of the product.

The information on the use of Ceramir Dental cement on the market collected over the last four years (2018-2021) did not uncover any unknown side-effects or any previously unknown risks associated with the use of the product.

11.5.1 Clinical evidence for CE marking

The initial CE-marking of Ceramir Crown & Bridge was based on the published results of a prospective clinical investigation performed at Kornberg School of Dentistry, Temple University, USA. A total of 38 crowns were cemented in 17 patients. The patients were followed for 36 months. The primary objective was to determine the safety and clinical efficacy of Ceramir Crown & Bridge for permanent cementation of fixed prosthodontics. Secondary objective was to explore the performance of Ceramir Dental cement by measuring cement performance parameters such as working and setting time and ease of excess cement removal.
Post-operative sensitivity and any adverse events were assessed first after 7-10 days after cementation and followed up after 30 days, 6 months, 1 year, 2 years and 3 years post cementation. The follow-up also included the assessment of mechanical parameters of the cement.

The results of clinical investigation including 3-year follow up on the clinical performance and safety of Ceramir CB showed that Ceramir cement is clinically acceptable for permanent cementation for all-metal and ceramic-fused to metal crowns and fixed to patient dentures. The favorable consistency and viscosity of the cement ensured the complete seating of all castings at cementation. Removal of excess cement from the margins was easy for all subjects and restorations. No patients noted any taste, adverse or otherwise, and no patients experienced any immediate post-cementation hypersensitivity. Three-year follow-up data yielded no loss of retention, no secondary caries, no marginal discolorations, and no subjective sensitivity. All restorations showed excellent marginal integrity. Average Visual Analog Scale (VAS) score for tooth sensitivity decreased from 7.63 mm at baseline to 0.44 mm at six-month follow-up, 0.20 mm at one-year follow-up and 0.00 mm at two- and three-year follow-up. Average Gingival Index (GI) score for gingival inflammation decreased from 0.56 at baseline to 0.11 at six-month follow-up, 0.16 at one-year follow-up, 0.21 at two-year follow-up, and 0.07 at three-year follow-up.

The results of the clinical investigation including 3-year follow-up, confirmed that Ceramir Crown & Bridge performed favorably as dental cement for permanent cementation of dental prosthetics (orthodontics).

11.6 Possible therapeutic alternative

When considering alternative treatments, it is recommended to contact your healthcare professional who can take into account your individual situation.

Alternatives to use Ceramir CB and Ceramir BIC would be to use other dental cements available on the market. Each dental cement has its advantages and disadvantages, and no material is perfect.
The choice of dental cement for a particular restoration should be done in consultation with the dentist.

11.7 Suggested training for users

Ceramir Crown & Bridge and Ceramir Bioceramic Implant cements can be used only by dentists or dental nurses. No product-specific training is required.