

In vivo studies

Prospective study

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The study is underway at two clinics in the Gothenburg area, Sweden. 89 restorations, class I and class II tunnel preparations are investigated. The 68 patients are between 8 and 59 years old, with a mean of 17 years. Gradual follow-up is carried out after 1, 3 and 5 years.

At the 3-year recall, 59 of the 89 fillings (66%) were examined. It can be concluded that Cerana seems to fulfil the expectations of an alternative to amalgam restorations in class I situations. Prefabricated inlays, a standardised technique and minimal amounts of composite can reduce disadvantages of both porcelain inlays produced by dental technicians and composite fillings. The treatment, however, places great demands on the finishing and polishing of the fillings. The results also suggest that the clinician cannot rely on the bonding of Cerana to strengthen the marginal ridge in cases with tunnel preparations. It must be recommended to use a proximal inlay instead, when the clinician wants to use this method. The manufacturer has since this study started put an inlay specially designed to use for class II situations called Proxi Primary inlays for primary caries and Proxi Replacement inlays for replacement of amalgam- or composite resin fillings. A prospective study on these inlays is desirable.

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Retrospective study 1

A new application of prefabricated ceramics within the therapy of fillings

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CERANA is the name of ceramic prefabricated inlays, which replace the enamel, made of a leucite reinforced glass ceramic material. For the evaluation of the quality of the CERANA therapy, 38 patients were investigated with in total 60 inlays in a retrospective cross-section study. The inlays were mostly of Class I indication but also of Class II, tunnel preparations and one Class V were investigated. The average age of the inlays was 1,5 year. A modified form of the California Dental Association criteria was used for the evaluation.

The result shows that all of the inlays were of excellent or acceptable mode concerning marginal adaptation, colour and surface roughness. None of the patients reported any post-operative pains. One restoration with a bad anatomic form as a result of fractured filling and one with a deep discoloration were found. The time for evaluation is short, but the results show that CERANA is an interesting alternative to other tooth coloured materials on the market.

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Retrospective study 2

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Up to three-year follow-up of about half of the patients being examined in retrospective study I. Extension: 34 inlays of varying age have been examined. The youngest inlays were 1 year old and the oldest ones 3 years. The average age of the inlays was haughtily 2 years. 26% of the inlays had a perfect marginal adaptation while 74% showed steps, and only one had a superficial marginal discoloration. There was a crack in one marginal ridge. The anatomical form of the fillings was excellent in 97% of the cases. No caries was found in connection with the fillings. Regarding the surface 76% had a smooth surface, while the rest had a slightly rough surface. None of the patients had experienced any postoperative sensitivity.

Thuisis, Switzerland, January 1996

Retrospective study 3

Per Ödman, PHD, University of Gothenburg, Sweden.

Extension: 92 inlays in class II situations. 49 patients were examined: 31 women and 18 men. They had received a total of 92 fillings: 20 maxillary premolars, 25 maxillary molars, 25 mandibular premolars and 22 lower jaw molars. The average age of the fillings was 1.6 years, the most recent one being six months old and the oldest 3 years old.

As in earlier follow-up studies of CERANA, marginal defects were found in the form of steps between tooth and ceramic material. The relatively large frequency of gaps, which had not been found in studies of class I restorations, occurred in association with composite material, not between ceramic and enamel or ceramic and ceramic. The same applies to marginal discoloration. Both the patients and the author agreed that the colour of the fillings was good. Only 3% of the patients in the material had reported post-operative symptoms. This can be compared with Rasmusson & al. (1997), where 7 % of the patients experienced post-operative symptoms after rehabilitation with class II composites, and with Milleding & al. (1995), who report 15% post-operative symptoms after cementing of ceramic inlays. The latter study was written in the form of a questionnaire. The conclusion from the present retrospective examination is that CERANA is a feasible form of rehabilitation for class II restorations too, but the amount of composite ought to be reduced.

References: Milleding P, Örtengren U & Karlsson S (1995). Ceramic inlay systems: some clinical aspects. *Journal of Oral Rehabilitation* 22:571-580.

Rasmusson C G, Köhler B & Ödman P (1997). A three-year clinical evaluation of two different composite resins. *ACTA, Odont. Scand.*

Ödman P, Nilsson E & Pietruszka K, (1997). Cerana - A new method for restoration of teeth with prefabricated ceramic inlays, *Journal of Oral Rehabilitation*, 1998 Vol. 25.

Ödman P (1997). Cerana - A prospective study of class I restorations carried out at two public dental clinics.

Ongoing prospective longitudinal study of over 30 inlays in class I and II cavities.

Dr. Brian J. Millar, GKT Dental Institute, University of London, UK

Ceramic materials provide aesthetic restorations, which are able to withstand the oral environment, but two appointments are needed to fabricate ceramic restorations by means of an indirect technique. However, single-visit systems are becoming available and a recent development, Cerana, utilises matched drills with pre-etched and silanated leucite inlays. The final restoration consists of a leucite inlay surrounded by a small amount of a restorative composite resin. The results over 6 years suggest that these restorations can be expected to perform well. The inlay colour was stable and the colour match was acceptable. There was a slight loss of marginal adaptation due to loss of marginal resin but no loss of ceramic. The restoration contour was maintained without marginal discoloration. There is a slight increase in surface roughness. In conclusion, the results were promising in terms of aesthetics, patient acceptance, occlusal wear and ease of use.

November 2002

Initial observations with a ceramic inlay technique for sealing endodontic access cavities

Dr. Brian Millar, Dr. Brett Robinson, King's Dental Institute, University of London, UK

This paper outlines the excellent use of Cerana to close and seal endodontic access cavities. Given the need for a complete and reliable coronal seal after endodontic treatment the Cerana technique provides an aesthetic seal, bonded all around and minimising polymerisation contraction.

Presented at the International Endodontic Society, 1996

Cerana – a direct ceramic inlay technique

Dr. Brian J. Millar, Dept. of Conservative Dentistry, King's Dental Institute, UK

This review looks at how Cerana can be used in class I and class II situations. The CERANA technique is explained to dentists and information supporting the method is provided. Dentists will discover how to use this novel approach to provide a quick and aesthetic solution to some of the problems encountered in practice, particularly those relating to the contraction of composite resin restorations.

Primary Dental Care, Vol. 6, no 2, April 1999.

Seven Year Results With Direct, Single-visit, Ceramic Inlays (Cerana). B J Millar, P B Robinson*. University of London, Team Care Dentistry, GKT Dental Institute, London, UK.

The results over 7 years of a prospective longitudinal study of 33 *Cerana* (Nordiska Dental, Sweden) prefabricated leucite ceramic restorations (25 CI I, 8 class II) are presented. Restorations were placed in single appointments by one clinician and assessed by two examiners using modified USPHS criteria and graded A, B, C or D for anatomical form (AF), marginal adaptation (MA), surface roughness (SR), marginal discoloration (MD), colour match (CM), discomfort (DT). The aim of the study was to assess the performance of *Cerana* inlays. The % of A scores for AF, MA, SR, MD, CM and DT at baseline (n=33) were: 100, 97, 79, 100, 21, 100; after 2 years (n=27) 100, 89, 33, 100, 19, 100 and after 4 years (n=19) 95, 74, 21, 95, 32, 100. At 6 years (n=13) 100, 77, 15, 92, 23, 100 and at 7 years (n=12) 100, 75, 0, 92, 17, 100. AF of the inlay was maintained but composite was lost where exposed in 75% restorations. SR increased to a B score for all inserts by 7 years. MD at B grade was observed in 8% between composite and tooth, none between insert and composite. The inlay colour was stable and the colour match was acceptable in all cases. DT was nil throughout the study. There were no scores less than B and so all restorations remain clinically acceptable and in function. The results suggest that these restorations can be expected to perform well. Over the seven year period there was a slight loss of marginal adaptation due to loss of marginal resin but no loss of ceramic and a slight increase in surface roughness. In conclusion, the results were promising in terms of aesthetics, patient acceptance, occlusal wear and ease of use.

Presented at the British Society for Dental Research (BSRD) April 2004

Eight year results with direct ceramic restorations (Cerana). B J Millar, P B Robinson*. University of London, Team Care Dentistry, GKT Dental Institute, London, UK.

Conclusion: The results suggest that these restorations can be expected to perform well. Cerana is acceptable in terms of aesthetics, patient acceptance, occlusal wear and ease of use and is a good alternative for a single-visit, tooth coloured restoration in suitable cavity shapes.

British Dental Journal, 2006; 201; 515-520.

In vitro studies

Marginal fit of occlusal Cerana inlays in vitro (single inlays and combined inlays)

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10 single and 10 combined Cerana inlays were made occlusally in 20 extracted teeth. Each combined Cerana inlay consisted of two inlays. All inlay teeth were sectioned in three slides for each inlay, randomly chosen. At each slide, the absolute marginal discrepancy and the thickness of the marginal luting cement was measured in a light microscope. The difference between single Cerana inlays and combined Cerana inlays was not statistically significant. However, a tendency to a poorer marginal fit was found for the combined inlays. This tendency

was seen for the parameter absolute marginal discrepancy, as well as the marginal thickness of the luting cement. For both inlay groups the absolute marginal discrepancy was much higher than the thickness of the luting cement. This difference was highly significant. The margins of the Cerana inlays should therefore be adjusted by the next follow-up visits. The average thickness of the marginal luting cement was about 100 microns for single Cerana inlays and about 140 microns for combined Cerana inlays. This marginal fit is comparable to other types of ceramic inlays (as CEREC inlays, Celay inlays and Vita Dur N inlays) but inferior to the marginal fit of cast gold restorations (about 50 microns). Any user of the Cerana system should therefore be concerned about the need for marginal (re-) adjustments for each inlay placed in the oral cavity, and for a distinct inlay preparation technique optimising the marginal fit.

November 1998

Studies of the marginal quality of four ceramic insert systems.

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Adhesively luted prefabricated ceramic inlays are discussed to prevent microleakage in different investigations. The purpose of this study was to compare the marginal quality of four different ceramic inlay systems. 80 standardised class II cavities were prepared above the cemento-enamel junction. The cavities were filled with high viscous luting cement and SDS Inlays, Beta Quartz Inserts, Cerafil Inlays and Cerana Inlays, respectively. After thermo cycling and abrasion by tooth brushing the dye penetration was measured. At the composite-ceramic interface the SDS-system showed a significantly higher dye penetration than the other systems tested. The difficult contouring and finishing probably resulted in the differences found. But under the chosen conditions for thermomechanical and abrasion load a comparable good marginal adaption for the four inlay-systems tested was obtained.

Deutschen Zahnärztlichen Zeitschrift, Vol. 53, 1998:494-500

Marginal Leakage in Class II Restorations after Use of Ceramic Inserts luted with different materials.

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The efficiency of using prefabricated ceramic inlays to prevent microleakage has been discussed in different investigations. The purpose of this study was to evaluate the marginal microleakage of a new glass ceramic inlay system in combination with two different composite luting materials and one polyacid modified composite respectively. Standardised class II cavities ($n = 60$) were filled with Empress inlays fixed with a highly viscous luting composite as a control group, and with glass ceramic inlays (Cerana) in combination with a highly viscous luting composite, a low-viscous luting composite and a polyacid modified composite, respectively. After thermocycling the marginal quality was analysed with scanning electron microscopy, and the dye penetration along the cavity walls was measured. The use of the Cerana inlays with a polyacrylic acid modified composite resin did not reveal a good marginal adaption. However, the combination of the Cerana and the Empress inlays with the highly viscous composite exhibited a comparable marginal fit. Within the limitations of an in vitro study it is concluded that the combination of the new glass ceramic inlays with a polyacid modified composite cannot be recommended for clinical use.

Journal of Oral Rehabilitation Vol. 25, 1998, 567-574

Dual cure systems for pre-shaped ceramic inlays; an in vitro evaluation.

Professor Alejandro Paz et col., University J.F.Kennedy, Argentina

The study compare the marginal leakage of ceramic inlays (CERANA) cemented with composite cements using different polymerisation techniques. Samples were randomly divided into five groups: 1. Calibra (C) dual cured, 2. Calibra (C) self cured, 3. High Q bond (HQ) dual cured, 4. High Q bond (HQ) self cured and 5. Ana Norm (AN) light cured. Shear bond strength and marginal leakage was determined. Compared to Calibra, High Q Bond cement showed

higher bond strength values and lowest leakage values. Ana Norm composite resin proved to be the best material according to the properties assessed. The difference between dual and light cured cements can be explained by the fact that the material might experience movements during the chemical reaction and therefore separate from tooth structure. It can be concluded that curing system of luting cements are closely related to marginal leakage. In the inlay system (CERANA) used the use of a composite resin (Ana Norm) as luting material can be recommended. Adhesive cements with chemical activation should not be used, as they showed the lowest bond strength and highest leakage.

December 2001

**In vitro behaviour of flow composites as luting cement for Cerana ceramic inlays.
Professor Alejandro Paz et col., University J.F. Kennedy, Argentina**

Three different flowing composites were tested for cementing Cerana leucite reinforced ceramic inlays. Four tests were carried out; SEM observation, Colour penetration in the interfaces, Adhesive strength and Hardness.

The materials that showed better performance were those with highest percentage of particles. Comparing with previous studies, we see that flow composites have higher adhesive values and smaller thickness of the material is obtained. Separation generally occurred between dental substance and luting material. The hardness was less than that of a conventional composites but reaching acceptable values for clinical use. Large marginal gaps were observed in the groups that used a second occlusal inlay producing a directly proportional relationship with the interfaces.

Conclusion: Flow composites can definitely be used as luting agents in rigid restorations of Cerana ceramic inlays in class I cavities and also in class 2 cavities where single proximal inlays are used. Flow composites should not be used for cementing inlays in class 2 cavities where multiple inlays are used.

January 2004

Study of wear of composite and leucite reinforced ceramic.

Professor Alejandro Paz et col., University J.F. Kennedy, Argentina

This study determine the wear between two bodies, comparing three hybrid composites, one leucite reinforced ceramic and dental enamel. The ceramic analysed in this study, Cerana, showed significantly less wear than all composites using dental enamel as antagonist. The wear of the enamel surface was insignificant. P-60 was the most resistant among the composites. In all cases the materials studied had more wear than dental enamel. The abrasive resistance is presented as one of the most significant properties for restorative materials in posterior teeth; the analysed ceramic represents the best alternative if abrasion is the determining property.

January 2005

Marginal Micro Leakage Around Class V Cavities Restored with Glass Ceramic Inserts of Different Coefficients of Thermal Expansion.

Dr Ario Santini. BDS, DDS, PhD, DGDP, Dip.F.Med. FADM. Director Biomaterial Research. Edinburgh Postgraduate Dental Institute. University of Edinburgh, UK

The study evaluated micro leakage around Class V resin restorations restored with glass ceramic inserts of different coefficients of thermal expansion.

Sixty, non-carious extracted human premolars were randomly assigned to three groups, as detailed below. Standard Class V preparations were cut in the buccal surface using customized Cerana burs, size 3. (Nordiska Dental AB, Helsingborg, Sweden). Glass ceramic inserts from two manufacturers (1. Cerana, Nordiska Dental AB, Helsingborg, Sweden: 2. Beta-Quartz, Hager Werken GmbH, Duisburg, Germany) were used to restore the cavities in conjunction with a resin based composite (Tetric Ceram: Ivoclar-Vivadent). A control group, without inserts, was bulk filled with the hybrid, high-viscous composite (Tetric Ceram).

The results strongly suggest that restorations restored with Cerana glass ceramic inserts, which have a coefficient of thermal expansion approximating to that of enamel, results in a decrease

in marginal micro leakage, compared to Beta Quartz glass ceramic inserts and Tetric Ceram resin based composite material.

J Clin Dent 16:26-31, 2005

Interface evaluation after manual and ultrasonic insertion of standardized class I inlays using composite resin materials of different viscosity

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The aim of the study was to investigate the effect of manual and ultrasonic insertion of standardized class I inlays (Cerana) using three composite resin materials of different viscosity (Tetric Flow, Tetric, and Tetric Ceram) on time to seat inlays, film thickness, and filler distribution within the materials. Results. Using an ultrasonic device, times for insertion values were significantly lower in the high and medium viscosity composite resin material groups compared to manual insertion ($p < 0.05$). The widest film thickness was recorded for the high viscosity composite resin material in combination with manual insertion ($p < 0.05$). However, when ultrasound was applied, there was no difference in film thickness between the three materials at any levels. Furthermore, the analysis of filler distribution revealed no significant differences between groups. Conclusion. Highly filled viscous composite resin materials may be used in combination with the ultrasonic insertion technique without untoward effects on film thickness or filler distribution.

Acta Odontologica Scandinavica, 2005; 63: 205–212

Effect of prolonged thermal cycling on microleakage around Class V cavities restored with glass-ceramic inserts with different coefficients of thermal expansion.

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120 non-carious extracted human premolars were randomly assigned to three groups. Standard Class V preparations were cut using customized Cerana burs, size 3. (Nordiska Dental AB, Helsingborg, Sweden) Glass ceramic inserts from two manufacturers (Cerana, Nordiska Dental AB, Helsingborg, Sweden; Beta-Quartz, Hager Werken GmbH, Duisburg, Germany) were used to restore the cavities and were luted with a hybrid, high viscous composite (Tetric Ceram: Ivoclar-Vivadent) and a bonding agent (Excite, Ivoclar Vivadent). A control group, without inserts, was bulk filled with the same hybrid. At the occlusal and gingival margins there were no significant differences in microleakage between the three groups without thermal cycling. After thermal cycling, microleakage at the occlusal and gingival margins were significantly less around cavities restored with Cerana glass-ceramic inserts versus Beta-Quartz and Tetric Ceram. The results indicate that after thermal cycling restorations restored with Cerana glass-ceramic inserts show a decrease in marginal micro leakage compared with Beta-Quartz glass-ceramic inserts and Tetric Ceram resin-based composite material.

Primary Dental Care, October 2006

In vitro study of abrasion for different dental materials

Paz Alejandro G.C (Professor University J.F.Kennedy Argentina

The abrasion is usually defined simply as "superficial loss of substance in a body". This single concept defines a property of the materials but in reality it is a complex process.

The abrasion of a material should be validated in vitro or in vivo, the optimal way to do this is to use a simulator that applies the same load as when chewing.

The wear of ceramic for direct method "Cerana" is significantly less than all analysed composites. At the same time, explicit differences exist among the compound materials in this work. We see as positive for the professionals to contribute with these analyses helping with the final choice of material for each clinical case.

Strengthening of immature anterior roots after apexification using CERANA[®]
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Dental School, Mashhad University of Medical Science, Iran

Thin dentinal walls of immature anterior roots after apexification are more susceptible to fractures rendering non-restorable teeth. Reports indicate that 30% of these teeth will fracture during or after endodontic treatment. Introducing this new technique using light transmitting prefabricated glass ceramic CERANA[®] inlays for strengthening residual tooth and access restorations. Twenty endodontically treated immature anterior teeth were used. Gutta percha was removed and cleared out from 1/3 of the incisal part of the root canals. DBA used after phosphoric acids etching of internal dentinal walls and cavity margins, and then immediately composite resin plus CERANA[®] inlay were inserted. 5 year follow up showed acceptable tooth structure reinforcement. Using appropriate light intensity pattern along with a better light transmission through CERANA[®] inlays produce better bottom polymerization and better bond strength of composite resin to dentinal walls in deep area. This technique could be considered for strengthening of immature anterior roots. *Presented at IFEA, Vancouver August, 2007*

Material Tests

A study regarding test of silane over time

Professor Erik Asmussen, Tandlægeskolen, Copenhagen University, Denmark

The discs (made of the same material as the Cerana inlays) are etched and silanised. The inlays are cemented with bonding against the discs. The specimens are stored for 1, 3, 6 and 12 months in normal room temperature. The adhesion is then measured after 7 days storage in water.

Conclusion: The adhesion after 1 year is relatively high, which indicates that the silane is kept active unless it is exposed to light and/or high temperatures.

June 1997

Trials of light polymerisation through the Cerana inlays of different thickness.

Professor Erik Asmussen, University of Copenhagen, Denmark

In the 4 series the following has been used:

- | | |
|-----------------------------|-----------------------------|
| 1) Inlay with stalk | 3) 3 mm inlay without stalk |
| 2) 4 mm inlay without stalk | 4) 2 mm inlay without stalk |

An analysis shows that there is no difference between the 4 groups ($p > 5\%$). Consequently it seems that the thickness of the Cerana inlays does not affect the bonding strength.

December 1998

Trials of light polymerisation through the Cerana Endo inlays.

Professor, Erik Asmussen, University of Copenhagen, Denmark

The light polymerisation through the Cerana Endo inlay is now completed. The bonding strength was measured to be 21 MPa, a value that corresponds to earlier measurements. I.e. even with the stalk still attached to the inlay of 4 mm the bonding result is still satisfactory.

February 1999