Six years' experience with glass-ionomer–silver cermet cement

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Glass-ionomer–silver cermet cement has been used extensively for restorations in children and adolescents since 1984. This work describes handling characteristics, clinical uses, and limitations of the material and documents representative examples up to 6 years after placement in the mouth. Observations about glass-ionomer–silver cermet cement in clinical use are also reported. (Quintessence Int 1991;22:783–793.)

Introduction

In 1986, we reported that if glass-ionomer–silver cermet cement (Ketac-Silver and Chelon-Silver, ESPE GmbH) proved itself in the mouth to be durable and reliable over a 4- to 7-year span, the material could be a worthy alternative to silver amalgam for restoring certain lesions in primary teeth.

After using Ketac-Silver extensively in primary and permanent teeth for more than 6 years, we have discovered the material's strengths, weaknesses, advantages, disadvantages, important handling characteristics, and strict limitations. When used properly, within those limitations, glass-ionomer–silver cermet cement is an excellent dentinal and enamel replacement restorative material that can last at least 6 years in the human mouth.

Ketac-Silver is a premeasured, encapsulated, injectable glass-ionomer cement material. Its non-predosed counterpart is Chelon-Silver. Although it retains characteristics of all glass-ionomer cements, such as chemical bonding to dentin and enamel, coefficient of thermal expansion similar to that of tooth structure, fluoride release to surrounding tooth structure without degradation of the hardened mass, extremely small dimensional changes and little heat production during the hardening reaction, good biocompatibility, and insolubility in oral fluids, Ketac-Silver differs from conventional glass-ionomer cement systems in key ways.

The glass powder in the formula is sintered with elemental silver at 800°C, fusing the two materials into a cermet (ceramic/metal) mass. That mass is ground into cermet powder, which, when mixed with the acid component of the formulation, hardens in the traditional glass-ionomer cement setting reaction. Although hardened glass-ionomer–silver cermet cement is only slightly less brittle than conventional glass-ionomer cement restorative materials, the addition of silver makes the cement radiopaque and greatly improves wear resistance.

This paper depicts a typical procedure for placement of a Class I glass-ionomer–silver cermet cement restoration and shows representative restorations and other uses of Ketac-Silver in primary and permanent teeth, up to 6 years after treatment (Figs 1 to 35). Our previous work describes placement of a Class II Ketac-Silver restoration.
Fig 1  Maxillary second primary molar with a Class I carious lesion in the disto-occlusal fossa.

Fig 2  Lesion is opened for access with a water-cooled, high-speed bur.

Fig 3  Caries is excavated and preparation completed with interlocking retention form, similar to preparation for a silver amalgam restoration.

Fig 4  Polyacrylic acid wash is applied for 10 seconds to remove the smear layer.

Fig 5  Ketac-Silver capsule is activated, mixed on a high-speed amalgamator, and the material is injected directly from a Centrix syringe tip (Centrix Inc.). Cement is slowly injected from the bottom of preparation, to prevent air voids.

Fig 6  Material is compressed into the preparation with a ball burnisher that has been wiped with isopropyl alcohol to prevent sticking. The preparation is intentionally overfilled.
Fig 7  After initial hardening (about 5 to 7 minutes), excess material is carved away with a round bur under water lavage.

Fig 8  Restoration immediately after placement. No varnish or resin glaze is placed.

Fig 9  Three-month postoperative view.

Fig 10a  Primary molar immediately after placement of an amalgam restoration in the mesial fossa and Ketac-Silver restoration in the distal fossa.

Fig 10b  Restorations shown in Fig 10a, 1 year after treatment.

Fig 10c  Restorations shown in Fig 10a, 5 years after treatment.
Fig 11. Primary second molar with Ketac-Silver restoration, 5 years after treatment.

Fig 12. Two glass-ionomer-silver cermet cement restorations, 4½ years after placement.

Fig 13. Five-year-old Ketac-Silver restorations.

Fig 14. Mandibular primary molars with 4-year-old occlusal Ketac-Silver restorations.

Fig 15. Cermet restorations used to restore nursing-related caries, 5 years after treatment.

Fig 16. Class II Ketac-Silver restorations, 4 years after treatment.
Fig 17 Narrow isthmus and shallow preparation resulted in a cermet fracture observed 2 years after restoration placement.

Fig 18 Class II cermet restoration was fractured when seen 14 months after placement.

Fig 19 Four-year-old Ketac-Silver restoration abuts a previously existing mesio-occlusal silver amalgam restoration. Cavity form, by design, provided a large bulk of cement.

Fig 20a Mesio-occlusal amalgam restoration in a primary second molar, 5½ years after placement. Compare with the tooth in Fig 20b.

Fig 20b Contralateral molar of the patient in Fig 20a. Ketac-Silver restoration, 5½ years after placement on same day as the amalgam restoration.

Fig 21 Two years after pulpotomy was performed and the primary molar was restored with cermet cement, the tooth is asymptomatic and radiographs showed no evidence of pathosis.
Fig 22. Two-year-old cermet restoration with marginal caries. It is believed that an air bubble was entrapped in the region during injection of the cement.

Fig 23a. Mesio-occlusal tunnel restoration, 4 years after placement, following exfoliation of the adjacent primary molar.

Fig 23b. Occlusal aspect of a mesio-occlusal tunnel restoration, 5 years after placement.

Fig 23c. Tunnel extension and restoration of the tooth in Fig 23b shown in cross section, after extraction for orthodontic purposes.

Fig 24. Failed tunnel restoration, 2 years after placement.

Fig 25. Class III cermet restoration, 5 years after placement.
Fig 26. Three years after repair of the occlusal surface of a stainless steel crown with Ketac-Silver.

Fig 27a. Ketac-Silver used as a dentinal replacement base, under a Class II amalgam restoration.

Fig 27b. Three-year-old silver amalgam restoration of the tooth shown in Fig 27a, after dental prophylaxis and polishing.

Fig 28a. Cermet dentinal replacement base for a bonded composite resin restoration.

Fig 28b. One-year postoperative view of the tooth shown in Fig 28a.

Fig 29. Interim Class I restoration of a deep carious lesion in this first permanent molar, 3 years after placement. The restoration and peripheral enamel were "glazed" with bonded resin sealant immediately after placement.
Fig 30 Three-year-old Class I cermet restoration that had no varnish or bonded resin glaze placed at the time of treatment.

Fig 31 Interim cermet restorations of the buccal and occlusal surfaces of second permanent molar, 1½ years after placement. The tooth was just beginning to erupt when the restorations were placed.

Fig 32 Four-year-old large occlusobuccal cermet restoration of the first molar, 2-year-old occlusal cermet restoration of the first premolar, and just-placed occlusal Ketac-Silver restoration of the second premolar.

Fig 33 Cermet repair of a stainless steel crown margin in a premolar, 4½ years after the repair.

Fig 34a Lingual cervical caries of a first permanent molar.

Fig 34b Three years after restoration of the lesion shown in Fig 34a.
Fig 35a  Buccal caries and decalcification of a first permanent molar.

Fig 35b  Immediately after placement of a Ketac-Silver restoration.

Fig 35c  Restoration of tooth shown in Fig 35a, 4 years after placement of the Ketac-Silver.

Discussion

Uses for glass-ionomer–silver cermet cement

The senior author has used Ketac-Silver for more than 6 years in these ways:

1. Class I restorations for primary and permanent teeth.
2. Class II restorations for primary teeth, especially for cases in which the restoration abuts a surface of a permanent tooth (e.g., disto-occlusal restoration of a primary second molar).
3. Interim Class I restoration for a partially erupted permanent tooth with limited access that precludes use of bonded composite resin restoration.
4. Class III restoration of primary canine teeth.
5. Class V restoration of primary and permanent teeth (e.g., lingual fossa restoration of primary incisors with nursing-related caries).
6. Repair of stainless steel crowns with wear through the metal occlusal surface.
7. Dentinal replacement base under composite resin or amalgam restoration.
8. “Tunnel” restorations for Class II carious lesions in primary and permanent teeth.
10. Final restoration in primary molars after pulpectomy in teeth with substantial residual coronal structure and an expected retention of less than 3 years.
11. Direct restoration of carious lesions on mesial surfaces of first permanent molars. Access may be available because of exfoliation of the adjacent second primary molar, prior to eruption of the second premolar. Such lesions, detected on bite-wing radiographs, can also be restored with cermet cement after disto-occlusal preparation of a second primary molar that is not yet ready for exfoliation or extraction.
12. As a core material for restoration of a severely broken down tooth, prior to preparation for a precision cast crown. Because of the material’s brittleness and low fracture toughness, however, cermet cement should not constitute more than 40% of the core and the cermet-tooth structure bond should not be relied on for crown retention.

Clinical observations after 6 years

The minor formula change (addition of a small
amount of titanium dioxide), which was made in 1986, has eliminated the problem of black staining of cavosurface margins that resulted from the silver ions. The use of the Centrix syringe is important during injection procedures. The manufacturer's capsule has a tip with a large-diameter lumen. That tip is too large for placement in deep recesses of some preparations, and air bubbles are not compressed out of the mixture during injection, as they are in a Centrix tip. In addition, great care should be taken during injection of the cement to avoid entrapment of air bubbles, which become voids in the hardened restoration (see Fig 22).

Ketac-Silver has radiopacity almost equal to that of amalgam.

Parents who request “no-mercury” restorations are pleased to hear about “bonded silver fillings that are mercury free.”

The Ketac-Silver capsule should be tapped a few times on a hard surface to loosen up the cermet powder for better mixing. Furthermore, when the capsule activator is squeezed to compress the acid into the mixing chamber of the capsule, squeezing should be continued for 5 seconds. That assures full expression of the acid portion. Proper handling of the capsule and its contents is critical to successful use of cermet cement.

If Ketac-Silver restorations are initially overfilled and permitted to achieve substantial hardness before trimming and finishing (about 5 to 7 minutes after injection), no varnish or resin glaze is needed to protect the freshly hardened surface (see Figs 29 and 30). Trimming and finishing procedures should be performed with water coolant, however, to avoid desiccation of the freshly hardened cermet surface.

Surface pitting and small cracks are common in cermet restorations and are usually shallow, self-limiting, and of no clinical significance (see Figs 10b, 10c, 12, 13, 20b, 23b, and 32).

Class I Ketac-Silver restorations do not show appreciably greater wear than do silver amalgam restorations within 5 years after placement (see Figs 10a to 10c and 20a and 20b).

Ketac-Silver Class II restorations have poor fracture resistance, so tooth preparation should include wide and deep channels (see Figs 16 to 19). In addition, whenever possible, marginal ridges of Class II cermet restorations should be finished out of occlusion, to avoid fracture from masticatory impact forces.

The effect of fluoride release at cavosurface margins of cermet restorations seems to be clinically significant, because the tooth in Fig 22 is the only posttreatment case of marginal caries in an unfractured cermet restoration that the senior author has been able to document, despite having performed thousands of such restorations since 1984. In addition, we believe that, because of fluoride ion release at proximal contact sites, a Class II Ketac-Silver restoration that contacts the axial surface of an adjacent tooth has a beneficial anticaries effect. Such a case would be a disto-occlusal restoration in a primary second molar that abuts the mesial aspect of the permanent first molar. Berg et al have reported this phenomenon and the effect of cerment cement on formation of interproximal Streptococcus mutans.

Tunnel restorations work well for permanent molars and primary second molars when done carefully and where the residual marginal ridge is thick and well supported. Tunnel restorations involving distal surfaces of primary first molars work well for 1 to 2 years, and then many of the marginal ridges fracture (Fig 24). We have abandoned tunnel restorations for primary first molars and restore Class II lesions in those teeth with silver amalgam, stainless steel crowns, or, on occasion, bonded composite resin. Stainless steel crown restorations are the treatment of choice in young patients because of their great durability and longevity.

Ketac-Silver is an excellent restorative material for partially erupted first or second permanent molars in which Class I cavities is detected in grooves exposed to the oral cavity. In such cases, with the tooth anesthetized, overlying soft tissue is displaced by seating an orthodontic band, caries is removed, and a restoration is placed. When the treated tooth is fully erupted, the cermet can be cut to form a dentinal replacement base, and the tooth restored with bonded composite resin (see Fig 31).

Bond strength between cermet cement and enamel or dentin is relatively weak and should not be relied on for retention of the cement. The chemical adhesion of glass-ionomer–cermet cement to tooth structure is more important for minimizing cavosurface marginal leakage than for retention of the hardened cermet mass. All principles of mechanical interlocking retention form in cavity preparation should be implemented when a cermet cement restoration is placed. This is the reason that Ketac-Silver performs well as a restorative material in a bur-cut preparation with mechanical undercuts, but is easily dislodged or worn away when used as a pit and fissure sealant.

Although we have not performed a controlled scien-
A scientific study on the subject, it is our clinical impression that glass-ionomer–silver cermet cement restorations, when placed as described, are at least as well tolerated by pulpal tissues as are equivalent silver amalgam restorations.13

References