AMALGAM BONDING

Dentalelle Tutoring

Adhesive Techniques

- Adhesive techniques are now used for many dental restorative materials, **including amalgam.**
- Several generations of dentin bonding agents have been developed, mainly for bonding composite resins. When bonding is used with amalgam restorations, the need for retention and resistance form is reduced, the seal is improved, and some procedures, such as amalgam sealants, which were not previously possible, can be considered.

Amalgam

- Bonding amalgam restorations gives promise for reduced need for mechanical retention features and resistance form which conserves sound tooth tissues.
- Bonding amalgam restorations **help to restore tooth integrity and fracture resistance.**
- Bonding amalgam restorations assist in the improvement of the marginal seal with potentially less sensitivity.

Components

- **Conditioners**
  - These are generally acid solutions such as phosphoric acid (aq) or dilute nitric acid. Acid etching removes the smear layer, and opens the intertubular and peritubular dentine. Removal of hydroxyapatite crystals leaves a collagen meshwork that can collapse and shrink because of the loss of inorganic support, especially if desiccated.
  - After placement, the conditioner is rinsed off. Many bonding agents, particularly those containing acetone as a solvent, work better on dentine that has been left moist after rinsing.

- **Primers**
  - A primer is applied after rinsing of the conditioner. Primer molecules such as HEMA (hydroxy-ethyl-methacrylate), biphenyl dimethacrylate (BPDM) and 4-methacryloxyethyl trimellitate anhydride (4-META) contain two functional groups — a hydrophilic group and a hydrophobic group. The hydrophilic group has an affinity for the dentinal surface and the hydrophobic (methacrylate) group has an affinity for resin.
  - The primer wets and penetrates the collagen meshwork, raising it almost back to its original level. The primer also increases the surface energy, and hence the wettability, of the dentinal surface.

Continued

- **Dentine adhesives**
  - These are applied by brush or other means to cover the treated surface to permit resin wetting and penetration. They are unfilled resins that may consist of hydrophobic monomers alone, such as bis-GMA, or may include adhesion promoters to facilitate wetting of the dentine. They attach to both the primed dentine surface and copolymerise with the overlaying composite restoration.
  - The latest generation of bonding systems combines either the primers and the bonding resins in one bottle, or the conditioner and primer in one bottle. This represents an improvement in convenience, though not necessarily in bond strength. Some examples are: Single Bond (3M), One-Step (Bisco), Prime and Bond (Dentsply) and Liner Bond 2 (Kuraray).
- **The 'hybrid layer'**
  - Unfilled resin, when applied, penetrates the primed dentine, copolymerising with the primer to form an intermingled layer of collagen and resin, termed the resin-reinforced zone, resin-infiltrated zone, resin-infiltrated layer, or the hybrid layer. Formation of this hybrid layer is thought to be the primary bonding mechanism of most current adhesive systems.

Development of Amalgam Bonding

- **Early methods of lining preparation walls for amalgam restorations**
  - The shortcomings of amalgam restorations, including poor appearance, lack of adhesion to tooth surfaces and microleakage are widely recognised. One of the first attempts to improve the retention and seal of amalgam restorations involved painting the cavity walls with a thin coat of zinc phosphate cement and condensing the amalgam immediately onto this wet surface.
- Further development in amalgam bonding came with the development of metal adhesive resins, originally formulated for bonding fixed partial dentures in the 'Maryland bridge' technique.
- As will be appreciated, the bond strengths found *in vitro* have tended to increase with successive products. However, there is still no minimum bond strength that has been definitively shown to satisfy requirements for retention, fracture resistance and other properties. Furthermore, high bond strengths do not necessarily mean low microleakage values for bonding materials.

Current Bonding Amalgam

- Although numerous commercial products are available for adhesion to enamel and dentine, most of these are intended for use with resin composites. Some of them also have metal bonding capabilities and may be used alone or with additional components for amalgam bonding. A few products have been specifically developed for amalgam bonding. Recently, some dental adhesive resins have shown excellent adhesive properties to both tooth structures and encouraging bonding to amalgam alloys.
- Also, in this respect, due to the method of condensing amalgam onto an unset adhesive resin liner, there is an intimate mechanical interlocking created. Some of the main adhesives used in amalgam bonding studies include All-Bond 2 (Bisco), Amalgambond Plus with HPA (high performance additive) powder (Parkell), Optibond 2 (Kerr), Panavia EX and Panavia 21 (Kuraray).
- When All-Bond 2 is used, enamel and dentine are both etched with 10% phosphoric acid for 15 seconds. ***After etching and rinsing, the tooth surface is left visibly moist.*** This is because drying of the dentine can cause collapse of the unsupported collagen network, inhibiting adequate wetting and penetration by the primer. An unfilled chemically activated resin is placed after the primer.
- Bonded amalgam sealants have been shown to be as effective as resin sealants in a clinical study, at least up to 2 years. However, it is not suggested that bonded amalgam sealants are preferable to resin composite sealants. Rather, it is a demonstration of another extension to the utility of the bonded amalgam technique. It is particularly appropriate in sealing adjacent anatomic fissures and pits at the time of bonded amalgam placement.

Summary of Amalgam Bonding

- While the search for suitable tooth-coloured alternative materials continues, dental amalgam still remains in extensive use internationally.
- This overview has highlighted the current intense development of materials for bonding dental amalgam restorations that has provided an opportunity for a re-evaluation of preparation design here-to-for based on providing undercuts for mechanical retention.
- The promise of reliable bonding of dental amalgam restorations enables more conservative restoration of carious destruction ranging from initial lesions, through to complex restorations with cuspal replacement.

Advantages of Bonded Amalgam

- Amalgam has been used to restore teeth since before G. V. Black described the classification of cavities over 100 years ago and is still a first choice material used by most clinicians to restore carious teeth, where aesthetics is not an overriding concern (Berry, Summit, Chung, and Osborne).
- A relatively recent development in amalgam restorations has been the introduction of bonded amalgam restorations. The theoretical advantages of bonding amalgam restorations are that.
- Bonding creates an adhesion between amalgam and the tooth surface, **reducing or eliminating reliance on macro-mechanical retention and allowing a more conservative cavity preparation without the need for pins.**
- Bonding improves natural tooth strength and fracture resistance.
- Bonding creates a better marginal seal, reducing the risk of dentine and pulpal contamination and reduced incidence of secondary caries.
- Bonding reduces postoperative sensitivity.

Key Points

- Bonded amalgam restorations provided significantly greater longevity than non-bonded amalgam restorations over a five-year period.
- The comparison of postoperative sensitivity rates between the two methods of restoration was inconclusive.
- Bonded amalgam restorations may offer a significant benefit compared to non-bonded amalgam restorations in terms of survival and re-intervention, but this is at the expense of additional clinical time and increased cost.

Resources

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- Flynn M. Six-year evaluation of *in vivo* performance of cervical restorative materials (Abstract no. 322). *J Dent Res* 1982; **4**: 214.