Techniques and Materials in Restorative Dentistry- an update

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Dental Amalgam

If we were to believe the opinions of some experts of the last decade, dental amalgam would not survive as a restorative material into the 21st century. Various forces at work seemed to doom it to extinction.

Berry TG, Summit JB, Chung AK, Osborne JW. J Am Dent Assoc. 1998 Nov; 129(11): 1547-56

Dental Amalgam

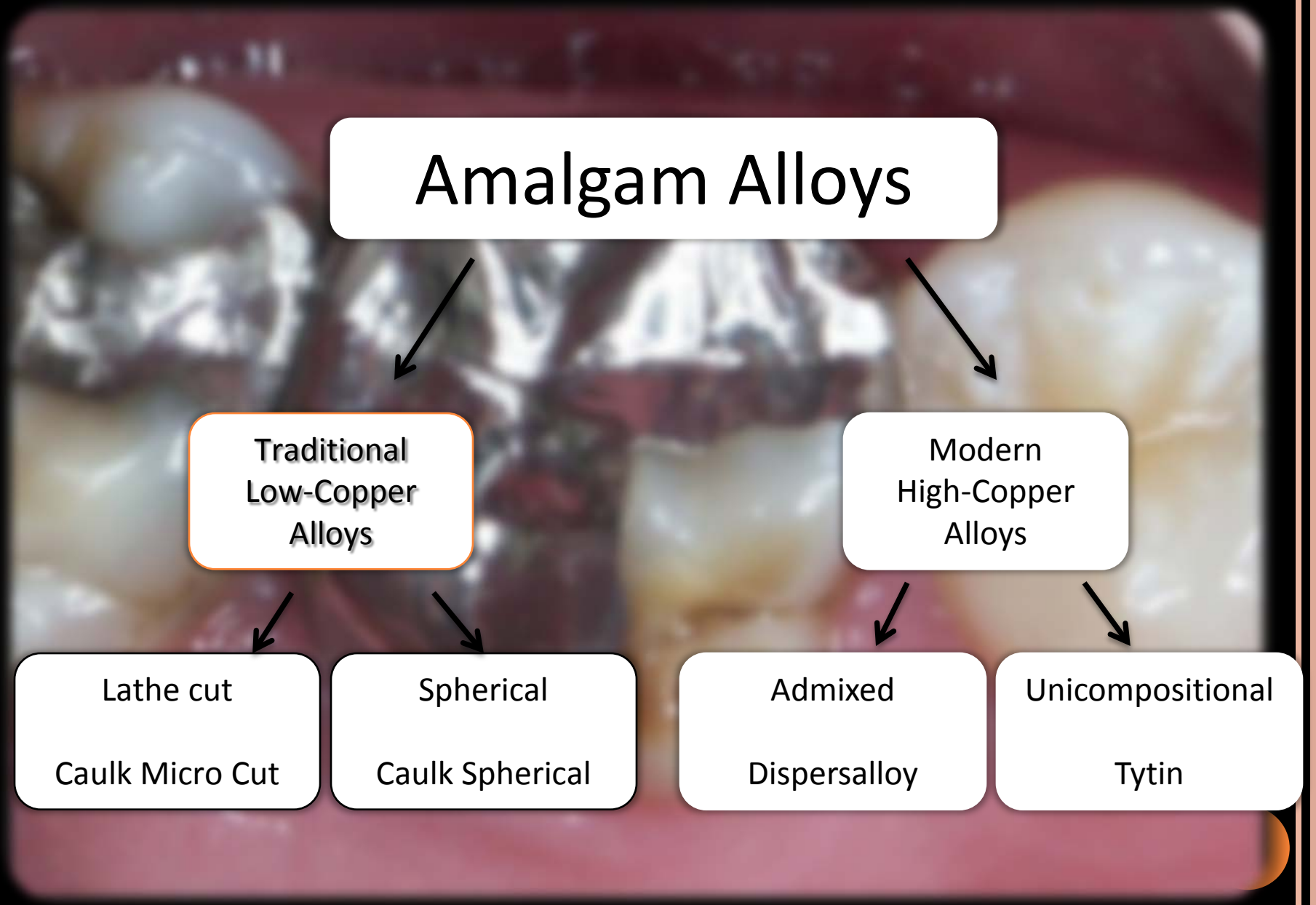
Among these forces includes:

-dev of durable composites

-concerns about mercury

-perceived advantages of bonding restorations.

However as we know it, amalgam is still a widely used restorative material around the world


Amalgam Alloys
Traditional Low-Copper Alloys
Modern High-Copper Alloys
Lathe cut
Caulk Micro Cut
Spherical
Caulk Spherical
Admixed
Dispersalloy
Unicompositional
Tytin

Alternative to Amalgam

Galium Based Alloy

1956 - Smith and Caul developed Galium alloy as a replacement for amalgam

1990 - Gallium Alloy GF(Tokurike Honten, Tokyo, Japan) was developed in Japan. Replaced by GF II which has lower Galium content. Didn't make it to the market dt crack teeth associated with moisture expansion of product.

1994 - A non-palladium gallium alloy, marketed as Galloy(Southern Dental Industries, Bayswater, Australia) was introduced in Australia.

Alternative to Amalgam

Study was done by Dunne and Abraham, which compared 25 restorations using Galloy and 25 restoration using Dispersalloy. (BDJ 2000; 189: 310 – 313).

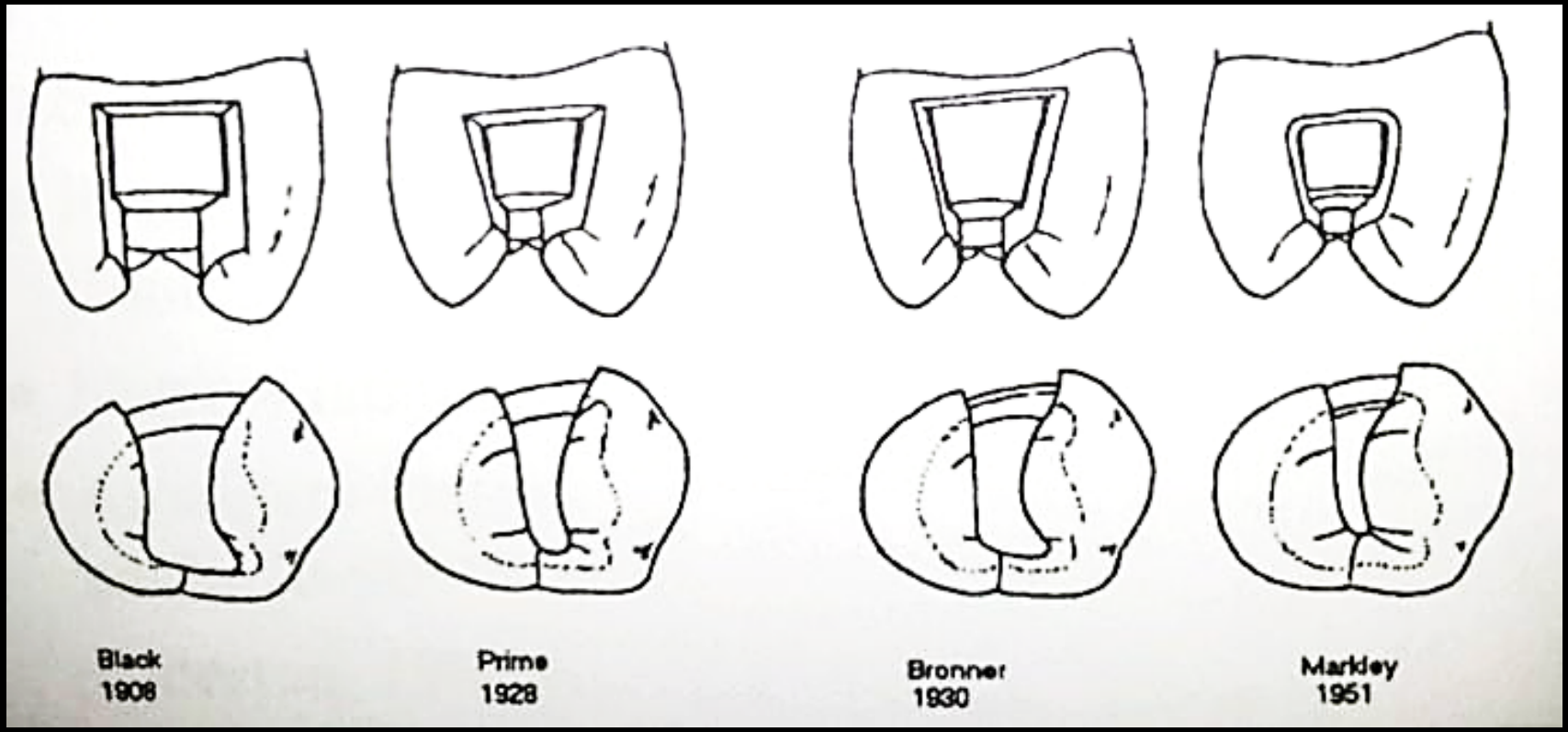
1)Handling of the Galloy differed from that of a conventional amalgam but was easily mastered.Galloy is adherent to the condensing instrument during the early stages of condensation but was easily removed.

2) Dt the problem of moisture expansion, a bonding sealant has to be placed over the restoration

3)Galloy restorations were associated with a much greater incidence and severity of post-operative sensitivity than Dispersalloy control restorations

4) Cases of cuspal fracture were also reported

Evolution of Cavity preparation for amalgam



Evolution of Preparation For Amalgam

GV Black

- Advocated extension for prevention and his cavity design had:
- Isthmus 1/3 bucco-lingual width, Dovetail 2/3 intercuspal distance
- Cavity squared up
- Subgingival extension of proximal box

Prime

- In 1964, plead for conservation dt his finding that overcutting leads to fractures teeth, death of pulp or injury to the gingivae
- His cavity design included a narrow and shallow occlusal step. Narrow inclined walls and triangular proximal box

Bronner

- Made his cavity design with converging proximal outline with aim of making it self retentive
- For occlusal, he made it extension for prevention in believes that this will aid it resistance to proximal forces on the marginal ridge.

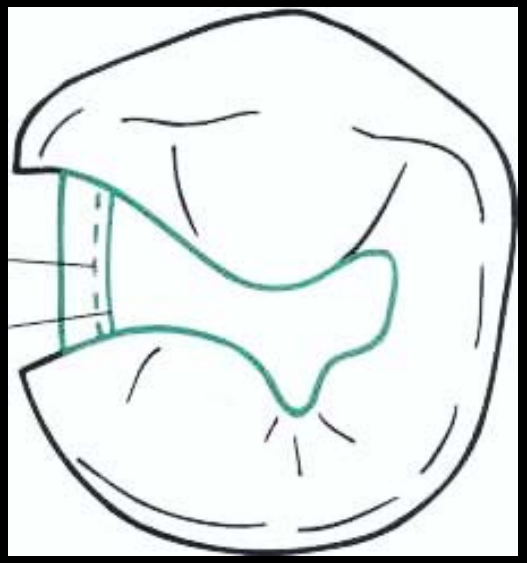
Markley

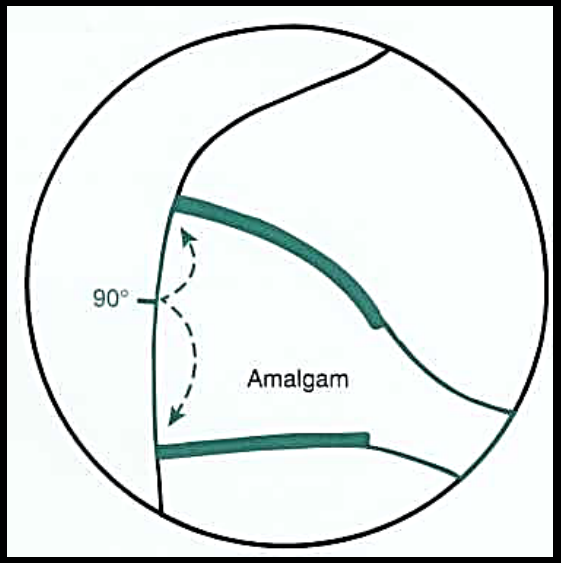
- Concerned with conservation of tooth structure
- Isthmus 1/4 intercuspal distance
- Depth of 0.5 into dentine, DEJ visible for inspection of caries
- Markley also designed the pear shaped 330 bur

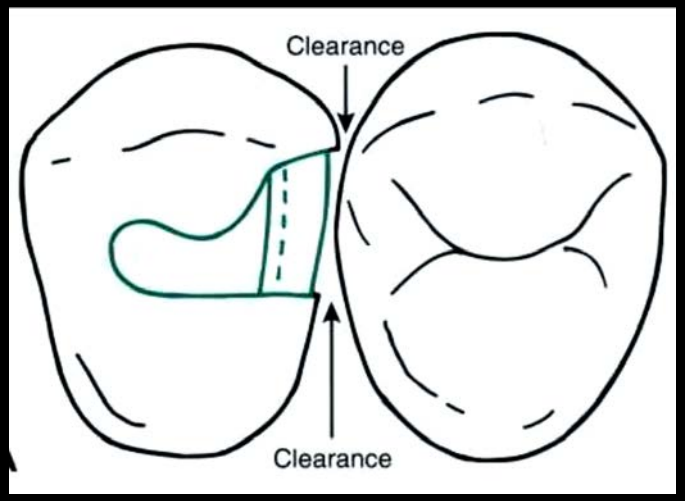
Current cavity design

- Shape of cavity dictated by caries (Gilmore 1964)
- Amalgam margin angle of at least 70°,minimize long term marginal fracture of restoration
- Isthmus not more than ¼ intercuspal width
- Rounded internal line angles
- Cavity floor 0.5mm into dentine
- Axial wall parallel to external curvature of tooth
- Floor of preparation not flat, removal of infected dentin without lowering the entire pulpal floor (Sturdevant et al 2009)

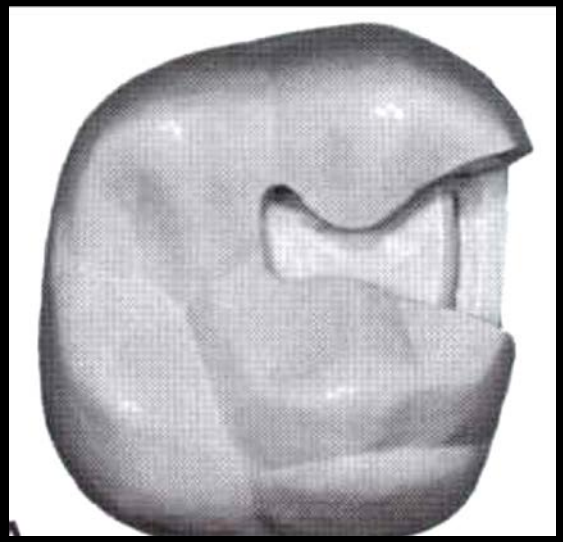
Site 2 amalagam restoration (studervant et al)

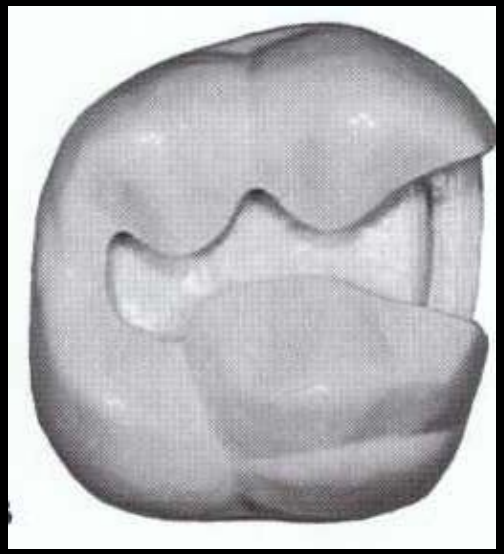


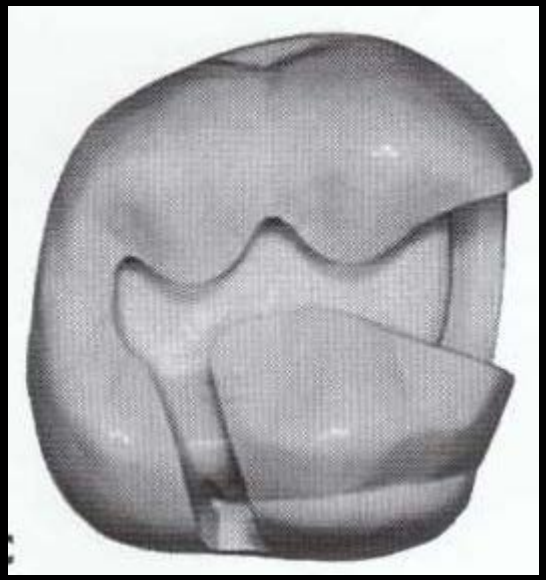


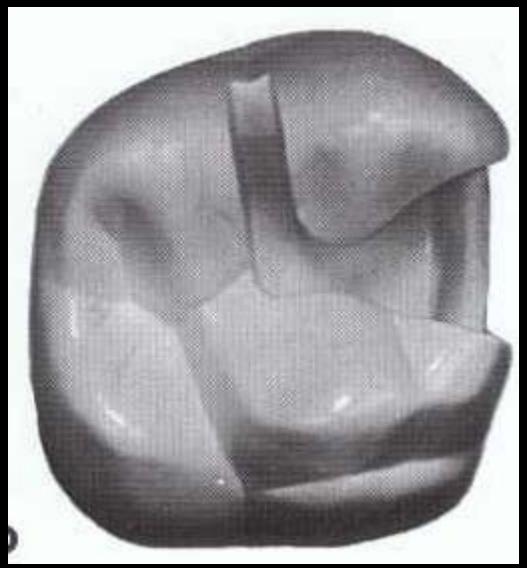


Site 2 amalgam restoration (Studervant et al)

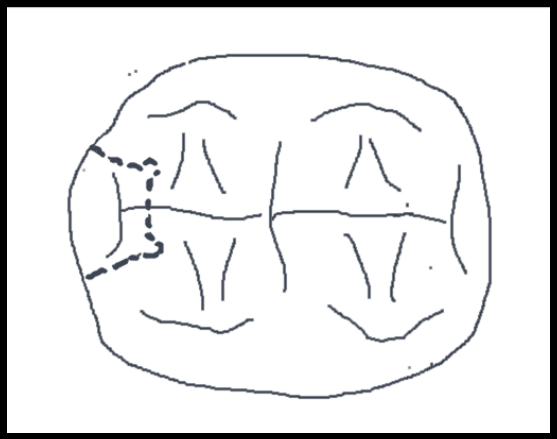


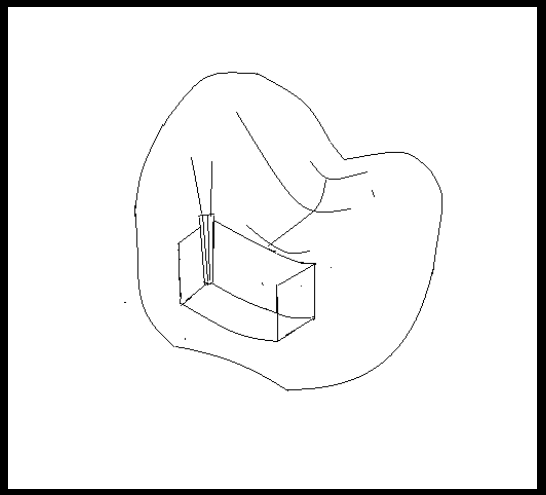


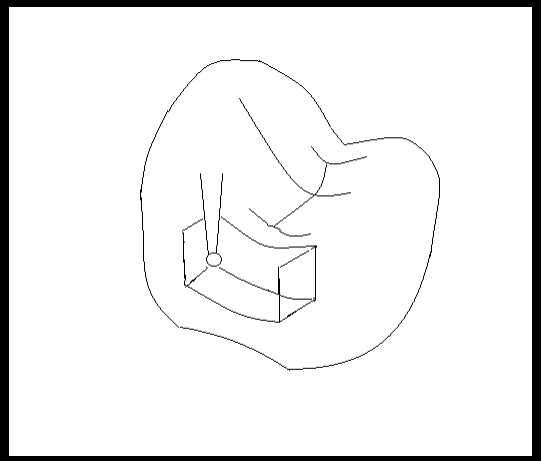


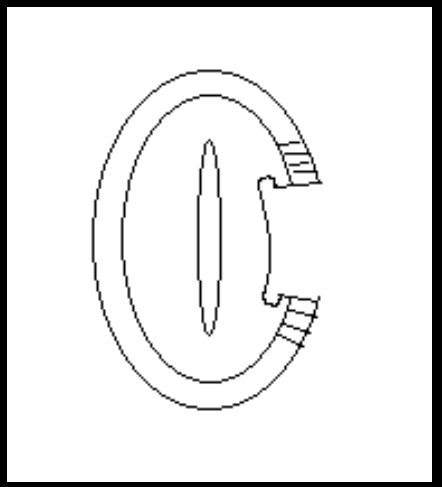


Site 2 amalgam restoration (sturdevant et al)









How does cavity preparation affect tooth strength?

- For all categories of posterior teeth, the more surfaces restored and/or the wider the isthmus, the greater the chance for cuspal fracture

(Cavel ,WT, Keley, WP,Blankenau, RJ. An in vivo study of cuspal fracture. J Prosthet Dent. 1985; 53(1):38-421985)

- Restoration bulk fractures could be related to cavities with narrow and deep occlusal parts , or deep proximal parts

(Jokstad, A.and Mjor I.A. Replacement reasons and service time of Class II amalgam restorations in relation to cavity design. Acta Odontol. Scand. 1991:49(2): 109-126)

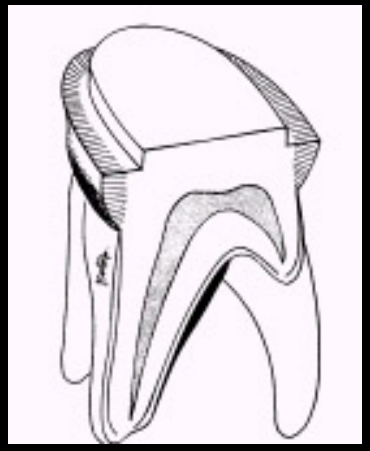
- Any preparation on tooth decrease tooth resistance to fracture . MOD design showed tendency for vertical fracture while MO/DO preparation shows fracture of single cusp. Conservative design may enhance options for subsequent restorations.

(Caron et al. Resistance of fracture of teeth with various preparation for amalgam. J. Dent 1996; 24(6): 407-410)

Supplementary retention form

Retention form: the features of tooth preparation that resist dislodgement in an axis along the path of insertion

For complex amalgam restorations:
Pins
Amalgapins
Slots
Grooves
Shelves



shelve

Dentinal slot

Amalgapin

VS

Self-threading pin

The evidence……..

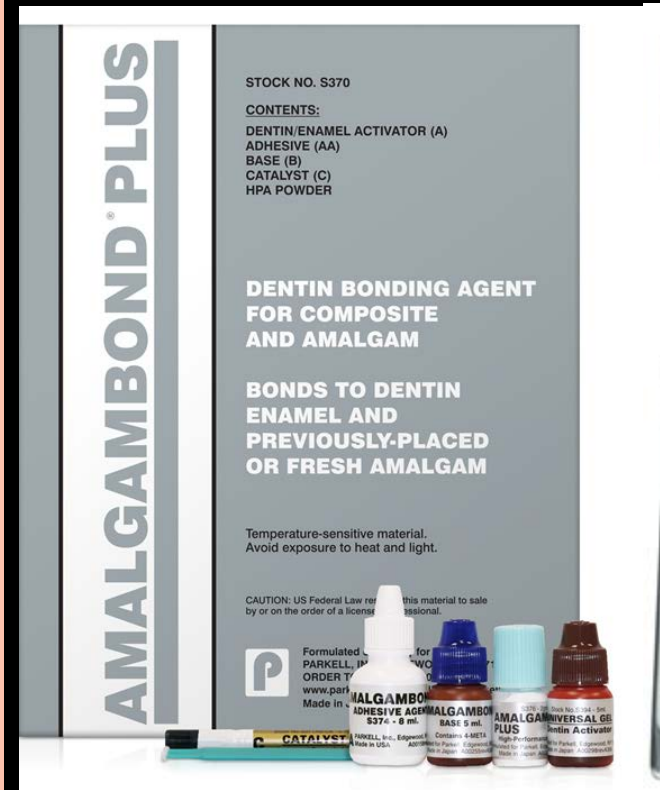
There was no difference in the resistance provided by pins, amalgapins and amalgampins plus peripheral shelf to complex amalgam restorations.

(Summit J. B et al. Comparison of resistance features for complex amalgam restorations.Am J. Dent 1991; 4(6):268-272)

Amalgambond, four amalgapins and four amalgapins in conjunction with Amalgambond provided more resistance to shear force than four regular TMS pins.

(Imbery TA, Hilton TJ, Reagan SE. Retention of complex amalgam restorations using self-threading pins, amalgapins, and Amalgambond. Am J. Dent; 8(3):1117-21)

Amalgam Bonding



uses :

-dentine boding agents

-resin cements (active agents includes 4-META, 10-MDP and Bis-GMA/HEMA

Amalgam Bonding

Indication: Large amalgam restorations in conjunction with supplementary retention features to avoid the use of pins

Technique: Following etching and application of bonding agent, amalgam is packed onto the unset bonding agent

Mechanism of bonding: Micromechanical, projection of resins are incorporated into amalgam at the interface

Fedorowicz Z, Nasser M, Wilson N
Cochrane Database of Systematic Reviews 2009

Authors' conclusions

There is no evidence to either claim or refute a difference in survival between bonded and non-bonded amalgam restorations. This review only found one methodologically sound but somewhat under-reported trial. This trial did not find any significant difference in the in-service performance of moderately sized adhesively bonded amalgam restorations, in terms of their survival rate and marginal integrity, in comparison to non-bonded amalgam restorations over a 2-year period. In view of the lack of evidence on the additional benefit of adhesively bonding amalgam in comparison with non-bonded amalgam, it is important that clinicians are mindful of the additional costs that may be incurred

Handling of amalgam

For cavity involving proximal areas, the use of matrix band and wedges help contain amalgam during packing and help to re-establish the contact point..

Mixing time should follow manufacturer's instruction and usually it is around 7-8 sec. Mixed amalgam appear as a homogenous and coherent mix (Not dry/crumbly or overshiny/wet)

Amalgam should be packed immediately after mixing and done incrementally starting from box and supplementary retention features moving inwards.

Material should be condensed using high forces and using smaller pluggers creates higher forces/unit area compared to larger pluggers.

Before carving amalgam should be pre-burnished to condense and improve strength of amalgam. Carving is done as much possible before removing matrix band.

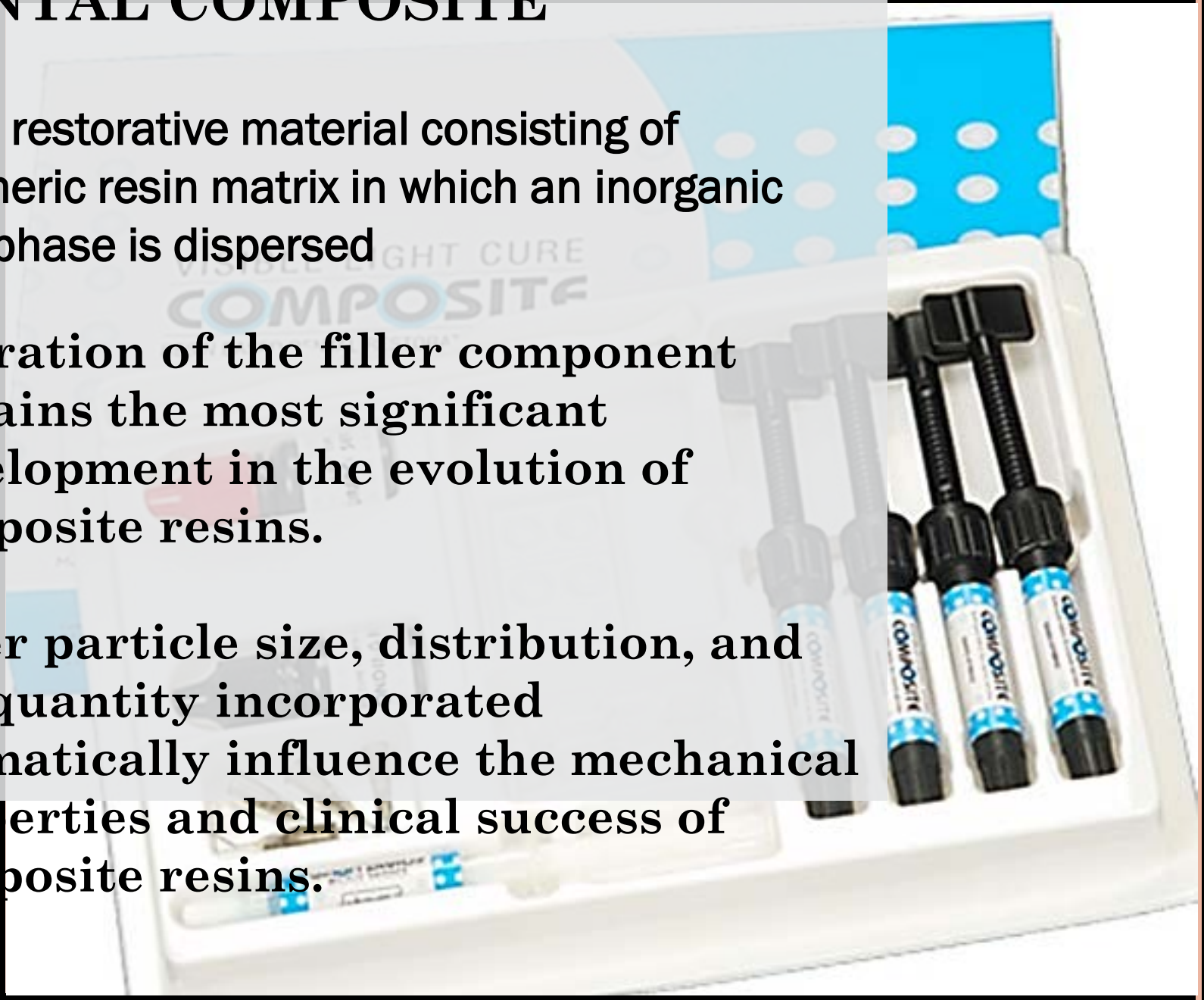
If polishing is done, it should be using water-coolant to reduce

DENTAL COMPOSITE

It is a restorative material consisting of polymeric resin matrix in which an inorganic filler phase is dispersed

Alteration of the filler component remains the most significant development in the evolution of composite resins.

Filler particle size, distribution, and the quantity incorporated dramatically influence the mechanical properties and clinical success of composite resins.



Evolution of Composite resin

1955 - M. Buonocore introduced the etching technique, showed that phosphoric acid etched enamel can be infiltrated by resin

1956 - Bis-GMA resin was formulated

1962 –Silane coupling agent introduced, and macrofilled composite was developed

1970 - UV activated composite was developed

1976-Microfilled composite was developed

1980's-Hybrid composites were developed

1997 -Packable composites were developed

2002 -Nanofilled composites were developed

2005 - Low shringkage posterior composites were developed

CURRENT COMPOSITE SYSTEM

Microhybrid and/or Nanohybrid Composites

Appeared in the market >< 10 yrs ago.
Aimed at improving the hybrid composites and create a more universal material.
Focused on enhancing wear resistance and esthetic properties, while maintaining strength.
Average particle size of 0.5 μm.

Microhybrids are worthy of being identified as universal materials. They have needed strength and wear characteristics for posterior restorations and the polish and aesthetic potential for anterior restorations

Examples:
Premise™ (Kerr Corporation)
Esthet-X® Improved (DENTSPLY Caulk),
Tetric EvoCeram® (Ivoclar Vivadent, Inc),
Gradia Direct (GC America, Inc, Alsip, IL),
Filtek Z250 (3M ESPE)

CURRENT COMPOSITE SYSTEM

Packable composites:

Developed to provide dentists with a composite material that could be handled in a similar manner as amalgam.

Increased the particle size as well as the filler volume.

Composition often sacrificed wear properties and esthetic potential.

When choosing this type of material look for material that exhibit wear rates similar to amalgam.

Examples:
SureFil™ (DENTSPLY Caulk),
Premise™ Packable (Kerr Corporation)
Filtek P60 (3M ESPE)

CURRENT COMPOSITE SYSTEM

Nano-composite Resin System

The industry may classify these type of composites under microhybrid. The are made for enhanced wear resistance and esthetics.
Also for universal use.

Unlike conventional fillers that are milled or ground, nanoparticles are built up on the molecular level.
THr prefix nano- something that is a billionth of a unit.

2 types of nanoparticles:
(Type I) -nanomeric particles dispersed as single units within the resin matrix and there are also agglomerated clusters of the nanoparticles.
Ex: Filtek™ Supreme Plus (3M ESPE)

(Type 2)-nanoparticles consist of a cage-like structure that is composed of eight silicon atoms and oxygen atoms. These nanoparticles forms part of the resin matrix
Ex: Artiste® and Simile® (Pentron Technologies)

CURRENT COMPOSITE SYSTEM

Flowable Composites

These materials have a very low viscosity and can easily flow due to alteration of their rheological properties

Filler content is 40-50%

Clinical applications
-lining material under a larger composite restoration.
-restoration of small site II anterior and site 3 restoration
-Repair bis-Acryl temporary restorations.
-Sealants
-Luting of porcelain veneers

Ex:
Filtek Flowable (3M ESPE)
Tetric EvoFlow® (Ivoclar Vivadent, Inc)

CURRENT COMPOSITE SYSTEM

Core Build-Up Composites

These composite resins have a dual-cure property and can be placed in bulk and thus shortens time for crown prep

Particle sizes and volume-modified to maximize compressive strength.

The aim of manufacturers is to create a material that cuts/feels like dentin and has a high compressive strength.

Ex: LuxaCore® (DMG)

Self-adhering Composites

Available as flowable composite.

Aims and reducing steps in restoration

Only suitable for lining, repairs, PRR and fissure sealant

Selection Of composites

Willem's et al. Composite resins in the 21st Century. Quintessence Int. 1993; 24(9):641-58.

Composite resins intended for posterior teeth should:

-have a Young's Modulus ≥ than dentine 18.5 Mpa

-have the compressive strength of enamel, 384MPa and Dentine, 297MPa

-have the fracture strength of a natural tooth:

premolar= 248 Mpa

molar= 305MPa

-occlusal contact wear rate must be comparable to the attritional wear rate of molars, 39 microns/year

-based on these the ultafine, compact filled (microhybrid) composites may be the material of choice for restoration of posterior teeth

Composite as a posterior alternative to amalgam

Indication:

-good moisture control

-pt wt good oral hygiene(plaque acids weakens retention of composite)

-cavity with enamel margin

-cavity that are not too deep

Contraindication:

-Very large and deep cavities (enamel near the cervical region is aprismatic and not good for bonding)

-poor oh

-control of fluid is impossible

-parafunction

Cavity Preparation for composite

-Shape of cavity is dictated by caries/ defect and has a less rigid design compared to amalgam cavity preparation

-minimum depth of preparation is 2 mm for strength of composite

-internal line angles are rounded

-pulpal floor and cavity wall need not be flat and uniform

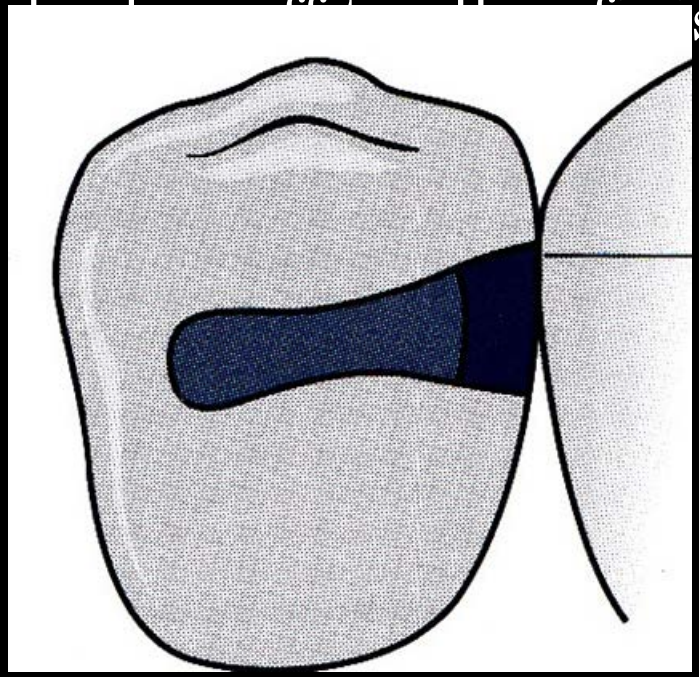
-depth of proximal box should allow for enamel margins and should no be beveled dt thinness of enamel when approaching the cervical region

-buccal and lingual walls of box preparation can beveled (Increase surface area of enamel rods for bonding)

Cavity Preparation for composite

Occlusal bevel is not recommended as this will create thin composite at the margin that is prone to fracture.

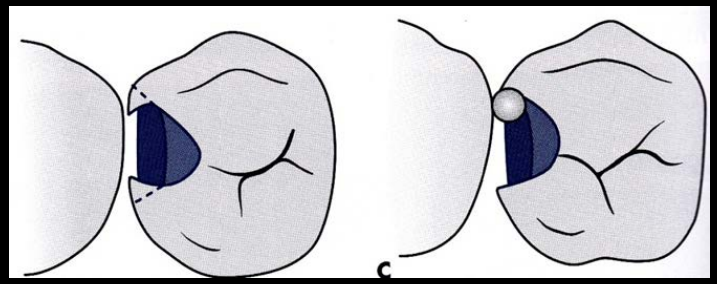
Contact may be maintained for small cavities or
shing.



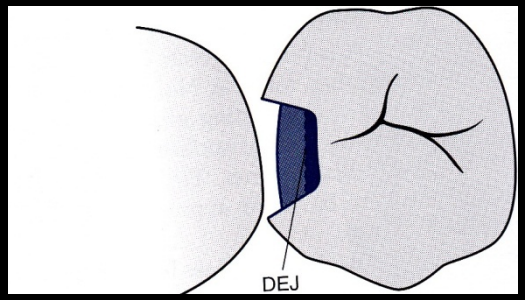
Margin left in contact

Cavity Preparation for composite

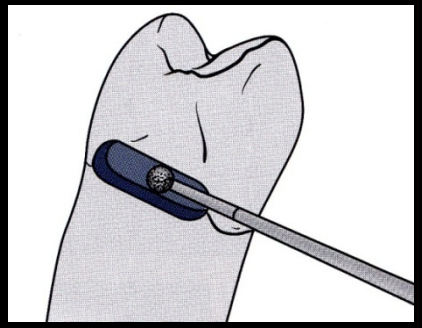
Slot preparation



Scooped-out preparation if using a round bur



Box-like preparation if using an inverted cone bur



Buccol-ingual slot preparation preparation if marginal ridge is intact and cavity can be approached fr. Buccal.

Bonding Strategy

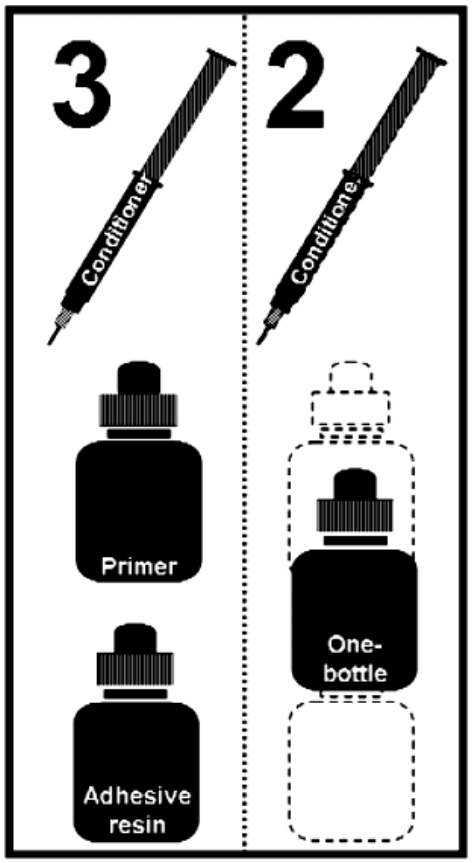
Van Meerbeek et al. Buonocore Memorial Lecture: Adhesion to Enamel and Dentin:Current Status and Future Challenges. Operative Dentistry.2003; 28(3): 215-235

The fundamental principle of adhesion to tooth substrate is based upon an exchange process by which inorganic tooth material is exchanged for synthetic resin

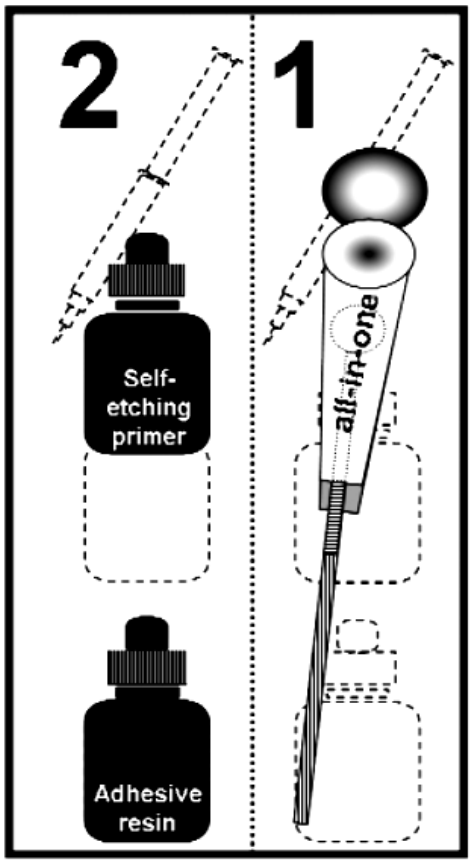
Classification:

- etch&rinse (smear layer removing DBA or total etch)
- self-etch (smear layer dissolving DBA)
- (esin-modified glass-ionomer adhesives

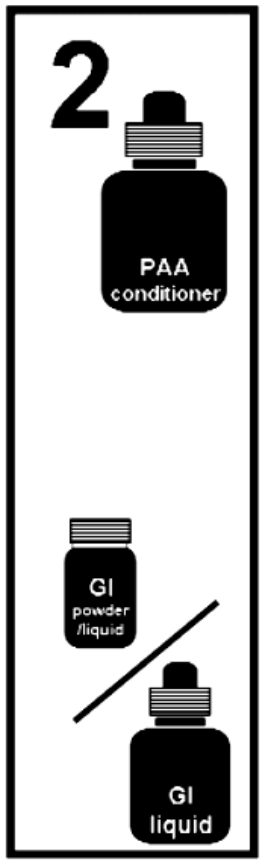
Bonding Strategy



1. Etch&rinse adhesives



2. Self-etch adhesives



3. Resin-modified glass-ionomer adhesives

Bonding Strategy

The etch&rinse technique/total etch is still the most effective approach to achieving efficient and stable bonding and **3-step is still the gold standard** and may achieve bond strength to dentine approaching that of enamel ><26MPa.

Most critical in the etch&rinse approach is the priming
step. When an acetone-based adhesive is used, the highly technique-sensitive “wet-bonding” technique is
mandatory.

Air-drying of acid-etch dentin (and enamel) / a “dry-bonding” technique still guarantees effective bonding when a water/ethanol-based adhesive is

Steps in composite restoration

-shade

-moisture control

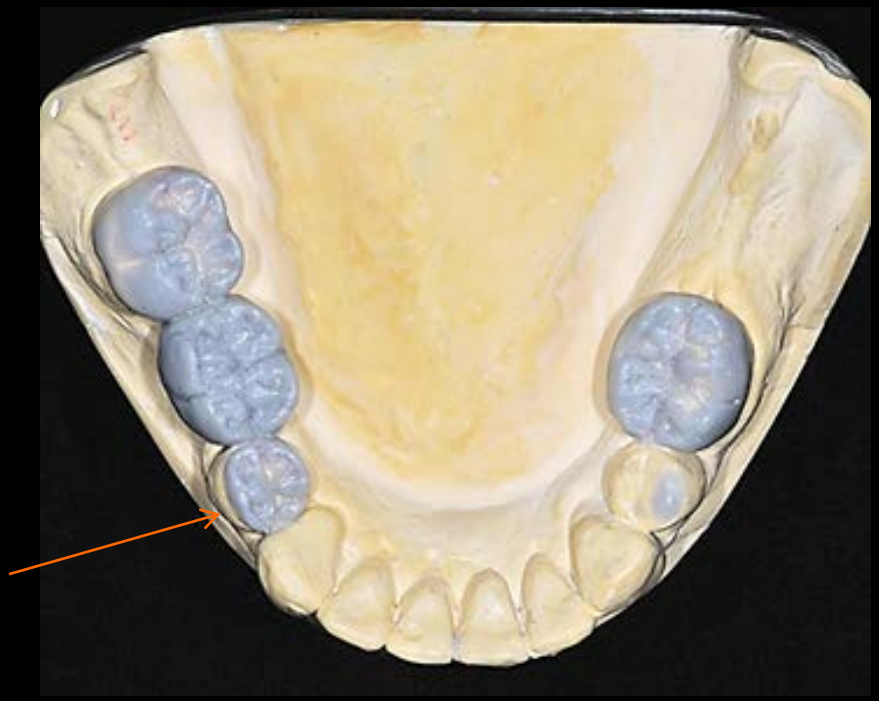
-cavity preparation

-etch and bond

-composite placement

-finishing

Case- Direct Composite onlay on 45



Wax mock-up to the idealised shaped and contour

- Tooth is isolated with rubber dam for moisture control.
- Removal of old amalgam using water coolant
- Sandblasting with fine grit aluminium oxide particles on the enamel surface to remove stain and roughened enamel surface to enhanced bonding
- Adjacent tooth is protected with a strip of matrix band

Etching with 37% Phosphoric acid 30s for enamel and followed by 15s dentin (total etch technique).

Wash acid thoroughly for 10s.

Drying method depend on bonding agent. May need to leave dentine moist in which case just dab with cotton pellet. Enamel must be totally dry.

Following application of primer and adhesive (4th generation type adhesives) or single bottle primer/adhesine (5th generation).

The use of liners/bases only indicated for direct/indirect pulp capping procedures. (Dycal and GIC)

The use of flowable composite as liner is gaining:
-to improve adaptation of composite and reduce voids

Clinical studies do not actually support the use of flowable composite as liner. When use near cervical margin it may result in more microleakage
The use of liners/bases only indicated for direct/indirect pulp capping procedures. (Dycal and GIC)

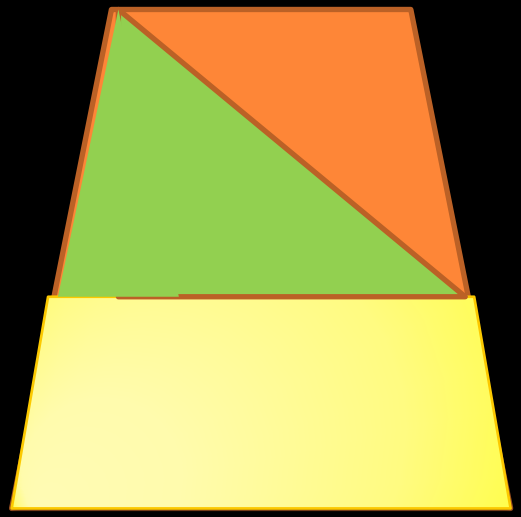
(Tredwin CJ, Stokes A and Moles DR. Oper Dent. 2005 Jan-Feb;30(1):32-8)

Composite build-up should be done incrementally as most composite has a depth of cure of 2mm. Cure time follow manufacter's instruction mostly 20-30sec unless using a darker shade.

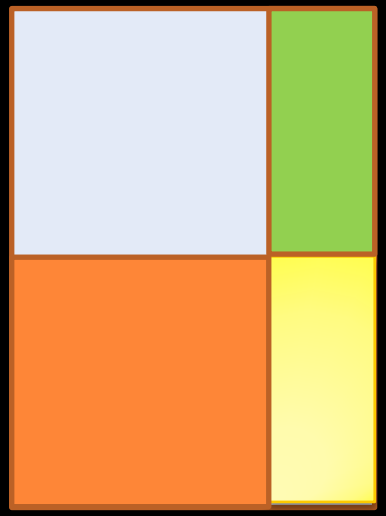
The main problem with composite restoration is secondary caries and most layering technique is not clinically proven to prevent microleakage.

Convert a Site 2 cavity into a Site 1 cavity for ease of restoration.

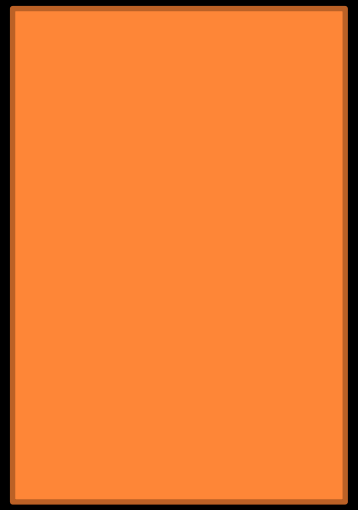
Incremental technique



Olique incremental technique



Centripetal incremental teachnique



Bulk placement

Matrix Aplication

For site 2 cavity a tight proximal is important to prevent food impaction that willl lead to perio disease and caries.

This may be achieved by: pre-wedging and use of proper matrix band system either conventional or sectional

Finishing

Gross finishing- multi-fluted tungsten carbide burs

Fine finishing- fine grit diamond burs, yellow and white band

Polishing using composite polishing system made up of dics and strips (eg soflex ,3M)

Abrasives impregnated rubber polishing device (Enhance, Caulk, Dentsply)

The End