A restorative dilemma?

Tom Bereznicki and Lucy Clements present the restoration of deep interproximal boxes in class II cavities using the 'sandwich' technique

Abstract
Class II cavities without enamel margins are commonly seen in general dental practice. The predictable restoration of these cavities can be challenging with many factors to consider including the choice of material, placement techniques and bonding systems chosen. These factors can greatly affect the longevity of the restoration placed. This article includes case examples where class II restoration failures have occurred using the sandwich technique.

Clinical relevance
As amalgam is phased out, alternative techniques for the restoration of class II cavities without enamel margins need to be considered by the general dental practitioner.

Objective
To consider options for restoring class II cavities and give examples of sandwich technique restorations.

Introduction
Historically, class II restorations were carried out either as gold inlays or amalgam restorations. The advantages of amalgam were that it was a cheap material and not particularly technique sensitive (Osborne, 2006). This allowed simple and predictable placement even in situations where moisture control was poor, as long as adequate retentive features were incorporated and sufficient sound tooth structure remaining.

Figure 1a shows a typical lathe cut conventional amalgam placed 30 years previously – note that despite surface corrosion and minor marginal breakdown this could still be regarded as clinically successful. In the 1960's, amalgam improved dramatically as a dental material following the development of spherical particle alloys and an altered chemistry (by the addition of copper to reduce the weak Gamma 2 phase) resulting in a stronger and more corrosion-resistant alloy (Bharti et al, 2010).


Figure 1a: Conventional 30-year-old amalgam restoration

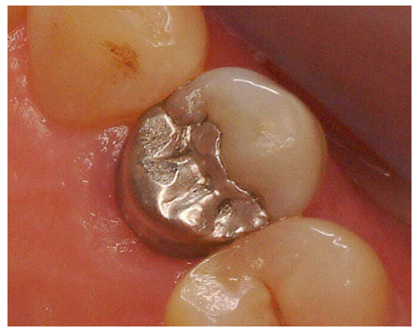
Figure 1b: A typical high copper amalgam after 25 years' service


Figure 2: Restoration suffering a rapid loss of marginal integrity and rampant caries


Figure 3a-3b: The ideal clinical situation if long-term success of the composite is expected – all the margins of the restoration being in enamel

Despite the lack of any adhesive properties, in the presence of good oral hygiene, General Dental Practictioners (GDPs) found recurrent caries to be rare (Lai et al, 2013), and the increased strength of the alloy to allow large cusp replacement restorations to be predictably placed (Wahl, 2003). Figure 1b shows a typical high copper amalgam after 25 years' service. Further improvements to longevity came with the development of 'amalgam bonding' (Setcos et al, 1999) although there is little clinical data indicating the effectiveness of this technique.

Following initial work by Buonocore in 1954, composite resins slowly started to replace silicate restorations in anterior teeth. With the development of auto-curing macrofilled composites for class III restorations, it only became a matter of time before their use spread to class II restorations. These materials were difficult to polish, with the poor bond of the filler particles to the resin rapidly leading to particle and matrix loss which in turn resulted in surface roughening and accelerated wear of the opposing teeth (Coombe and Burke, 2000). In addition, initial bonding strengths to enamel were poor and non-existent to dentine, resulting in these restorations suffering a rapid loss of marginal integrity and rampant caries as shown in Figure 2 (Pashley, 2003).

Strengths of composites were improved by hybrid filler size, and surface polish by the introduction of microfine particles (Coombe and Burke, 2000). In the late 1970's, the arrival of 'command' cure with the use of a blue light (rather than the initial ultraviolet) facilitated simplified placement (Pelissier et al, 2011). The advent of enamel etching with phosphoric acid and the use of an unfilled bonding resin enhanced bond strengths to enamel (Buonocore, 1955). The success of the technique became reliant on numerous factors but especially moisture control. Despite all these efforts, long-term success of these composite restorations became elusive particularly if the margins of the restorations were not entirely on enamel (Auisello et al, 1999).

Despite the ongoing failure of composites, patient demand for these restorations was gaining pace and fewer amalgams were being placed. Mackenzie et al (2009) explored some of the reasons for the placement of fewer amalgams:

- Alleged health concerns and environmental considerations regarding amalgam
- The dental profession's desire for an adhesive material that demands less invasive cavity preparation
- Patient demand for tooth-coloured restorations in posterior teeth.

The advent of simultaneous bonding to both enamel and dentine in 1977 (type one bonding agents) helped in the provision of more predicable composite restorations (Burke, 2004). Ongoing extensive research by dental manufacturers and studies sought to further enhance predictability. Research focused on three main areas:

- The materials themselves
- Placement techniques
- Improvement of enamel/dentine bonding systems.

Materials
With the passage of time, factors such as the improvement of the bond of filler particles to the matrix, particle size and shape (most recently nano particles), enhanced strength, wear resistance and polishability of composites (Coombe and Burke, 2000). The introduction of indirect composite restorations was an attempt to limit polymerization shrinkage and improve longevity. The latest development is with the introduction of 'bulk-fill' materials.


Figure 4a: September 2004 - Left LCPA showing intact mesio occlusal restoration on lower left second molar (LL7) after placement in March 2003


Figure 4b: June 2006 - Left bitewing showing intact mesio occlusal restoration in the LL7

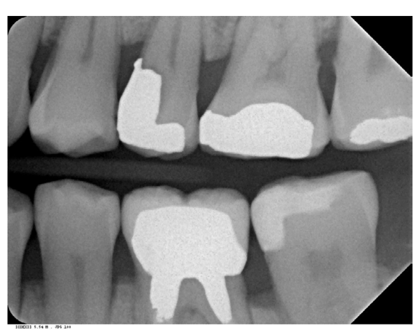
Figure 4c: January 2008 - Left bitewing showing intact mesio occlusal restoration in the LL7


Figure 4d: September 2009 - Left bitewing showing sudden rapid recurrent caries in the LL7 mesially


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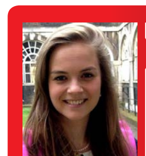
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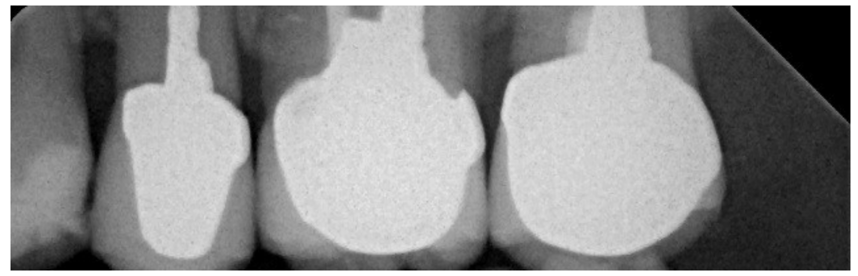
Figure 5a: Radiograph taken in 2005, three years after placement of an open sandwich technique restoration in UL4 with conventional GIC and universal light cure composite. With the benefit of hindsight early GIC loss is visible distally

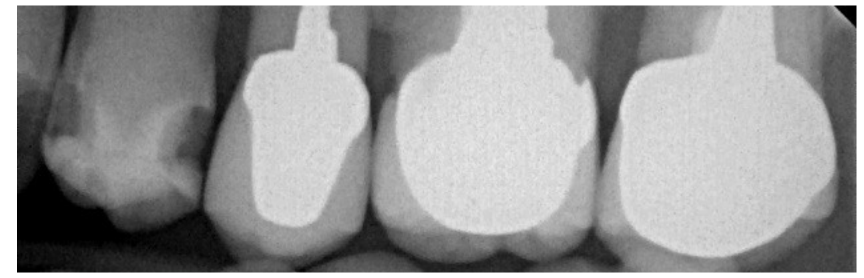
Figure 5b: Radiograph taken in 2012 showing loss of GIC in UL4 below the intact composite mesially and distally

Placement techniques
Factors contributing to failure include: (Pashley, 2003)

- Poor moisture control
- Over or under-etching with the 'wet' bond technique
- Over or under-drying dentine in the 'wet' bond technique
- Reduced bond strengths with the 'self-etch' technique if the primer is inadequately dried
- Excessive thickness in incremental layering or bulk packing of the composite
- Poor manipulation of very viscous materials resulting in air voids being trapped in turn leading to poor marginal adaptation (Strassler H and Price, 2014)
- Inadequate light curing in the depths of proximal boxes particularly in the posterior quadrants in the presence of metal matrix strips
- Failure to 'ramp' cure
- Lack of maintenance to ensure that the light source is emitting the correct strength and wavelength of light
- Polymerization shrinkage (in the region of 2.5%) which invariably pulls the composite towards the light source and away from the base of deep boxes (Zeiger et al, 2009)
- High caries risk individuals and increased number of surfaces included in the restoration (Fusayama, 1992).

Enamel/bonding systems
Concurrent with improvements with composite resins, bonding techniques were also undergoing dramatic improvements. The development of the 'total etch technique' or 'wet bonding' as first explained by Fusayama in 1977 (Opdam et al, 2014), was the first instance of the simultaneous etching of both enamel and dentine with 37% phosphoric acid (type one). This has remained the gold standard with separate etch, prime and bond stages. Further advances have led to development of further types of bonding agents – simpler techniques with fewer steps and self etching systems.

Figures 3a and 3b show the ideal clinical situation if long-term success of the composite is expected – all the margins of the restoration being in enamel.

Meanwhile, research was confirming clinical findings that the expected median longevity of composite restorations was four years (Chrysanthakopoulos, 2012). Much of this has been attributed to the breakdown of the bond of composite to dentine which starts to degrade as early as six months post placement (Breschi et al, 2008). Figures 4 a to d show the all too typical sudden appearance of caries once the bond to dentine suffers total failure –in this case six and a half years.

These all too common failures led a search for more predicable techniques to bond composite materials to dentine in deep boxes within class II cavities. The ability of glass ionomer cement (GIC) to chemically bond to dentine and micromechanically to enamel, therefore reducing micro-leakage, had been well documented (Holton et al, 1990) but its use solely in class II cavities for the long-term had been limited by its physical characteristics (Stockton, 2007). Although the bond of GIC to dentine is excellent, it has a weaker bond to enamel, has suboptimal wear rates (McLean et al, 1985) and is soluble in the dilute organic acids found in plaque which could lead to failure particularly in dentitions subject to large occlusal loads.

McLean et al (1985) first described a technique called 'the closed sandwich technique' where the bulk of the cervical portion of a class II restoration is replaced with conventional GIC and then this and the remainder of the cavity is completely covered with bonded composite – the bond being both to the surrounding enamel and underlying GIC. The 'closed-sandwich technique' remains an effective method for reducing micro-leakage where proximal boxes have gingival cavosurface margins located in enamel (Holton et al, 1990). This in turn led to the development of the 'open sandwich technique' where the GIC is left open with the composite resin placed over the top of the GIC. Logeurcio et al (2002) found that the best results and least marginal leakage occurred in the 'open sandwich technique' where Resin Modified Glass Ionomer Cement (RMGIC) was used cervically rather than conventional GIC.


Figure 6: Intra oral photograph of UL4 showing intact composite occlusally despite dissolved GIC in the cervical box beneath

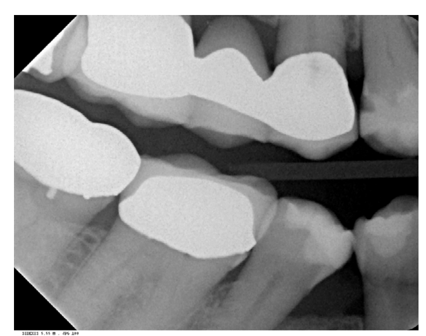
Fig 7a- 'Open Sandwich technique' restorations placed in the upper right first (UR4) and lower right second premolar 'closed sandwich' restoration (LR5) by Dr Tom Bereznicki

Case one
In June 2003 the upper first premolar (UL4), shown in Figure 5, was restored with a conventional 'open sandwich technique' due to the absence of enamel in the floor of the cavity. A conventional GIC was used in the base of the box of the UL4 MOD restoration followed by conventional acid etching and bonding and placement of a light cured composite in the coronal portion of the restoration. The radiograph taken in December 2005 shows sound margins and no recurrent caries in the floor of the distal box, although with the benefit of hindsight there would appear to be mild dissolution of the GIC base. Figure 5b shows the same restoration in 2012, nine years after placement. The GIC placed has almost entirely dissolved, leaving the overlaid composite 'in situ'.

Figure 6 shows a photograph of the same restoration in 2012. The overlying composite placed over the GIC is intact despite the dissolving GIC which had been placed cervically in the box of the class II cavity.

Logeurcio et al (2002) found that best results and least marginal leakage occurred in the open sandwich technique using RMGIC cervically rather than conventional GIC. This correlates with RMGIC being insoluble in dilute organic acids found in plaque while conventional GIC is soluble.

Interestingly, on removal of the restoration there was no secondary caries present in the floor of the box despite the absence of the original GIC.

Case two
Figures 7a and 7b show a similar case. The radiographs were taken just over five years post placement of restorations in both upper first premolars (UL4 and UR4). Both were placed with the 'open sandwich' technique composite restorations described earlier. On this occasion conventional GIC was used as the base, with acid etching and then prime/bond and a coronal nano-composite. The dissolving GIC base is clearly seen in both radiographs. It is interesting to contrast this radiographic picture with that of the successful 'closed-sandwich' technique restoration placed nine and a half years earlier in the lower right second premolar where all the margins of the composite were in enamel. It should be noted that Opdam et al (2007) showed that class II composites placed with a total etch technique showed less fractures than those with a RMGIC lining.

In a personal communication regarding the 'open sandwich technique' restoration case shown in Figures 5a and b, Dr G Christensen of *Clinician's Report* (a publication of CR foundation) stated: 'The nine year longevity restoration in the UL4 appears to be dissolving significantly. Since the proximal box forms were filled with Fuji IX, it appears that the patient has oral physiology predisposing to glass ionomer dissolution. I have seen it only a few times.'

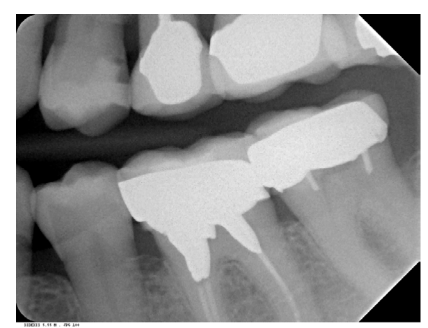
Fig 7b-'Sandwich technique' restorations placed in the upper left first premolar (UL4)

Conclusion
Practitioners should be aware that the 'open sandwich technique' using conventional GICs may have its pitfalls and alternative techniques should be explored. The use of RMGICs, which are less soluble in the oral environment, may be the preferred option if the 'open sandwich technique' is to be used.

With the progressive phasing out of amalgam it remains a restorative dilemma for the GDP as to how to restore deep posterior class II cavities when the margins are on dentine

On the other hand, the advent of the newer type three and type four and five of enamel/dentine bonding agents may or may not make the placement of composite restorations in deep boxes with no enamel margins more predictable. Although their use is less technique sensitive they still require meticulous application and the issues of moisture control remain inhibiting. There is an absence of long-term clinical data on their success in the situations described.

With the progressive phasing out of amalgam it remains a restorative dilemma for the GDP as to how to restore deep posterior class II cavities when the margins are on dentine. If amalgam is not used, then gold seems to be the only material that has proven long-term success (Studer et al, 2000) but its use is unlikely to return on the grounds of cost and aesthetics. D

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