

# Direct or indirect restorations?

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The majority of clinical decisions regarding the most appropriate choice of restorative material and technique are relatively straightforward and are usually dictated by a variety of factors including:

- Lesion size and aetiology
- Aesthetic, occlusal, endodontic and periodontal considerations
- Number of teeth affected
- Patient compliance, habits and preferences
- The dentist's own competence and underlying beliefs about restorative treatment.

The decision-making process involved when choosing to use either a direct or an indirect approach for any given clinical situation can be facilitated by considering the following continuum, which has at one end direct restorations and at the other indirect restorations and which can be split into three distinct categories.

## Category A: direct restorations clearly indicated

Category A is populated by the overwhelming majority of Class I, III, IV and V restorations, as well as most small Class II (MO, DO and MOD) restorations. Unless there are other contributory factors at play, the restoration of choice will be direct and, most probably, composite. While many

amalgam restorations continue to be placed, as far as this paper is concerned direct restorations refer to resin-based composite unless otherwise stated. In the US, it appears that around two-thirds of direct restorations currently being placed are made of composite and one-third amalgam (Christensen GJ, 2010). As Christensen points out, amalgam isn't dead – it is simply being used less often. Glass ionomer may be considered in a limited number of situations where its cariostatic effects might be considered useful (Tay FR et al, 2001).

## Category C: indirect restorations clearly indicated

At the other end of the spectrum, Category C is also relatively straightforward in that here we find large cavities and/or failed direct restorations with multiple missing cusps; anterior teeth with large interproximal cavities along with maybe one or both mesial and distal incisal edges requiring replacement; replacement of failed crowns; and



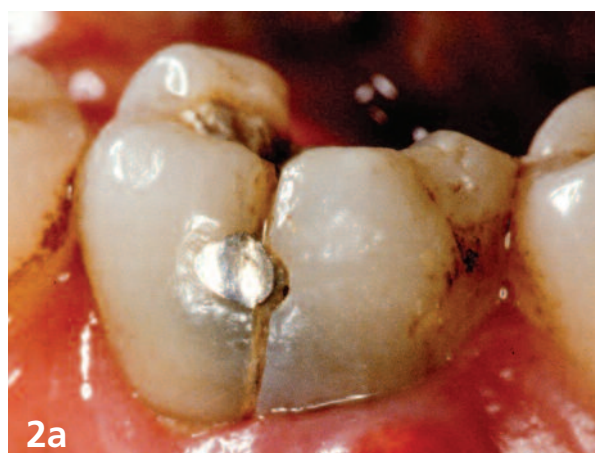
**Figure 1: It is clear that in this case replacing these failing amalgams and composites with further direct restorations would be inappropriate and that indirect restorations are required.**

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**Figure 2a and b:** The combination of endodontic treatment and extensive tooth loss, especially if this involves loss of one or both marginal ridges makes a tooth highly susceptible to fracture.



**Figure 3a and b:** Most posterior root-filled teeth require some form of indirect occlusal coverage to provide protection and prevent subsequent tooth fracture.

large rehabilitation cases requiring the recreation of multiple occlusal surfaces. There is little contention that the treatment of choice in such situations is some form of indirect restoration (Figure 1). The choice of material (gold, porcelain fused to metal (PFM) or all-ceramic) depends on an analysis of the various factors listed in the introduction.

### **Category B: uncertainty over which is the most appropriate approach**

It is in the middle ground of Category B where we find a number of commonly occurring clinical scenarios that can and do cause confusion among many dentists who are unsure which avenue they should pursue – direct or indirect. These are the clinical situations we wish to explore further in this paper.

### **Root-filled teeth**

Compared to teeth with healthy pulps, root-filled teeth are considered to be more susceptible to fracture (Figure 2) as they possess reduced dentinal elasticity (Johnson JK et al, 1976), lower water content (Rosen H, 1961), deeper cavities (Madison S, Wilcox LR, 1988) and substantial loss of dentine including, critically, the strengthening effect of the pulp chamber roof (Assif D et al, 2003).

It has therefore been a long and widely held view (Goerig AC, Mueninghoff LA, 1983; Reeh ES et al, 1989) that posterior root-filled teeth require some form of indirect occlusal coverage (onlay or crown) in order to protect the tooth against subsequent root fracture (Figure 3).

It has also been suggested (Assif D et al, 2003; Smales RJ, Hawthorne WS, 1997) that where more extensive tooth



**Figure 4a and b:** In cases where, for whatever reason, indirect occlusal coverage restorations are not able to be placed, amalgam can be used, provided that there is sufficient occlusal reduction.



**Figure 5a and b:** Large, durable, aesthetic direct placement restorations are now possible thanks to modern composite/bonding technology. It is imperative though that the operator has an excellent understanding of the sensitive nature of the clinical techniques required.

loss has taken place it is possible to use a directly-placed amalgam onlay to protect the teeth (at least as a medium term, cost effective precursor to a later indirect restoration) provided that sufficient bulk of material – at least 2mm (Nayyar A et al, 1980) – is present (Figure 4).

This type of extensive restoration is more difficult and clinically demanding to create in direct composite (see below), and there are concerns whether such a restoration would exhibit sufficient strength to resist occlusal forces. If there is only an occlusal access cavity requiring restoration then, increasingly, a simple direct restoration is deemed to be sufficient (Hernandez R et al, 1994). Apart from conserving tooth tissue this would have the added benefit of reducing the length of restoration margin and therefore the potential for microleakage, a highly significant factor in long-term endodontic success (Tickle M et al, 2008).

There are caveats to this approach, however. For example, the presence of suspicious crack lines and heavy occlusal loading combined with parafunctional habits

would steer one towards using indirect occlusal coverage. Additionally, premolar teeth are thought to be more likely to fracture when a direct intracoronal restoration is placed, simply because the tooth tissue loss caused by the access preparation is proportionally larger than in a molar tooth. Lastly, there is a theoretical possibility that the effect of contraction stress generated through polymerisation shrinkage (Feilzer AJ et al, 1987) may be magnified on teeth that are already more susceptible to fracture.

In anterior teeth where the occlusal loading is much less, it is common practice now to use direct composite in cases with simple cingulum access cavities. The greater the extent of any previous caries, restoration or trauma, the more likely some form of extra-coronal restoration will be required. For example, a tooth with mesial and distal cavities, connected by an occlusal access cavity, will have lost much of its integral strength and would be much more prone to fracture if restored simply by means of a direct composite. Once again, caution must be exercised



**Figure 6:** Simple at-home tooth whitening can produce dramatic results and, as in this case, is a useful precursor to restorative treatment. The upper arch has been whitened to give the patient an initial indication of the level of improvement achieved.

whenever there is evidence of crack lines and heavy occlusal loading.

### Cusp replacement

In cases where a single cusp of a posterior tooth has been lost for whatever reason (crack line, caries, trauma, etc), it is now considered acceptable to restore the tooth using direct composite (Figure 5). Key to this is the dentist's own clinical ability, in particular the skill and knowledge of

dental anatomy to re-create correctly a replacement cusp directly in the mouth. These skills are far removed from those required to carve a large amalgam. While it may be possible to recreate more than one cusp directly inside the mouth, concerns over the strength of the final restoration, as well as the considerable chairside time required to complete such a restoration, mean that many authorities on the use of direct composite would often draw the line at replacing just one cusp. Instead, they would recommend using either an indirect restoration or a so-called 'semi-direct' or 'direct-indirect' approach (Spreafico R, 1996) for these more extensive cavities.

### Deep proximal boxes

Direct composites are more likely to be aesthetic, functional and durable when cavity margins are situated within enamel, free from heavy occlusal contact and easily accessible in terms of visibility, ease of isolation and relationship to adjacent gingival tissues. The more a cavity fails to fulfil these criteria, the more difficult it becomes to predict success. Therefore, consideration should be given to an alternative means of restoring the tooth. One very common example of this is when the box of a class II cavity extends beyond enamel. Apart from the likelihood of a significant loss of tooth substance, the main problem arising in such a situation is the difficulty inherent in trying



**Figure 7a and b:** Non-vital tooth whitening is an extremely efficient, conservative way of dealing with minimally restored darkened non-vital teeth.



**Figure 8a and b:** It was initially thought that this discolouration would be impossible to treat and further options were discussed with the patient. The whitening occurred within three months and was very rapid using 10% carbamide peroxide. The patient was very happy with this result. After a period of two weeks further composite bonding was undertaken to improve the shape of the upper left central incisor. (Photographs courtesy of Dr Linda Greenwall).



**Figure 9a and b:** Indirect composite onlays are more durable than many believe, are extremely conservative of tooth structure and are unlikely to damage the opposing dentition. In any case, does it really matter that they may occasionally require replacement if the underlying tooth is preserved and tooth vitality maintained with minimal effect on the periodontal tissues?

to seal subgingival cervical margins located within dentine and/or cementum.

### Dentine bonding

While bonding to enamel is now highly predictable, doing so either to dentine or cementum is far more problematic, primarily because of the difficulty forming an effective hybrid layer. This is dependent on the successful execution of a series of crucial clinical steps – etching, washing and drying, primer and bond application, and, finally, the polymerisation of adhesive resin in order to stabilise the fragile structure of the hybrid layer itself. In light of this great complexity, there are well-documented concerns about the lasting stability of dentine bonding (Dietschi D et al, 1995; Van Meerbeek B, Perdigao J, 1998; Hashimoto M et al, 2000). The majority of cavities are entirely bounded by enamel and it is thought that the seal achieved at the margin (i.e. between resin and enamel) protects any ‘internal’ resin-dentine bond at the floor of the cavity. However, what happens when part of the cavity margin is bounded by dentine? How should one proceed?

If the decision has been taken to place a direct composite restoration, Liebenberg (2005) advocates a resin-modified glass ionomer cement sandwich technique. This is, of course, not a new technique (Suzuki M, Jordan RE, 1990) and traditionally the filler of the ‘sandwich’ was a glass-ionomer cement. However, resin-modified glass ionomer cements (RMGIC) have been shown to possess superior mechanical properties and bonding strength to dentine (Pereira LC et al, 2002). Andersson-Wenckert (2004) examined the durability and cariostatic effect of a modified open sandwich restoration using RMGIC and concluded that it exhibited acceptable durability for the extensive restorations evaluated.

Another approach is to use indirect porcelain or composite inlay/onlays, thereby minimising potential resin shrinkage to that exhibited by the thin layer of luting resin. These restorations require a cavity with a location above the gingival margin (Dietschi D et al, 1994) and either a bevel-free butt margin or a hollow chamfer (Hannig M et al, 1991). Where the margin is slightly subgingival, Dietschi (1998) advocates ‘relocating’ the cervical preparation above the gingival margin, also known as ‘margin elevation’, by applying an increment of flowable composite resin at the margin. This represents a non-invasive alternative to surgical crown lengthening.

### Tooth discolouration

Tooth discolouration has a number of different possible aetiologies and may be either intrinsic or extrinsic in nature. Most extrinsic discolouration can be removed easily and it is the intrinsic variety that is more difficult to treat, depending on the severity and depth of discolouration.

Dentists are often unsure which is the best strategy to adopt and much depends on the aetiology of the discolouration. A correct diagnosis is important and allows the dental practitioner to explain to the patient the exact nature of the condition. In some instances, the mechanism of staining may have an effect on the outcome of treatment and, in turn, influence the treatment options the dentist will be able to offer to patients (Watts A, Addy M, 2001). A large number of discoloured teeth are nowadays treated either conservatively by tooth whitening (Figure 6) or less conservatively by means of ceramic laminate veneers or even full coverage crowns.

Dentists will often restrict the use of bleaching to mild forms of discolouration – in other words, the darkening of teeth through normal ‘wear and tear’ of daily life – while ceramic solutions are reserved for more severe situations

such as tetracycline discolouration. Meanwhile, non-vital bleaching is very effective in most cases (Figure 7) and is an excellent adjunct to bonded composite when the only tooth tissue loss is a result of the access preparation (Deliperi S, Bardwell DN, 2005).

Tetracycline discoloured teeth present their own specific problems. Veneers are often prescribed for such teeth. The difficulty, however, with using veneers to treat tetracycline discolouration is that the staining usually extends deep within the structure of the tooth. As the enamel is removed the discolouration tends to get worse, and so more dentine is removed to allow for a greater thickness of ceramic. As the preparation inevitably moves further into dentine, the retention of the veneer becomes increasingly dependent on dentine bonding rather than enamel bonding with all the attendant difficulties described earlier in this paper. A further problem is that removal of enamel in this way for veneer restorations is an attempt to match up high elastic modulus porcelain with lower elastic modulus dentine. It is predictable that functional loading of the veneered tooth will transfer this energy to the interface, resulting in debonding or cracking in the porcelain. The upshot of all this is that the greater the depth of the veneer, the greater the need for additional (i.e. conventional) means of retention and this means the use of full coverage restorations.

Are there other, more conservative means of dealing with the type of deep discolouration caused by tetracycline? Certainly, long-term tooth whitening can yield acceptable results (Figure 8), with success depending on the depth, severity and degree of the discolouration (Greenwall L, 2001), as well as on the patient's particular expectations of treatment. With the development of more efficient opaquing systems, the use of direct composites is likely to increase in the future, probably in conjunction with prior tooth whitening.

### Tooth surface loss

Tooth surface loss (TSL) is defined as loss of tooth substance in the absence of caries or trauma. Traditionally, indirect restorations have been used as the treatment of choice in such cases as they confer greater strength than direct restorations. Improvements in composite mechanical properties and bonding chemistry over the years have, however, made it possible to restore surfaces of worn teeth directly without recourse to indirect restorations, although this option remains if the need arises in the future.

Dentists often focus on the survival of their restoration when, in fact, the focus should be on survival of the tooth on which it has been placed (Figure 9). It is relatively

unimportant if the restoration fails, provided the tooth still has a good prognosis. Indeed, an increasing number of studies have illustrated the feasibility of this approach to the treatment of TSL cases.

Clinical trials conducted by Hemmings et al (2000) and Redman et al (2003) examined the use of direct composite restorations for the treatment of localised anterior tooth wear and revealed relatively low failure rates of the composites, with a median survival rate of five years. Those failures that did arise were mainly the result of generalised marginal failure and discolouration. Similarly, Poyser et al (2007) evaluated clinical performance and related patient satisfaction of direct composite restorations used to restore worn mandibular anterior dentitions. The authors concluded that direct composite restorations placed at an increased occlusal vertical dimension are a simple and time-efficient method of managing the worn mandibular anterior dentition. They also found that patient acceptance and adaptation to the technique is good and is maintained for the medium-term.

### Conclusion

In virtually every clinical case there will be more than one way to achieve a result. Many decisions regarding treatment are straightforward, as the advantages of one particular procedure outweigh its own disadvantages and the relative advantages of other available options. There are, however, a variety of situations where the choice is less clear-cut and in this paper we have tried to highlight some of these in relation to the selection of an indirect or a direct restorative approach.

There will never be a completely black and white guide to dental treatment, and grey areas will always exist. As long as treatment is performed with care, to a high standard and with a nod to the underlying science, it will more than likely be successful.

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