Duggan Oral Design Resources

The Rise of Adhesive Dentistry

There is even an International Academy for Adhesive Dentistry, which illustrates the importance of this subject to dental providers. Wikipedia has a section on dental bonding, but here I will address adhesive dentistry in a more all inclusive manner – what has adhesive bonding technology added to our toolbox as dental practitioners?

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Adhesive Bonding in Dentistry: History

In the **early 60s** a researcher named Ray Bowen developed the technique for adding enough crystalline filler to a particular resin polymer to make it compatible with tooth structure. He created the **composite resin** material which is used today in dentistry. Commercial development followed, until by the mid 80s we had products that were available for restoring teeth.

In those early years it was not clear **how these materials could best be used** – whether they could just be put into prepared teeth like silver amalgam, or whether there should be a different treatment of the tooth structure for retaining the materials in the teeth.

By 1990 we had pretty well developed methods for restoration with composite resin. In fact these methods were successful enough clinically, in patients, that **even the dental schools were teaching the use of composite resin materials as an alternative to silver amalgam.**

From the start, it was clear that in order to get the most successful restoration with composite materials, the dentist had to take his/her time with the procedure – it could not be rushed – every step had to be done carefully for the best results. And since this required more TIME to do a composite resin restoration compared to the time required for filling with silver amalgam, **the cost of the composite to the patient is higher,** and reasonably so. It was so clear that we needed to charge more for composite resin restorations, that even insurance companies were willing to pay a dentist more for the composite, if it was covered – and insurance companies would prefer to pay nothing!

So, by 1990 we entered into an ethical parallel universe in dentistry – suddenly the dentist had two options for restoring posterior teeth. The advantages and disadvantages of each will be discussed in the next section, but the **CHOICE** is what became critical.

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Who Makes the Choice of What Material to Use?

WHO makes the choice? Back in the early 90s, when composite resin ("white") fillings first became widely available and accepted, dentists were representing to patients that the advantage of the composite is that it is tooth colored, or even more "natural". Some dentists were even discouraging patients from using amalgam due to the presence of mercury. But, clearly, **most dentists were eager to do more composite resin restorations than amalgam restorations**. Why was this?

The ***primary reason*** is that **it is possible to make more money from doing composite restorations.** This happens in two ways, you can convince the patient that the old amalgams should be replaced with newer composites, and **if the dentist cuts corners and does them more quickly,** then they make more money because they are still charging the fee appropriate for taking longer.

A ***secondary reason*** why many dentists prefer to do composite restorations is because they have the sense that they can prepare the tooth more carelessly. They may think that the adhesive nature of the composite will make up for their lack of skill or intention – basically gluing the tooth together so it's not as likely to fracture if left weakened. This is a false belief.

A ***third reason*** MAY be that dentists and patients are concerned about the potential adverse health consequences of silver amalgam restorations – and there HAS been much concern expressed over the last TWO centuries about its use. However, the most current and thorough research demonstrates clearly that the mercury from amalgam is likely to be less toxic to the system than the consumption of tuna for the vast majority of us.

A ***fourth reason*** is that dentists seem to think their patients will simply be happier with restorations that look like natural tooth structure, **despite the short lifetime and the need to have these fillings redone frequently.**

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So Dentists Tend to Choose to do Composite

And the first three reasons for their choice are all fallacious, while the fourth SHOULD take into consideration the desires of the patient.

First, with the materials and methods that were available in the 90s and beyond, speeding up always meant compromising lifetime – and it is questionable whether things have improved with newer materials. But dentists even started doing preparations without proper bevels just to save time! **Second**, as we have seen, whenever undermined enamel is left on a tooth, composite may bond to it, but upon curing shrinkage, it will be displaced. And, as well, if parts of the tooth are weakened after preparation, it likely signifies that the filling would have to be too large to be within acceptable guidelines for composite, for larger restorations tend to wear out more quickly.

All that being said – it is clear that the **adhesive part** of the development of composite resin materials has altered the course of dentistry more than anything since the development of silver amalgam in 1819.

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Consequences of Composite Resin Technology

Composite resin is sometimes used in the mouth for purposed for which it was not designed, the potential adverse health consequences of composite are not fully elucidated, and the longevity of composite in the mouth does not compare with amalgam, BUT, *the technology has been impactful.*

Cosmetic dentistry would not have come into existence were it not for composite resin technology – the materials and the adhesive techniques. We would not have porcelain veneers, because before the resin technology of etching and bonding, we **could not cement** the porcelain to enamel! The advent of computer aided dentistry through CAD/CAM machines (visit Chapter VII.4 for a discussion of high-technology methods) would never have happened because we would not have had a cement with which to bond the porcelain crown to the tooth structure, both enamel and dentin. We

can even adhesively bond GOLD to tooth structure using the modern technology of dental resin adhesion.

So it is inarguable that the developments starting in the 60s have taken dentistry far beyond what we even imagined – even just in the cosmetic arena, but we now have digital technologies used in dentistry solely as a consequence of the development of adhesive methods.

I will review for you some of the aspects of what it takes to get adhesion between materials in dental applications below – for each of the materials for which this is important.

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Adhesive Bonding in Dentistry: Adhesion to Enamel

We've seen before that **when we etch an enamel surface where the ENDS of the enamel rods are exposed there is the possibility of good adhesion**. In reality, the etching opens up spaces between these rods, and it is considered that tags of resin penetrate into these microscopic open spaces, creating a kind of "micromechanical" bond, which we'll just call adhesion for convenience. It is the best bond we can get between tooth structure and resin materials. If the ends of the rods are not exposed, for instance in an amalgam preparation, comparatively little adhesion would be achieved, even if etching were done. For the Class II composite preparation, as differentiated from that for amalgam, the angle between the box walls and the surface are normally kept obtuse, so that there is some exposure of the enamel rod ends on these walls.

As we've seen, bonding to enamel consists of insuring the enamel rods are exposed by creating the appropriate angle of a wall at the margin, bevelling the margin, or simply bringing the composite onto the outer surface of the tooth, where the rod ends are always exposed. In the latter case, the composite would extend beyond the original contours of the tooth, but that may be the intention, to create a different contour esthetically.

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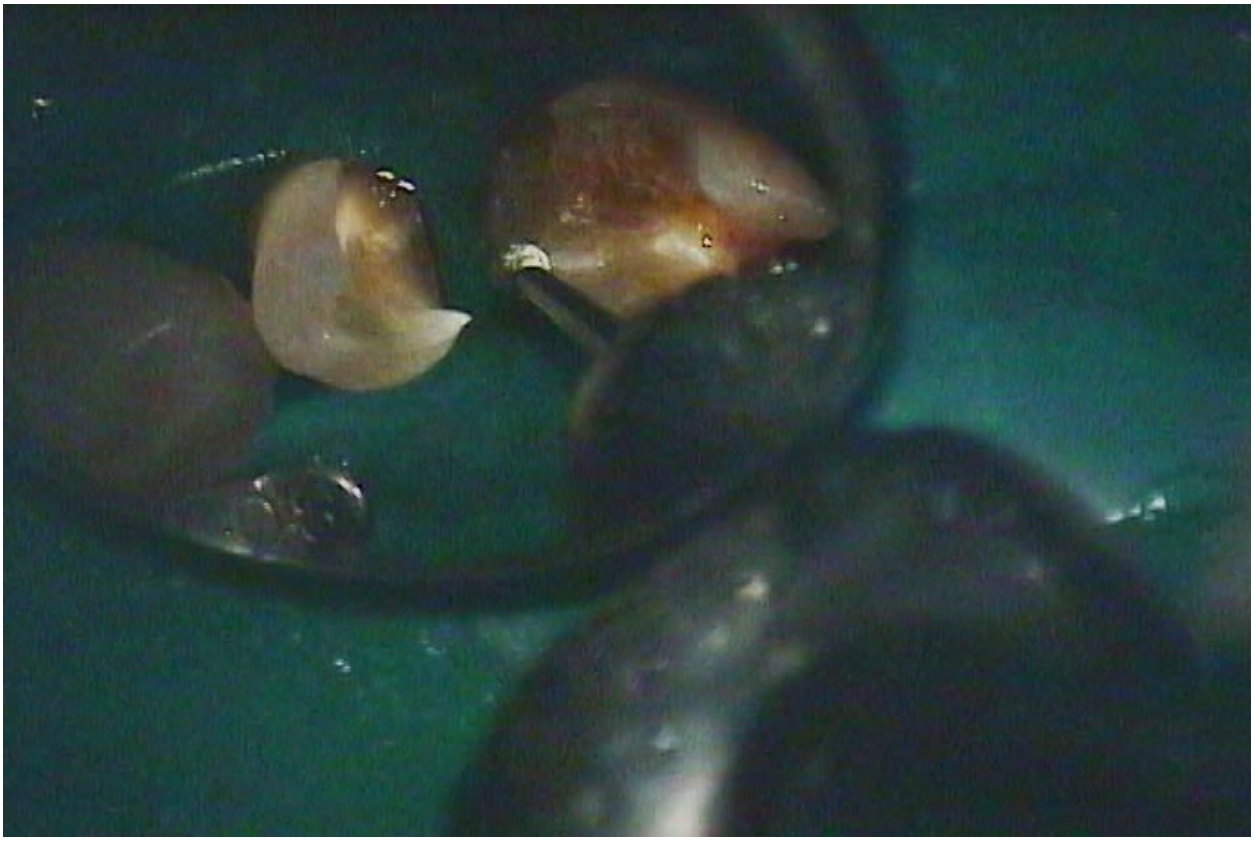
Adhesive Bonding in Dentistry: Adhesion to Dentin

Here the dentist has available many different types and generations of DENTIN PRIMERS, which are materials designed to penetrate into the tubular surface of dentin after that surface is etched. These materials are thinned out with a rapidly evaporating solvent, like ethanol or acetone, so they penetrate more. They are not light curable, but will set when a resin bonding agent applied against them sets or polymerizes. When the primers polymerize in the dentin layer in which they penetrate, it creates what is called a hybridization layer, where the properties are a combination of the dentin and the resin.

Not all dentists utilize dentin priming where they should. In a large composite restoration for an anterior tooth, for example, when the amount of enamel at the margins is far less than the dentin exposed in the center, priming the dentin can be an important component of the adhesion of the restorative material.

You can imagine that for the prepared teeth shown in the picture below, the need for dentin priming will be high.



Also, **when a porcelain or ceramic crown is cemented** to a prepared tooth, it must be adhesively bound because porcelain is too brittle to do well with mechanical retention (which builds up forces in the material intentionally). In this instance **the bond MUST be to dentin, because there is no enamel left!** Many dentists use cements that are put on the market which presumably provide some adhesion to dentin by "self-etching", and involve SOME penetration into the dentin surface. These compromised "one-step" materials are often the culprits when porcelain crowns fall out.

I've had two porcelain onlays (we'll discuss onlays in detail later, Chapter V.7), which are basically partial crowns, fall out in my mouth because of using one-step cements. This was not at all necessary, as we have the technology to cement them in with far greater reliability, if the dentist deigns to take the time to do this.

Unfortunately, sometimes the commercial side of dentistry overwhelms the basic mission of what we do – it is to help our patients satisfy their needs. If it is to help them look better, or get out of pain, or avoid unnecessary costs due to continuing decay, it only matters that our patient's

needs come first. This is the way it has to be. But dentists have to run a profitable business, and the companies that make dental materials need to provide products that dentists will buy, to satisfy their stockholders. If a manufacturer says he has an adhesive material that works just as well but it can be utilized more quickly, one step instead of three, for example – then dentists will buy it without researching whether the benefits to the PATIENT are actually there or not.

This is no more true than in the area of adhesive and cosmetic dentistry.

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Adhesive Bonding in Dentistry: Adhesion to Porcelain

This is a very interesting situation chemically – **we have a wholly organic cement which we want to bond adhesively to a totally inorganic material**, porcelain. Porcelain is basically silicon oxide and dental cements are hydrocarbons – and that sounds, and IS, very different.

How do we make them like each other? The answer was originally utilized in the glass industry for making shatter proof and bullet proof glass. One needs to interpose a molecule between the disparate surfaces where **one end of the molecule likes one surface while the other end likes the other**. In the case of porcelain and dental resin cements – the molecule is a hydrocarbon chain which has a silicon atom at one end and a double bond at the other. In dentistry this is generally referred to as a **COUPLING AGENT or silinating agent.**

We also have to etch the porcelain – this activates the surface so it is eager to get together with its silicon compatriot on the coupling agent. So once the porcelain is etched, with an acid which dissolves glass, and the coupling agent is painted on. Upon drying, the porcelain may be thought of as a surface from which extend billions of tiny molecular tails with double bonds on the ends. These double bonds polymerize INTO the cement when the cement is setting.

To bond a porcelain crown to a prepared tooth, essentially all dentin, the tooth and the porcelain are both etched (different acids!), the dentin is primed and the porcelain is painted with coupling agent, and then when the cement is placed in the crown and the crown placed on the tooth, all is bonded together – likely for a long time to come.

THIS is what I call the FULL TECHNOLOGY of porcelain cementation, but it is used rarely by practicing dentists because it takes some extra time!

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Adhesive Bonding in Dentistry: Adhesion to Gold

Few dentists even know that this is possible!

Consider I had a patient come in with a gold crown in her hand that had fallen out, obviously, but the inside part of the crown was filled with amalgam. What the dentist had apparently done is to build up a very short tooth with amalgam to make it taller so that a crown would hold on to it better. Unfortunately **the amalgam fell off the tooth, taking the crown with it.**

Now, why did the amalgam fall off the tooth?

There was essentially NO tooth left, just a thin layer above the gumline, so it needed to be built up. I believe he felt that he could adhesively bond the amalgam to the remaining tooth, and use this to retain the crown. In the next part I will talk about the possibility of amalgam bonding – but in the mid 90s most dentists felt it was possible and materials were sold for this purpose. Prior to that we used pins – little screws in the dentin – to mechanically hold the amalgam into or onto the tooth (visit Chapter V.2). He/she would have been better advised to have used pins.

So, the patient wants to cement the crown back on, but there is little left of the tooth to hold onto. She said she has saved up $50 and could give that to me for the procedure. **In this day and age virtually NO dentist would do what I did.** Virtually every dentist would tell the patient it could not be done, and they would need a new crown, AND a root canal first. Now the patient is looking at $3000 at today's prices.

I simply removed the amalgam from within the crown, cleaned the gold on the inside surface, electrolytically plated TIN onto the inside of the crown on the gold, let it dry, producing a tin-oxide surface, much like a silicon-oxide surface of porcelain – and applied a coupling agent and recemented with resin cement after etching and priming the dentin. That crown stayed on for over a year, at which point I actually did need to do a root canal on the tooth, but did it THROUGH the gold crown and then refilled the access to the canal afterward in a way that would keep the crown on even better.

The more we know about the technology that is available to us, the more options we have for doing optimal dentistry for our patients, and WITHIN their budget!

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Adhesive Bonding in Dentistry: Adhesion to Amalgam

As indicated above, the concept of amalgam-bonding was at one time thought to be of great value. Dental schools were teaching this method, thinking it would eliminate the necessity for placing pins, which some students were careless about.

The essence of the method is that a preparation is done for amalgam in the usual way – there may be areas of tooth structure around the preparation that are weakened and we are thinking we can adhesively bond these areas to the amalgam, helping to protect them, or that the amalgam might not be well retained in the tooth by mechanical means, so we can supplement this with adhesive methods. The case I illustrated above represents an extreme case of this latter consideration – obviously a failing case.

So, the prepared tooth is ready for condensing the amalgam. The prep is first etched and primed as if we were doing a composite restoration, and then adhesive cement is painted into the preparation and the amalgam is condensed over the cement while it is still wet. The theory is that the composite adhesive would form fingers that reach into the amalgam while it

was being condensed, thereby essentially mechanically holding it to the dentin surface where the cement was bonded adhesively.

The initial results and laboratory results with this method seemed encouraging, so dentists and even schools jumped on the method pretty quickly. It was a few years later that we started seeing failures in cases where we could have done better with the traditional methods.

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Bottom Line for Adhesive Bonding in Dentistry

Adhesive dentistry has permitted many procedures that would have been impossible decades ago – but we must utilize the technology that is available to us **completely and without compromise** to provide the best care to our patients. It is possible that using products that are marketed heavily by manufacturers will take us to a whole new level of dental performance and success, or it is possible that the use of mediocre products, or with modest skill and attention will produce a poor result for our patients.