VITAL GUIDE SERIES

4 Adhesive dentistry: a revolution in restorative dentistry

- What is adhesive dentistry?
- How are adhesive materials used to restore teeth?
- When should adhesive dentistry be used?

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VITAL GUIDE TO Adhesive dentistry

Welcome to the fourth article in the Vital Guide Series. At the end of the article are some CPD questions, which are designed to get you thinking about the article and to help you remember some of the key points. Here, **Christopher Lynch**[1] explains contemporary adhesive dental techniques and their application.

Introduction

Of the many recent developments in dentistry, perhaps one of the most revolutionary has been in the practical applications of adhesive dentistry. The term 'adhesive dentistry' refers to dental procedures and techniques that do not depend on traditional mechanical factors for retention, but rather 'adhere' to tooth substance. Examples include the placement of composite resin restorations, composite and porcelain veneers, and resin-bonded bridgework.

The success of adhesive dental techniques depends on establishing some form of a 'bond' or 'adhesion' between the restorative material and underlying tooth substance. An example of this is when placing composite resin in a cavity following the removal of caries. The placement of 'traditional' restorative materials, such as amalgam, would require the removal of healthy tooth substance to create undercuts which provide mechanical retention. This is not necessary when placing an 'adhesive' restoration, as it does not depend on mechanical undercuts for retention. This has clear implications for the longevity of the tooth itself, as the amount of healthy tooth substance lost is reduced. Similarly the restoration of worn and fractured teeth with composite resin, porcelain veneers, or dentine-bonded crowns, rather than the use of traditional full-coverage crowns with deep retentive preparations, can reduce the chances of damage to pulpal tissues.

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What forms of adhesive restorations are available in dentistry?

Available forms of adhesive dentistry can be broadly considered to be adhesive restorative materials and adhesive luting cements.

'Adhesive' restorative materials

Examples of these include composite resin and glass-ionomer cement. Both of these may be used as an intra-coronal restoration following the removal of caries, though composite resin, being more resistant to wear, is better suited to restoring occlusal cavities. Composite resin may also be used as an extra-coronal restoration when restoring fractured, worn or discoloured teeth, examples being composite resin 'build-ups', or composite resin veneers, as well as for splinting reimplanted or luxated teeth.

Cut along the dotted line and keep!

Fig. 1a Minimal cavity preparation for a composite restoration

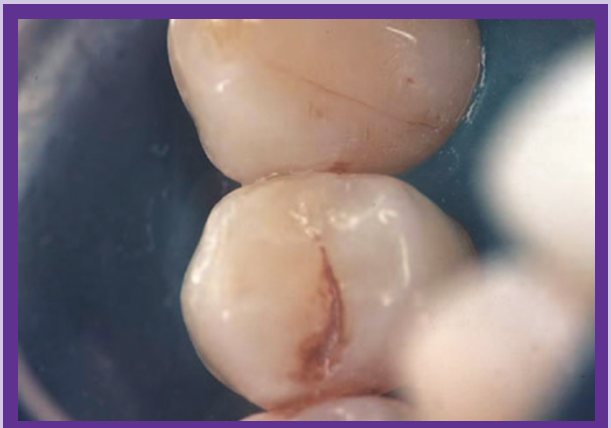

Fig. 1b Placement of composite restoration

'Adhesive' luting cements

Examples of these include those used to retain porcelain veneers and resin-bonded bridgework.

Porcelain veneers are used to restore and improve the appearance of discoloured or misshapen teeth. Prior to the introduction of adhesive dentistry techniques, discoloured maxillary anterior teeth would have been restored using full-coverage crowns, which would have required sacrificing almost 2 mm of healthy tooth substance circumferentially to enhance the physical characteristics, aesthetics, and mechanical retention of the planned crown. In contrast, a porcelain veneer requires removal of as little as 0.5 mm of tooth substance (often just within the enamel without any removal of dentine) from the labial surface of the affected tooth. Using an 'adhesive' luting cement, the veneer can be retained successfully for many years.

Resin-bonded bridgework is a successful means of replacing missing teeth, but usually where this is confined to one unit. Many practitioners prefer to use a cantilever design (ie attaching the bridge to only one abutment tooth). The retainer (often termed a 'wing') is made up from an alloy containing nickel-chromium. The tooth preparation for a resin-bonded bridge is quite conservative, and is confined to the palatal surfaces of the abutment teeth. It requires approximately 0.5-0.8 mm of palatal tooth reduction, though this can be reduced when the occlusal clearance is greater than normal, as would occur where there is an anterior open-bite or missing opposing tooth. Retention is achieved by using a special luting cement that forms a bond between the underlying tooth and metal alloy in the retainer.

How do adhesive restorative materials and luting cements work?

There are two main means by which adhesive restorative materials and luting cements 'stick' to a tooth. They can be considered as:

- **Micromechanical retention**, where the surface of the prepared tooth is 'roughened' and the restorative material engages in the created pits and crevices by means of retentive tags
- **True chemical adhesion**, where the restorative material or luting cement forms true chemical bonds with the tooth substance.

It is also important to understand what parts of the teeth adhesive techniques 'stick' to. The external surface of the tooth, enamel, is mainly inorganic (ie without organic substances). Enamel at a microscopic level is composed of millions of prisms that stick together, and run outwards from the dentino-enamel junction (DEJ) to the external surface of the tooth (think of millions of 'Toblerone' bars running outwards from the DEJ to the surface of the tooth). In contrast, dentine has much more organic material. It is composed of millions of dentinal tubules that contain odontoblast extensions (extensions of tissue cells from the pulp), and tissue fluid. To visualise dentine, it is best to imagine a block of Swiss cheese. The dentinal tubules are the 'holes' in the Swiss cheese, and the material in between is dentine, containing much more organic material that enamel. It contains proteins such as collagen.

> 'To visualise dentine, it is best to imagine a block of Swiss cheese...'

Enamel bonding

When adhesive dentistry techniques were being developed, bonding to enamel ('enamel bonding') was far more successful than bonding to dentine ('dentine bonding'). Bonding to enamel is achieved as follows:

1. The cut enamel surface is etched by covering with 37% phosphoric acid (applied as a gel or liquid) for 30-40 seconds. This dissolves the underlying enamel prisms, but not all at the same rate. Some prisms are dissolved more quickly than others, effectively creating a roughened surface, with deep pits from where enamel has been dissolved. The phosphoric acid is then washed away, and the surface dried. This produces the familiar 'frosted' appearance to enamel.
2. A 'primer' is then applied to the etched enamel surface. The purpose of this is to make it easier for the bonding resin (which is applied subsequently) to flow into the roughened enamel pits.

Fig. 2a This elderly patient presented with missing teeth and extensive tooth surface loss

Fig. 2b The patient was restored using removable partial dentures and composite build-ups. In previous times, this patient would have required root canal treatments, periodontal surgery and post-retained crowns to produce a similar result.

3. A 'bonding' resin is then applied. This is a dilute (or 'runny') form of the composite resin that will be used to restore the cavity. It flows into the etched enamel surface and is set when a curing light is shone on the resin (the bonding resin contains millions of tiny molecules, called monomers, which when exposed to the curing light link together in a chain called polymers). These now form millions of minute resin tags, which will retain eventual filling at a micromechanical level.

The composite resin material is then placed in the cavity and being the same material as the bonding resin, sticks to it. The composite resin restoration is thus retained by micromechanical retentive means.

Dentine bonding

In the early years of adhesive dentistry an effective bond to dentine was difficult to achieve. Over the past few years, the technology behind dentine bonding has improved. Dentine bonding occurs by a similar principle to enamel bonding:

- The cut dentine surface is etched (though for a much shorter time than enamel — it has less inorganic material); this removes debris from the opening of the dentinal tubules (remember the Swiss cheese)
- A primer is applied, which will help the bonding resin to flow. It also prepares and encourages proteins found in dentine to form chemical links with the bonding resin
- The bonding resin is then applied; it enters the dentinal tubules forming resin tags (micromechanical retention), but is also thought to form chemical links with the dentinal proteins (chemical linkages).

As the precise handling characteristics of the various bonding systems vary between companies, it is essential that dental staff follow the manufacturers' instructions exactly with regard to length of time for applying each step, whether a curing light should be used, and whether each agent should be washed, dried, or both. As little as 10 years ago, the etch, primer, and bonding agent existed as three separate steps. Around that time, combined primer and bonding agents were produced, thereby reducing the number of steps involved in placing composite resin restorations, and reducing the time required to place composite resin restorations. In the last five years, combined etch, prime and bonding systems (or 'self-etching' systems) have been introduced. These again reduce the number of steps as well as the time required for placing composite resin restorations.

'Glass-ionomer cement is an exciting prospect, as it prevents bacteria from getting between the filling and the tooth.'

Cementing veneers and resin bonded bridgework

When 'bonding' porcelain veneers to a tooth, an etch, prime, and bond system is used to prepare the tooth surface; the fitting surface of the porcelain veneer is roughened using a strong acid, and a special luting cement, often containing silane is applied to link the treated tooth surface to the treated fitting surface of the veneer. When fitting a resin-bonded bridge, the surface of the tooth is treated as above, but the fitting surface of the metal wing is abraded using aluminium oxide (using a 'sand-blaster') and a luting cement is used which links with the applied bonding agent on the tooth surface and metal ions on the fitting surface of the metal wing.

Glass-ionomer cement is thought to chemically adhere to dentine by forming chemical bonds with proteins within the dentine. This is an exciting prospect, as it prevents bacteria from getting between the filling and the tooth. Glass-ionomer cement also releases fluoride, further preventing decay.

Cut along the dotted line and keep!

Fig. 3a This young patient presented complaining of poor appearance of her upper incisor teeth

Fig. 3b The patient's appearance was dramatically improved using porcelain veneers on both these teeth

When should adhesive dentistry be used?

Adhesive dental techniques are ideally suited for patients with minimal dental caries, intact teeth, and a controlled diet. An example is a patient who has a congenitally absent maxillary lateral incisor and the rest of their teeth are caries-free. The damage to the patient's adjacent natural teeth would be significant if a conventional bridge were to be provided. In contrast, a resin-bonded bridge with minimal preparation to one of the adjacent natural teeth will cause little damage while achieving the same aesthetic result.

When restoring discoloured teeth that are caries-free, again the use of full-coverage crowns would cause far more damage to these teeth than the use of porcelain veneers, which involve removal of minimal tooth tissue.

When restoring cavities in both anterior and posterior teeth, composite resin can be successfully used and is often requested by patients with high aesthetic demands.

For which situations is adhesive dentistry not suitable?

Adhesive dental techniques are not suitable for patients with uncontrolled dental caries, or a sugar-rich diet, as the chances of the restorations failing due to caries are significant.

Adhesive dental techniques are not suitable for patients who grind their teeth. Restorations such as porcelain veneers or resin bonded bridgework are at greater risk of being dislodged due to high occlusal loading.

Adhesive dental techniques are not suitable in situations where moisture control cannot be achieved, as in patients who are poor co-operators. Moisture contamination of tooth surfaces can result in the bond failing more quickly.

What problems can occur with adhesive dentistry?

The most significant and obvious form of failure of adhesive restorations is loss of retention — the restorations simply 'fall off'. This complication is obvious, occurring when there is total loss of retention. However, there are also situations where there is partial loss of retention — for example where part of a composite filling 'leaks' or where part of a metal wing of a resin-bonded bridge 'leaks'. This complication is less obvious — it is difficult to detect, but the consequences can be catastrophic — this leaking can allow bacteria to get in between the restoration and tooth, causing decay destroying tooth substance, and ultimately, if undetected, causing the pulp to die, requiring root canal treatment.

Some of the materials and chemicals used, such as the phosphoric acid etch, can cause damage if inappropriately applied to the patient's gums, or if dropped or splashed in the patient's eyes.

> 'The concept of adhesive dentistry has revolutionised contemporary dental practice and has greatly widened the range of treatment options available.'

Conclusion

The concept of adhesive dentistry has revolutionised contemporary dental practice and has greatly widened the range of treatment options available. Adhesive dentistry is a successful form of dental treatment, but as with all treatments, its use in appropriately selected scenarios and patients is critical for its success. There is further scope for development of new and successful forms of treatment in this area in future years.

CPD Answers

Here are the answers to last issue's CPD questions on infection control.

1. Hepatitis is caused by:
   - **A** A bacterium
   - **B** A virus
   - **C** A fungus
   - **D** A prion

   Answer B

2. vCJD is caused by:
   - **A** A bacterium
   - **B** A virus
   - **C** A fungus
   - **D** A prion

   Answer D

3. Who is the most appropriate person to advise on vaccination regimes for dental staff?
   - **A** Dentist
   - **B** General medical practitioner
   - **C** Occupational health physician
   - **D** Maxillofacial surgeon

   Answer C

4. Which of the following is NOT an item of personal protective equipment in the dental surgery?
   - **A** A visor
   - **B** Latex gloves
   - **C** Spectacles
   - **D** An autoclave

   Answer D

Congratulations to the first three correct entries to be drawn from our autumn issue.

They were: Ms Christine Stead from Gravesend, Mrs Seema Shah from Barnet and Mrs Sharon de la Rosa from Javelin Barracks. They all win a copy of the book *Management of medical emergencies for the dental team.*

CPD Questions

In future, *Vital* will be offering verifiable CPD when it becomes mandatory for DCPs in 2008. In the meantime we have provided some CPD style questions for our 'Vital Guide to…' series to encourage you to anticipate future CPD requirements. By way of extra encouragement we are pleased to offer a copy of the *Basic guide to dental instruments* (see review on page 17) to the senders of the first three correct answers to be drawn on 1 February 2007. The answers to the questions will be published in the next issue of *Vital*. After reading the article have a go at the following questions and send in your completed form to us. In the context of this article, only one of the answers to each of the following questions is correct.

1. The term 'adhesive dentistry' refers to:

- **A** The placement of composite veneers
- **B** The placement of resin-bonded bridgework
- **C** Procedures that depend on traditional mechanical factors for retention
- **D** A and B

2. What can composite resin be used for?

- **A** Splinting luxated teeth
- **B** Restoring occlusal cavities
- **C** As an extra-coronal restoration for discoloured teeth
- **D** All of the above

3. Adhesive dentistry CANNOT be used when:

- **A** A patient has broken teeth
- **B** A patient has a controlled diet
- **C** A patient has minimal dental caries
- **D** A patient has a congenitally absent incisor

4. Which one of the following is FALSE?

- **A** Dentinal tubules contain odontoblast extensions
- **B** Enamel is mainly composed of organic substances
- **C** Bonding resin contains millions of monomers
- **D** Self-etching systems have recently been introduced

CPD Answer form

Please **PRINT** your details below:

Title

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Postal Code

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Your Work

What is the name of your practice/ CDS/hospital?

What is your job title?

Please **TICK** (✔) the answer to each question

	A	B	C	D
Q.1	☐	☐	☐	☐
Q.2	☐	☐	☐	☐
Q.3	☐	☐	☐	☐
Q.4	☐	☐	☐	☐

☐ *If you prefer not to be contacted for purposes other than this competition, please tick this box. We will not pass your details on to any third parties.*

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