Clinical Evidence for Selection of Materials and Techniques

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October 11, 2007
What decisions must be made by dentists?

- Restoring a class I or II cavity
  - Amalgam?
  - Composite?
  - Compomer?
  - Glass ionomer/composite sandwich?
- What specific material to use?
- What isolation method is best?
- What adhesive to use?
- What base or liner, if any to use?
- What placement methods to use
- What curing methods to use?
Summary

- According to Bogacki et al. (2002) the use of composite has increased and more restorations are place with composite than with amalgam (includes anterior composite)
- Composite restorations outnumber amalgam restorations
From the beginning

• Posterior use – 30 years experience
• Materials problems
  – Rapid loss of material at margins
  – Marginal staining & bulk discoloration
• Dentist difficulties
  – No light-curing
  – Set in 2-3 minutes – had to pack into cavity quickly
  – No specially designed matrix system
• Patient complaints
  – Teeth sensitive
  – Discolored restorations
Rates and causes of restoration failure

• Manhart J & others (2004), Hickel R, Manhart J (2001)
  – 2.2% per year in clinical trials

• Mjör I (2005) and other publications
  – 50% replacements due to secondary caries
  – Median age 6-8 yrs
Restoration survival probability

- Earlier studies showed composite restorations last about half as long as amalgam restorations
- More recent data indicated the difference is minimal
- Bogacki et al. 2002 used insurance claims data to compare survival of composite and amalgam restorations
Posterior composite restorations failures

- Brunthaler et al. (2003)
  - Bulk fracture most common reason for failure for periods up to 5 years
    - 1 to 14% - most below 5%
    - 14% was Solitaire
  - Secondary caries most common reason for failure periods beyond 5 years
    - 3 to 16%
    - Higher percentage for longer observation periods
  - Failures due to pain
    - Most 2 to 8%
    - One was 15% due to biting pain
    - Only 5 of 24 studies reported failures due to pain
Does initial marginal quality have anything to do with clinical longevity?

- Our notions of marginal quality derive from traditional operative dentistry criteria.
- Outcome criteria for clinical evaluation derive from these traditional notions of quality dentistry.
- Why would we expect criteria used to grade restoration placement performance are correct for evaluation of clinical performance?
Does initial marginal quality have anything to do with clinical longevity?

- Gaps, excess material, or chips/fractures can only be viewed or detected by explorer at the junction line.
- This represents only a small percentage of the restoration contact with tooth structure.
- Marginal quality evaluation does not include monitoring of bacteria.
Does initial marginal quality have anything to do with clinical longevity?

• Clinical evaluation process usually begins after the restoration is placed.
• What about information on the restoration process?
• What about the decision matrix that guided the decision to restore the tooth in the first place?
  – Patient’s caries risk
  – Dentist experience and ability
Clinical Evaluation Using Modified USPHS Criteria

- Surface
- Color
- Anatomical Form
  - Occlusal Contours
  - Proximal Contact
  - Retention
- Marginal Integrity
  - Visual
  - Tactile
  - Discoloration
  - Caries
- First Week Sensitivity (Y/N)
- Sensitivity to Air Blast (0-10) at Recall
Challenges with scoring marginal integrity

- Is it only a gap?
- Is it only stained?
- Gap plus stain tends to be scored as secondary caries
- Tendency for bias toward declaring secondary caries
Secondary caries process

Sensitivity and specificity of secondary caries diagnosis is poor

- Visual and explorer examination of restorations in extracted teeth
- Restorations removed to assess for true secondary caries
Prediction of secondary caries

- Compared margins of tooth-colored restorations with staining, stained dentin visible through enamel, ditching, and frank secondary caries
- Measured bacterial composition of plaque at the margin and in underlying dentin at the DEJ after removing the restorative materials
- Assessed the presence of hard or soft dentin at the DEJ
Prediction of secondary caries

• 79.5% of soft dentin areas were below stained margins
• But, 55.5% of hard dentin areas were below stained margins
• After excluding sites with frank carious lesions, only 38 of 167 sites contained soft dentin
• Except for the presence of a frank carious lesion, none of the clinical indicators evaluated could predict the presence of soft dentin
Prediction of secondary caries

- Significant associations were found between the marginal plaque and the underlying dentin
- More bacteria were present in the marginal plaque of frank secondary caries compared with sites with no outer lesion
- More bacteria present in marginal plaque over sites with soft dentin compared with hard dentin.
Marginal gaps and secondary caries

- Increasing likelihood of secondary caries with increasing size of marginal gap
- Oral hygiene also a significant factor in likelihood for secondary caries
- For some sites, oral hygiene effect was more pronounced
Marginal gaps and secondary caries

- Marginal deterioration not associated with restoration replacement rates
Marginal gaps and secondary caries

- No statistical difference in gap size for secondary caries free sites vs. true caries sites
Marginal gaps and secondary caries

  - Only gaps > 4 mm resulted in increased bacteria in the underlying dentin
  - Frank carious lesions had similar levels of bacteria to wide gaps, however the *s. mutans* levels were greater

  - Micromorphological evaluation of posterior composite restorations
  - Concluded that imperfections in marginal integrity do not contribute to increased secondary caries risk
Polymerization Shrinkage – Important but

• Much studied “problem”
  – 609 publications in PubMed on May 31, 2004
  – 704 on February 22, 2006
  – [dental AND (composite OR resin) AND (shrink* OR contract*)]

• “Problems” blamed on polymerization shrinkage
  – Secondary caries
  – Pain
  – Fractured teeth
Polymerization Shrinkage

• The simple model on secondary caries
  – Shrinkage > loss of adhesion > marginal and interfacial gaps
    > bacteria being allowed in > secondary caries

• Secondary caries – what do the clinical studies tell us?
  – Brunthaler et al. (2003) found secondary caries most common reason for failure beyond 5 years
  – Practice-based studies found secondary caries the most common reason for failure and accounts for 30% to 60% of all replaced restorations
  – No strong evidence of difference between composite and amalgam restorations

• Eliminate shrinkage and you eliminate secondary caries – simple right?
Polymerization Shrinkage

• Why things are not this simple
  – Modern understanding of caries risk points to the patient as the main factor in secondary caries
    ▪ Bacteria strength
    ▪ Diet – carbs
    ▪ Fluoride exposure

• Developing composites with anticariogenic activity will be more effective in decreasing secondary caries than will developing non-shrinking composites
Tooth sensitivity

- Polymerization shrinkage was once thought to be a source of pain due to gaps and microleakage or cuspal deflection
  - Opdam and others (1998)
  - No evidence of relationship between marginal gaps, microleakage, and sensitivity
- Failure of dentin bonding system to create hybridized dentin and block dentinal tubules appears to be true cause
  - No increase in post-operative sensitivity or need to replace restorations that were bulk-cured
Does initial marginal quality have anything to do with clinical longevity?

• No strong evidence you can predict the clinical outcome of a restoration based on traditional margin quality evaluations
  – Limited evidence margin quality promotes secondary caries
  – No evidence margin quality affects post-operative sensitivity
Does initial marginal quality have anything to do with clinical longevity?

• There is evidence that failures due to secondary caries are strongly related to bacterial counts, oral hygiene

• There is evidence that we as dentist have poor diagnostic tools to assess the need to replace/repair restorations except in the case of frank carious lesions at the margin
Does initial marginal quality have anything to do with clinical longevity?

• Current clinical evaluation criteria for marginal integrity lack the ability to predict future risk for the need for intervention
  – Replacement
  – Repair
Anticariogenic Composites – Desired properties

- Inhibit plaque collection
- Inhibit caries producing bacterial growth
- Mitigate pH drops
Key Factors for Success with Posterior Composite Restorations

• Conserve tooth structure
  – caries risk assessment
  – focus on caries removal

• Controlling the operating environment
  – tissue management

• Understanding how to achieve quality bonding

• Composite placement technique
  – void free placement
  – anatomical buildup to avoid carving

• Maximum curing of composite
Sources of variability in clinical outcomes

• Materials Properties
• Dentist
• Patient
### Posterior composite materials – ADA

**Professional Products Review Vol. 1, Issue 1**

<table>
<thead>
<tr>
<th>Product</th>
<th>Filler</th>
<th>Particle Size</th>
<th>Volume Fraction (%)</th>
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</thead>
<tbody>
<tr>
<td>Aelite LS Posterior</td>
<td>Silica, strontium glass</td>
<td>0.05-4 μm</td>
<td>74</td>
</tr>
<tr>
<td>Esthet-X</td>
<td>Barium-fluoro-aluminum-boro-silicate glass</td>
<td>10-20 nm 002-25 μm</td>
<td>60</td>
</tr>
<tr>
<td>Filtek Supreme Plus</td>
<td>Zirconia silica with cluster agglomerates</td>
<td>20-75 nm 06-1.4 μm</td>
<td>595</td>
</tr>
<tr>
<td>Gradia Direct Posterior</td>
<td>Fluoro-alumo-silicate glass, organic filler</td>
<td>0.016-0.16 μm</td>
<td>65</td>
</tr>
<tr>
<td>GrandiO</td>
<td>Silica glass</td>
<td>20-60 nm 0.74 μm</td>
<td>71.4</td>
</tr>
<tr>
<td>Heliomolar HB</td>
<td>Silica, yttrium fluoride and copolymers</td>
<td>0.04-0.2 μm</td>
<td>46</td>
</tr>
<tr>
<td>Herculite XRV</td>
<td>Barium-alumo-boro-silicate glass, colloidal silica</td>
<td>0.6 μm (avg.)</td>
<td>59</td>
</tr>
<tr>
<td>Venus</td>
<td>Silicone dioxide, barium-aluminum-boron-fluoride silica glass</td>
<td>0.01-0.04 μm 0.7-2.0 μm</td>
<td>61</td>
</tr>
</tbody>
</table>
Figure 1. Mean (±SD) Depth of Cure Values.

- Aelite LS Posterior
- Heliomolar HB
- Esthet-X
- Venus
- Gradia Direct Posterior
- Filtek Supreme Plus Universal Restorative
- Grandio
- Herculite XRV

*C Mean values based on n=3 specimens. Vertical black bars designate products that performed equally based on statistical analysis (one-way ANOVA, p > 0.05).
† We used the manufacturer recommended cure time for these products. For Herculite XRV, the recommended curing time was twice that of the other composites (40 vs. 20 seconds).
**Figure 2. Mean (±SD) Flexural Strength.**

<table>
<thead>
<tr>
<th>Material</th>
<th>Strength (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heliomolar HB</td>
<td>100</td>
</tr>
<tr>
<td>Gradia Direct Posterior</td>
<td>95</td>
</tr>
<tr>
<td>Esthet-X</td>
<td>80</td>
</tr>
<tr>
<td>Filtek Supreme Plus</td>
<td>75</td>
</tr>
<tr>
<td>Universal Restorative</td>
<td>70</td>
</tr>
<tr>
<td>Venus</td>
<td>65</td>
</tr>
<tr>
<td>Aelite LS Posterior</td>
<td>60</td>
</tr>
<tr>
<td>GrandiO</td>
<td>55</td>
</tr>
<tr>
<td>Hercule XRV</td>
<td>50</td>
</tr>
</tbody>
</table>

*Mean based on n = 5 specimens. Vertical black bars designate products that performed equally based on statistical analysis (one-way ANOVA, p > 0.05).*

**Figure 3. Mean (±SD) Flexural Modulus.**

<table>
<thead>
<tr>
<th>Material</th>
<th>Modulus (GPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heliomolar HB</td>
<td>1.5</td>
</tr>
<tr>
<td>Gradia Direct Posterior</td>
<td>1.2</td>
</tr>
<tr>
<td>Venus</td>
<td>1.0</td>
</tr>
<tr>
<td>Esthet-X</td>
<td>0.8</td>
</tr>
<tr>
<td>Filtek Supreme Plus</td>
<td>0.6</td>
</tr>
<tr>
<td>Universal Restorative</td>
<td>0.4</td>
</tr>
<tr>
<td>Hercule XRV</td>
<td>0.2</td>
</tr>
<tr>
<td>Aelite LS Posterior</td>
<td>0.1</td>
</tr>
<tr>
<td>GrandiO</td>
<td>0.05</td>
</tr>
</tbody>
</table>

*Mean based on n = 5 specimens. Vertical black bars designate products that performed equally based on statistical analysis (one-way ANOVA, p > 0.05).*

**FLEXURAL STRENGTH & FLEXURAL MODULUS**

*Clinical Significance:* Represents the composite's ability to initially withstand occlusal stress and flex under load, but does not predict resistance to wear or fatigue.

*Results:* We tested five specimens of each brand, and report the mean results in Figures 2 and 3.

*Comments:* Heliomolar HB and Gradia Direct Posterior had lower strengths and stiffness compared with the other brands. By contrast, the stiffness of GrandiO was significantly higher than any of the other brands. The ISO requires that posterior, light-cured materials have a minimum flexural strength of 80 MPa. There is no established minimum value for flexural modulus.
Figure 4. Mean (±SD) Radiopacity.

- Human Dentin
- Human Enamel
- Aelite LS Posterior
- Gradia Direct Posterior
- Herculite XRV
- Venus
- Filtek Supreme Plus
- Universal Restorative
- Grandio
- Esthet-X
- Heliomolar HB

* Mean based on n = 3 specimens. Vertical black bars designate products that performed equally based on statistical analysis (one-way ANOVA, p > 0.05).
† Radiopacities for human dentin and enamel are from Attar et al. VCU Medical Center
POLYMERIZATION SHRINKAGE STRESS & STRESS RATE

Clinical Significance: Indicates the amount of shrinkage for one hour after polymerization and the rate of stress development the adhesive would be subjected to during this time. Theoretically, a lower maximum shrinkage stress and a slower rate of stress development would be advantageous to maintain marginal integrity, prevent microleakage, and may limit post-operative sensitivity.
Practitioner Input

Through a web-based survey, we collected input from 413 dentists about the posterior composites they use.
Slide 38

Dentists, Educators Discuss Posterior Composites

**Abstract**

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Atlanta, Georgia, Professor of Operative Dentistry
Department of Restorative Dentistry
Oregon Health & Science University School of Dentistry

**Participants**

- Jack Forgione, PhD
  Dentistry, Department of Biomaterials and Biomechanics
  Oregon Health & Science University School of Dentistry

- William Lebowitz, DDS, MS
  Professor of Operative Dentistry
  Oregon Health & Science University School of Dentistry

- David G. Conner, DDS, MS
  Professor of Dentistry
  Associate Vice President for Health Science – Academic Affairs
  Virginia Commonwealth University School of Dentistry
  Editor, ADA Professional Product Review

- Edward J. Smidt Jr., DDS
  Professor and Chief Operative Dentistry
  University of North Carolina School of Dentistry

**Discuss:** What are the current consensus and indications for posterior composite use? Are we at the point where we consider composite to be an analog replacement?

**Participants:** We don’t know whether we will use the same form of posterior composites as we do with amalgams. There’s definitely some arguments of composite vs. amalgam in all situations except where is a metal cavity restorations.

**Moderator:** The most important factor in the selection of composites is the patient’s needs. Composites are more malleable, and they can be used in situations where traditional amalgam might be less than ideal.

**Dentist:** Can posterior composites be used to repair a tooth that has a metal crown? In particular, can you do an intracoronal restoration and use a composite between the tooth and the intracoronal material to build up for the long term, and we don’t go to a crown and1 composite to build up for the long term?

**Moderator:** That is essentially the limitation of the technique. The bonding is probably a factor with composite restorations. This may be the solution for a Class III or V restoration, but we should be careful to ensure that the restoration will hold up as well as a metal restoration of the same design.

**Dentist:** I saw a bond test intracoronal restoration in a cracked tooth as a temporary; I think there’s a lot of similarities to that bonded restoration. I think it’s a good technique, and we need to go to a composite between the tooth and the intracoronal material to build up for the long term, and we don’t go to a crown.

**Moderator:** There is evidence that bonded restorations are more predictable than amalgam restorations. The bonding is probably the key reason why bonded restorations are so attractive.

**Dentist:** The intracoronal/bond is not an option, but it’s a non-invasive treatment for posterior composites.

**Participants:** I think that’s probably more of a problem with posterior composites than with other posterior restorations.

**Dentist:** For my clinical impressions, we do more secondary cases and associated with more anomalies, and it needs to be more sensitive.

**Moderator:** I think that the secondary case is a little more complex when the adhesive system is used, and we need to be more careful with the technique.

**Dentist:** What do you think about the technique of using secondary cases? When the adhesive systems are used, we need to be more careful with the technique, and we need to be more sensitive towards the secondary case.

**Moderator:** I think that’s probably more of a problem with posterior composites than with other posterior restorations.

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The Dentist

- Brunthaler et al. (2003)
  - No influence of status of operator on failure rate
    - University
    - Practice
  - No influence of isolation techniques
    - Cotton rolls
    - Rubber dam
  - Conclusion limited by the study descriptions
The Dentist

• Söderholm et al. (2001)
  – Wear study at two clinical sites
  – Randomized controlled double blinded study
  – 8 experimental materials
  – 2 dentist
    ▪ Significant differences in wear rates
    ▪ Cutting instruments
    ▪ Anatomical carving style
    ▪ Handpieces
The Dentist

• Limited data on effects of the dentist
  – Standardized clinical studies vs. practice-based research
• Is intuitive dentist would have some affect
• Areas to work on
  – Easier void free placement
  – Decreased moisture sensitivity
  – Improved carving and shaping ability prior to curing
  – Decrease cure variability
Dentist’s decisions are influenced by many factors

- Education
- Comfort zone – complexity of systems
- Time
- Fee potential
- Advertising myths
- Science knowledge
- Opinion leaders
- Anecdotal experiences
- No generally agreed upon algorithms or practice guidelines
- Few agreed upon clinical facts

Recent research symposium on “Status of Laboratory Studies for Predicting Clinical Behavior” concluded little value beyond being screening tests for very poor materials.
The Patient

- Unknown and unquantifiable factors
- Dentist will tell you the patient is most important factor in success or failure
- Söderholm et al. (2001)
  - Significant differences in two clinical sites
- Possible factors
  - Occlusal bite forces, parafunctional habits
  - Salivary composition –enzymes, plaque acids
  - Dietary factors –hardness and abrasiveness, foods & beverages that act as solvents - ethanol
Clinical Evidence vs. In vitro

- Predicting clinical performance from laboratory studies is limited if not irrelevant
- Clinical success or failure does not follow any basic materials properties
- So what do we know from clinical studies?
How was this review performed?

- A search of PubMed was completed on January 24, 2007 using the following search string: clinical AND (performance OR evaluation OR trial) AND (posterior OR class II OR stress-bearing OR occlusal) AND composite
- Generated 699 references
- Titles reviewed to eliminate
  - In vitro only studies
  - Studies on deciduous teeth
  - Clearly unrelated studies
- Reduced list to 347 references
How was this review performed?

- The abstracts were read to find studies that evaluated clinical performance
  - Types of materials
  - Clinical techniques
  - Patient characteristics
  - Operator characteristics
- Only publications from 2000 on were considered
  - To include primarily materials marketed in past ten years which have been shown to perform better
  - Not include bias caused by poor training in posterior composite restorations before the mid to late 1990s
- 85 papers describing 73 studies were included
- Other review articles were included
Here are the clinical questions for which data were found in the literature

<table>
<thead>
<tr>
<th>Clinical Variable Tested</th>
<th>Number of Studies</th>
</tr>
</thead>
<tbody>
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<td>Isolation method</td>
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<td>Light-curing modes</td>
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<tr>
<td>Location of composite restorations</td>
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<td>Matrix type</td>
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<td>Nanofilled composite materials</td>
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<tr>
<td>Operator variability</td>
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<tr>
<td>Ormocer materials</td>
<td>2</td>
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<tr>
<td>Packable composite materials</td>
<td>11</td>
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<tr>
<td>Preventive resin restoration of occlusal grooves</td>
<td>2</td>
</tr>
<tr>
<td>Pulp pathology</td>
<td>1</td>
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<tr>
<td>Sandwich restorations – composite/glass ionomer/compomer</td>
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<tr>
<td>Self-etching adhesives</td>
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<tr>
<td>Slot cavity preparation</td>
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</tr>
<tr>
<td>Solitaire composite material</td>
<td>1</td>
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<tr>
<td>Tunnel restorations</td>
<td>3</td>
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</tbody>
</table>
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<thead>
<tr>
<th>Clinical Variable Tested</th>
<th>Number of Studies</th>
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</thead>
<tbody>
<tr>
<td>Adhesive steps – number used</td>
<td>1</td>
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<tr>
<td>Ariston pHc – pH control material</td>
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<td>Bacteria relationships</td>
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<tr>
<td>Bulk-curing</td>
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<tr>
<td>Calcium aluminate cement materials</td>
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<tr>
<td>Cavity size</td>
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<td>Compomer materials</td>
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<td>Cracked Teeth – restoring with composite</td>
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<td>Dentin pretreatment</td>
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<td>Direct vs. indirect composite restorations</td>
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<td>Endodontically treated teeth – restoring with composite</td>
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<td>Flowable composite liner use</td>
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<td>Giomer – fluoride containing glass</td>
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<td>Glass fibers containing composites</td>
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<td>Hypomineralized teeth – restoring with composite</td>
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Annual failure rates of posterior stress-bearing restorations (Manhart et al. 2004) can be used as benchmarks

<table>
<thead>
<tr>
<th>Material</th>
<th>Annual Failure Rate</th>
<th>Study Length</th>
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<tbody>
<tr>
<td>Amalgam</td>
<td>3.0%</td>
<td>3-20</td>
</tr>
<tr>
<td>Direct Composite</td>
<td>2.2%</td>
<td>2-17</td>
</tr>
<tr>
<td>Compomers</td>
<td>1.1%</td>
<td>1-3</td>
</tr>
<tr>
<td>Glass Ionomer</td>
<td>7.2%</td>
<td>3-5</td>
</tr>
<tr>
<td>Tunnel GI</td>
<td>7.1%</td>
<td>3-7</td>
</tr>
<tr>
<td>Composite inlay/onlay</td>
<td>2.9%</td>
<td>2-11</td>
</tr>
<tr>
<td>Ceramic inlay/onlay</td>
<td>1.9%</td>
<td>2-11.5</td>
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<tr>
<td>Cast Gold inlay/onlay</td>
<td>1.4%</td>
<td>2-25</td>
</tr>
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</table>
Key Factors for Success

• Conserve tooth structure
  – caries risk assessment
  – focus on caries removal
• Controlling the operating environment
  – tissue management
• Understanding how to achieve quality bonding
• Composite placement technique
  – void free placement
  – anatomical buildup to avoid carving
• Maximum curing of composite
Key Thought

Composite is not a substitute for other restorative materials
Fluoride effect has created a new restorative challenge for pit & fissure caries.

Dentin that is carious with barely no evidence of caries in the enamel.
Which molar has the greatest amount of dentinal carious involvement?
Now look at the completed caries excavation.
Use 1/4 and 1/2 round burs to determine the extent and depth of the caries.
It is not matter of esthetics to choose composite. Composite is better than any other restorative material for these situations.
Flowable Composite Uses

• Preventive Resin Restorations (PRR)
• Class I and II initial restorative layer
• Pit & Fissure sealant

• Restoring tunnel preparations
• Seal implant screws
• Undercut block out
• Porcelain repair
Fractured distolingual cusp on caries free tooth

Conserving tooth structure

Tissue management
Flowable composite placed for control and to insure adaptation

Quality bonding

Void free placement
Composite placed to restore anatomy

Anatomical buildup and maximum curing
Flowable composite use (3 studies)

• Lindberg et al. (2005)
  – Compared interfacial adaptation in class II restorations in premolars scheduled for extraction
  – Half used flowable composite, half w/o
  – Three curing modes
    ▪ Soft start
    ▪ 500 mW/cm² continuous
    ▪ 700 mW/cm² continuous
  – Use of flowable composite was not significantly different
  – No significant difference among curing modes
Flowable composite use (3 studies)

- Efes et al. (2006) – 2 year study
  - Pairs of occlusal restorations in 54 patients
    - Composite or ormocer used
    - One of each pair used flowable composite
  - One failed restoration overall
  - No significant differences between restorative materials
  - No significant difference with flowable use

- Ernst et al. (2003) – 2 year study
  - Prodigy condensable composite w/ and w/o flowable composite liner in 116 class II restorations
  - 50 patients with pairs of restorations
  - GI base used 36%
  - No significant difference with flowable use
  - Failure rates
    - w/ flowable 7.2% (3.6% annual)
    - w/o flowable 5.4% (2.7% annual)
Does the use of flowable composite used as a liner improve clinical performance?

- One clinical study on internal adaptation showed no difference.
- Two studies of two-year length showed no differences.
- In the short-term, it does not appear to have any affect.
Experienced teeth simply wearing out!
Crowns are not always the answer
Use combination of flowable composite and hybrid composite
Combination of flowable composite and hybrid composite
Maintain marginal and transverse ridges when possible to conserve tooth strength.
Micro cavity preparation
Key Factors for Success

• Conserve tooth structure
  – caries risk assessment
  – focus on caries removal
• Controlling the operating environment
  – tissue management
• Understanding how to achieve quality bonding
• Composite placement technique
  – void free placement
  – anatomical buildup to avoid carving
• Maximum curing of composite
Controlling the Operating Environment

- Astringedent
  - Ultradent
- Retraction cord
  - Ultrapak
- Rubber dam
Controlling the Operating Environment

- Tissue removal with bur in high speed with water coolant
- Astringedent
  - rub with pressure
Isolation method (3 studies)

- Raskin et al. (2000) – 10 year study
  - Compared rubber dam use to cotton roll isolation
  - 37 restorations
  - Both methods proved satisfactory

- Whitworth et al. (2005)
  - Evaluated amalgam and composite restorations for outcome of pulp pathology
    - Adhesive dentin sealing vs. CaOH liner
    - Rubber dam vs. no rubber dam
  - Composite had higher odds (2.1) of a negative pulp outcome compared with amalgam
  - No significant effect of use of CaOH liner
  - No significant effect of rubber dam use
Isolation method (3 studies)

- Huth et al. (2003) – 4 year study
  - Study of clinical performance of Hytac compomer
  - No difference in isolation methods

- Brunthaler et al. (2003) – Review
  - Longevity of direct composite restorations
  - 1-17 year studies
  - Failure rates not significantly different
    - w/ rubber dam 9.6 to 27.6%
    - w/o rubber dam 0 to 27.3%
Does rubber dam use enhance longevity of posterior composite restorations?

- Data are limited but point to no difference
- The assumption is no rubber dam use means excellent use of cotton and suction
Success with posterior composites requires attention to detail.
Key Factors for Success

• Conserve tooth structure
  – caries risk assessment
  – focus on caries removal

• Controlling the operating environment
  – tissue management

• **Understanding how to achieve quality bonding**

• Composite placement technique
  – void free placement
  – anatomical buildup to avoid carving

• Maximum curing of composite
Enamel and Dentin Bonding

- M. Buonocore
  JDR 1955:
  Simple method to increase retention of resin restorations
  - 85% phosphoric acid
  - 60 seconds
Dentin Smear Layer

- 10-15 µ thick
- Melted and fractured tooth substances
- Bacteria
- Blood
- Saliva
Dentinal Tubules

• 1 µ near the DEJ
• 2.5 µ near the pulp
• Become smaller with age - sclerosis
• Bonding better near the DEJ because more intertubular dentin is present
Priming

- Displacement of water from etched enamel and dentin
- Resin impregnation of enamel and demineralized dentin collagen
- Penetration of dentinal tubules
Critical Steps in Using Adhesives

• Isolation

• Etching with 35% phosphoric acid
  – Begin on enamel,
  – Move to dentin, 15 s on dentin

• Wet bonding surface
  – Wet surface critical for acetone based primers
  – Water and ethanol based primers less technique sensitive

• Primer application
  – If surface is wet, time for evaporation of water needed
  – If surface is dry, time for rehydration of collagen needed

• Adhesive application
  – Brush or applicator, no excessive air thinning - 100µm layer
Total-etch and self-etching adhesive systems

• **Total-etch** – phosphoric acid conditioning
  – 3 steps: etch, primer, resin adhesive
  – 2 steps: etch, single primer/resin adhesive

• **Self-etch** – conditioner with adhesive
  – 2 steps: self-etch primer, resin adhesive
  – 1 step: etch, primer, resin adhesive all-in-one

<table>
<thead>
<tr>
<th>Adper Prompt L-Pop Self-Etch Adhesive</th>
<th>CLEARFIL SE BOND</th>
<th>Nano-Bond</th>
<th>Simplicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>3M ESPE</td>
<td>Kuraray</td>
<td>Pentron Clinical Technologies</td>
<td>Apex Dental Materials, Inc.</td>
</tr>
<tr>
<td>800-634-2249</td>
<td>800-879-1676</td>
<td>800-243-3969</td>
<td>877-273-9123</td>
</tr>
<tr>
<td>Brush&amp;Bond</td>
<td>GC G-Bond</td>
<td>ONE-STEP PLUS</td>
<td>Xeno IV</td>
</tr>
<tr>
<td>Parkell, Inc.</td>
<td>GC America</td>
<td>Bisco</td>
<td>DENTSPLY Caulk</td>
</tr>
<tr>
<td>800-243-7446</td>
<td>800-323-7063</td>
<td>800-247-3368</td>
<td>800-532-2855</td>
</tr>
<tr>
<td>IBond</td>
<td>Heraeus Kulzer</td>
<td>OptiBond Solo Plus</td>
<td>Kerr Corp.</td>
</tr>
<tr>
<td></td>
<td>800-431-1785</td>
<td></td>
<td>800-537-7123</td>
</tr>
<tr>
<td></td>
<td><a href="http://www.heraeus-kulzer-us.com">www.heraeus-kulzer-us.com</a></td>
<td></td>
<td><a href="http://www.kerrdental.com">www.kerrdental.com</a></td>
</tr>
</tbody>
</table>

VCU Medical Center
<table>
<thead>
<tr>
<th>Product</th>
<th>Components (no.)</th>
<th>Steps (no.)</th>
<th>Unit Dose Available</th>
<th>Filler Amount</th>
<th>Shelf Life (mos.)*</th>
<th>Cost/ml†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adper Prompt L-Pop</td>
<td>Two compartments</td>
<td>One (mix and use)</td>
<td>Yes</td>
<td>None</td>
<td>24</td>
<td>$17</td>
</tr>
<tr>
<td>Brush&amp;Bond</td>
<td>One bottle Initiator-Impregnated Microbrushes</td>
<td>One</td>
<td>No</td>
<td>None</td>
<td>36</td>
<td>$20 ($.05/ Microbrush)</td>
</tr>
<tr>
<td>CLEARFIL SE BOND</td>
<td>Two bottles (one primer, one adhesive)</td>
<td>Two</td>
<td>No</td>
<td>10%</td>
<td>24</td>
<td>$13</td>
</tr>
<tr>
<td>GC G-Bond</td>
<td>One bottle</td>
<td>One</td>
<td>Yes</td>
<td>5%</td>
<td>24</td>
<td>$22 (unit dose: $32)</td>
</tr>
<tr>
<td>iBond</td>
<td>One bottle</td>
<td>One</td>
<td>Yes</td>
<td>None</td>
<td>28</td>
<td>$30 (unit dose: $4)</td>
</tr>
<tr>
<td>Nano-Bond</td>
<td>Two bottles (one primer, one adhesive)</td>
<td>Two</td>
<td>No</td>
<td>&lt; 5%</td>
<td>24</td>
<td>Primer: $5  Adhesive: $10</td>
</tr>
<tr>
<td>Simplicity</td>
<td>Two bottles (one primer, one adhesive)</td>
<td>Two</td>
<td>No</td>
<td>None</td>
<td>18</td>
<td>$8</td>
</tr>
<tr>
<td>Xeno IV</td>
<td>One bottle</td>
<td>One</td>
<td>No</td>
<td>None</td>
<td>36</td>
<td>$28</td>
</tr>
<tr>
<td>ONE-STEP PLUS</td>
<td>Etchant plus one bottle</td>
<td>Two</td>
<td>No</td>
<td>8.5%</td>
<td>24</td>
<td>$15</td>
</tr>
<tr>
<td>OptiBond SOLO Plus</td>
<td>Etchant plus one bottle (one bottle for direct restorations and veneers; two bottles for indirect restorations)</td>
<td>Two</td>
<td>No</td>
<td>15%</td>
<td>24</td>
<td>$24</td>
</tr>
</tbody>
</table>

* From date of manufacture.
† MSRP: Actual retail price may vary.
### Figure 1. Shear Bond Strength of Tested Bonding Agents on Human Dentin.

<table>
<thead>
<tr>
<th>Nano-Bond</th>
<th>iBond</th>
<th>CLEARFIL SE BOND</th>
<th>ONE-STEP PLUS*</th>
<th>OptiBond Solo Plus*</th>
<th>Simplicity</th>
<th>Xeno IV</th>
<th>Adper Prompt L-Pop</th>
<th>GC G-Bond</th>
<th>Brush&amp;Bond</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="chart1.png" alt="Bond Strength Chart" /></td>
<td><img src="chart2.png" alt="Bond Strength Chart" /></td>
<td><img src="chart3.png" alt="Bond Strength Chart" /></td>
<td><img src="chart4.png" alt="Bond Strength Chart" /></td>
<td><img src="chart5.png" alt="Bond Strength Chart" /></td>
<td><img src="chart6.png" alt="Bond Strength Chart" /></td>
<td><img src="chart7.png" alt="Bond Strength Chart" /></td>
<td><img src="chart8.png" alt="Bond Strength Chart" /></td>
<td><img src="chart9.png" alt="Bond Strength Chart" /></td>
<td><img src="chart10.png" alt="Bond Strength Chart" /></td>
</tr>
</tbody>
</table>

*One-Step Plus and OptiBond Solo Plus are total-etch systems; the other products are self-etch.

### Reader Tip: Experts suggest that 20 MPa represents a minimum acceptable value for dentin shear bond strength. At least some specimens of each brand we tested, except Adper Prompt L-Pop and Nano-Bond, achieved that value. But notice the wide range of results for each product, including the length of the whiskers and the degree of their overlap. This variability makes it difficult to judge performance differences between most of the products (although Nano-Bond clearly performed poorly in our test). *Editor's Note:* After receiving the results of our laboratory evaluation, the makers of Nano-Bond (Pentron Clinical Technologies) informed us that the system has been modified to enhance bond strength for improved performance. Since we have not tested the reformulated product, we cannot comment.

### Figure 2. Shear Bond Strength of Tested Bonding Agents on Bovine Enamel.

<table>
<thead>
<tr>
<th>Nano-Bond</th>
<th>iBond</th>
<th>CLEARFIL SE BOND</th>
<th>ONE-STEP PLUS*</th>
<th>OptiBond Solo Plus*</th>
<th>Simplicity</th>
<th>Xeno IV</th>
<th>Adper Prompt L-Pop</th>
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<td><img src="chart5.png" alt="Bond Strength Chart" /></td>
<td><img src="chart6.png" alt="Bond Strength Chart" /></td>
<td><img src="chart7.png" alt="Bond Strength Chart" /></td>
<td><img src="chart8.png" alt="Bond Strength Chart" /></td>
<td><img src="chart9.png" alt="Bond Strength Chart" /></td>
<td><img src="chart10.png" alt="Bond Strength Chart" /></td>
</tr>
</tbody>
</table>

*One-Step Plus and OptiBond Solo Plus are total-etch systems; the other products are self-etch.

### Reader Tip: Unlike the graph for dentin bond strength, this graph does not depict outliers due to smaller sample size. Notice that the whiskers in Figure 2 extend from the lowest to the highest values of the entire data set. Beyond this, notice the spread of data, which again makes distinguishing performance between the brands difficult.
Bottom Line

• Using in vitro bond strength data for purchasing decisions not recommended
  – High variability
  – Useful for researchers and manufacturers
  – Lack of standardized methods
  – No info on bond deterioration
• Cannot tell the dentist the “best” product
• ADA ACE Panel Discussion
  – Total-etch still preferred for reliability
  – Self-etch may produce less sensitivity
  – Consider compatibility with cements and restoratives
  – All still require good isolation
Adhesives with fewer steps (1 study)

• Gallo et al. (2005) Oper Dent 30:290-6
• Total etch systems
  – Gluma Solid Bond – two adhesive steps
  – Gluma Comfort Bond and Desensitizer – one adhesive step
• Solitaire 2 composite
• 62 class I and II restorations
• After two years no significant differences in clinical criteria between the two adhesive groups
• Both adhesive groups had 97% acceptable ratings
  – 3% (1.5% annual) failure in each group due to secondary caries
Self-etching adhesive (5 studies)

• Gordon et al. (2005) Am J Dent 18:45-9
  – 26 class I and 35 class II Fluorobond plus Beautifil composite in 31 patients
  – 39 restorations after four year
  – Occlusal marginal staining significantly different from baseline, no other differences
  – No sensitivity at 24 months
  – One restoration replaced at one year recall due to sensitivity (2% annual)

  – Retrospective review after five years Clearfil Liner Bond II
  – 83 restorations in 36 patients
  – 75% survival (5% annual)
Self-etching adhesive (5 studies)

• Wilson et al. (2006) J Adhes Dent 8:47-51
  – 108 class I and II restorations with fluoride releasing composite
  – Five restorations failed over three years (1.5% annual)
  – No secondary caries
  – Proximal marginal adaptation poorest results

  – Compared total etch with self-etching after six months
  – 30 Clearfil SE Bond + Clearfil AP-X composite
  – 36 Prime&Bond NT + Esthet-X composite
  – No significant difference in post operative sensitivity or marginal discoloration
Self-etching adhesive (5 studies)

  – 105 restorations in 65 patients
  – Non-Rinse Conditioner and Prime & Bond NT
  – Packable (Surefil) and hybrid (Spectrum TPH) composites
  – Survival rate after 3.5 years – no sign. difference
    ▪ 81% for packable (5.4% annual failure)
    ▪ 92% for hybrid (2.3% annual failure)
Are the adhesives with fewer steps as effective as total-etch systems plus two steps?

- Annual failure rates 1.5 to 5.4% (2.9% mean)
- Studies ranged from 2 to 5 years
- Compare with benchmark 2.2%
- The clinical findings are leaning toward Yes
Key Factors for Success with Posterior Composite Restorations

• Conserve tooth structure
  – caries risk assessment
  – focus on caries removal
• Controlling the operating environment
  – tissue management
• Understanding how to achieve quality bonding
• Composite placement technique
  – void free placement
  – anatomical buildup to avoid carving
• Maximum curing of composite
Matrix Systems for Class II Composite

- 0.001” dead soft metal bands
- Advantages
  - Use in Tofflemire retainer
  - Easy to establish contacts
- Disadvantages
  - Lacks precontour
Use autocured resin cement as your flowable composite
Matrix Systems for Class II Composite

• Bitine rings

• Advantages
  – Easy to establish proximal contact
  – Can use either thin metal or contoured plastic matrix material

• Disadvantages
  – Limited to small to moderate width cavities
Matrix Systems for Class II Composite

- Palodent Technique
- Darway Inc
- 650-548-9261
- palodent@darway.com
Matrix Systems for Class II Composite

- Garrison Dental Solutions
- Composi-Tight
- 1-888-437-0032
Without cotton wedge

With cotton wedge

Without cotton wedge

With cotton wedge
Matrix type – clinical performance (2 studies)

- Demarco et al. (2006) – 2 year study
  - Compared metallic and translucent matrices
  - 23 patients with at least two restorations
  - 109 restorations with metal matrix cured from occlusal or translucent matrix cured through reflective wedge.
  - No significant differences in clinical evaluation

- Cenci et al. (2006)
  - Similar study as above
  - No clinical differences
Matrix type – proximal contacts (2 studies)

• Loomans et al. (2006 & 2007)
  – Compared proximal contact pressure before and after treatment
  – Sectional matrix with separation rings resulted in stronger contacts compared with circumferential matrix
  – Contacts that were tighter after treatment loses some pressure but remains tighter than before treatment
  – Contacts that were looser after treatment remain so

• Prakki et al. (2004)
  – Compared metal and polyester matrices
  – Compared incremental fill vs. prepolymerized particles
  – No differences in the contacts from each group immediately or after 18 months
Does the type of matrix used affect clinical performance?

- Two studies indicate clinical performance not affected by type of matrix and curing direction
- One study did not find a difference in proximal contact establishment between a metal and polyester matrix.
- One study found tighter contacts with separating rings
- Dentists should use whatever matrix system they can establish good proximal anatomy with
Packable Composites (11 studies)

• Sarrett et al. (2006) – 3 year study
  – Prodigy Condensable, no control
  – 57 class II restorations
  – 0.13 K-M probability of repair/replacement at three years
• Burke et al. (2003 & 2005) – 2 year study
  – Five UK dental practices
  – 88 restorations, two failures (1.1% annual)
  – No control
• De Sourza et al. (2005) – 1 year study
  – Two packable materials (SureFil, Filtek P60), one control microhybrid (Suprafill)
  – 60 occlusal restoration
  – No significant differences between material
Packable Composites (11 studies)

• Ernst et al. (2001) – 3 year study
  – One material (Solitaire), no control
  – 250 of 165 class I and II restorations evaluated
  – 72% class II
  – 27 failures (6% annual) due to fracture and sensitivity
  – Material withdrawn from use

• Fagundes et al. (2006) - 2 year study
  – Alert and SureFil packable composites, no control, paired design
  – No failures of either material
  – SureFil had significantly better performance for surface finish and marginal discoloration compared with Alert
Packable Composites (11 studies)

• Loguercio et al. (2001) and Reis et al. (2006) – 3 year study
  – Four packable materials (Alert, Solitaire, SureFil, Filtek P60), one control
  – Solitaire was not acceptable
  – SureFil and Filtek 60 performed similar to control Spectrum TPH
  – Alert had poor surface finish

• Lopes et al. (2002 &2003) – 2 year study
  – Two packable materials (Prodigy Condensable, Definite) used in all patients, no control
  – 74 of original 78 restorations in 34 patients evaluated
  – Two (5.3%) Definite composite restorations failed
  – No Prodigy Condensable failed
  – Combined annual failure rate 1.3%
Packable Composites (11 studies)

- Oberlander et al. (2001) – 1 year study
  - Two packable composites, no control
  - Four dentist in practice and one university based dentist
  - Definite composite had failure rate of 9.6% for one year
  - Solitaire suffered significant marginal gaps, discoloration, bulk fractures

- Perry and Kugel (2000) – 2 year study
  - 22 of 25 SureFil restorations satisfactory, no control
  - 6% annual failure rate

- Turkun et al. (2003 & 2005) – 3 year study
  - SureFil and no control, 55 class I and II restorations
  - 6% failure rate (2% annual)
Packable Composites (11 studies)

- Yip et al. (2003) and Smales et al. (2005) – 3.5 year study
  - One packable composite, one control, no pairing in patients
  - 65 patients, 3 dentists
  - 29 SureFil and 25 Spectrum TPH evaluated
  - Six SureFil and two Spectrum restorations failed
  - SureFil annual failure 5.4%
  - Spectrum TPH annual failure 2.3%
  - No significant differences between the two materials
How does the performance of packable composites compare with other composite?

- Three studies compared packables with non-packable
  - 1-3.5 years long
  - Annual failure ranged from 0 to 10%
  - Simple average 4%
  - Benchmark 2.2%
- The original Solitaire material was clearly unsatisfactory
- Definite and Alert are questionable
- SureFil, Filtek P60, and Prodigy Condensable appear to perform similar to non-packable materials
Faulty composite placement

Caries never removed
Matrix Systems for Class II Composite

Slide 135
Step by Step Procedure for Class II Composites

• Remove restorative materials and open access for caries removal
  – Use 330 bur in high speed/water
  – No rubber dam or cotton roll isolation

• Tissue removal and management
  – Remove tissue with 330 bur in high speed/water
  – Astringedent to control bleeding
- Isolation with rubber dam or cotton rolls
- Dentinal caries and stain removal
  - #4 or #6 round bur in slow speed handpiece
  - Enamel smoothing
    - 330 bur or 7902 pointed finishing bur in high speed without water spray
  - Matrix
    - bitine system
• Achieve quality bonding and place composite
• Trim proximal excess
  – 12b scaple blade
• Complete occlusal anatomy with bur
  – 330 and #4 or #6 round burs
  – slow speed handpiece
  – Enhance polishers
Polishing posterior composite

- Surface finish
  - Large quartz filler – high hardness
    - Difficult to polish
    - Become rough with wear
  - Hybrid composite
    - Softer glass fillers – barium
    - Range of particle sizes
One year
Class II Video
Compomers (5 studies)

- Kramer et al. (2006) – 4 year study
  - Two compomers, no control
  - 21 class I, 50 class II in 30 patients
  - 38 Hytac, 33 Dyract
  - Four year failure rate overall was 16% (4% annual)
    - Hytac 21% (5% annual)
    - Dyract 9% (2.3% annual)

- Luo et al. (2000 & 2002) – 2 year study
  - Dyract, no control, 50 class II and 41 class I
  - 82 of 91 restorations evaluated at one year
  - 8% failure rate due to fracture and secondary caries
  - 76 evaluated at two years
  - 6% failure rate (3% annual)
Compomers (5 studies)

- Huth et al. (2003 & 2004) – 4 year study
  - 53 class I and II Hytac restorations were placed in 14 patients
  - Kaplan-Meier probability of survival 0.89 after four years
  - No significant effect of tooth type, cavity size, class, isolation method, or use of CaOH liner

- Wucher et al. (2002) – 3 year study
  - Compared Dyract, Spectrum TPH, and a sandwich with Spectrum over Dyract
  - 23 patients, each had 3 restorations in premolar teeth
  - One sandwich restoration lost due to secondary caries
  - No post operative sensitivity for any restorations
  - Dyract had significantly higher wear rate
  - Composite had significantly better marginal integrity
Compomers (5 studies)

- Demirici & Uysal (2006) – 3 year study
  - 108 class I Dyract restorations, no control
  - 21 patients
  - 7% cumulative failure (2.3% annual)
Can compomers be used for class I and II restorations?

- Five studies are 2-4 years long
- One studied compared Dyract with composite with similar performance in premolar cavities
- One study only class I restorations
- Annual failure rates 0 to 8%
- Benchmark 1.1% for studies 1-3 years long
- Can be used in lower stress areas such as premolars.
- But why? Is there any advantage?
Combining resin cements with composite restorations
Post cementation with resin cement
Endodontically treated teeth (5 studies)

- Can Say et al. (2006) – 2 year study
  - 39 class II restorations using total-etch technique
  - No failures after two years
  - Significant change in marginal discoloration

- Grandini et al. (2005) – 2.5 year study
  - 62 teeth restored with resin-cemented fiber posts and composite in three private offices
  - Reported results were “good” w/o data in abstract
Endodontically treated teeth (5 studies)

• Mannocci et al. (2002) – 3 year study
  – Compared fiber posts and composite with full crowns
  – 66 premolars with composite and 57 with composite plus crowns
  – No significant difference in failure rate between two groups

• Mannocci et al. (2005) – 5 year study
  – Compared cemented fiber posts plus composite with amalgam restorations in premolar class II restorations
  – 110 with composite and 109 with amalgam
  – No significant difference in failure rates
    ▪ 9-10% (2% annual)
  – Composite more effective in preventing root fractures but less effective in preventing secondary caries
Endodontically treated teeth (5 studies)

- Adolphi et al. (2007)
  - 44 patients with match pairs of composite restorations
    - One vital and one with root canal treatment
  - Mean ages of restorations was 81 months ± 11
  - Tooth and root fractures more common in root-filled teeth
  - 86% survival rate for root-filled vs. 93% for vital teeth
  - Odds ratio of need for revision was 1.98 for root-filled teeth but with weak statistical significance
Can endodontically treated teeth be effectively restored with composite?

- Within a five year window, yes
- Beyond five years likely minimal increases in failures compared to vital teeth
- This appears to be a good option while waiting to complete a full crown
Mr. is 79 years old.
What are your restorative options?
• Cement post with resin cement
• Use the cement as a flowable composite between the post and remaining mesial tooth structure

• Place sectional contoured matrix
• Add hybrid composite to the gingival margin and cure
• Insert partial denture
• Complete composite build-up in three increments
Key Factors for Success

• Conserve tooth structure
  – caries risk assessment
  – focus on caries removal
• Controlling the operating environment
  – tissue management
• Understanding how to achieve quality bonding
• Composite placement technique
  – void free placement
  – anatomical buildup to avoid carving
• Maximum curing of composite
Composite Curing Factors
Curing Lights

- Halogen
  - 50 to 100 watt bulb
  - 400 to 800 mW/cm²
  - peak output at 468 nm wavelength, 400 to 500 nm range
  - 99% of energy output is heat
  - power density can be varied for delivering curing energy at a low rate at first, followed by a high rate
### LED CURING LIGHTS

<table>
<thead>
<tr>
<th>Blue Phase</th>
<th>Elipar FreeLight 2</th>
<th>L.E. Demetron II</th>
<th>SmartLite iQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ivoclar Vivadent</td>
<td>3M ESPE</td>
<td>Kerr Corp.</td>
<td>DENTSPLY Caulk</td>
</tr>
<tr>
<td>800.533.6825</td>
<td>800.553.9215</td>
<td>800.537.7123</td>
<td>800.532.2855</td>
</tr>
<tr>
<td>Colt lux LED</td>
<td>FLASH-lite 1401</td>
<td>Radii Plus</td>
<td>Ultra-Lume LED 5</td>
</tr>
<tr>
<td>Coltene Whaledent</td>
<td>Discus Dental</td>
<td>SDI Inc.</td>
<td>Ultradent Products Inc.</td>
</tr>
<tr>
<td>800.221.3046</td>
<td>800.422.9448</td>
<td>800.228.5166</td>
<td>800.496.8337</td>
</tr>
</tbody>
</table>
Table 2. Power Density (Light Intensity) measured by a power meter and two radiometers

<table>
<thead>
<tr>
<th></th>
<th>blue phase Ivoclar Vivadent</th>
<th>Coltene LED Coltene Whaledent</th>
<th>Ellpar Freelight 2 3M ESPE</th>
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<th>Radii Plus SDI Inc.</th>
<th>SmartLite IQ DENTSPLY Caulk</th>
<th>Ultra-Lume LED 5 Ultradent</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM3 Power Meter</td>
<td>1076</td>
<td>609</td>
<td>673</td>
<td>439</td>
<td>1010</td>
<td>635</td>
<td>544</td>
<td>577</td>
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<tr>
<td>Cure Rite Radiometer</td>
<td>1720</td>
<td>1158</td>
<td>1123</td>
<td>1139</td>
<td>1955</td>
<td>1834</td>
<td>890</td>
<td>1398</td>
</tr>
<tr>
<td>Demetron Radiometer</td>
<td>1300</td>
<td>850</td>
<td>1000</td>
<td>825</td>
<td>1400</td>
<td>800</td>
<td>750</td>
<td>900</td>
</tr>
</tbody>
</table>

Lab Tests

POWER DENSITY (commonly referred to as “Light Intensity”): Measures the power output of the light per unit area. The ANSI/ADA specification for curing lights requires an irradiance of at least 300 mW/cm².

Results: The highest light intensities were achieved with blue phase and the L.E. Demetron II, which were both over 1000 mW/cm². FLASH-lite 1401 with a power density of 439 mW/cm² was the lowest (Table 2).
Figure 1. Depth of cure - Herculite at 20 seconds

Vertical black bars designate products that performed equally based on statistical analysis (one-way ANOVA followed by the Student-Newman-Keuls method for multiple comparisons, p>0.05). Mean based on n = 5. Composite shade = A2.

Figure 2. Depth of cure - Heliomolar at 40 seconds

Vertical black bars designate products that performed equally based on statistical analysis (one-way ANOVA followed by the Student-Newman-Keuls method for multiple comparisons, p>0.05). Mean based on n = 5. Composite shade = A2.
Corded or Cordless?
The advantages of a cordless light are obvious, but the disadvantages are not so apparent. When selecting a light, there are a few things to consider with respect to the type of battery and maintaining cordless operation. Consider how often and for how long you use your curing light. More frequent, light intensive procedures will require a battery that has a higher energy capacity. The lights tested used the Nickel Metal-Hydride (Ni-MH) or Lithium-Ion (Li-ion) batteries. These batteries cost about $100 to replace when they can no longer hold a charge. Two of the lights used a non-removable rechargeable battery (see Table 1). When they can no longer hold a charge, the light has to be replaced. To get the longest life out of a new Li-ion battery (the newest battery type), perform an initial conditioning of the battery. For the first three charge cycles, fully charge the battery overnight and allow it to fully discharge before recharging. Ni-MH batteries must also be conditioned before use and then again every 3-5 charge cycles. Li-ion batteries have a higher power density than Ni-based batteries. This allows longer battery life in a lighter weight battery. You can also recharge a Li-ion battery whenever convenient, without the full charge or discharge cycle required to keep Ni-MH batteries operating at peak performance. Lithium-ion batteries need to be used for maximum performance. If you don't use your light very often, make sure you complete a charge cycle at least once per month.
Curing Techniques

- uniform light intensity cure
- ramped intensity cure
- step intensity cure
- interrupted step intensity cure
- high energy pulse cure
Bulk curing of posterior composite restorations (2 studies)

• Lopes et al. (2004)
  – Class II cavities filled in premolars scheduled for extraction
  – Filtek P60 packable placed in six teeth
  – Z250 incrementally placed in six teeth
  – Teeth extracted in one week
  – Percent of dentin gap formation on sections
    ▪ Incremental 6.1%
    ▪ Bulk 18.7%
Bulk curing of posterior composite restorations (2 studies)

• Sarrett et al. (2006) – 3 year study
  – Prodigy Condensable cured in 5mm increments in 57 class II cavities (most restorations bulk-cured)
  – No significant difference in pre-op and post-op sensitivity over 3 years
  – No restorations totally replaced
  – 11 required repair
    ▪ 9 due to marginal defects
    ▪ 2 secondary caries
  – Kaplan-Meier 0.13 probability of repair/replacement at three years (4.3% annual)
More on Polymerization Shrinkage

- Fracturing of teeth due to shrinkage
Fracture in facial cusp upon curing of composite

No visible fracture in lingual cusp
Restorations were bulk-cured – no significant difference in pre-op vs. post-op sensitivity
Can posterior composite restorations be cured in bulk?

- Prodigy Condensable perhaps, but more evidence clearly needed
Do indirect restorations perform better than direct restoration?

- Seven studies 3 to 11 years long
- Six studies compared with direct composite
  - All found no significant difference
- Annual failure rates 1 to 3.5%
- The evidence indicated there is no significant clinical performance advantage to using indirect composite restorations vs. direct composite restorations
- Indirect restoration likely take longer to complete
Temporary reinforcement of teeth with cracks
Cracked teeth (1 study)

- Opdam and Roeters (2003) – Six month study
  - 40 teeth in 39 patients with symptoms of pain to cold and biting
  - Visible fracture line in dentin inside cavity
  - Half restored with cusp replacement, half w/o
  - Frequency of sensitivity decline over time
  - 75% of teeth were functioning w/o complaint after six months
  - No significant difference in cuspal replacement vs. w/o cuspal replacement
Can composite be used to treat cracked teeth?

- One studies showed good result up to six months
- Good alternative if crown not possible
Our goal is: Scientific, unbiased, clinically relevant product comparison.

- Featuring:
  - Lab data
  - Clinical Input
  - Manufacturer contact

- Supplemented by:
  - Expert Panel Discussions
  - Practitioner Panel Discussions
  - Literature Reviews
  - Buyer’s Checklists or Guides
When is new really new? Why make a change? Many new things are only new packaging. And some things are new but unproven.
“Laser Assisted New Attachment Procedure (LANAP)
Cementum-mediated periodontal ligament
new-attachment to the root surface in the
absence of long junctional epithelium.”
(FDA 510k Clearance K030290)

LANAP x 3 months

LANAP x 3 months

Key: N = notch in calculus; B = new bone; C = new cementum; OC = old cementum; JE = junctional epithelium

Pre-treatment

9 months post-Tx

14 months post-Tx

RADIOGRAPHIC DENSITY

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Virginia Commonwealth University

Millennium Dental Technologies, Inc.
When is new really new? Why make a change?

• Makes patients more comfortable
• Makes for less stress to dentist
• Greatly improved longevity based on clinical evidence
• Remarkable esthetics compared with existing methods and materials
• Reduces treatment time
• Saves $$$
• Does what nothing else will
• Required by law or regulation or good practice