Discussion on choices of and advances in dental materials

Summary
- Where have we come from?
- What do we currently have?
- Where could we be heading?

Where have we come from?
- Pre 1960
  - Gold
  - Amalgam
  - Zinc phosphate / Zinc oxide & Eugenol
  - Bowen’s resin (BIS-GMA) 1955
- 1960
  - Adhesion to enamel
- 1980
  - Glass ionomer chemistry
  - Composite bonding to enamel
- 1990
  - Dentine bonding
- 2000
  - No etch bonding and the rise of the posterior composite

Cohesive gold

Amalgam

Zinc phosphate
Composite resin

Zinc cement - glass polyalkynoate spectrum

Glass Ionomer Cement

What do we currently have?

Amalgam
Do teeth with amalgam have a high incidence of cuspal fracture?

- No
  - 1.5% in 600 teeth after 5 years
  - 1.8% in 1400 teeth after 10 years
  - 5% in 1213 teeth after 15 years
- Bonded amalgams may fare even better

Do temperature changes in amalgam cause cusp fracture?

- No
  - Coefficient of thermal expansion of resin is greater than amalgam
  - No prolonged contact with temperature extremes before swallowing
  - Of greater importance is tooth preparation and parafunction

Do teeth with amalgam restorations have a higher rate of recurrent decay?

- No
  - 0% of 600 teeth at 5 years
  - 1.1% of 1400 teeth at 10 years
  - 0% of 35 teeth at 10 years
  - <5% after 14 years (no nos.)

Do resin composite restorations usually last as long as amalgam restorations?

- No
- 2001 study
  - 12 yrs = median age 1827 failed amalgams
  - 5 yrs = median age of 1548 failed composites
- 2000 study of 6761 teeth
  - median age of replaced amalgam = 10 yrs
  - amalgam lasting longer than composite in C I, II III IV and V restorations
- 1998 study
  - median age of amalgam replacement = 15 yrs,
  - composite = 8 yrs

Aren’t bonded restorations preferable to amalgam restorations?

- Yes
  - Composite bonded to enamel and dentine creates a monoblock whereas amalgam may create a wedge
  - Increasing numbers of dentists are bonding amalgam restorations
  - Some evidence of good bond strength of amalgam to dentine
Amalgam is over 100 years old – doesn’t that make it old fashioned?

- No
- So is radiography, nitrous oxide, gold and rubber dam
- High copper formulations, factory measured components, pre-capsulated amalgam

Has amalgam been banned in Sweden and Germany?

- No
- Amalgam use in the EU is governed by Medical Devices Directive 93/42/EEC.
- 1998 EU working group stated, “no scientific evidence of systemic health problems or toxic effects from dental amalgam.

Do amalgam restoration release a large amount of mercury?

- No
- It is estimated that a patient would have to have 2740 amalgam restorations to reach the threshold limit value of 82.20 microns per day considered dangerous for occupational exposure in the USA

Does mercury from amalgam restorations cause ill health?

- No – except rare cases of allergy (Eg Lichenoid reaction)


Lichenoid reaction

Desquamative gingivitis
Is there credible scientific literature that shows health problems due to mercury in dental amalgam?

- No
- Independent analysis of data shows incorrect conclusions often drawn
- Data extrapolating snail cells to human clinical response
- Exposure to Hg levels x100 normal levels

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Is mercury from dental amalgam dangerous to dental staff?

- No
- “the infants of dental workers actually had a lower perinatal death rate than the rest of the infants” (Chesnow A, Källén B. Pregnancy outcome in women working in dentists, dental assistants of dental technicians. Int Arch Occup Environ Health 1984; 58: 227–232.)
- “In a study of 21,634 male dentists and 21,202 dental assistants there was no difference in the rate of spontaneous abortions or congenital abnormalities” (Broadley IR, Cohen H, Whitcher C, et al. Occupationally-exposed mercury in dentistry and pregnancy outcome. J Am Dent Assoc 1986; 113: 775–780.)
- Of 1706 dentists screened at a 1991 ADA meeting, only 29 (2%) had high urinary mercury levels. These high levels were correlated to poor mercury hygiene (the use of squeeze cloths). (Echeverria D, Heyer N, Martin MD, et al. Behavioral effects of low-level exposure to Hg among dentists. Neurotoxicol Teratol 1995; 17: 161–168.)

Are the ingredients of resin composite non-toxic?

- No
- The ingredients of resin composite have been shown to be
  - cytotoxic
  - mutagenic
  - To cause immunosuppression or
  - to inhibit DNA5S and RNA6S synthesis.
- Wataha et al. stated,
  - “the components of resin composites are hazardous in that they all cause significant toxicity in direct contact with fibroblasts.”

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Is the death of amalgam imminent?

- Not yet………
- Sig. number of dentists still use amalgam
- Many patients prefer tooth coloured restorations
- Such patients do not tend to have health concerns over amalgam

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Does amalgam in waste water cause harmful environmental effects?

- Probably not
- Most amalgam from dental surgeries captured by amalgam traps
- 3-4% of worldwide consumption of mercury is for dental purposes
- Estimated that 0.3% of amalgam waste is soluble

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It may be prudent to consider ‘phasing down’ instead of ‘phasing out’ of dental amalgam at this stage. A multi-pronged approach should be considered. Short-, medium- and long-term strategies should be developed.

1. What is taught in UK dental schools

Surveys

- 1989 – worldwide survey – 90% schools do NOT teach posterior composite
- 1998 – little change in American dental schools
- 1997 – paper, use of composite in load bearing posterior cavities should be, “limited to the occlusal surfaces of premolars, and preferably those with limited occlusal function”

BDJ, 2010;209:129

Guidelines

- 2007 , British Association of Teachers of Conservative Dentistry (BATCD) published a consensus document which recommended that
  — composite should be taught to dental students as the ‘material of choice’ when restoring posterior teeth, in particular when managing teeth with an initial lesion of caries

Surveys

- 2004 – 2005. 30% of posterior restorations placed by dental students are composite
Conclusions

- 2005 - 2010 has seen great increase in use of posterior composite in dental schools
- Many schools now place more posterior composite than amalgam
- General Dental Practice surveys show more amalgams than posterior composites
- Some concern over teaching methods not considered best practice
  - Transparent matrices and transparent wedges
  - Bevelling cavity margins

Types of Resin Composites

- All contain
  - Resin
    - Susceptible to shrinkage upon polymerisation
      - May be modified methacrylate/acylate
    - OR a chemical that upon setting expands due to a ring opening mechanism eg Oxirane
      » This expansion in resin volumes offsets to a degree the polymerisation shrinkage
      » Still however a net shrinkage
  - Filler
    - Type, concentration, particle size & particle size distribution control properties

- Classification
  - Method of Activation
    - Chemical/light

- Resin and Filler alone useless without effective coupling
  - “The coupling agent transfers the stresses generated under loading from the rigid and brittle filler to the more flexible and ductile polymer matrix”
  - Matrix may be regarded as a “shock absorber”
Types of Resin Composites

<table>
<thead>
<tr>
<th>Classification</th>
<th>Handling Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional (1)</td>
<td>1 – 50 µm</td>
</tr>
<tr>
<td>Microfilled (2)</td>
<td>0.01 – 0.1 µm Mean + 0.04 µm</td>
</tr>
<tr>
<td>Hybrid</td>
<td>Blend of (1) &amp; (2)</td>
</tr>
<tr>
<td>Nanocomposites</td>
<td>Uses particles less than 1 µm diameter (really like (2))</td>
</tr>
</tbody>
</table>

Types of Resin Composites

• Classification
  — Intended clinical application
  • ISO 4049
    — Type 1 – restoration of cavities involving occlusal surfaces
    — Type 2 – All other polymer based filling and restorative materials

Where could we be heading?

Amalgam

• Likely to be phased down then out
• Dictated by NHS SDR
  • Informed by dental/therapy school teaching policies
    — Eg All direct occlusal restorations in composite
  • Advantages
    — Strength, colour and moisture tolerance

Composite

• Will grow in popularity
  — Patient desire
• Placement techniques will improve
• Shrinkage reduction will make for less post-operative pain
• Wider applications
  — Splinting
  — Core build-up
  — Occlusal rehabilitation
And far ahead.........?

- Restorations that inhibit caries and periodontal disease
  - Fluoride release
  - CaPO₄ release
  - Slow release CHx
- Restorations that indicate when they are failing
  - Colour change?