Prediction of Clinical Outcome of a Restoration Based on Marginal Quality Evaluation

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March 9, 2006
Outline of presentation

• Focus mainly on posterior composite restorations and reasons for intervention
• Clinical evaluation criteria and challenges with assessing marginal integrity
• Secondary caries
  – Development
  – Risk and diagnosis
  – Association with marginal defects
• Polymerization shrinkage
• Summary/Conclusions
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 systems
- 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 from practice-based studies
  – Median age of failure 6-8 yrs
  – Higher failure rates
Secondary (recurrent) caries and restoration replacements

- Practice-based surveys of restoration replacement
- 50% of replacements with diagnosis of secondary caries
- For composite the combination of secondary caries and discoloration is higher than 50%
- Replacement rates in general practice due to secondary caries much higher than in controlled clinical trials which is 2-3%/year
Class II restoration survival probability

- Studies in 70’s and 80’s
  - Composite restorations last about half as long as amalgam restorations
- Recent data indicated the difference is minimal
- Bogacki *et al.*, 2002
  - Insurance claims data to compare survival of composite and amalgam restorations
- Changing dentist results in lower survival probability
Posterior composite restoration 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 (or microscopy) 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 data matrix that guided the decision to restore the tooth in the first place?
  - Patient’s caries risk
  - Tooth information
  - Dentist experience and ability
How have we evaluated clinical outcomes?

- Gunnar Ryge – United States Public Health Service Criteria or Ryge Criteria
- USPHS/CDA Quality Evaluation System
- Two step evaluation process

- **Clinically Satisfactory**
  - Meets all criteria (Romeo or Alpha)
  - One or more features deviates from ideal (Sierra or Bravo)

- **Clinically Unsatisfactory**
  - Future damage likely to occur (Tango or Charlie)
  - Damage is occurring (Victor or Delta)
Clinical performance evaluation of a packable posterior composite in bulk-cured restorations.

• Our contribution to the confusion
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
Scoring Marginal Integrity

- **R** – No evidence of ditching along margin and no discoloration; No excess material
- **S** – Evidence of ditching not extending to DEJ and/or discoloration between the restoration and the tooth structure; Excess material
- **T** – Ditching along the margin extending to DEJ and/or penetration of discoloration toward pulpal direction; Excess material
- **V** – Restoration is mobile or fractured, tooth is fractured, or caries present contiguous with margin of restoration; Overhanging material
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
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

**Fig 8** Comparison of regions which were recommended for replacements (black field in A) and regions with clearly identified caries after restoration removal (unfilled field in B).

**Fig 9** Superimposing the charts in Fig 8 shows that slightly less than 50% of the restorations recommended for replacement overlap the surfaces with caries detected after restoration removal (striped field represents the overlap). Almost 25% of B falls outside of A (represented by the unfilled region). This finding suggests that about 25% of the true carious regions were not treated.
Secondary caries process

Prediction of secondary caries

- Compared margins of tooth-colored restorations
  - Staining and stained dentin visible through enamel
  - ditching and frank secondary caries
- Bacterial composition
  - plaque at the margin
  - underlying dentin at the DEJ
- Dentin at the DEJ
  - Hard or Soft
Prediction of secondary caries

- 79.5% of soft dentin areas were below stained margins
- But, 55.5% of hard dentin areas were also below stained margins
- 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 bacteria and bacteria in 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

  – Concluded that imperfections in marginal integrity do not contribute to increased secondary caries risk

  – Early marginal deterioration and discoloration associated with higher failure rates
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
- 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?

- Patients who change dentist have a higher restoration failure rate and likely a higher rate of secondary caries diagnosis
- Current clinical evaluation criteria for marginal integrity lack the ability to predict future risk for the need for intervention
  - Replacement
  - Repair
Thank you for your support of this symposium.