Survival Analysis of Posterior Restorations Using an Insurance Claims Database

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Clinical Relevance
This study indicates that composite restorations do not last as long as amalgam restorations in posterior teeth. Dentists can use this information to better inform their patients when choosing restorative materials.

INTRODUCTION
Over the past decade, resin composite has become increasingly popular as an alternative to amalgam for restoring posterior teeth (Anderson, 2001). Figure 1 shows patients in the Washington Dental Service have received an increasing number of resin composite restorations each year since 1993. Composite usage exceeded amalgam beginning in 1999 and continued through December 2000. Several factors may contribute to this increase in use of resin composite. Patients may be asking for composite because of its tooth-colored appearance (Dietschi & Dietschi, 1996). Dentists may believe that composite is better in many clinical situations (Wiggins, 2001). There may be a growing fear of mercury present in amalgam (Roulet, 1997). In any case, based on current trends, composite's popularity will probably continue to rise.

Previous studies suggest that the average amalgam restoration longevity is 10-12 years and resin composite's longevity is about half that time (Leinfelder, 2000). These estimates of survival are based on studies conducted between 1977 and 1989. However, resin composites have improved considerably since 1989 in terms of properties, handling and longevity. This study determined whether the choice of material used to restore a posterior tooth had an effect on the survival of the restoration.

METHODS AND MATERIALS

Data Source
Data for this study came from the Seattle-based Washington Dental Service (WDS), a member of the Delta Dental Plans Association. Washington Dental Service has a claim-based data warehouse that has stored data longitudinally since 1993. The data warehouse is updated monthly and contains data on dental services provided to approximately 650,000 primary subscribers and 1.5 million patients. Specific elements include information related to treatment, provider-specific information (that is, specialty, date of graduation, number of clinics) and patient-specific information and data related to the purchaser. The
sample of data used in this study included the dental care services provided on the dates from 1 January 1993 until 30 June 2000.

**Study Design**

This was an inception cohort study of adult patients who received either an amalgam or composite multi-surface posterior restoration between 1 January 1993 and 31 December 1999. Each patient contributed only one multi-surface posterior restoration in order to maintain independent data (Aalen, Bjertness & Soonju, 1995). Every restoration had to include the occlusal and at least one other tooth surface. The study end date was 30 June 2000, which ensured that all patients had a chance of being followed for at least six months.

A restoration failed if it was replaced by another restoration with the same tooth surfaces. A

![Figure 1. Number of restorations per 100 patients per year. (Source: Washington Dental Service, Seattle)](image)

### Table 1: Sample Size and Description: A = Amalgam C = Composite

<table>
<thead>
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<th>1993</th>
<th>1994</th>
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<tbody>
<tr>
<td>Characteristic</td>
<td>A</td>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>Sample Size</td>
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<td>46,494</td>
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<tr>
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<td>46%</td>
<td>58%</td>
<td>48%</td>
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<tr>
<td>Average Patient Age</td>
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<td>Average Provider Age</td>
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<td>% Female</td>
<td>47%</td>
<td>58%</td>
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<td>Average Patient Age</td>
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<tr>
<td>Average Provider Age</td>
<td>48</td>
<td>48</td>
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<table>
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<td>C</td>
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<tr>
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<tr>
<td>% Female</td>
<td>45%</td>
<td>54%</td>
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<tr>
<td>Average Patient Age</td>
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<td>37</td>
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<tr>
<td>Average Provider Age</td>
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<tr>
<td># of 4+ Surface Restorations</td>
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restoration was censored if the tooth received a larger restoration, crown, endodontic treatment or was extracted. Restorations were also censored if patients received no additional treatment on that same tooth by the end of follow-up or at the time of discontinuation of WDS coverage. Each patient was followed until the restoration was censored or failed.

**Data Management and Analysis**

Data management and analysis used SAS versions 8.0 and 8.1. The outcome variable of interest was restoration longevity, defined as the time from index restoration placement until failure or censorship. The potential predictor variables studied were patient gender, age, dentist age, tooth location, prior restorative history, year of treatment, change of dentist and restoration material type. Prior restorative history was defined as the number of restorations the patient received in the year prior to entering the study. Tooth location made discrete with four categories based on maxillary or mandibular, molar or premolar teeth. The reference category was the maxillary molar. Dentist age and patient age were made categorical by decade with the third decade of life as the reference category. Univariate Cox proportional hazard (PH) models were used to test the association between each predictor variable and restoration longevity (Woodward, 1999). All statistically sig-
significant variables were included in the multivariate Cox PH model and tested for significance. Variable and model significance was tested using likelihood ratio tests. The proportional hazards assumption was checked using a log cumulative hazard plot.

RESULTS

Sample Size and Description

Of the 300,753 patients included in this study, 207,558 (69%) had amalgam restorations placed and 93,195 (31%) had resin composite restorations placed. Patients with amalgam restorations were observed for an average of 44 months, and those with composite restorations were observed for an average of 36 months. Table 1 presents a more detailed description of the sample.

Variables Associated with Restoration Longevity

In the univariate Cox PH models, restoration type, prior restorative history, dentist age, patient age, tooth location, year of treatment and change of dentist were statistically significantly associated with restoration longevity ($p<0.0001$). In addition, the multivariate model showed the interaction between restoration type and change of dentist to be statistically significant ($p<0.0033$). A partial list of the likelihood ratio test results is presented in Table 2. Of all the variables tested, only patient gender was not statistically significant. All other variables tested were significant and were retained in the final model. Table 3 presents a list of the estimated hazard ratios associated with restoration type, estimated separately by change in dentist.

Survival Curves

Kaplan Meier graphs are used to illustrate the probability of restoration survival to a given point in time. Figure 2 compares amalgam with composite for patients who stayed with the same dentist versus patients who changed dentists. This figure shows that the probability of survival is always slightly higher for amalgam throughout the follow-up. Amalgam for a patient who stayed with the same dentist had a probability of 0.94 of surviving five years, while composite had a probability of 0.93. For patients who stayed with the same dentist, the probability that their restoration would survive seven years was about 0.92. For patients who saw a different dentist, the probability of survival was about 0.60. The probability of survival was much lower when the patient changed to a different dentist.

DISCUSSION

The estimated hazard ratio for restoration type when the patient stayed with the same dentist was 1.164 (95% confidence interval, 1.118-1.212). The interpretation of this ratio is that a patient with a composite restoration had a 16.4% greater chance of restoration failure at any given time than if they had an amalgam placed. The confidence interval indicates that the probability of failure could have been as much as 21.2% higher or as little as 11.8% higher. This hazard ratio shows that amalgam survives significantly longer than composite, controlling for prior restoration history, dentist age, patient age, tooth location and year of treatment (Hosmer & Lemeshow, 1999). These results agree with previous studies of restoration survival, although the magnitude of difference is less than generally observed (Papathanasiou, Curzon & Fairpo, 1994).

The estimated hazard ratio for restoration type where the patient saw a different dentist at the follow-up visit was 1.058 (95% CI, 1.014-1.103). This lower hazard ratio implies that composite has a lesser chance of failure compared to amalgam when the patient goes to a different dentist. This was caused by the strong effect a dentist change had on restoration survival as illustrated in Figure 2. Both composite and amalgam had a much greater chance of failure when the patient changed dentists. Previous studies have shown that dentists have a high level of variability in their diagnostic decisions, which may help explain this effect (Rytoma, Jarvinen & Jarvinen, 1979; Bader & Shugars, 1993). Moreover, coverage policies for people insured through Washington Dental Service entitles patients to restoration replacement within two years if they change dentists.

A restoration was deemed to have failed if it was replaced by another restoration with the same surfaces. This does not mean that the restoration definitely failed. Patients may have had their amalgams replaced with composite for esthetic reasons or a fear of mercury. Dentists may have deemed the composite a failure because of a small marginal stain. Therefore, at least part of the failure in this study may actually be replacement.

The limitations of using insurance claims data is the lack of control over experimental conditions. For example, there was no control over what material was used, how the material was used or when a restoration was considered a failure. This equation is further compounded by the ever-changing formulations of resin composite. While these limitations may appear to be weaknesses, they should also be considered strengths because they represent real-world dentistry. Each dentist has his or her own approach to care and each patient has different oral habits, diets and caries susceptibility. These data represent the true complexity of what occurs daily in dental offices.

CONCLUSIONS

This study determined whether the material used to restore a posterior tooth, either composite or amalgam, had a significant effect on the survival of that restoration. The results show that in a broad population of insured adults a restoration had a statistically significant greater chance of failing if it was resin composite. The results also show that composite fared almost as
well as amalgam. Given these results, dentists should advise their patients that composite might not last as long as amalgam in a posterior tooth but is a good alternative to amalgam.

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References


