

# Survival and reasons for failure of amalgam versus composite posterior restorations placed in a randomized clinical trial

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The performance of dental restorations is influenced by several factors, including the restorative materials used,<sup>1-3</sup> the clinician's level of experience,<sup>4</sup> the type of tooth,<sup>5,6</sup> the tooth's position in the dental arch,<sup>7,8</sup> the restoration's design,<sup>9</sup> the restoration's size,<sup>6</sup> the number of restored surfaces<sup>10,11</sup> and the patient's age.<sup>4,11</sup> Failure occurs when a restoration reaches a level of degradation that precludes proper performance either for esthetic or functional reasons or because of inability to prevent new disease.

Failure of dental restorations is of major concern in dental practice. It has been estimated that the replacement of failed restorations constitutes about 60 percent of all operative work.<sup>12</sup> Survival and failure rates may be used as measures of clinical performance. The reason why a restoration fails also is important, because it points to a specific weakness of the restoration-tooth system.

The two direct dental restorative materials most commonly used today are silver-mercury amalgam and resin-based composites. Amalgam is not suitable for visible resto-

## ABSTRACT

**Background.** Failure of dental restorations is a major concern in dental practice. Replacement of failed restorations constitutes the majority of operative work. Clinicians should be aware of the longevity of, and likely reasons for the failure of, direct posterior restorations. In a long-term, randomized clinical trial, the authors compared the longevity of amalgam and composite.

**Subjects, Methods and Materials.** The authors randomly assigned one-half of the 472 subjects, whose age ranged from 8 through 12 years, to receive amalgam restorations in posterior teeth and the other one-half to receive resin-based composite restorations. Study dentists saw subjects annually to conduct follow-up oral examinations and take bitewing radiographs. Restorations needing replacement were failures. The dentists recorded differential reasons for restoration failure.

**Results.** Subjects received a total of 1,748 restorations at baseline, which the authors followed for up to seven years. Overall, 10.1 percent of the baseline restorations failed. The survival rate of the amalgam restorations was 94.4 percent; that of composite restorations was 85.5 percent. Annual failure rates ranged from 0.16 to 2.83 percent for amalgam restorations and from 0.94 to 9.43 percent for composite restorations. Secondary caries was the main reason for failure in both materials. Risk of secondary caries was 3.5 times greater in the composite group.

**Conclusion.** Amalgam restorations performed better than did composite restorations. The difference in performance was accentuated in large restorations and in those with more than three surfaces involved.

**Clinical Implications.** Use of amalgam appears to be preferable to use of composites in multisurface restorations of large posterior teeth if longevity is the primary criterion in material selection.

**Key Words.** Amalgam; composite; randomized controlled clinical trials; dental restoration failure.

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rations in anterior teeth for esthetic reasons, but it still is used widely for posterior restorations. In recent years, the use of resin-based composites for the restoration of posterior permanent teeth has increased significantly, although they are more technique-sensitive to place and more costly.<sup>13</sup> The reasons for this situation have to do with the better esthetic properties of the composites, and with the general concerns about the use of metals in the mouth. There is some evidence that the longevity of composite restorations is less than that of amalgam restorations in similar circumstances.<sup>13</sup> It is important to consider the impact of the increasing use of composites in posterior teeth and for clinicians to be aware of the longevity of these materials and likely reasons for their failure.

The Casa Pia Study of the Health Effects of Dental Amalgams in Children was a randomized clinical trial designed to assess the safety of low-level mercury exposure attributable to dental amalgam restorations.<sup>14</sup> It began in 1996 as a collaborative project between the University of Washington, Seattle; the University of Lisbon, Portugal; and the National Institute of Dental and Craniofacial Research, and it recently concluded with publication of its main findings.<sup>15</sup> As approved by the institutional review boards of the University of Washington and the University of Lisbon Faculty of Dental Medicine, this study enrolled 507 children and provided comprehensive dental care for each of them for a period of seven years.

Because one-half of the subjects received only composites and the other one-half only amalgams for posterior restorations, this study provided the opportunity to compare the survival and the reasons for failure of posterior amalgam and composite restorations in a randomized, controlled clinical trial with seven years of follow-up.

### SUBJECTS, METHODS AND MATERIALS

The study sample consisted of 472 children born from 1986 through 1989. We obtained consent from parents or guardians as well as assent from the children for participation in the study. The children attended seven different schools in Lisbon, all belonging to the same school system. In addition to age, eligibility criteria included

- at least one carious lesion in a permanent posterior tooth;

- no prior exposure to dental amalgam;

- urinary mercury concentration of less than 10

micrograms per liter;

- blood lead concentration of less than 15 µg per deciliter;

- an IQ score of at least 67 on the Comprehensive Test of Nonverbal Intelligence;

- no interfering health conditions.

The subjects included in the trial ranged in age from 8 through 12 years. Forty-three subjects were aged 8 years, 122 subjects were aged 9 years, 156 subjects were aged 10 years, 136 subjects were aged 11 years, and 15 subjects were aged 12 years.

We randomly assigned subjects to one of two treatment groups for restoration of posterior permanent teeth: one-half of the children received only amalgam restorations, and the other one-half received only composite restorations. Only resin-based composite and amalgam restorations of permanent posterior teeth were considered for the purposes of this study, although any anterior teeth needing restoration were treated (with composite in both groups). The reason for placement of all the restorations was primary caries.

Figure 1 shows the composition of the treatment groups and the number of restorations done at baseline within each group. For purposes of the comparison of restoration failures presented here, we chose to include only the restorations placed at baseline. Restorations placed at baseline were done under the same initial conditions and were observed for the same period, allowing for direct comparisons between restorative materials.

During follow-up, we instituted oral hygiene and prevention programs to decrease disease rates. This meant that restorations placed during follow-up were done in oral environments altered from those at baseline, which could in turn make longevity of newer restorations different from that of those placed at baseline.

All dental care was provided at the University of Lisbon Faculty of Dental Medicine, using existing standards of care common to both the United States and Portugal. We chose the materials used in the study, Dispersalloy (Caulk/Dentsply, Milford, Del.) and Z100 MP + Scotchbond Multi-Purpose (3M ESPE, St. Paul, Minn.), to be representative of those most commonly in use at the time the study began; they still are representative of materials in use today.

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**ABBREVIATION KEY.** mAFR: Mean annual failure rates.

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