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Clinical longevity of extensive direct composite restorations in amalgam replacement: Up to 3.5 years follow-up☆

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ABSTRACT

Objectives: This prospective clinical trial evaluated the longevity of direct resin composite (DRC) restorations made on stained dentin that is exposed upon removal of existing amalgam restorations in extensive cavities with severely reduced macro-mechanical retention for amalgam replacement.

Methods: Between January 2007 and September 2013, a total of 88 patients (57 women, 31 men; mean age: 51.6 years old) received extensive cusp replacing DRCs ($n = 118$) in the posterior teeth. DRCs were indicated for replacement of existing amalgam restorations where dentin substrates were stained by amalgam. After employing a three-step total-etch adhesive technique (Quadrant Unibond Primer, Quadrant Unibond Sealer, Cavex), cavities were restored using a hybrid composite (Clearfil Photo Posterior, Kuraray). At baseline and thereafter every 6 months, restorations were checked upon macroscopically visible loss of anatomical contour, marginal discolouration, secondary caries, fractures, debonding and endodontic problems. Restorations were scored as failed if any operative intervention was indicated for repair, partial or total replacement.

Results: Restorations were observed for a minimum of seven, and maximum 96 months (mean: 40.3 months). In total, four failures were observed due to fracture ($n = 1$), endodontic complications ($n = 2$) and inadequate proximal contact ($n = 1$). Failures were related neither to inadequate adhesion nor to secondary caries. Cumulative survival rate was 96.6% (95% CI: 89–95) up to a mean observation time of 40.3 months (Kaplan–Meier) with an annual failure rate of 0.9%.

Conclusion: In case of amalgam replacement, dentin that is exposed upon removal of existing amalgam restorations does not impair clinical longevity of extended cusp replacing direct resin composite restorations.

Clinical significance: Extensive amalgam restorations can be replaced with a variety of treatment options. This clinical study indicates that in such cases directly applied resin based composites offer a reliable and low-cost treatment option, even if dentin is stained by amalgam corrosion products.

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1. Introduction

Amalgam has proven to be a predictable material over the years for restorations of posterior teeth, even in extensive restorations. Numerous decayed posterior teeth have been saved or had their lifetime extended by amalgam restorations.[1]

Almost three decades ago, resin composite (hereon: composite) materials have been regarded as not suitable for restoration of posterior teeth, especially in cases of extensive loss of tooth substance. Main points of concern were wear, marginal integrity, adhesion to dentin, radiopacity, dimensional stability and compressive strength.[2] However, with the advances in filler and polymer technologies and adhesive resins for enamel and dentin, composites progressed and became predictable materials even for use in stress bearing situations. Today, they are often regarded as the preferred material of choice not only for small restorations[3,4] but also for large and stress bearing direct posterior restorations.[5,6] This implicates that if old amalgams need to be replaced, in many cases they will be replaced by composite restorations even in extensive cavity designs.

After removal of amalgam, dentin is commonly characterized by dark staining underneath the amalgam. This stain is not limited to the interface but protrudes into dentin in pulpal direction. Corrosion products from amalgam are held responsible for this kind of dentin staining.[7] It has been demonstrated that especially Sn and Zn ions from amalgam can penetrate dentin, underlying amalgam.[7] Until now it is not clear what is the impact of staining in respect to adhesive properties in clinical circumstances. In an in vitro study, Harnirattisai et al.[8] reported decreased bond strengths of composites to amalgam stained dentin.

The objective of this study was to evaluate the clinical longevity of extensive cusp-replacing direct composite restorations (DCR) made after amalgam replacement on stained dentin substrate with amalgam ions, in extensive cavities with severely reduced macro-mechanical retention. The hypothesis tested was that dentin that is exposed upon removal of existing amalgam restorations is not a reliable substrate for direct restorations.

2. Materials and methods

2.1. Study design

The brands, types, chemical compositions and manufacturers of the materials used in this study are listed in Table 1.

2.2. Inclusion and exclusion criteria

Between January 2007 and September 2013, a total of 118 extensive cusp replacing DRCs were placed in 88 patients (57 women, 31 men; mean age: 51.6 years old) in the posterior teeth in a general practice. As the restorations in this study were made as a part of standard dental care with the employed treatment philosophy based on minimal invasive dentistry, no ethical committee approval was requested.

DRCs were indicated for replacement of existing amalgam restorations where dentin substrates were stained by amalgam ions. Information was given to each patient regarding the alternative treatment options. Based on the informed consent, patients wished to have DCRs because of lower costs and the less invasiveness of the treatment compared to indirect restorations. Extensive restorations were scheduled because of complete or incomplete fracture of tooth structure, weakened cusps after cavity preparation, and/or secondary caries. An exact calculation of the amount of enamel and dentin surfaces present in a cavity in relation to the overall cavity margins was not feasible. Therefore, the zone of unstained dentin along the cavity outline, the absence of at least one cusp in premolars, and at least two cusps in molars were considered during inclusion and for classification. The inclusion and exclusion criteria for the teeth in this study are listed in Table 2.

2.3. Clinical procedures and restoration fabrication

Cavity preparation and restoration was performed in the general dental practice setting employing four-handed dentistry. One operator applied all the restorations who has experience in adhesive dentistry (>25 years since graduation).

Existing amalgam was removed with diamond burs (Rondomant 233/010, Heraeus Kulzer, Hanau, Germany) using

Table 1 – The brand, type, manufacturer, and chemical composition of the main materials used in this study.

Brand	Type	Manufacturer	Chemical composition
Ultra-Etch	Etching gel	Ultradent, South Jordan, USA	35% Phosphoric acid
Quadrant Unibond Primer	Dentin primer	Cavex Holland, Haarlem, The Netherlands	Methacrylate-based monomers 39.6 wt%, carboxylic acid based monomer 6.3 wt%, polymerization catalysts 0.3 w%, solvents 53.8 wt%
Quadrant Unibond Sealer	Adhesive resin	Cavex Holland	Methacrylate-based momomers 69.4 wt%, carboxylic acid based monomer 4.3 wt%, polymerization catalysts 0.5 wt%, silica and silicate glass fillers 25.8 wt%
Clearfil PhotoPosterior	Resin composite	Kuraray Dental, Tokyo, Japan	Filler amount: 86 wt%, 71 vol%; filler type: silica and quartz; mean filler particle size: 4 μm; monomer: bis-GMA