available at www.sciencedirect.com

ScienceDirect

journal homepage: www.intl.elsevierhealth.com/journals/jden

Restoration techniques and marginal overhang in Class II composite resin restorations

B.A.C. Loomans *, *N.J.M. Opdam*, *F.J.M. Roeters*, *E.M. Bronkhorst*, *M.C.D.N.J.M. Huysmans*

College of Dental Science, Department of Preventive and Restorative Dentistry, Radboud University Nijmegen Medical Centre, The Netherlands

ARTICLE INFO

Article history:
Received 6 March 2009
Received in revised form
19 May 2009
Accepted 20 May 2009

Keywords:
Interproximal overhang
Class II
Composite resin restoration

ABSTRACT

Objectives: The objective of the study was to compare *in vitro* interproximal overhang formation of Class II composite resin restoration when using different matrix systems.

Methods: 240 lower left molar phantom head teeth with an MO-preparation were divided into 12 groups ($n = 20$). In six groups a circumferential matrix (Tofflemire X-thin matrix, HaweNeos 1001-c, SuperCap) was used, combined with either a hand-instrument (PFI49 or OptraContact) or separation ring (Composi-Tight Gold). In the other six groups two sectional matrix systems were used (flexible and dead-soft), with three separation rings (Composi-Tight Gold, Contact Matrix, Palodent BiTine). Matrices were secured with wooden wedges and preparations were restored with composite resin Clearfil AP-X (Kuraray) placed and polymerized in increments. After matrix removal overhang was measured on a standardized digital macroscopic image in mm^2. For analysis a multiple linear regression model was used.

Results: Use of circumferential matrices resulted in less overhang than sectional matrices ($-0.85\ mm^2$, $p < 0.001$). A flexible matrix led to less overhang than dead-soft matrices ($-0.54\ mm^2$, $p < 0.001$), and no difference was found between straight and pre-contoured matrices ($p = 0.945$). The insertion of the OptraContact resulted in a much increased overhang of $2.54\ mm^2$ ($p < 0.001$). The Composi-Tight Gold and the Contact Matrix System rings resulted in less overhang, -0.69 and $-0.68\ mm^2$, respectively (both $p < 0.001$), whereas the Palodent BiTine ring did not.

Conclusions: Use of circumferential matrices or sectional flexible matrices resulted in the least marginal overhang when combined with a Contact Matrix separation ring or a Composi-Tight Gold ring.

1. Introduction

From literature it is known that overhanging restorations promote gingivitis or lead to periodontal diseases due to local accumulation of bacterial plaque rather than resulting in mechanical irritation. Epidemiological and clinical experimental studies have demonstrated close associations between such iatrogenic factors and the pathogenesis of local periodontal lesions.[1–7] However, all these studies have been performed in a time where only amalgam was placed and literature on the effect of composite resin overhang is scarce.

Formation of cervical overhang of the restoration is a possible risk when placing Class II restorations. Overhang formation is considered to be related to the type of restoration

* *Corresponding author at*: Radboud University Nijmegen Medical Centre, College of Dental Sciences, P.O. Box 9101, 6500 HB, Nijmegen, The Netherlands. Tel.: +31 24 3616410; fax: +31 24 3540265.

E-mail addresses: b.loomans@dent.umcn.nl (B.A.C. Loomans), n.opdam@dent.umcn.nl (N.J.M. Opdam), j.roeters@dent.umcn.nl (F.J.M. Roeters), e.bronkhorst@dent.umcn.nl (E.M. Bronkhorst), m.c.d.n.j.m.huysmans@dent.umcn.nl (M.C.D.N.J.M. Huysmans).

0300-5712/$ – see front matter
doi:10.1016/j.jdent.2009.05.025

material and matrix technique. Frankenberger et al. (1999) showed that the use of flowable materials always led to higher percentages of marginal overhangs in beveled cavities *in vitro*. Moreover, higher viscous materials resulted in higher percentages of underfilled margins of beveled box-shaped cavities.[8] From a clinical study it was found that the majority of approximal composite resin restorations presented marginal overhang, which was also related to the anatomy of the restored tooth.[9] A study on the effect of different matrix systems showed more overhang formation at the margins when using plastic instead of metal matrices.[10] In this study the plastic matrices were combined with plastic (reflective) wedges. These wedges are very stiff and lack the ability of wooden wedges to adapt themselves to the natural anatomic tooth contour. As a result, these wedges can make contact to the matrix placed on the tooth at only one point and permit the development of large gaps between the matrix and the tooth at the critical cervical cavity margin and generates substantial overhang formation during restoration procedures. It is obvious that such an overhang at the approximal part will be difficult to detect and even more difficult to remove.

One of the goals in restorative dentistry is to re-establish a tight proximal contact together with an optimal marginal adaptation without overhang. In the past, good proximal contacts were difficult to create with composite resin, as this material cannot be condensed like dental amalgam. Now, with the help of special separation rings, tight proximal contacts can be established under *in vitro* and *in vivo* conditions.[11,12]

Besides the proximal contact tightness also the proximal contour of the restoration is important. A well-contoured proximal surface may help to prevent food impaction and will facilitate interdental cleaning, both important factors to maintain healthy interdental papillae.[13] These anatomically correct contoured restorations can be achieved when pre-contoured (sectional or circumferential) matrix bands are used for the restorative procedure.

The effect is of these modern matrix systems combined with separation rings on the formation of interproximal marginal overhang has not yet been evaluated. Therefore, the objective of this study was to compare *in vitro* interproximal overhang formation of Class II composite resin restoration using different matrix systems.

2. Materials and methods

To simulate the clinical situation and to standardize the restorative procedure a manikin model (KaVo, Dental, Biberach, Germany) was used. For the experiments the contact site between left second premolar and first molar in the lower jaw was selected. In the molar tooth an MO-preparation was made with a proximal box cavity of 5.0 mm in bucco-lingual, 6.0 mm in occlusal–gingival and 1.3 mm in mesial–distal dimension. The occlusal step was 4.5 mm in buccal–lingual width, 2.5 mm deep and 6.0 mm in mesial–distal width. This simulated an amalgam replacement situation. The margins of the box were prepared without a bevel. Using a copy-milling machine (Celay, Mikrona Technologie AG, Spreitenbach, Switzerland) the model was replicated, resulting in 240 identical preparations in artificial first molars. The prepared teeth were apically equipped with a stem-like anchoring system, which allowed some mobility of the tooth simulating normal physiological tooth mobility. Teeth were divided in 12 different groups ($n = 20$), each assigned to a specific matrix type as shown in Table 1. Table 2 summarizes the product profiles, LOT numbers and the characteristics of the materials used in the study.

Matrix bands were secured interdentally from the buccal side with wooden wedges (Slim-Jim, Wizard wedge) and in groups 4 and 6–12 a separation ring was placed. Then in all groups the contact area was burnished with a hand-instrument (PFI49) so that no visual space was left between matrix and adjacent tooth. All cavities were restored with an adhesive and a hybrid composite (Clearfil Photo Bond and Clearfil AP-X; Kuraray Medical, Tokyo, Japan). The adhesive system was mixed and applied in the preparation, gently air-dried and cured for 10 s with a halogen polymerization unit (PolyLux II, KaVo, light intensity 600 mW/cm^2). Subsequently, the composite resin was injected from the compule into the cavity in two horizontal increments. In groups 1–3 a hand-instrument (PFI49 or OptraContact) was used during polymerization of the first layer to apply pressure towards the distal contact area of the second premolar in order to obtain a solid proximal contact. Each increment was cured separately for 20 s from the occlusal surface. After removal of the matrix, restorations were post-cured for 20 s from the buccal and lingual side. Restorations were not finished or adjusted in order to prevent changes of the proximal surface. All restorations were placed by one operator and all measurements were performed blind by an independent observer.

Following the restorative procedure each tooth was removed from the manikin model and placed horizontally in a special mould made of polyvinylsiloxane (Express Putty STD, 3 M ESPE). Using a stereomicroscope (Leica MZ 12) standardized digital images were made of the proximal surface with a magnification of 7.89×, with the box placed horizontally. Leica Qwin software was used to measure digitally the total proximal restoration surface (mm^2) by marking the border of the restoration on the digital image.

Table 1 – Experimental groups in the study.

Groups	Matrix system
1	Tofflemire retainer + Tofflemire X-thin matrix + PFI49
2	Tofflemire retainer + 1101-c matrix + OptraContact
3	Tofflemire retainer + 1101-c matrix + PFI49
4	Tofflemire retainer + 1101-c matrix + Composi-Tight Gold ring
5	SuperCap matrix
6	SuperCap matrix + Composi-Tight Gold ring
7	Contact Matrix System Stiff Flex matrix + Composi-Tight Gold ring
8	Palodent Standard Matrix + Composi-Tight Gold ring
9	Contact Matrix System Stiff Flex matrix + Contact Matrix ring
10	Palodent Standard Matrix + Contact Matrix ring
11	Contact Matrix System Stiff Flex matrix + Palodent BiTine ring
12	Palodent Standard Matrix + Palodent BiTine ring