

Restoration removal with and without the aid of magnification

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SUMMARY This study aims to quantify any cavity size change following removal of tooth-coloured restorations *in vitro* using unaided vision and 2.6× magnification. Occlusal composite restorations were removed under simulated clinical conditions and changes in cavity size were measured, blind to method, using standardized photographs. The outline of the cavity was digitized and its area was used as a surrogate for cavity size. The change in cavity size was determined for unaided vision and 2.6× magnification, with any differences between the

techniques investigated. There were significant increases in cavity size using both techniques and although the increase in size was less when magnification was used, the difference was not statistically significant. Cavity size changes significantly during re-restoration and the use of magnification may be of benefit for some clinicians in reducing the size of the change.

KEYWORDS: conservative dentistry, magnification, operative dentistry, re-restoration, vision and cavity enlargement

Introduction

Replacement of restorations is one of the most commonly performed tasks by general dental practitioners. In fact, more replacement restorations are provided, by General Dental Practitioners in the United Kingdom, than first time restorations (Wilson *et al.*, 1997) and the total NHS cost for all simple restorations in Scotland for the year 1996–97 was over £25 million (Scottish Dental Practice Board, 1997). It has been proven that each time a restoration is removed, sound tooth tissue is also removed and the cavity is enlarged (Millar *et al.*, 1992). This will lead to a larger filling being inserted, irrespective of caries development, which in time will need to be replaced and so the cycle of ever enlarging restoration continues. If more sound tooth tissue could be preserved, there would be a better chance of the restoration lasting longer and therefore the cycle of re-restoration could be slowed down. This would have considerable benefits, both to the patient and financially to the dental service providers. With the advent of 'preventive' approaches to conservative (or preservative) treatment, there has been a large increase

in the use of tooth-coloured filling materials which bond to the tooth. Removal of these restorations is far more difficult than removal of amalgam restorations which have no inherent retention and can easily be differentiated from the tooth. There are few studies examining replacement of tooth-coloured restorations and none principally considering the role of magnification in this process.

The aim of this study was to quantify the change in cavity size during re-restoration of occlusal composite restorations when unaided vision and 2.6× magnification were used.

Materials and methods

This study was undertaken in three phases: (1) a pilot study phase to test the study design and provide data allowing a power calculation to estimate the number of teeth needing to be re-restored in the main study; (2) a main phase designed to answer the research question and (3) a final phase to help interpret the results from the main study. All phases used different clinicians but followed the same protocol as detailed below.



Fig. 1. A model with prepared cavities.

To allow insertion of the teeth into a mannequin with the correct anatomical arrangement, extracted teeth were placed into a rubber mould and dental stone* was poured in after the crowns of the teeth had been coated in cold mould seal. Upon setting, the models (Fig. 1) were removed from the mould and trimmed in the occlusal plane so that when upper and lower models were inserted into the phantom head† the distance between the upper and lower first premolar teeth was 45 mm.

An occlusal cavity (Fig. 1) was prepared in each tooth using an air rotor with water spray and a size 14 diamond bur‡. The cavities were then photographed and after developing, their outline was digitized from the prints into a drawing and analysis package (NIH Image) and the area of each cavity was measured in mm².

The teeth were then restored using visible-light cured composite resin with an acid-etch technique. The preparations were not bevelled, no bonding agent was used and no attempt at accurate shade matching was undertaken. The restorations were then removed with an air rotor with water spray and a size 14 diamond bur using unaided vision or 2.6× magnification while the models were in the mannequin. The new cavities were photographed and measured in the same way as

described above. The data were entered into a statistical package (SPSS) and analysed.

In the pilot study, four teeth were re-restored using each method and only one clinician removed the restorations. The number of teeth calculated to be necessary for the main study was 46 with $\alpha = 0.05$, $\beta = 0.8$ and $\delta = 0.47$ (the difference found in the pilot study).

The main phase, that followed the same protocol, utilized 24 models that provided 48 restored teeth in 12 'mouths'. The removal of the restorations was undertaken by clinicians 1 and 2 aged 58 and 27 years, respectively. Neither of them had previous experience in the use of magnification and no training time was allocated. The models were allocated randomly such that each operator would remove 12 restorations (three mouths) using each technique. The unaided vision removal was undertaken prior to magnification.

To assist in the interpretation of the results from the main study, it was decided to investigate some potential confounding factors. Two more clinicians (numbers 3 and 4) were recruited for the study and undertook removal of restorations on new models which were prepared in the same manner as described above. These clinicians were approximately age matched to the initial clinicians, in addition, they both had experience of using magnifying loupes.

Results

It was possible for a clinician not to remove all the restoration and therefore, cavities could either increase or decrease in size. For the purpose of this study, where there was no caries associated with the restorations, no change in cavity size was considered ideal and therefore absolute cavity size change will be considered. The accuracy of the measuring technique was tested by measuring the area of a circle of known radius (2.125 mm), the error between the actual and the mean digitized area was found to be 0.4%, 14.18 versus 14.24 mm², respectively. The results detailed below are those of clinicians 1 and 2 only.

Unaided vision

The mean cavity size prior to removal of the restorations, with unaided vision was 7.97 mm² (s.d. 1.54 mm²). Upon removal of the restorations, the mean size of the cavity was 8.95 mm² (s.d. 1.99 mm²). The

*Vel-mix, Kerr, Peterborough, U.K.

†Nissin Dental Products, Kyoto, Japan.

‡Komet, Lemgo, Germany.

mean cavity size change was 19.7% and this represented a significant change ($P = 0.007$, paired t -test). There was no significant difference in cavity size change between the clinicians ($P = 0.87$, independent t -test).

2.6× magnification

The mean cavity size prior to removal of the restorations, with the aid of 2.6× magnification was 8.36 mm² (s.d. 1.8 mm²). Upon removal of the restoration the mean cavity size was 8.72 mm² (s.d. 2.2 mm²). There was no significant change in mean cavity size during re-restoration ($P = 0.25$, t -test). However, this was because similar numbers of cavities increased and decreased in size and when they are considered separately there was a significant change in cavity size ($P < 0.01$, t -test). For clinician 1, the mean cavity size change was 8.73% (s.d. 8.14%) and the corresponding value for clinician 2 was 19.39% (s.d. 16.16%). There was a statistically significant difference between clinicians ($P = 0.05$, independent t -test). Table 1 provides a summary of the results for each clinician.

Comparison of techniques

One of the main aims of this study was to determine whether the use of magnification reduced the cavity size change during re-restoration compared with

normal vision. There was no significant difference in the size of the restorations being re-restored by either technique ($P = 0.42$, t -test).

Clinician 1 produced a significantly smaller cavity size change with magnification than with unaided vision ($P = 0.023$, t -test), whereas for clinician 2, although magnification produced a smaller cavity size change than normal vision, the result was not significant ($P = 0.90$, t -test). When the data for both clinicians was combined, there was no significant difference in cavity size change when comparing unaided vision and 2.6× magnification ($P = 0.17$, t -test).

To assist in interpreting the different results found for the two clinicians, two further volunteers, with experience of magnification, were recruited into the study. The additional clinicians were eyesight matched to the original clinicians, as the potential reason for the difference between the two main clinicians was their ability to focus unaided on close objects. The additional clinicians found that there were significant changes in cavity size with both unaided vision and 2.6× magnification but that there was no significant difference between the techniques (Table 2).

Discussion

This study followed a similar measurement protocol to other workers investigating cavity enlargement (Millar

Table 1. Absolute cavity size change, clinicians 1 and 2

| Operator | Unaided vision | | | 2.6× magnification | | |
|----------|-----------------|-----------------|------------------|--------------------|-----------------|------------------|
| | % Change (s.d.) | Number enlarged | Number decreased | % Change (s.d.) | Number enlarged | Number decreased |
| 1 | 19.22 (12.41) | 8 | 4 | 8.73 (8.13) | 8 | 4 |
| 2 | 20.23 (16.94) | 11 | 1 | 19.39 (16.16) | 5 | 7 |
| 1 + 2 | 19.7 (14.5) | 19 | 5 | 14.1 (13.6) | 13 | 11 |

% change = mean absolute % change in cavity size; number enlarged = number of cavities that enlarged; number decreased = number of cavities that decreased in size.

Table 2. Absolute cavity size change, clinicians 3 and 4

| Operator | Unaided vision | | | 2.6× magnification | | |
|----------|-----------------|-----------------|------------------|--------------------|-----------------|------------------|
| | % Change (s.d.) | Number enlarged | Number decreased | % Change (s.d.) | Number enlarged | Number decreased |
| 3 | 33.2 (19.9) | 9 | 3 | 36.8 (21.4) | 7 | 1 |
| 4 | 36.9 (23.2) | 4 | 0 | 47.7 (18.2) | 3 | 1 |

% change = mean absolute % change in cavity size; number enlarged = number of cavities that enlarged; number decreased = number of cavities that decreased in size.

et al., 1992; Cruickshank, 1998) and the mean cavity size change measured in this study (19.7%) lies between the findings of these authors. However, this is the first study to focus on occlusal restorations and to compare the use of magnification with unaided vision.

When the results from all four clinicians are considered, there appeared to be some difference in cavity size change between clinicians. However, the range for each clinician is large (Tables 1 and 2) and therefore there is no significant difference between clinicians for unaided vision ($P = 0.10$, ANOVA). However, when the use of 2.6× magnification was considered, there were significant differences between the four clinicians ($P < 0.001$, ANOVA).

Possible reasons for the large range of cavity size changes include the non-uniformity of cavities and different positions in the mouth. Although they were not of uniform size, all cavities were confined to central areas of the occlusal surface and there were no significant differences in the size of restorations replaced by different clinicians or by either technique. Moreover, no significant differences in cavity size change following re-restoration were found between the different quadrants ($P = 0.97$, ANOVA).

The results from the main study indicated that the use of magnification did not significantly alter the cavity size change, compared with the use of unaided vision during re-restoration, although there were conflicting results from the two clinicians. Clinician 1 showed a significant reduction in cavity size change with the use of magnification, whereas clinician 2 showed a non-significant decrease in cavity size change with magnification. It was postulated that a potential reason for the difference between the two main clinicians was the difference in their ages, 58 years (clinician 1) compared with 27 years (clinician 2), and hence their ability to focus on close objects. Clinician 2 was able to work close to the mannequin, thereby achieving postural magnification, whereas clinician 1, who required reading glasses, with a fixed focal length, was not. The restriction of movement as a result of narrow depth of field and longer working distance when using 2.6× magnification would prevent clinician 2 from achieving postural magnification by moving closer to the task. Therefore, the benefit of using magnification to improve vision would, on a theoretical basis, appear to be greater for clinician 1 than for clinician 2. However, clinician 4 who also required reading glasses found no significant difference between 2.6× magnifi-

cation and unaided vision and therefore, the significant difference between clinicians 1 and 2 cannot be explained by a difference in age or visual acuity.

This study used one level of magnification (2.6×) and this may not have been optimal. The decision to use 2.6× magnification for this study was evidence-based as it has been found to perform well for other clinical tasks (Forgie *et al.*, 1999). Furthermore, this level of magnification is easily accepted by inexperienced users whilst still giving a noticeable level of magnification for the clinician. Subjectively, all the clinicians reported that magnification eased the task and were in favour of its use during routine conservative work.

When investigating any clinical task, it is essential to assess the clinical significance of the findings in addition to the statistical analysis. In this study, magnification has been shown to decrease the cavity size change by about 5% compared with unaided vision and whilst it is difficult to predict the importance of this reduction, it is clear that over the course of a practising career, the effect will be positive. However, this study has also shown that the benefit of 2.6× magnification varies between clinicians and it would therefore seem prudent for individuals to test different levels of magnification to find the most suitable power, if any, for their individual requirements.

Conclusions

There was a significant change in cavity size during removal of a class I composite restoration with both unaided vision and 2.6× magnification. The range in cavity size change was large for both techniques, however, the use of 2.6× magnification led to a decrease in cavity size change compared with unaided vision which was found not to be statistically significant using this study design. When considering the large numbers of restorations replaced by a clinician in their career, any improvement could be considered clinically important.

Acknowledgments

The authors would like to acknowledge the help of the four clinicians who removed the restorations. Professor Pitts acknowledges support from the Chief Scientist Office of the Scottish Office. The views expressed are those of the authors and not necessarily those of the Scottish Office.

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