RESEARCH

Effect of The Use of Dental Loupe on Cavity Size After Removal of The Aged Composite Resin Restorations

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ABSTRACT

Effect of The Use of Dental Loupe on Cavity Size After Removal of The Aged Composite Resin Restorations

Background: The aim of the present study was to evaluate the effects of removal of artificially aged and non-aged resin composite restorations in-vitro with or without aid of dental loupe on cavity size change.

Methods: A low-speed hand piece was used to prepare occlusal cavities in 32 acrylic molar teeth. The size of cavities after cavity preparation were calculated using ImageJ software. The teeth were restored with composite resin and divided into four groups according to the use of dental loupe (2.5x magnification) (with and without magnification) and ageing effect (non-aged and aged). In order to simulate the ageing effect, samples were kept in boiling water for 8 hours. The effects of artificial ageing on the color and translucency of the resin composites used were also analyzed using spectrophotometer. Cavity sizes after the removal of restorations were re-calculated by using the ImageJ software and differences in cavity sizes were also calculated. Paired t-tests were applied to data ($P < 0.05$).

Results: There were significant increases in cavity size using both techniques and both type of restorations although the size increase in percentage was less only when magnification was used during removal of non-aged restorations.

Conclusion: Cavity size changes significantly during the replacement of restorations and the magnification technique may not be useful to minimize the size of cavity in the removal of aged resin composite restorations.

KEYWORDS

Magnification, Dental Loupe, Restoration Replacement, Cavity Enlargement

ÖZ

Dental Lup Kullanımının Yaşlandırılmış Kompozit Rezin Restorasyon Değişimi Sonrasında Kavite Boyutu Üzerindeki Etkisi

Amaç: Bu çalışmanın amacı, in-vitro olarak yapay olarak yaşlandırılmış ve yaşlandırılmamış rezin kompozit restorasyonların dental lup yardımıyla veya dental lup kullanılmadan uzaklaştırılmasının kavite boyutu değişikliği üzerindeki etkilerini değerlendirmektir.

Gereç ve Yöntemler: Düşük hızlı mikro-motor ile 32 adet akrilik molar dişte oklüzal kaviteler hazırlandı. Kavite hazırlandıktan sonra kavitelerin boyutu ImageJ yazılımı kullanılarak hesaplandı. Kaviteler kompozit rezin ile restore edildikten sonra dental lup kullanıma (2.5x magnifikasyon) ve yaşlandırma etkisine göre dört gruba ayrıldı. Yaşlandırma etkisini simüle etmek için örnek 8 saat kaynar suda bekletildi. Yapay yaşlanmanın da kullanılan rezin kompozitin rengi ve translüsentliği üzerindeki etkileri spektrofotometre kullanılarak analiz edildi. Restorasyonların uzaklaştırılmasından sonra kavite boyutları ImageJ yazılımı kullanılarak yeniden hesaplandı ve kavite boyutlarındaki farklılıklar hesaplandı. Verilere bağımlı örneklem t testleri uygulandı ($P < 0.05$).

Bulgular: Her iki teknik ve restorasyonda da kavite boyutlarında anlamlı artışlar olmasına rağmen, kavite boyutu artışı yaşlandırılmamış restorasyonların uzaklaştırılasında dental lup kullanıldığında daha az olmuştur.

Sonuç: Restorasyon uzaklaştırılması sırasında kavite boyutu anlamlı olarak değişmektedir, ve dental lup kullanımı yaşlandırılmış rezin kompozit restorasyonların uzaklaştırılmasında kavite boyutunun artmasını azaltmada fayda sağlamayabilir.

ANAHTAR KELİMELER

Magnifikasyon, Dental Lup, Restorasyon Uzaklaştırma, Kavite Genişlemesi

INTRODUCTION

The use of resin-based restorative materials, both in the anterior and posterior regions, has increased in recent years. However, the restorations can be unsuccessful due to different reasons and need to be replaced. Unfortunately, the removal and renewal of old restorations cover a significant part of the practical time of dentists. In the literature, it is stated that the dentists spend about half of their time on the renewal of old restorations. In addition, it is reported that these restoration renewals bring huge burdens on health care service providers of countries.[1]

It is a well-known fact that the size of a cavity which is formed expands after the restoration renewal. Since there is an inverse relationship between the size and longevity of the restorations, this could lead to the loss of the restored tooth in a shorter period. Besides, restoration renewal takes too much time and causes discomfort for

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patients. If more dental tissue can be preserved during restoration replacement, the restored teeth may survive longer. It is clear that this has benefits for both the patients and the health care service providers.

As a result of the improvements in preventive approaches in restorative dentistry, there has been a significant increase in the use of resin composite restoratives that can bond to the tooth tissue. However, it is much more difficult to remove these restorations from the tooth without causing unintended sound tissue damage than removing an amalgam[4] because these restorations bond to dental hard tissues much stronger than amalgam restorations.. Furthermore, when the resin composite and dental tissues have good color matching, it is difficult to distinguish the resin composite from the tooth tissue during removal of the old composite restoration. Hunter et al.[5] stated that removal of resin composite restorations provides significantly larger cavities than does removal of amalgam.

The use of optical magnification equipment such as magnifying loupes is increasingly growing in dental practice and dental education.[6-8] Scientific evidence is unclear about their benefits. It is generally stated that improving the visual acuity by using magnification in dental procedures increases the quality of treatment and modifies decision-making behavior of dentists.[7] Several studies also indicate the benefits of magnifying loupes for the education of dental students.[6,9] Maggio et al.[6] reported that dental magnification loupes significantly enhanced student performance during preclinical dental education and were considered an effective adjunct by the students who used them. Leknius et al.[9] also stated that students using magnification in crown preparation made fewer mistakes than students who did not. Fergie et al.[10] reported that the use of magnification in the removal of composite fillings reduced unintended sound tissue damage. However, some studies show the use of magnification is not as beneficial as suggested. Donaldson et al.[11] reported that the use of magnification did not provide significant benefit in pediatric procedures. In their study, Lussi et al.[12] reported that the use of magnification was not effective in decreasing the iatrogenic damage to the adjacent tooth during cavity preparation.

With the ageing process of the resin composite material over time, the aesthetic properties of restorations deteriorate. Therefore, optical properties of a restoration become worse than a new one, making it easier to distinguish from the tooth tissue. In a previous study, Fergie et al.[10] used magnification to remove non-aged composite restorations having good color match and reported that cavity size changes dramatically during restoration and the use of magnification may be of benefit for some clinicians in reducing the size of the change.

To the best of our knowledge, a study investigating how the use of magnification during removal of aged composites affects the size of the cavity is not available yet. In this study, it has been assessed whether the use of 2.5x magnification in the removal of artificially aged composite restorations has an effect on the change in cavity size.

MATERIAL AND METHOD

Study Design

In this study, the use of a dental loupe with 2.5 x magnification (with and without) and artificial ageing effect (with and without) are independent variables. The cavity size (mm) is the dependent variable. Also, opacity and transparency measurements were performed to determine whether the artificial ageing had a change in the color and transparency of the composite used.

Cavity Preparations and Measuring Cavity Sizes

In order to determine how many teeth to use per group, a power analysis was planned and a pilot study was performed. The pilot study used four teeth fitted to the phantom jaws for each group. While the teeth were in the phantom head, the cavity preparations were performed with a low-speed rotary instrument. Steel round and cylindrical burs were used. Black I occlusal cavities were prepared in the first and second molar teeth in four dental arches. After the preparations were finished, the phantom jaws were removed from the phantom head. With the digital camera, photographs of each cavity were taken from certain distance, and outline of each cavity was recorded and area of each cavity was calculated with ImageJ software (NIH, http://rsb.info.nih.gov/ij/). The focus distance had determined by the clear appearance of the cavity in the photograph and kept fixed for all shots. The phantom jaw was repositioned on the phantom head. Then, a self-etch adhesive (Clearfil SE Protect Bond, Kuraray, Osaka, Japan) was applied. The adhesive was applied to better bond the composite to the artificial tooth tissue.[4] The visible-light cured resin composite (Nova Compo, Imicryl, Konya, Turkey) was matched with the color of the artificial tooth (A1). The resin composite was then placed with the layering technique and the restoration was finished. In the groups using magnification, the operator removed the composite restorations with a high-speed rotary instrument by using a dental loupe with 2.5x magnification. In the other group, the same operator removed the restorations with a high-speed rotary instrument under water cooling without using the dental loupe. Round and cylindrical diamond burs were used. After removal of the resin composite restorations, the phantom jaws were removed again from the phantom head and photographs of the cavities were taken from the same distance again. In order to determine change in cavity

size after resin composite removal, outline of each cavity was recorded and area of each cavity (mm^2) was re-calculated on photographs with the ImageJ program (Figure 1).

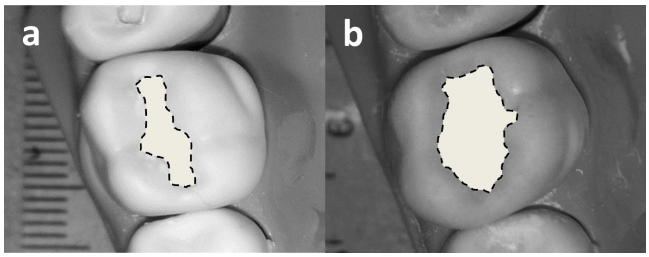

Figure 1

Representive photographs show outlines of cavities before (a) and after removal of resin composite restoration (b).

Three measurements were averaged. Paired t-tests were applied to data per group ($P < 0.05$). All calculations were performed using a software package (SPSS 17.0 for Windows, SPSS Inc., Chicago, IL, USA).

According to the results of the pilot study, the number of teeth to be used in each group in the main study was determined as at least seven by using G*Power version 3.1 Program (Kiel, Germany). ($\alpha=0.05$, power $(1-\beta) =0.80$ at a confidence level of 95%). However, eight molar teeth (upper and lower first and second molars) were used for each group. The same protocol described before was followed in the main study. In the ageing groups, the teeth with resin composite restorations were placed in the phantom head again after artificial ageing and the same procedures was carried out. Resin composite restorations were immersed in boiling water and throughout 8 hours they were expected to be artificially aged. All restoration removal operations were performed by a single operator using a dental loupe for more than 5 years.

Color Measurements

The color properties of ten cylindrical composite discs (A1, Nova Compo, Imicryl, Konya, Turkey) were measured three times with spectrophotometer (Vita Easyshade V, Vita Zahnfabrik, Bad Säckingen, Germany) according to the CIE L*a*b system and they were averaged. Dimensions of each disc were 2 mm in height and 8 mm in diameter. The color readings were performed by placing the composite discs against a white standard background, and to assess opacity, readings were performed by placing the test specimens against a white and black standard background, considering the coordinate L* only. After the initial readouts, these samples were immersed in boiling water for 8 hours and then left at room temperature for 2 weeks in distilled water. After ageing, the color properties of the samples were measured again with the same protocol. Initial color (E1) and post-ageing color (E2) were calculated by the formula $E = [(L^*)2 + (-a^*)2 + (b^*)2)]1/2$. Color alteration (ΛE) was calculated by formula $\Lambda E = E2 - E1$. Values of $\Lambda E \geq 1.23$ were considered clinically unacceptable.[15] The opacity was calculated according to the formula: Opacity = L*b/L*w, where L*b and L*w correspond to the coordinate L* readout against the black and white background, respectively. The opacity variation (ΛOP) was calculated from the difference between the opacity readings before (initial opacity) and after ageing (final opacity). The paired t-test was used to analyze the effect of ageing on the color and opacity of the resin composite at a confidence interval of 0.05 using the SPSS program.

RESULTS

Table 1 shows a summary of results. Initial cavity size mean without magnification was 16.03 ± 3.3 and cavity size mean after removal of non-aged resin composite restoration was 22.18 ± 3.7 The cavity change mean was 38.3 % and this was a significant change (P=0.000, paired t-test). Initial cavity size mean with magnification was 16.40 ± 2.1 and cavity size mean after removal of non-aged resin composite restoration was 20.43 ± 4.6 mm2. The cavity change mean was 24.6 % and this was a significant change (p=0.018, paired t-test). The findings show that the use of magnification in the removal of non-aged restorations cannot significantly prevent the increase in cavity size. However, magnification aid the percentage in cavity size change.

Table 1.

Cavity size differences (n=8)

Group no	Procedures	Cavity size (mm2)			Change
		Initial	After		%
1	Removal non-aged restoration without magnification	16.03 ± 3.3	22.18 ± 3.7	*p=0.000	38.3
2	Removal non-aged restoration with magnification	16.40 ± 2.1	20.43 ± 4.6	*p=0.018	24.6
3	Removal aged restoration without magnification	17.13 ± 2.9	22.05 ± 4.9	*p=0.008	28.8
4	Removal aged restoration with magnification	16.62 ± 3.2	21.11 ± 3.1	*p=0.005	27.1

** indicates significant differences within the same row (p<0.05).*

Initial cavity size mean without magnification was 17.13 ± 2.9 and cavity size mean after removal of aged resin composite restoration was 22.05 ± 4.9 The cavity change mean was 28.8 % and this was a significant change (p=0.008, paired t-test). Initial cavity size mean with magnification was 16.62 ± 3.2 and cavity size mean after removal of non-aged resin composite restoration was 21.11 ± 3.1 The cavity change mean was 27.1 % and this was a significant change (P=0.005, paired t-test).

Results of color measurements revealed that there were significant differences in color changes and opacity variation after artificial ageing regime (Table 2).

Table 2.

Color stability of resin composite after artificial ageing (n=10)

Color	Initial E (E1)	Post-ageing E (E2)	p	ΔE
	79.60	82.40	p=0.000*	2.80
Opacity	**Initial OP**	**Final OP**		**ΔOP**
	1.09	1.07	p=0.001*	-0.14

** indicates significantly different within the same row (p<0.05).*

DISCUSSION

The effects of dental loupes using magnification on the change of the cavity size after the removal of new or artificially aged restorations were investigated in the present study. As far as we know, there is limited research in the literature. Our findings suggested that regardless of whether the restoration was removed with aid of magnification or not, and restoration was a new or aged one, removal of restoration expands cavity size significantly. This is well-correlated with the literature, as it is frequently reported that replacement of old restoration inevitably results in larger restoration.[4,18] Due to the limited research on this subject, it was difficult to compare our results with other articles. Szep et al [17] evaluated the effects of changing the restorations using three different restorative materials on cavity size. The researchers stated that restoration replacements increased cavity sizes. However, in case of the removal of new resin composite restoration with good color match and bonding to tooth tissues, the use of magnification during removal expanded the size of the cavity less. This finding is supported with the results of the study of Forgie et al.[10] When we remove the resin composite restoration which is recently made and have good color-match, resin composite and tooth tissue may not be distinguished from each other without using dental loupe magnification. The other subject in our present study was the use of magnification in removal of the aged resin composite restoration which has bad color match. This study showed that the use of magnification did not have any benefit in the removal of the old restoration. As a result of the hydrolysis and thermal exposures of resin composite in the oral environment, the color match deteriorates. Thus, it can be to distinguish with the naked eye and it may not be necessary to use magnification. In order to obtain old resin composite restorations, we conducted an artificial hydro-thermal ageing regime to age resin composite in-vitro. [18] Our findings of color measurement showed that immersion of resin composite in boiling water for 8 h than storing in water for 2 weeks significantly reduced color properties of resin composite used in this study.

In this study, a dental loupe with magnification of 2.5x was used as an aid for removal of resin composite restorations. The reason for using this type of magnification is that is widely used in dentistry and sufficient for many clinical applications.[8] Furthermore, this level of magnification is easily accepted by inexperienced users whilst still giving a noticeable level of magnification for the clinician.[10] One limitation of this study was that acrylic teeth were used for cavity preparations instead of natural teeth. While the tactile feeling of natural teeth is superior, acrylic teeth also have some advantages. Acrylic teeth have a standard contour and anatomy. This helps the prepared cavities to be standard. However, as a result of increased emphasis on preventive dentistry and infection control, it is now difficult to collect natural teeth in the faculties of dentistry. It seems that for these reasons, acrylic teeth were also used in the literature as an alternative to natural teeth.[4] However, future studies should evaluate the magnification and ageing effect on natural teeth, in order to confirm these results.

CONCLUSION

Removal of old or new resin composite restorations both with and without the aid of 2.5x magnification increased the size of the cavity significantly. For non-aged composite restorations, the use of magnification allowed for less expansion of the cavity size, but this benefit was not observed for removal of aged resin composite restorations.

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Conflicts of interest

There are no conflicts of interest to declare.

Author Contributions

M.K.A., P.G. and D.W. have contributed equally to this research

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