Effects of Reduced Light through Zirconia on the Interfacial Adaptation

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Introduction

The intensity of curing-light penetrating a restoration is reduced depending on the thickness of the restorative material. The reduced light can decrease the degree of conversion of the resin cement. Poorly polymerized resin cement may result in higher interfacial gap.

A universal adhesive for resin cement can be light-cured in two different methods; with a pre-cure method or with a co-cure method. In the pre-cure method, the adhesive is light-cured before the cement placement. In the co-cure method, the adhesive is not light-cured prior to the cement placement, but instead after the cement is applied with a restoration, the adhesive and cement are simultaneously light-cured.

When a restoration is to be cemented by the pre-cure method, care should be taken. If a small amount of adhesive pools in the line angles of prepared cavity and is polymerized, the pre-cured adhesive prohibits accurate restoration seating. Therefore, for good adaptation without interference, it should be determined under what conditions the co-cure method may be applied effectively.

Purpose

The first objective was to determine if the dual-curing of resin cement with reduced light through zirconia could affect interfacial adaptation of restoration. The second objective was to investigate whether pretreatment methods using universal adhesive affected interfacial adaptation.

Materials and Methods

1. Specimen preparation

The setup employed in this study is schematically illustrated in Fig. 1. Extracted non-carious human third molars were used (n=48). After the occlusal surface of the tooth was made flat, cylindrical Class I cavity was prepared. The dimensions were 3 mm in diameter and 1, 2 or 3 (each) mm in depth depending on the Group. The tooth specimen was cut 1 mm below CEJ (cemento-enamel junction). Then, the cervical base of each tooth was also made flat until the remaining dentin thickness of the cavity base was 0.4 mm.

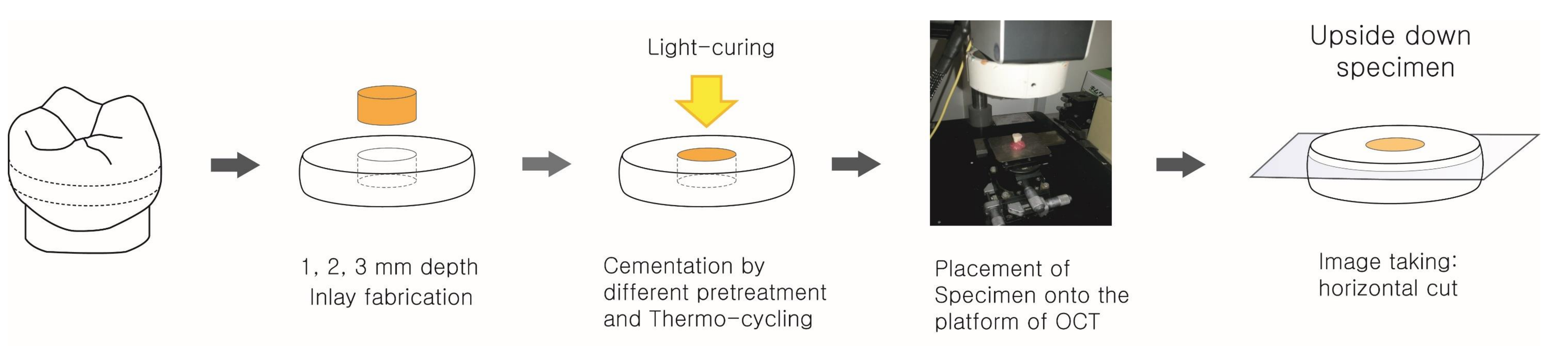

Fig. 1. Experimental procedure of this study

2. Groups and restorative procedures

The teeth were divided into three experimental groups:

Groups I, II, and III in which the restoration thicknesses were 1, 2, and 3 mm. Each group had two subgroups according to different pretreatment methods. For subgroup 1, universal adhesive (SBU, Single Bond Universal, 3M ESPE) was applied and light-cured before cement placement. Then, the zirconia restoration was placed with resin cement (RXU, RelyX Ultimate, 3M ESPE) and light cured. For subgroup 2, the same universal adhesive was applied, however, light-curing was done after RelyX Ultimate cement and zirconia restoration placement. For Self-cure group, a zirconia restoration was cemented using the same adhesive (SBU) and cement (RXU) by self-curing.

3. Thermo-cycling procedure

The specimens were fatigued with 10,000 thermo-cycles between 5°C and 55°C at a dwell time of 30 s per temperature and a transfer time of 5 s between water bathes.

4. SS-OCT imaging and analysis

A swept-source OCT system (Santec OCT-2000, Santec Co., Komaki, Japan) was used. Because the imaging depth of the SS-OCT is known to be about 2 mm, the specimen was positioned upside down to take the image at the interface. The first horizontal image was obtained parallel to the cavity floor at 5 µm below the cavity base. A total of seven images were taken for each specimen at 15 µm intervals.

OCT raw data were imported into image analysis software (ImageJ™, National Institutes of Health). Presence of air or water, which means a microgap between the tooth material and restorative material, is visualized as bright spots on the SS-OCT image (Fig. 2).

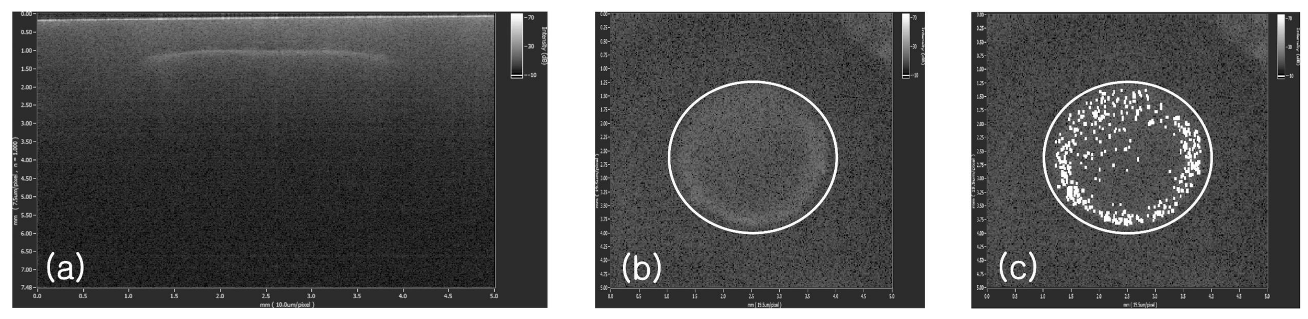

Fig. 2. SS-OCT images of a specimen upside down

(a) Lateral cross-sectional image of a specimen in an experimental group (b) Horizontal cross-sectional image in the cement space. White circle represents the cavity border. (c) The same image as in (b) processed by GapAnalyzer. The white dots on the image are the pixels which have a higher signal intensity than the threshold, indicating a microgap.

For quantitative analysis, images were processed by GapAnalyzer, a plug-in software . The interfacial adaptation (HB%) was calculated to indicate a microgap at the cavity floor. It was defined as the percentage of brighter pixels with higher signal intensity above the threshold value. Higher HB% indicates inferior interfacial adaptation.

5. Statistical Analysis

The interfacial adaptation (HB%) was evaluated using two-way ANOVA to check the effect of cavity depth, pretreatment, and their interaction. For comparison of the effects of cavity depth, one-way ANOVA and Scheffe's test were performed (Table, each row). For comparison of the effects of pretreatment in each Group, independent t-test was performed (Table, each column).

Results

Table Interfacial adaptation (HB%) by different pretreatment for each group

	Group I (1 mm)	Group II (2 mm)	Group III (3 mm)	Self-cure
Cement with pre-cure	15.8 (3.8)[c,A]	17.3 (3.7)[c,A]	22.0 (3.8)[b,A]	28.5 (4.0)[a,A]
Cement with co-cure	16.3 (3.8)[c,A]	17.9 (3.5)[c,A]	24.2 (3.8)[b,B]	34.2 (4.1)[a,B]

Numbers in parentheses are standard deviations.

Values followed by the same lowercase letters in each row are not significantly different (one way ANOVA and Scheffe's test, $p>0.05$).

Values followed by the same capital letters in each column are not significantly different (independent t-test, $p>0.05$).

Conclusion

Interfacial adaptation of zirconia restoration can be different depending on the restoration thickness, pretreatment, and activation mode. Lower irradiance by reduced light through zirconia may lead to inferior adaptation of the restoration with resin cement.