Influence of a Vent Hole on the Retentive Force of a Cement-retained Superstructure before/after Thermocycling

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Clinical significance
 Provision of a vent hole in a cement-retained superstructure is considered to be useful in the cementing of fixed prostheses. It remains under debate whether provision of a vent hole results in not only dissolution of the cement material, but also decrease of the retentive force of the restoration. This study examined the influence of a vent hole on the retentive force of a restoration, and the results suggested that the retentive force of superstructures with a vent hole was equal to or better than that of those without a vent hole, both before and after thermocycling.

Abstract
Purpose: The purpose of this study was to evaluate the influence of a vent hole on the retentive force of a cement-retained superstructure to an abutment.
Methods: The retentive force of superstructures with/without a vent hole, retained using one of two luting cements, was measured using a universal testing machine both before and after thermocycling.
Results: The retentive force of the cement-retained superstructure with the vent hole was greater than that of the cement-retained superstructure without the vent hole. While the retentive force decreased significantly after thermocycling, the size of the vent hole had little influence on the retentive force.
Conclusion: It was concluded that placement of a vent hole in the superstructure is useful, with little adverse effect on the retentive force of the restoration.

Key words: retentive force, cement-retained superstructure, vent hole, thermocycling

Introduction
 Implant therapy has gained wide recognition as a viable prosthetic option. With the increasing number of edentulous patients requiring treatment, cement-retained prostheses have become popular because of the easy laboratory work, easy control of occlusal contacts, good restoration aesthetics, and low cost.

Use of a cement-retained superstructure results in minimal marginal discrepancy, with complete filling of the space between the superstructure and the abutment by cement material. The seating of the cement-retained superstructure on the abutment is, however, often arrested at the axial wall, where the superstructure has an excellent fit with low taper of the abutment. The placement of a cement space was demonstrated to be effective in relieving the difficulties associated with seating of the superstructure. Provision of a vent hole on the axial surface of the superstructure has been proposed as a useful technique to allow escape of the cement residues in cement-retained restorations.

A vent hole about 0.8 mm in diameter is recommended in clinical practice. With larger vent holes, the amount of surplus cement may increase, however, the retentive strength of the restoration may be adversely affected and the dissolution of the cement material may increase. There is little evidence to support the merits and demerits of the placement of a vent hole in cement-retained superstructures. The purpose of this study was to evaluate the influence of a vent hole on the retentive force of a cement-retained superstructure on the abutment before/after thermocycling.
Materials and methods

A mandibular acrylic resin model with a single missing tooth was fabricated, as shown in Figure 1. One implant (STERI-OSS® CAT No.3912HL. Nobel Biocare, Yorba Linda, CA, USA) was placed in the second premolar region and the abutment (STERI-OSS® CAT No.2235. Nobel Biocare, Yorba Linda, CA, USA) was connected to the implant. A single-unit cement-retained superstructure was fabricated using an Au-Ag-Pd alloy (Castwell MC®, GC Co., Tokyo, Japan) according to a standard protocol at our dental laboratory: autopolymerizing acrylic resin (Pattern Resin®, GC Co., Tokyo, Japan) was mixed and flowed into the abutment with a chamfer margin design. Casting wax Green (MDL Inc., WA, USA) was used to refine the superstructure on the polymerized acrylic resin. After casting, the abutment was removed from the implant and attached to an implant replica.

After the luting cement was mixed in accordance with the manufacturer’s instructions, it was applied to the inner aspect of the superstructure in the same way for each measurement. During cementation, a static load of 49 N was applied vertically to the center of the abutment. Two cement materials were used: eugenol-free temporary cement (Freegenol temporary pack®, GC Co., Tokyo, Japan) and polycarboxylate temporary cement (Hy-Bond temporary cement soft®, SHOFU, Kyoto, Japan). Three test superstructures were fabricated and tested. The results of a preliminary experiment revealed no significant differences in the retentive force among the three types of superstructure.

First, the retentive force of each test specimen was measured after the superstructure without a vent hole was cemented using either one of the two luting cement materials. Thereafter, the measurements were conducted for the superstructures with a vent hole, while increasing the diameter of the vent hole in 0.1-mm increments from 0.8 mm to 1.0 mm; the hole was positioned at the corner between the lingual surface and proximal surface, at a distance of 3 mm from the superstructure margin (Fig. 1).

After cementing, the specimens were stored in water at 37°C for 24 hrs. The retentive strength was then measured using a universal testing machine (AG-100A, Shimadzu, Kyoto, Japan) at a cross-head speed of 0.5 mm/min, both before and after thermocycling (cycled between 4°C and 60°C in water with a 1-min dwell time per bath for 2,000 cycles). Each measurement was repeated nine times after sufficient time intervals.

Statistical comparisons were performed using a two-way ANOVA. Tukey’s HSD (honestly significant difference) procedure was used for multiple comparisons. All the statistical analyses were conducted using the SPSS™ for Windows, Release 12.0, software package. Statistical significance was defined as $P<0.05$.

Results

Figure 3 shows the retentive force of the superstructures with and without the vent hole cemented using the eugenol-free temporary cement and Table 1 shows the results of a the two-way ANOVA. The retentive force of the restoration without the vent hole before thermocycling was about $32.5\pm7.5$ N, and the retentive force of the same superstructures with a vent hole tended to
Influence of a Vent Hole on the Retentive Force of a Cement-retained Superstructure

The retentive force of the cement-retained superstructure was compared with and without a vent hole using eugenol-free temporary cement and polycarboxylate temporary cement. The retentive force of the superstructure with a vent hole was significantly better than that of those without the vent hole. The size of vent hole had little influence on the retentive force. Furthermore, the retentive force decreased significantly by 69% after thermocycling. No interactions between the vent hole/thermocycling conditions were found.

Table 1 Summary of the results of two-way ANOVA (eugenol-free temporary cement).

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermocycling</td>
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<td>2193.0</td>
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<td>.000</td>
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<tr>
<td>Vent hole</td>
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<td>109.7</td>
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<td>.092</td>
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<tr>
<td>Hole/Thermo</td>
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<td>2.62</td>
<td>0.79</td>
<td>.528</td>
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<tr>
<td>Error</td>
<td>3130.21</td>
<td>64</td>
<td>48.91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>70563.66</td>
<td>72</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Fig. 3 Comparison of the retentive force with eugenol-free temporary cement. Bars show significant differences between two groups using (Tukey’s HSD test).

Table 2 Summary of two-way ANOVA (polycarboxylate temporary cement).

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
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<tbody>
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<td>Hole/Thermo</td>
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</tbody>
</table>

Fig. 4 Comparison of the retentive force with polycarboxylate temporary cement. Bars show significant differences between two groups (Tukey’s HSD test).

Discussion

A cement-retained superstructure with an excellent fit and low axial taper of the abutment is often arrested at the axial wall during cementation; in this study, however, no measurement of the cement thickness was performed. In one study in which fabrication was conducted using the same method as in this study, it was reported that the average elevation after cementing a 3-unit superstructure with eugenol-free temporary cement was 8.4 μm, and that after cementing with polycarboxylate temporary cement was 55.1 μm.

Chen et al reported that provision of a 0.8-mm vent hole in the three-unit superstructure significantly decreased the elevation caused by cementing. It was supposed that in addition to the vent hole causing dissolution of the cement material, it may also decrease the retentive force of the restoration. This study examined the influence of the presence of a vent hole as well as its size on the retentive force of a 2.5-degree-tapered superstructure on a 5-mm high titanium abutment.

Few thermocycling tests to evaluate the retentive force of implant superstructures have been examined. GaRey et al. reported that thermocycling...
clinging had minimal effect on the retentive force of cementing abutments fixed into threaded implants.\textsuperscript{13} The results of this study suggested that thermocycling significantly decreased the retentive force, regardless of the presence of a vent hole. This may be partly attributable to differences in the cement materials used, e.g., temporary cements in this study and resin cements in GaRey’s study. On the other hand the size of the vent hole had little influence on the retentive force, either before or after thermocycling.

Contrary to our expectation, the retentive force of a superstructure with a vent hole was higher than that of one without a vent hole even after thermocycling.

Provision of a vent hole decreased the elevation during cementing.\textsuperscript{12} This could possibly imply that a thin cement layer enhances the retentive force, while conversely, a thick cement layer decreases the retentive force in the same manner as that observed with conventional crowns during seating.\textsuperscript{14,15}

It is clearly recognized that the retentive force mainly depends on the properties of the cement materials. The interaction between cement materials/thermocycling and between vent hole conditions/cement materials may also be mainly dependent on the properties of the cement materials.

It is concluded that the provision of a vent hole in the cement-retained superstructure may be useful for preventing elevation of the cementing with little adverse influence on the retentive force of the restoration.

References