Original Research

Marginal Fit of Fixed Bridges Made Using Accelerated-type Gypsum-bonded Investments

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Clinical significance

The fit of fixed bridges constructed using accelerated-type gypsum-bonded investments was similar to that of fixed bridges made using conventional-type investment. The accelerated-type gypsum-bonded investments are effective at shortening the working time of bridge production.

ABSTRACT

Purpose : This study evaluated the marginal fit of fixed bridges constructed using accelerated-type gypsum-bonded investment and compared them with fixed bridges constructed using conventional-type investment.

Materials and Methods : Four types of accelerated-type gypsum-bonded investment and one type of conventional-type investment were used. A three-unit fixed bridge was cast in 12% gold-silver-palladium alloy and Type III gold alloy using different types of investment. Each bridge was seated in the master die, and the margins were inspected via microscopy.

Results : The results failed to show any significant differences between the bridges constructed from either alloy using the accelerated gypsum-bonded investment and those constructed using the conventional investment. In most of the investments, the gold bridges had slightly smaller marginal gaps than the 12% gold-silver-palladium alloy bridges, but the differences were not significant.

Conclusion : The results obtained indicated that the fit of fixed bridges made in accelerated gypsum-bonded investment is similar to that of bridges made in conventional investment.

Key words

fixed bridge, accelerated-type gypsum-bonded investment, marginal fit, Type III gold alloy, gold-silver-palladium alloy

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Received February 5, 2003/Accepted on July 7, 2003

INTRODUCTION

The time required for bench set and wax burnout in the conventional casting method is approximately three hours. An accelerated casting method requires less time for these steps, and therefore, the total casting process takes only approximately 1 hour^{1,2)}. When conventional-type investment is used in an accelerated casting method, the risk of mold fracture increases^{2,3)}. In addition, the fit of the crown made with the accelerated casting method appears to be inferior because the shorter heating time results in less heating expansion⁴⁾. However, the fit of crowns constructed using the accelerated casting method has been reported to be relatively problem-free compared to crowns made using the conventional casting method^{1,2,5)}.

Recently, accelerated-type gypsum-bonded investments for the accelerated casting method have been marketed; these investments were designed to prevent mold fracture and to reduce heating expansion^{6,7)}. Murakami et al.⁶⁾ and Mori et al.⁷⁾ reported that these accelerated gypsum-bonded investments produced castings with almost identical marginal fit compared to a full cast crown made with conventional investment. However, there were no reports that described the accuracy of bridgework constructed using an accelerated-type gypsum-bonded investments.

The purpose of the present study was to evaluate the marginal fit of fixed bridges constructed using accelerated-type gypsum-bonded investment and to compare them with fixed bridges constructed using conventional-type investment.

MATERIALS AND METHODS

Duplication of Master Dies

The dimensions of the master die are illustrated in Fig. 1. The stainless steel master die (Tokyo Giken, Tokyo, Japan) was duplicated using 10 custom trays (Resin made by Ostron II, GC, Tokyo, Japan) and polyvinyl siloxane impression material (Extrude wash, Kerr, Michigan, USA). The 10 impressions were poured simultaneously with die stone (New Fujirock, GC, Tokyo, Japan). After a 45-minute bench set, the stone dies were distributed randomly among the conventional and accelerated groups. Impressions were re-poured until 40 stone replicas were obtained. Five groups were made: one conventional group and four accelerated groups. Therefore each group had four pieces of stone die.

Fabrication of the Wax Pattern

The surface of each die stone was treated with a layer of separating agent (Sep, Shofu, Kyoto, Japan). A wax pattern was formed by means of a stainless steel die assembly. The marginal area was refined, and the wax pattern was stored at room temperature for 24 hours to release internal stresses.

Investment of the Wax Pattern

Each wax pattern was composed of three pieces of wax sprue (diameter 2.5 mm) placed at a 45-degree angle to the occlusal surface. The casting ring was lined with one layer of cellulose ring liner. The upper margin of the bridge and the top of the casting ring were 5 mm apart. Surfactant (Surcast Spray, GC, Tokyo, Japan) was sprayed on the wax pattern and allowed to dry for three minutes. A total of five types of investment were used in the present study (Table 1). The ratio of investment and

Fig. 2 Four sites measured on the bridge

cantly affected marginal gaps or not. A multiple comparisons test was carried out to determine any significant differences among groups. The significance level was set at $p=0.05$.

RESULTS

The mean marginal gaps of the bridges measured for the 12% gold-silver-palladium alloy and the Type III gold alloy are presented in Fig. 3. The ANOVA failed to indicate any significant differences for either alloy between the bridges constructed using accelerated investments and those made with conventional investment. The gold bridge had a smaller marginal gap than the 12% gold-silver-palladium alloy bridges in all investments except for Cristobalite New F-1. However, no significant differences were found between the two alloys in any investment.

DISCUSSION

The primary purpose of this study was to evaluate the marginal gaps of bridges constructed using accelerated-type gypsum-bonded investments compared to those constructed using conventional-type investments.

Dentists emphasize the importance of the marginal fit of restorations because defective margins act as a niche for plaque that causes secondary caries, which was reported to be the most frequent cause of restorative failure accord-

Fig. 3 Average marginal gaps of bridges constructed using investments of two types of alloys (in microns)

ing to reports by Schwartz et al.⁸⁾ and Walton et al.⁹⁾ The clinical criteria for acceptable restoration marginal gaps are not uniform and range from 0.039 mm¹⁰⁾ to 0.12 mm¹¹⁾. The fit of bridges using the conventional investment was reported to be 29~33 μm ¹²⁾ or 106 μm on average¹³⁾. The range of the mean marginal gaps of bridges constructed using the accelerated-type gypsum-bonded investments did not exceed the above range, and no marked differences were found compared to the conventional investments for either the 12% gold-silver-palladium alloy or Type III gold alloy.

In a previous study⁷⁾, we reported that gold crowns had significantly smaller marginal gaps than did the 12% gold-silver-palladium alloy. For the gold bridges, the mean marginal gaps were slightly smaller than those for the 12% gold-silver-palladium alloy in most investments, but no significant differences were found. These results indicated that bridges constructed using accelerated gypsum-bonded investments met the clinical requirements.

Surface roughness affects the marginal gaps of crowns¹⁴⁾. No difference in surface roughness has been reported for 12% gold-silver-palladium

alloy or Type III gold alloy cast in either conventional investments or accelerated gypsum-bonded investments⁷⁾. Therefore, no difference in the marginal fit of bridges constructed using either investment was found.

Gypsum-bonded investment is composed primarily of gypsum, silica and modifiers¹⁵⁾. During heating, it is expected to expand thermally in order to compensate partially or totally for the casting shrinkage of the alloy. However, gypsum shrinks a lot when heated, whether it is set in plaster or stone. When the proper form of silica is employed in the investment, this contraction during heating can be changed to an expansion. The thermal expansion of a gypsum-bonded investment is directly related to both the amount and type of silica present. Murakami et al.⁶⁾ reported that the thermal expansion of accelerated gypsum-bonded investments did not differ from conventional investment. In our study, the bridges constructed using the accelerated investments showed no difference in their marginal gaps for both alloys. This finding might suggest that the expansion of the accelerated gypsum-bonded investments compensates for the shrinkage of both the wax pattern and the alloy that takes place during the casting procedure.

CONCLUSIONS

The following conclusions were drawn from the results of this study :

1. The marginal gaps of the bridges constructed using the accelerated-type gypsum-bonded investments were not significantly different from the conventional-type investment.
2. The marginal gap of the Type III gold alloy bridges was not different from that of the 12% gold-silver-palladium alloy bridges.
3. The accelerated-type gypsum-bonded investments used in this test were produced by different manufacturers, but did not show a

marked difference with respect to casting performance.

Acknowledgements : This study was supported by a grant from the Miyata Foundation.

This article was presented at the 79 th General Session of the International Association for Dental Research, Chiba, Japan, June 29, 2001.

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