A basic study on accuracy of a zirconia coping fabricated by CAD/CAM system -Application for post for scanning-

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Abstract

The purpose of this study was to evaluate the fitting accuracy of zirconia keeper copings manufactured by computer-aided design and manufacturing using scan posts.

The keeper copings, made from a zirconia block, were fabricated with four different cement spaces as specimens (n=3 for each). The fitting accuracy of the specimens was evaluated using the cement replica technique. Each silicone replica specimen was sectioned in the buccolingual direction through the center of the coronal aspect of the root. The thickness of the white silicone layer was examined at five measuring points (A: canal orifice of the lingual wall, B: center of the lingual wall, C: apical part of the post, D: center of the labial wall, E: canal orifice of the labial wall).

The mean thickness of the white silicone layer at the five measuring points was 81±22, 239±39, 574±68, 223±43 and 67±19 μm for points A, B, C, D and E, respectively. There was no significant difference between the results for each cement space (P<0.05).

Within the limitations of this study, it was suggested that the fitting accuracy of zirconia keeper copings manufactured with this CAD/CAM system using scan posts was within the clinically acceptable range, excluding marginal gaps.

Introduction

Advancements in computer-aided design/computer-aided manufacturing (CAD/CAM) techniques have improved prosthetic devices milled in the dental clinic and laboratory. With CAD/CAM techniques, copings and frameworks for all-ceramic restorations can be made from zirconia, because of its high stability and toughness. Digital impression systems are generally composed of a three-dimensional scanner recording the object and CAD software that uses the scanned image to design the prosthesis.

Although a method for manufacturing CAD/CAM keeper copings using a scanning probe has been reported[1)], the keeper coping of the magnetic attachment was still manufactured using the lost-wax casting method.

Recently, laser scanning using a dental CAD/CAM system has been primarily used for producing zirconia prostheses because of its high-precision performance. However, there is greater distortion of the digital impression when scanning a prepared root canal, possibly because of the limitations of the specific scanning technology. Although applying a scan post could enable digital images of the prepared root canal to be obtained, there have not been any studies investigating this method.

The purpose of this study was to evaluate the fitting accuracy of zirconia keeper copings manufactured by CAD/CAM using scan posts.

Materials and Methods

Keeper coping fabrication

Prepared epoxy resin mandibular canine teeth (338; Nissin) with a root canal length of 5.0 mm were selected as the abutment teeth for the keeper copings. Impressions were taken of the prepared teeth using silicone impression material (Examixfine Regular Type, GC). The working casts were made of type IV gypsum (New Fujirock, GC). A scan post (Scan Posts, 3Shape) was placed into the prepared post space on each working cast (Fig. 1). The keeper copings were designed using CAD software (Dental Designer, 3Shape) after digitalization of the die was performed using a laser scanner (Aadva Scan D850, GC).

The keeper copings, made from a zirconia block (Aadva Zirconia Disk, GC), were fabricated with four

different cement spaces as specimens (Fig. 2). Each cement space for the zirconia copings was fabricated using a milling machine (GM-1000, GC).

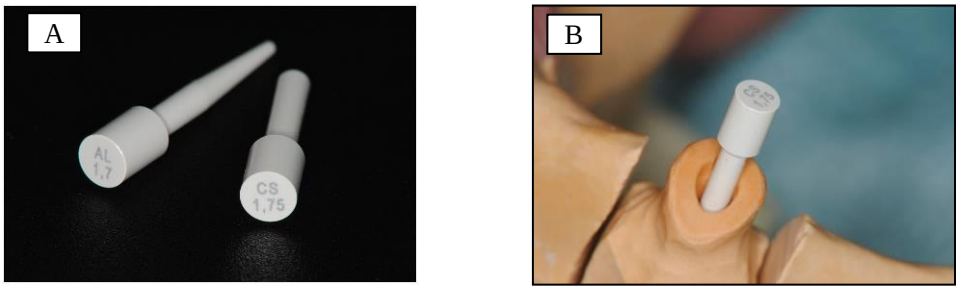

Fig. 1 Scan post placed into the prepared root canal on the master die
(A. Scan posts, B. Insert into the master die)

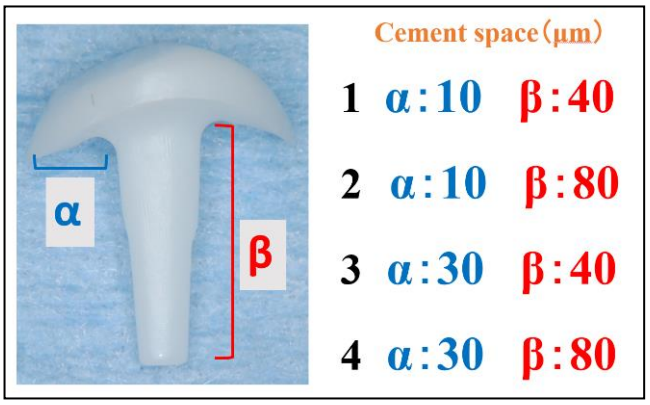

Fig. 2 Four different cement spaces

Cement replica technique

The fitting accuracy was evaluated using a cement replica technique. The post space was filled with a white silicone material (Fit Checker Advanced, GC) and the keeper coping was seated on the master die using finger pressure. After curing the white silicone, the keeper coping and white silicone material were removed from the master die. These keeper copings were then embedded in a blue silicone material (Examixfine Regular Type, GC) and the space created by demounting the keeper copings from the cured silicone material was filled by the blue silicone (Fig. 3).

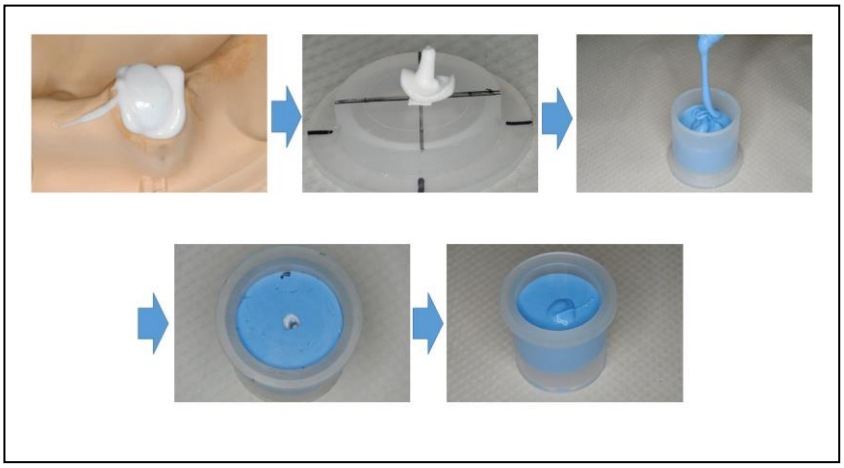

Fig. 3 Fabrication of the specimens (cement replica technique)

Fitting accuracy

The silicone replica specimens were sectioned in the buccolingual direction through the center of the coronal aspect of the root (Fig. 4). The thickness of the white silicone was determined as a measure of the discrepancy between the die and the restoration. The distances were recorded at five different measuring points. The measuring points are defined in Fig. 5.

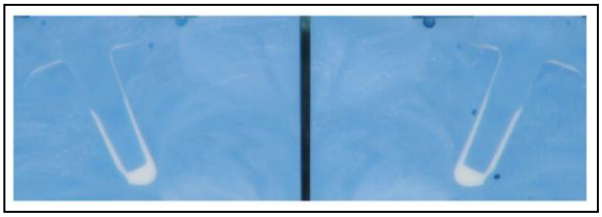

Fig. 4 Silicone replica specimen sectioned in the buccolingual direction

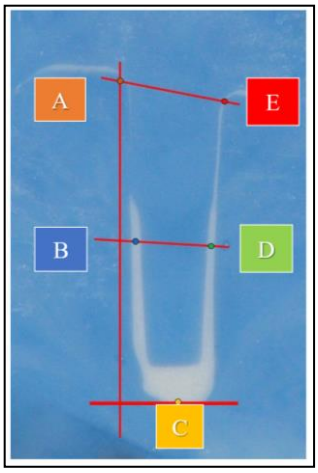

Fig. 5 Measuring points
(A: canal orifice of the lingual wall, B: center of the lingual wall, C: apical part of the post, D: center of the labial wall, E: canal orifice of the labial wall)

Statistical analysis

The fitting accuracy at the different measuring points was analyzed statistically using one-way analysis of variance and post hoc Scheffé test ($P<0.05$).

Results

The mean thicknesses of the white silicone were 81±22, 239±39, 574±68, 223±43 and 67±19 μm for points A, B, C, D and E, respectively. C point had significantly higher values when compared with the other measuring points (Fig. 6).

There were no statistically significant differences among the different cement spaces.

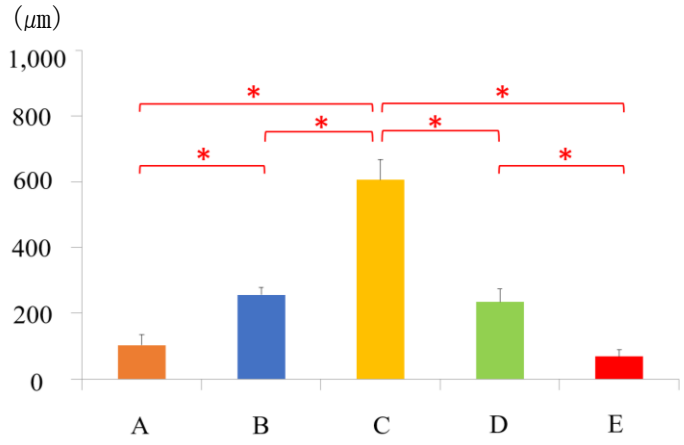

Fig. 6 Thicknesses of the white silicone layers at five measuring points

Discussion

Suto et al. reported that the clinically acceptable limit for the fitting accuracy of CAD/CAM restorations is a discrepancy up to 100 μm.[2)]

The gaps at B, C and D points had higher values when compared with the clinically acceptable range. However, there was a possibility that the fitting accuracy achieved was within the clinically acceptable range because of modifications to the spacer setting on the CAD software.

The mean of the internal gaps at A and E points in this study were within 100 μm. The fitting accuracy of the zirconia copings fabricated using the scan posts method was within the clinically acceptable range when excluding marginal gaps.

The fitting accuracy of the marginal gaps in the keeper copings manufactured with this CAD/CAM system should be examined in future studies.

Conclusion

Within the limitations of this study, it was suggested that the fitting accuracy of zirconia keeper copings manufactured with this CAD/CAM system using scan posts was within the clinically acceptable range, excluding marginal gaps.

References

1. K. Tsuda, Y. Tanaka, T. Kanazawa, M. Sakane, and K. Kumano: Fabrication of a Keeper Coping by use of the CAD/CAM System, J J Mag Dent, 13(1), 9–17, 2004.
2. N. Suto, S. Miura, R. Inagaki, M. Yoda, and K. Kimura: A Basic Study on Fitness of All-ceramic Crown fabricated by CAD/CAM system, Ann Jpn Prosthodont Soc, 1, 21–28, 2009.