

MARGINAL FIT OF THE AURO GALVANO CROWN SYSTEM MADE USING THE ELECTROFORMING TECHNIQUE

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Statement of problem. There have been few studies about the marginal fit of Auro Galvano Crowns.

Purpose. The purpose of this study was to compare the marginal fit of the anterior single restorations

Material and methods. The in vitro marginal discrepancies of metal-ceramic, Auro Galvano Crown and coping were evaluated and compared. The Auro Gavano Crowns were made from one extracted maxillary central incisor prepared by milling machine. 30crowns per each system were fabricated. Measurements of a crown were recorded at 50 points that were randomly selected for marginal gap evaluation. Parametric statistical analysis was performed for the results.

Results. Mean marginal gap dimensions and standard deviations at the marginal opening for the anterior single crowns were $74 \pm 21 \mu\text{m}$ for the control (metal-ceramic restoration), $45 \pm 11 \mu\text{m}$ for Auro Galvano Crown coping, and $51 \pm 9 \mu\text{m}$ for the Auro Galvano Crown.

Conclusions. Auro Galvano Crown showed significantly smaller ($P < .05$) marginal gap than the control. Ceramic application did not significantly affected the marginal fit of Auro Galvano Crown. ($P > .05$)

Key Words

Marginal fit, Electroforming technique, Auro Galvano Crown

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As a result of the increasing interest in esthetics and concern regarding toxic and allergic reactions to certain alloys, the demand for metal reduced or metal-free tooth colored restorations has increased significantly. To overcome the problems which traditional metal ceramic restorations have, research has focused on new materials that will not only eliminate esthetic problems and create functional, biocompatible restorations, but will also reduce the working time and, consequently, the costs of the fabrication of the restoration.

The restorations, Auro Galvano Crowns and bridges, offer several evident advantages over conventional metal ceramic restorations with alloy frames. In compare with metal ceramic restoration, the superiority of electroforming restoration is better esthetics, biocompatibility, precision of the margins, and less preparation of dental hard tissue.

Especially in the aspect of marginal accuracy, dentists generally believe that marginal fit is a very important aspect for fixed restorations because a large marginal gap allows more plaque accumulation, gingival sulcular fluid flow and bone loss, resulting in micro leakage, recurrent caries and periodontal disease.

Electroforming utilize the electrochemical reaction to achieve electrodeposition. The electricity passes through an anode, an electrolytic solution, and a cathode. Closing the circuit generates the ion flow and results in deposition of the molecule onto the cathode. The gold is contained to an ionic form in the electrolytic solution based on ammonium sulfite, and deposits on the die which positioned at the cathode.

So, the waxing, investing and casting steps that had been used metal ceramic restoration, are eliminated. So less dimensional changes has taken. Therefore in theory, Auro Galvano Crowns have accurate marginal adaptation.

Few studies have been conducted upon the

marginal discrepancies of Auro Galvano Crown made by the electroforming systems. In the study of Setz et al.¹, the number of specimens used for the statistics of marginal gap in each group was 5. In the study of Petteno et al.², the marginal gap of Auro Galvano Crown had no significantly difference from metal ceramic restorations.

The purpose of this study was to compare the marginal fits of the anterior single restorations made using the electroforming systems with metal-ceramic restorations. It was also our intention to obtain more accurate information by using a large enough sample size, and by making sufficient measurements per specimen.

MATERIAL AND METHODS

One extracted maxillary central incisor without caries was cleaned and embedded in a autopolymerizing resin-manufactured block (Orthodontic resin, Dentsply International Inc., Milford, DE). The long axis of the tooth was set perpendicular to the surface of the block. The tooth was prepared for crown fabrication. Using a high-speed hand-piece, an incisal reduction of 2-3 mm and axial reduction of approximately 1 mm was prepared. The tooth was finished by milling (F2, Degussa Korea Inc., Seoul, Korea), which resulted in about a 1 mm shoulder margin, 6 tapered angles and an approximate height of 7 mm (Fig. 1).

A preliminary impression using a stock tray was made using irreversible hydrocolloid impression material (Aroma fine, GC Korea Inc., Seoul, Korea), and a plaster (Samwoo plaster, Samwoo Co., Ulsan, Korea) cast was made. After obtaining the relief of two sheets of baseplate wax on the plaster cast, the 60 custom-made trays were fabricated using acrylic resin (Quicky, Nissin dental products Inc., Kyoto, Japan). Final impressions were made with polyvinyl siloxane (Examix, GC Korea Inc., Seoul, Korea) using custom trays. 60 master stone dies were fabricated (Rhombrock, Mitsubishi,

Tokyo, Japan) (Fig. 2).

Sixty veneered crowns (30 crowns per group) were fabricated; 30 metal ceramic (Rexillum III, JENERIC/PENTRON Inc., Wallingford, Conn. and VMK 95, VITA Zahnfabrik, Bad Sckingen, Germany) crowns, 30 Auro Galvano Crowns (AGC® electroforming, Wieland Dental + Technik GmbH & Co.KG, Pforzheim, Germany) (Fig. 3) were made. Each group of crowns was fabricated by an experienced dental technician who was accustomed to specific system. All crowns were fabricated according to their respective manufacturer's recommendations. In the case of Auro Galvano Crowns, coping were fabricated, and then the marginal fit was evaluated. After that, the ceramic were built-up.

The marginal fit was evaluated by measuring the gap between the edge of the crown and the prepared tooth margin in a light microscope with image processing (Acura 2000, INTEK PLUS, Daejeon, Korea) (Fig. 4) at $\times 240$ magnification. The accuracy of this light microscope is $\pm 0.1 \mu\text{m}$. The gap was measured as the minimum distance from one point of the crown edge to a line determined by least squares of points at the tooth margin (Fig. 5). All measurements and the least squared lines were computed by the programmed macro provided by Acura 2000 software system. Measurements were made without cementation. The marginal gap of one crown was measured at 50 points along the margin that were randomly selected in distances of about $400 \mu\text{m}$. The marginal fit of one crown was defined as a mean

value of these 50 measurements. Groten et al³⁾ reported that 50 measurements along the margin of a crown yielded clinically relevant information and a consistent estimate for the gap size and that error size for the calculation of the measurement's mean is about $\pm 5 \mu\text{m}$. The means and standard deviations of the marginal fit were, therefore, rounded to $1 \mu\text{m}$ level.

The means and standard deviations per group were calculated and statistical inferences among the groups were made using paired *t*-test (in the case of Auro Galvano Crown coping and Crown) and *t*-test (in the case of metal ceramic crown and Auro Galvano Crown) at .05 level of significance.

RESULTS

Table I showed the means and the standard deviations of the average gap dimensions of the crown groups. The means and standard deviations of the marginal fit were $74 \pm 21 \mu\text{m}$ for the control group, $45 \pm 11 \mu\text{m}$ for the Auro Galvano Crown coping group, $51 \pm 9 \mu\text{m}$ for the Auro Galvano Crown.

The paired *t*-test of the marginal discrepancies between Auro Galvano Crown coping and Crowns were performed. Significant differences were not found between groups ($P(=0.67) > .05$).

The *t*-test of the marginal discrepancies between Auro Galvano Crowns and metal-ceramic crowns. Significant differences were found between

Table I. The mean and standard deviations of marginal fit in each of the 3 groups (unit: μm)

	N per group	Mean(μm)	SD*(μm)
Metal ceramic	30	74	21
Auro galvano Crown coping	30	45	11
Auro Galvano Crown	30	51	9

* SD: standard deviation

groups ($P(=0.00) < .05$).

Based on the criterion of 120 μm as the limit of clinical acceptability, the mean marginal fits of Auro Galvano Crown and metal-ceramic crown were acceptable.

DISCUSSION

There have been few studies about the marginal fit of Auro Galvano Crowns. In Auro Galvano Crown, Setz et al¹ and Petteno et al² reported the marginal gap, which was smaller than this study. An explanation of the larger measurement is the variation in the method used in studying marginal accuracy. In Setz's article, smaller sample size are also contributed to the variation. In Petteno's article, insufficient measurements per specimen are contributed to the variation.

Variation exists regarding what constitutes a clinically acceptable margin. McLean⁴ and von Fraunhofer proposed that a successful restoration was possible if restorations could be constructed so that marginal gaps and cement films of less than 120 μm were achieved. This criterion has been cited in some articles.⁵⁻⁷ The value of 120 μm was, therefore, used as the maximum clinically acceptable marginal opening in this study. The marginal discrepancies found in this study were all within clinically acceptable standards.

It was considered that there were two variables that were distinguished between the groups in this experimental design; one was the difference between the systems, and the other the difference between the skills of dental technicians who made the single restorations. It was assumed in this study that there was no difference in the techniques of the dental technicians, because they had fabricated more than 500 crowns using each system, and were considered experienced. It was, therefore, thought that the difference between the systems was the only significant

variable and that the other conditions were identical. The present study showed clinically acceptable marginal discrepancy of all groups. However, as compared with the standard deviation of the metal-ceramic crown, Auro Galvano Crowns were considered to produce anterior single crowns which had more homeogenous quality in marginal fit.

All samples, regardless of the fabrication technique, showed a reduction in marginal precision after baking. This confirms the well-documented fact that the application of ceramic distorts the metal substructure.⁸⁻¹¹ Especially Auro Galvano Crowns had unknown problems with creep.¹² Most opaque porcelains fired at 970°C, which is close to the temperature at which the Auro Galvano Crown coping may deform. So in manufacturer's recommendations, the opaque may be fired 20°C lower and held at this temperature for 2 minutes to minimize this potential.¹³ Petteno et al.² reported that ceramic application affects the marginal fit of Auro Galvano Crowns. In this study, ceramic application showed reduction in marginal precision but not significantly different.

There were some limitations in this study. Marginal opening is measurable in this experimental design. Internal fit of the crowns is, however, impossible to measure. Setz et al.¹ evaluated the inner fit of artificial crowns. In order to measure the inner fit of artificial crowns, cementing the crowns and sectioning the specimens are required. In case of sectioning, the number of measurements per specimen is limited. Further investigations of developing new experimental design to measure both the marginal and inner fit are required.¹⁴ Electroforming anterior 3-unit fixed partial dentures as well as single crowns have been applied for aesthetics. It requires more strength and dimensional stability that has resulted in clinically acceptable marginal fit. Further studies of marginal accuracy in electroforming fixed partial dentures are necessary.

CONCLUSIONS

Within the limitations of this study, the following conclusions were drawn:

1. Mean gap dimensions and standard deviations at the marginal opening for the anterior single crowns were $74 \pm 21 \mu\text{m}$ for the control (metal-ceramic restoration), $45 \pm 11 \mu\text{m}$ for Auro Galvano Crown coping, and $51 \pm 9 \mu\text{m}$ for the Auro Galvano Crown.
2. Auro Galvano Crown showed significantly smaller ($P < .05$) marginal gap than the metal-ceramic crown.
3. Ceramic application did not significantly affected the marginal fit of Auro Galvano Crown ($P > .05$).

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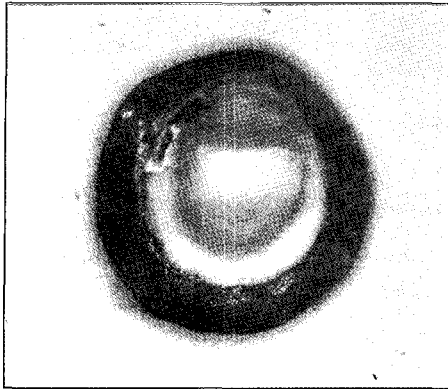
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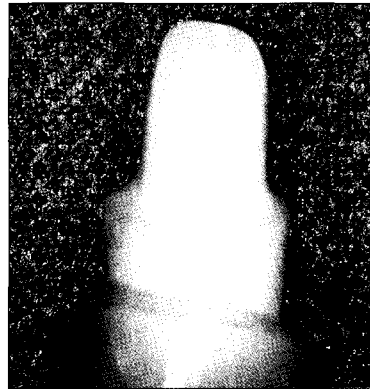
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A. Incial view.



B. Labial view.

Fig. 1. The prepared tooth which (the maxillary central incisor) was cleaned and embedded in a self-curing resin block. The long axis of the tooth was perpendicular to the block.

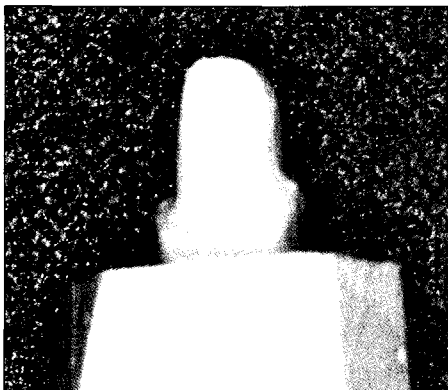


Fig. 2. The master die for final restoration.

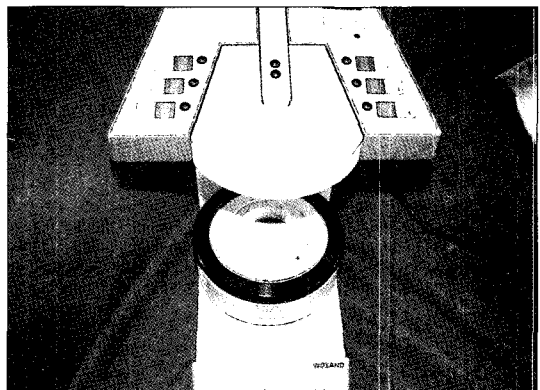


Fig. 3. The electroforming machine(AGC-micro).

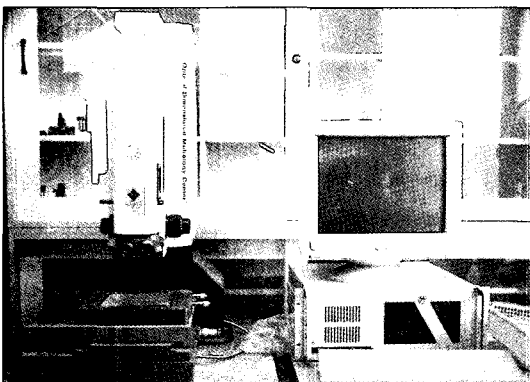


Fig. 4. The light microscope with image processing (Accura 2000).

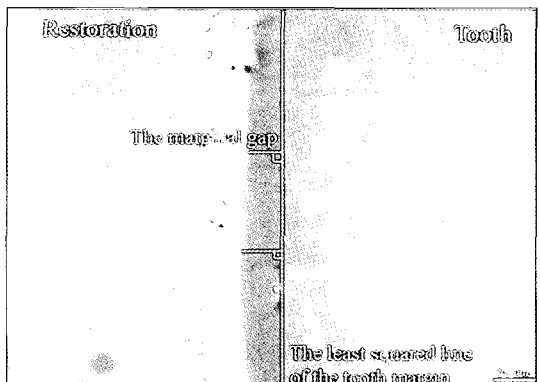


Fig. 5. Demonstration of computer aided measurement of marginal fit.

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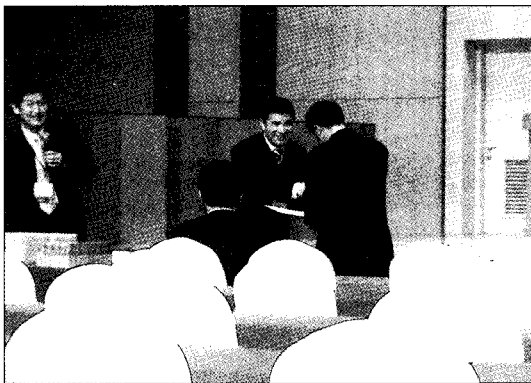
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The 2004 Autumn Scientific Meeting of the Korean Academy of Prosthodontics was held at Hotel Interbugo in Daegu city in November 26 to 27, 2004.



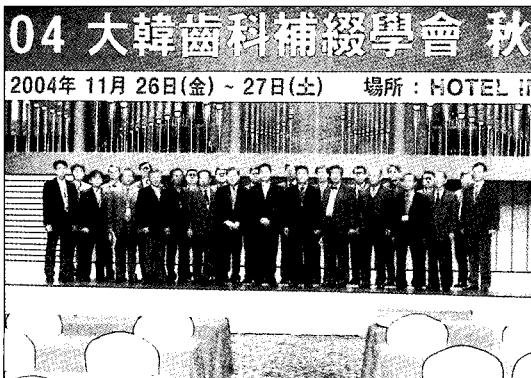
Prof. Home-Lay Wang from Michigan University gave a lecture as a keynote speaker in front of 950 audience at the 2004 Autumn Scientific Meeting of the Korean Academy of Prosthodontics.



Prof. In-Ho Cho as President of KAP gives an award to an excellent speaker at the 2004 Autumn Scientific Meeting of the Korean Academy of Prosthodontics.



Prof. In-Ho Cho as President of KAP gives a gift to a participant at the final day of the 2004 Autumn Scientific Meeting of the Korean Academy of Prosthodontics. Many gifts sponsored by Exhibition companies were awarded to 45 participants.



➔ At the end of the 2004 Autumn Scientific Meeting of the Korean Academy of Prosthodontics, a photography was taken with all of the KAP executive members.