Evaluation of the marginal fit of electroformed copings in function of the cervival preparation*

Avaliação da adaptação marginal vertical de *copings* eletroformados

Leonardo BUSO
Postgraduate student – Restorative Dentistry Program – Dental Materials and Prosthodontics – Dental School of São José dos Campos – UNESP– São Paulo – Brazil

Maximiliano Piero NEISSER
Professor – Department of Dental Materials and Prosthodontics – Dental School of São José dos Campos – UNESP– São Paulo – Brazil

Marco Antonio BOTTINO
Posgraduate Coordinator – Restorative Dentistry Program – Professor – Department of Dental Materials and Prosthodontics – Dental School of São José dos Campos – UNESP– São Paulo – Brazil

ABSTRACT

*The scope of this study was to evaluate the marginal fitness of coping made with the electroforming Gramm system. Two identical stainless steel master casts were milled simulating the tooth reduction for metal ceramic crowns; one with long chanfer and another with round shoulder preparations. The impression material used was a polivinilsyloxane silicone with the double impression technique, thus obtaining ten specimens of each master cast. To establish a pattern for impression a sheet of accetate with 1,4 mm thick was used. A dental surveyor was prepared to maintain constant the insertion and the removal axis of the master casts during all the impressions. The dies were made with gypsum type IV and after the casts were dyed with spacer, these were duplicated with laboratory silicone to obtain a second master cast with special gypsum. The casts were prepare with copper wire and coated with silver to promove the galvanic current so that a gold eletroforming is achieved. Upon adjustment and cleansing, the copings were adjusted to the master casts, which were fixed in an octagonal stainless steel table, and observed at a measuring microscope Olympus equipped with digital desk. The data obtained was submitted to "t" test and Mann-Whitney statistical test with significance level of 5%. The mean values of long chanfer and round shoulder were 29,77*mm *and 26,77*mm*, respectively, (p=0,657 and p=1,00). With the results obtained, it may be concluded that there was not a statistically significant difference, so both marginal preparations may be used.*

UNITERMS

Electroforming coping, margin adaptation dentistry, coping, fitting; electrolysis, dental costing investiment electroplating.

INTRODUCTION

One of the preoccupying problems and reason of studies in the dentistry concern the marginal misfit of crowns[2,23], total or partial, that substitute lost dental structure. Depending on the making process, this marginal misfit can be larger or smaller.

The technique of lost-wax casting involves a series of precaution[11] as well as laboratories steps[6] that they can negativelly affect the seating of the prosthetic restorations. Thus, the interest for the manufacture of metalceramics restorations using electroforming system has increased.

The use of electroformed gold copings as the core of fixed oral prostheses was first introduced by Rogers & Armstrong[21] in 1961, describing the laboratories steps for the confection of a gold matrix and gold alloy into the matrix. In a series of

* Sumary of Master Dissertation – Restorative Dentistry Program – Concentration Area in Prosthesis – Dental School of São José dos Campos – UNESP– São Paulo – Brazil.

articles, the type of union between cast gold dental alloys and an electroformed gold matrix in an inlay technique, metallografics informations and the fabrication of ceramometal crowns were described [15-21].

However, the largest inconvenience of this technique was the use of highly toxic electrolyte that contained potassium cyanide, posing a potential health hazard, and the need of large, expensive equipment, making this system impractical for the average laboratory. These problems were solved in 1970 when Wismann developed an electrolytic system that uses a cyanide-free electrolyte and in 1991 when a new, much smaller system was developed by Gramm Technik, an industrial plating company in Germany[1]. In addition to being smaller, the equipment was less expensive tham other systems[1,24-5], bringing electroforming closer to the range of affordability and practicality for dental laboratories.

The electrodeposition of 24-Kt gold copings directly onto a stone die would seem to offer the potencial for less distorcion and misfit[8], eliminating the steps of conventional casting techniques, producing copings with an even wall thicknesses of 0.2mm, no porosity, high strength after application of the ceramic, biocompatibility with adjacent tissue and facility to the ceramist in enhance the esthetics[3,4,5,8,10,13, 22,25].

In literature few studies evaluated the electroformed crowns adaptation, existing little consensus for the correct type of marginal designs to be used in the dental prepare. For this, this study evaluated the marginal fit of electroformed copings, before the application of the porcelain and cimentation, varying the cervical preparation.

MATERIAL AND METHOD

Two master die were prepared with stainless steel, one with a chamfer margin and another with a rounded shoulder margin, which represented endings for metalceramics restorations of a maxillary lateral incisor (Figure 1 and Figure 2).

With aid of a dental surveyor (type Ney) specifically prepared for this study (Figure 3), ten impressions were taken by the double impression technique with a polyvinylsiloxane impression material (Elite, Zhermack S.p.A., Badia Polesine, Rovigo, Italy) for each master die. To establish a pattern for impression with the heavy impression, a relief of a 1.4mm thick acetate sheet was confectioned under vacuum, being this used in both dies.

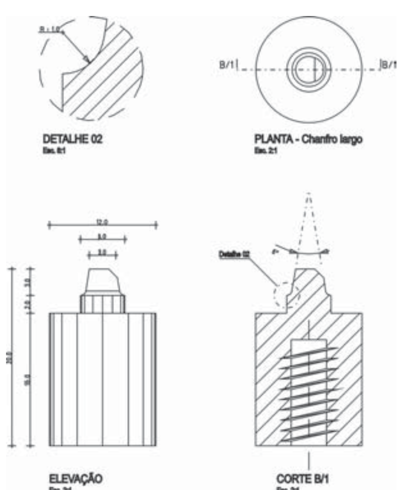

FIGURE 1 – A diagram of the stainless steel die master with a chamfer margin (mm).

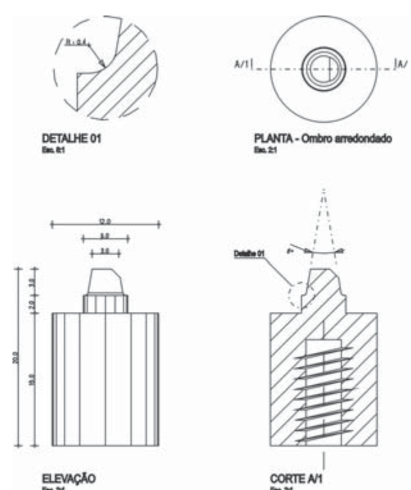

FIGURE 2 – A diagram of the stainless steel die master with a rounded shoulder margin (mm).

In the dental surveyor anchorage a device was fixed allowing the placement of specially constructed trays in the same position and in the mobile vertical stem a thread was shaped to allow the steel dies attachment. During the impression the mobile vertical stem was lowered, stopping the screw of the sheath, and the depth of the impression was standardized by the existence of a spring between the fixed horizontal stem and the mobile vertical stem.

After the first impression the relief was removed, beginning the impression with the regular material. The impression were poured with type IV plaster (Super Ex-3 Porcelain Rock Whrite, Noritake – Dental Stone, Nishikamo-gun, Aichi - Japan), and trimmed dies were identified. After identification two layers of die spacer (Tru-Fit, George Taub Products & Fusin Co., Jersey City, New Jersey - EUA) were painted within 1mm of the finish line[6,8,9], as recommended by the manufacturer. The thickness of die spacer was approximately 25µm[6,8].

The duplication of the plaster die was made with polyvinylsiloxane (Elite Double – Zhermack S.p.A., Badia Polesine, Rovigo, Italy) and the impression were poured using a type III plaster (Durone - Dentsply, Nova Iorque, Pensilvânia, EUA), and a small copper wire was attached with cyanoacrylate cement into a small hole drilled 2mm below the cervical margin. Two layers of silver conducting lacquer were painted over the surface, extending slightly over the finished line of the preparation and a thin strip of silver lacquer was also used to connect the painted die to the cooper wire, allowing the passage of galvanic current.

The dies were placed in a beaker and immersed in a gold electrolyte solution (GAMMAT free – Gramm Technik, Tiefenbronn, Muehlhausen - Germany) (Figure 4) to initiate the electrodeposition process. After deposit the gold coping, the copper wire was disconnected and the coping separated from the plaster with gypsum remover in a

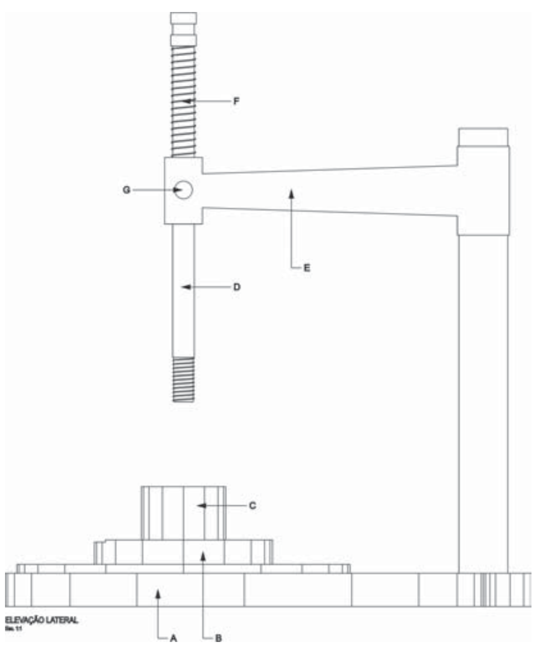

FIGURE 3 – Schematic representation of the dental surveyor (A= anchorage, B= device to receipt the tray, C= custom tray, D= mobile vertical stem, E= fixed horizontal stem, F= spring, G= screw of the sheath).

FIGURE 4 - *GAMMAT free*.

ultrasonic cleaner. The copings returned to the first plaster die and the margins were trimmed with rubber polisher.

The finished copings returned to the respective metallic pattern, wich was fixed in an octagonal base, to evaluate the marginal adaptation in eight different sides. The coping stabilization on the master die was made with a device developed by Pavanelli et al.[14] (Figure 5). The plunger was lowered and stabilized, locking the lateral screws and remaining a constant force.

Each specimen was measured with a optical microscope (Olympus Microscope Precision STM, Japan) with digital table, with 30X magnification and precision of 0,5μm. The marginal discrepancy was measured from the margin of the coping to the cavosurface angle of the preparation. This measurement is named "absolute marginal discrepancy"[7,12]. Three measurements were made for each side, obtaining the arithmetic mean of this region. When finished the measurement of a side, the lateral screws were untiet and the octagonal base turned, initiating the measurement process of another side. At the end, the eight values obtained during the measurement of a coping were submitted to an arithmetic mean.

The data obtained were submitted to the parametric test "t" and no parametric test Mann-Whitney, with level of significância of 5%.

Results

The comparation of statistical means and standard deviations are presented in the Table 1 and Figure 6, with the mean of the marginal discrepancy of 29,774μm for chamfer and 26,779μm for round shoulder. There was no significant difference between the marginal designs (P=0,657).

The no-parametric test Mann-Whitney compared the median (Table 2). The analysis showed there was no significant difference between the marginal designs (U=104,5; P=1,00).

In the Figure 7 it can be observed that the variability of the cervical designs in chamfer it is the double of the round shoulder, with values between 8,77μm and 63,92μm.

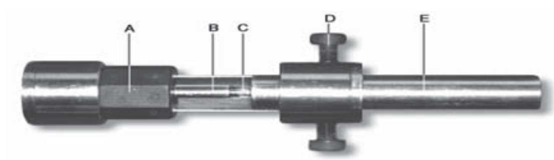

FIGURE 5 – Device for fixation of the coping on the master die and octagonal base (A = octagonal base, B = master die, C = coping, D = lateral screws, E = plunger).

Table 1 - Means and standard deviation of the marginal discrepancy of the parametric test "t"

Marginal Design	Nº specimen	Mean (μm)	SD	C.V. (%)
Shoulder	10	26,779	9,596	35,83
Chamfer	10	29,774	18,663	62,68

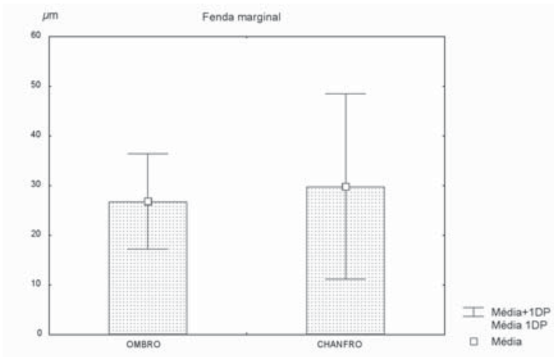

FIGURE 6 – Comparasion of means and standard deviation of the marginal misfit regarding the type of cervical designs.

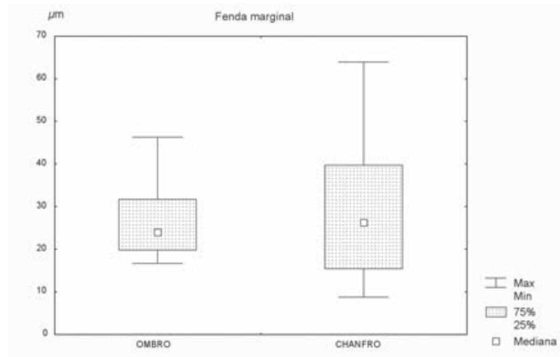

FIGURE 7 – Schematic representation (type BOX-PLOT) of the median of the data of the marginal discrepancy regarding the type of cervical designs.

Table 2 - Descriptive statistics of data after no parametric test Mann-Whitney

Marginal design	Nº specimen	Median (µm)	25%	75%	Interquartil
Shoulder	10	23,985	19,650	31,710	12,06
Chamfer	10	26,265	15,300	39,900	24,60

Discussion

The appropriate analysis of the marginal adaptation of the prosthesis in their respective abutment is very difficult in the clinic, demanding extreme ability and sensibility of the dentists, as observed by Christensen[2] (1966). This evaluation can be done by radiographic and an explorer examination, techniques that many times don't allow a direct and accurate vision, having the necessity of obtaining prosthesis with the minimum laboratorial distortion.

The manufactory of metaloceramics crowns by the technique of lost-wax casting involves a series of laboratories steps that negatively affect the prosthetic restorations sealing when compared with the electroformed crowns, as observed by Holmes et al.[8] (1996), that obtained 36µm of marginal misfit for the eletroctroforming system and 64µm for the conventional system.

Besides the laboratories steps, some clinical phases can take the an increase of the marginal discrepancy, for example, the marginal design, impression material, axis of insertion and removal of the impression, types of cements, retentions grooves and pressure during cementation.

In this study were not accomplished the copings cementation and the confection of the retention grooves, eliminating the clinical steps effect, which could influence the final result, remaining the pressure of the seating in measurements constant.

The precision and fidelity of the die were achieved by impressions with polyvinylsiloxane. However, the disoriented removal of the master die could cause alterations in the impressions and in the final result of the marginal fit, as observed by Stephano et al.[23] (1989), that obtained larger misfit in the lingual face, justified for the vicious tendency in the manual removal of the impression for the operator in this face. The use of a dental surveyor prepared specifically for this study it made possible the analysis around of only eight points of the specims, because the force of removal of the master die and impression possible alterations in the cervical region equally transmitted in all its perimeter.

As the gold deposition occurs on the silver lacquer, applied directly on the plaster die and extending slightly over the finished line of the preparation, we expected that no type of marginal gap be found. However, it exists and we believe that it can have occurred during the laboratorial finishing steps, with trimmed with rubber polisher. For this reason, clinically, it would be interesting the use of the alternatives of finishing, as the burnishing of the coping during the prove in the mouth.

The studies that evaluated the marginal adaptation of this system are divergent as for the type of cervical design and methodology. The most indicate, according the manufacturer, is it chamfer. However, the rounded shoulder configuration could be also an alternative during the preparation[10,22]. This study, compared the two marginal designs, under same conditions, it showed there was not a statistically significant difference between the confugurations.

Setz et al.[22] (1989) evaluated the marginal adaptation of electroformed crowns after cimentation. The studied marginal configuration was rounded shoulder and the crown margins were evaluated in two ways, using the circunferential test and slice test, obtaining a mean of 20µm. Using this same cervical design Huls & Rinke[10] (1995) obtained, after cimentation simulation with static load of 30N, a mean gap of 26µm. These two studies evaluated the whole circumference of the coping, what was not evaluated in this study. However, during our measurements it could be observed that beside the areas for the reading the adaptation was perfect, fact observed in practically all specimens. This way, it was expected that if the reading of the whole circumference was accomplished the found results would be smaller.

Holmes et al.[8] (1996), using chamfer in marginal design, observed superior values to the this study. However the authors cemented the crowns with composite cement, that depending on the thickness might have caused larger marginal misfit.

The use of bevels for this system is not indicated, because they would provide very thin thickness of pure gold, causing distortions during the porcelain firing. This was observed by Patennó et al.[13] (2000), that after the application of the porcelain verified sensitive increase of the marginal gap that passed from 14µm to 34µm and for Hammerle et al.[5] (1994) that obtained worse results for the electroforming system (53,7µm) when compared to the lost-wax casting method (36µm).

The results of this study are within of the previous studies, however the particular laboratory protocol for fabrication of any restorations can vary from technician to technician and other parameters of measurement can also generate small variations, showing differences of results. This fact was observed by Holmes et al.[8] (1996) in the measurements accomplished by Setz et al.[22] (1989) that measured the marginal gap, but neither vertical or horizontal discrepancy nor overextension or underextension of the restorations was mentioned.

In this study were verified valoues acceptable clinically, with means gap of 26µm and 29µm to rounded shoulder and chamfer respectivally. These data prove the excellent quality of the marginal adaptation of the electroforming system, making possible her use with safety in preparations with rounded shoulder and chamfer, usually used at the clinic.

Conclusion

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

1. There was not a stastitically significant difference between the confugurations;
2. Both cervical configurations can be used with the electroforming system.

Resumo

O objetivo deste trabalho foi avaliar a adaptação marginal de *copings* eletroformados variando o término cervical (ombro arredondado e chanfro largo). Dois modelos padrão em aço inoxidável foram usinados simulando preparo de coroa total, sendo um com término cervical em chanfro largo e o outro em ombro arredondado. As moldagens foram feitas com polivinilsiloxano pela técnica da dupla moldagem, obtendo-se dez moldes para cada preparo. Para padronizar a moldagem foi confeccionado um alívio com uma placa de acetato com 1,4mm de espessura. Um delineador foi preparado para manter constante o eixo de inserção e remoção do modelo padrão durante as moldagens. Os moldes foram vazados com gesso tipo IV e sobre os modelos aplicado espaçador de troquel 1mm aquém da margem. Estes troquéis foram duplicados com silicone de laboratório para a obtenção de um segundo troquel em gesso especial, o qual recebeu uma ligação com fio de cobre e uma cobertura com laca de prata, permitindo a passagem de corrente galvânica e a deposição do ouro. Após limpeza e ajuste, os *copings* retornaram ao modelo padrão que estava fixado numa base octogonal, iniciando-se a leitura em microscópio óptico Olympus com mesa digital e 30 vezes de aumento. Os dados obtidos foram submetidos ao teste "t" e Mann-Whitney com nível de significância de 5%. Os valores médios do chanfro largo e ombro arredondado foram, respectivamente, 29,77µm e 26,77µm, com p=0,657 para o teste "t" e p=1,00 para o teste Mann-Whitney. Com os resultados obtidos, concluiu-se que não houve diferença estatisticamente significante, com ambas configurações marginais podendo ser empregadas durante o preparo dental.

Unitermos

Eletrodeposição, *copings*; adaptação marginal odontologia, copings; término cervical; eletrólise, revestimento com metal para fundição odontológica

Referências

1. Behrend F. Gold electroforming system: GES restorations. J Dent Technol 1997 Mar.; 14 (2): 31-7.
2. Christenden GJ. Marginal fit of gold inlay casting. J Prosthet Dent 1966 Mar/Apr.; 16 (2): 297-305.
3. Dölger J, Gadau C, Rathmer R. Treatment behavior and complete-mouth rehabilitation using AGC crowns: a case report. Int J Periodontics Rest Dent 2001 Aug.; 21 (4): 373-9.
4. Erpenstein H, Borchard R, Kerschbaum T. Long-term clinical results of galvano-ceramic and glass-ceramic individual crowns. J Prosthet Dent 2000 May; 83 (5): 530-4.
5. Hammerle CH, Mesaric W, Lang NP. Marginal fit of porcelain with galvanized frames. Schweiz Monatsschr Zanmed 1994; 104 (6): 740-5. Disponível em: http://www.ncbi.nlm.nih.gov/PubMed/ . Acesso em :17/09/01. (Abstract).
6. Harris IR, Wickens JL. A comparison of the fit of spark-eroded titanium copings and cast gold alloy copings. Int J Prosthodont 1994 July./Aug.; 7 (4): 348-55.
7. Holmes JR, Bayne SC, Holland GA, Sulik WD. Considerations in measurement of marginal fit. J Prosthet Dent 1989 Oct; 62 (4): 405-8.
8. Holmes JR, Pilcher ES, Rivers JA, Stewart RM. Marginal fit of electroformed ceramometal crowns. J Prosthodont 1996 June; 5 (2): 111-4.
9. Holmes JR, Sulik WD, Holland GA, Bayne SC. Marginal fit of castable ceramic crowns. J Prosthet Dent 1992 May; 67 (5): 594-9.
10. Huls A, Rinke S. Marginal fidelity of crowns produced with six different fabrication techniques [Abstract-1665]. J Dent Res 1995 Jan.; 74 (165): 421.
11. Hunter AJ, Hunter AR. Gingival margins for crowns: a review and discussion. Part II: discrepancies and configurations. J Prosthet Dent 1990 Dec.; 64 (6): 636-42.
12. Mitchell CA, Pintado MR, Douglas WH. Nondestructive, in vitro quantification of crown margins. J Prosthet Dent 2001 June; 85 (6): 575-84.
13. Pattenó D, Schieramo G, Bassi F, Bresciano ME, Carossa S. Comparison of marginal fit of 3 different metal-ceramic systems: a in vitro study. Int J Prosthodont 2000 Sept./Oct.; 13 (5): 405-8.
14. Pavanelli CA, Nogueira Jr L, Figueiredo AR, Rocha CAJ. Discrepância vertical de assentamento de coroas totais: dispositivo para fixação e mensuração pré e pós cimentação *(in vitro)*. Pós-Grad Rev Fac Odontol 2001 maio/ago.; 4 (2): 60-4.
15. Rogers OW. The electroformed gold matrix inlay technique. Aust Dent J 1970 Aug.; 15 (4): 316-23.
16. Rogers OW. The type of union between cast gold and an electroformed gold matrix in an inlay technique. Aust Dent J 1976 Dec.; 21 (6): 479-87.
17. Rogers OW. Porosity in gold cast an electroformed gold matrix in an inlay technique. Aust Dent J 1977 Apr.; 22 (2): 100-6.
18. Rogers OW. The dental application of electroformed pure gold.I Porcelain jacket crown technique. Aust Dent J 1979 June; 24 (3): 163-70.
19. Rogers OW. The dental application of electroformed pure gold II. Aust Dent J 1980 Feb.; 25 (1): 1-6.
20. Rogers OW. The dental application of electroformed pure gold III. Aust Dent J 1980 Aug.; 25 (4): 205-8.
21. Rogers OW, ARMSTRONG BW. Electroforming a gold matrix for indirect inlays. J Prosthet Dent 1961 Sept./Oct.; 11 (5): 959-66.
22. Setz J, Diehl J, Weber H. The marginal fit of cemented galvano-ceramic crowns. Int J Prosthodont 1989Jan./Feb.; 2 (1): 61-4.
23. Stephano CB, Roselino RF, Roselino RB, Campos GM. Adaptação cervical de coroas totais fundidas com diversas ligas metálicas, usando troquéis com e sem espaçador. Rev Odontol USP 1989 jul./set.; 3 (3): 383-9.
24. Stewart RM. Electroforming as an alternative to full ceramic restorations and cast substructures. Trends Tech Contemp Dent Lab 1994 Apr.; 11 (3): 42-7.
25. Vence BS. Electroforming technology for galvanoceramic restorations. J Prosthet Dent 1997 Apr.; 77 (4): 444-9.

Recebido em: 12/03/03
Aprovado em: 19/05/03

Leonardo Buso
Rua Dr. Alfredo Ellis nº 249 aptº 62
CEP: 01322-050 – Bela Vista
São Paulo – SP
tel: (11)32841868
mailto:leobuso05@hotmail.com