Evaluation of the marginal adaptation of ceramic copings in function of the cervical endings and treatment of the internal surfaces*

Avaliação da adaptação marginal de copings cerâmicos em função do término cervical e tratamento das superfícies internas

Edson HILGERT, MDS
Postgraduate student – Resthorative Dentistry Program – Prosthesis – Dental School of Dentistry of São José dos Campos – UNESP, São Paulo, Brazil

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

Marco Antonio BOTTINO, PhD
Professor – Department of Dental Materials and Prosthodontics – Dental School of Dentistry of São José dos Campos – UNESP, São Paulo, Brazil

Abstract

This study evaluates the marginal adaptation of ceramic copings (In-Ceram, Vita) front of two finish lines and internal surface treatment (Rocatec, ESPE). For this, two master steel dies were milled with all-ceramic crowns preparation, one with a round shoulder (RS) margin design, and the other with a deep chamfer (DC). Twenty copings were made, and the marginal discrepancy was evaluated in measuring microscope, obtaining an initial measure. Each group was divided in two others, which received two kinds of silica sandblasting: (1) in all inner crown surface - DCt and RSt - and (2) in the inner crown surface, but preserving the cervical edge - DCa and RSa. The discrepancies were measured again and the data submitted to the statistical analysis. Marginal discrepancy values of 42,37±18,78μm were observed for group DC and 33,35±20,08μm for group RS in the initial measures, without significant statistical differences among them. The initial and final gap values were compared to each one of the experimental groups, being observed statistical differences in DCa and DCt. Statistical differences was not observed among the post-sandblasting values. It was concluded that both cervical endings present similar marginal adaptations between them when not submitted to any treatment type. When accomplished the surface treatment, negative influence was observed in the marginal adaptation of some groups, if compared the initial and final values, in spite of differences among the last ones were not been observed.

Uniterms

Ceramics, surface treatment, marginal adaptation, finish lines

Introduction

Nowadays, the esthetic lives a great moment in the history of Dentistry, as much for the development of new materials as for the own inherent esthetic appeals to the modern society. Besides, the discussion related to the biocompatibility of dental alloys becomes more and more constant. That turns the use of metal free prostheses a tendency of the modern dentistry, due to its low toxicity and allergic potential, besides the excellent aesthetic properties (CHRISTENSEN[6], 1999).

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This way, the development metal free prostheses came in a fast way, its source being the first porcelain jacket crowns, going through modifications as the addition of alumina content, announced firstly by McLean & Hughes[19] in 1965, coming into several ceramic systems with high flexural resistance and quite a lot of indications. One of the most versatile systems is named In-Ceram (Vita Zahnfabrik), created by Sadoun in 1986 (GROTEN et al.[7], 1997), who uses alumina or zirconia ceramic. In In-Ceram Alumina, particles of alumina with fine granulation are joined to form a porous sub-structure and lately infiltrated by liquefied glass. The association between these two processes confers to the material its outstanding properties. In the sinterization process, the contraction is almost inexistent, providing an excellent adaptation, while the glass infiltration practically does not leave porosities, resulting in high resistance of the material (KERN et al.[14], 1991; PRÖBSTER & DIEHI[23], 1992; PERA et al.[22] 1994).

With the innovations in restorative systems, the union agents also increased in order to promote appropriate adhesion of these materials to the dental structures. In the In-Ceram case specifically, the acid etching and silanization did not achieve good results related to the union with resins BIS-GMA, due to the high alumina content and lower silica content (KERN & THOMPSON[11], 1994). Because of that, the use of conventional cements or phosphate monomer based ones has been introduced when an adhesive luting is desire (KERN & THOMPSON[13], 1995; MADANI[16], 2000).

Thus, ways to make these materials compatible were researched, and a found alternative was to raise the superficial content of silica of the aluminized structures across a tribochemical process, by using a developed system for metallic structures. This system, named Rocatec (ESPE), consists of two sandblasting stages procedure, being the first a pre-treatment with alumina powder (Rocatec Pre), followed by the second sandblasting with particles of the silica base (Rocatec Plus or Rocatec Soft). The use of Rocatec has been extrapolated, with good results, to the high density alumina structures, providing a better likeness of this to the silane, due to the greater superficial concentration of silica given to these structures by the sandblasting (KERN & THOMPSON[13], 1995; KOURTIS[15], 1997).

With the sandblasting, superficial modifications as the inclusion of the silica particles and superficial abrasion can cause variations in the seating of the prosthetic crown and in the marginal fidelity. Kern & Thompson[12] (1994) comment that the sandblasting of ceramic restorations has the potential of removing significant amounts of material and to affect the clinical adaptation of the restoration. The importance given in literature for the marginal adaptation makes the investigation of these variations necessary and if they are clinically significant; also, to verify the best configurations of finish lines of dental preparations for ceramic crowns, once the cement line of fixed and unitary partial prostheses is still a critical point in the prosthetic treatment.

This way, the aim of this study was to evaluate the marginal adaptation of aluminized ceramic copings infiltrated by glass, attesting the influence of the finish lines configuration and the possibility of changes in the marginal adaptation of them by using a silica sandblasting method (Rocatec, ESPE), varying the application method.

MATERIAL AND METHODS

Two metallic dies were milled in stainless steel, which served as master models (BOTTINO[3], 1998), simulating prepares for metal free total crowns, with mean dimensions of a second inferior molar, differing only in the type of finish line (Figure 1). The finish lines used were the round shoulder (RS) and deep chamfer (DC), extolled in the literature for making metal free prostheses (PRÖBSTER & DIEHL[23], 1992; SHEARER et al.[25], 1996). In the cervical margin a semicircular notch was done in a way to permit the replacement of the ceramic copings for the readings accomplishment.

From these metallic dies, plaster replicas were obtained on which the copings would be made. For the reproduction of the metallic die, moldings were accomplished with addition silicone (Elite H-D Putty Soft - Normal Setting and Regular Body - Normal Setting, Zhermack, Italy) by the double impression technique. The standardization of the insert and removal axis during the procedure were achieve with an adapted dental surveyor, where in your movable vertical rod a thread was made, that allowed the fixation of the metallic die. In its base was an attachment that allowed the positioning of the centralized tray to the vertical rod's axis. The-

se trays were made in steel, with a cylindrical design and perforations for the impression material retention. The manipulation procedures of the impression material and the plaster pouring were accomplished according to the manufacturers' recommendations. The impressions and the plaster dies (Durone, Dentsply) were analyzed related to the presence of bubbles or imperfections and if detected, the procedure was repeated. For each prepare, twenty impressions were accomplished, resulting in forty moulds and models.

After the attainment of all the plaster dies, the In-Ceram system spacing was applied on them, then duplicated in a special plaster, with aid of addition silicon. From these dies, the copings were made according to the protocol established by the manufacturer.

This way, the initial measurements were accomplished (L_0). Firstly, the metallic die was fixed on an octagonal base that served as orientation of the marginal discrepancy measuring points. The coping was positioned on the metallic die and blocked in position with the aid of a gadget developed by Pavanelli et al.[21] (2001). This provided constant pressure during the whole measurement process through a piston fixed by lateral screws (Figure 2).

The measurements were accomplished according to the definition of marginal gap by Holmes et al.[8] (1989), in a measuring microscope (Olympus Microscope Precision STM, Japan), with digital table, 30X of magnification and 0,5mm precision. The readings were done three times in each measurement point, achieving a mean, being that four opposite points diametrically were read in each coping, originating 12 gap measurements for each sample.

After the initial reading of the first two groups (DC and RS), each one of these was divided in other two subsets groups (n=10), according to the silica coating application: total application (DCt and RSt) or with relief in the border (DCa and RSa) (Picture 1). In the groups with total application, the alumina oxide sandblasting was applied in the whole internal surface of the crown and cervical ending and, after cleaning with compressed air, the silica sandblasting (Rocatec Plus, ESPE), with pressure of 2,5bar; distance of 10mm and time of application of 14seg (KERN & THOMPSON[13], 1995). In the groups in that the application with relief, previously to the surface treatment, the cervical border of the coping was alleviated in approximately 1mm with inlay wax in its entire circumference, to avoid the contact of the sandblasting with this area. With the sandblasted copings, the measurements marginal gap values was proceeded again, (L_1) for the four treated groups, with the same procedures and criteria used in the previous measurements.

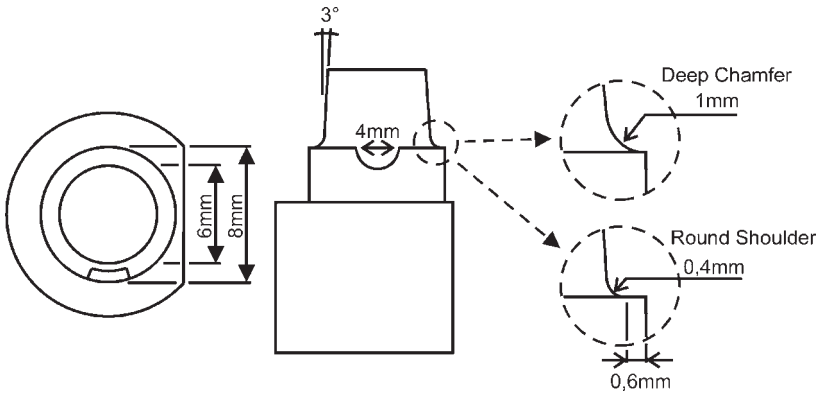

FIGURE 1 – Schematic drawing of the master dies.

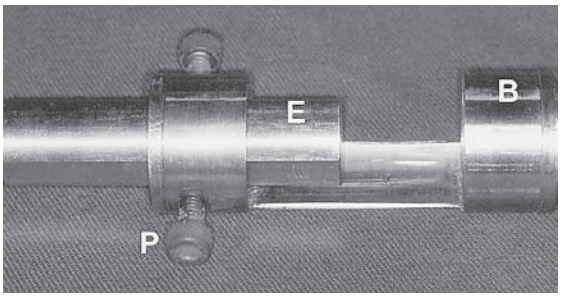

FIGURE 2 – Gadget developed to blocking the coping on the master die: (P) fixing screw; (E) piston; (B) base.

The data acquired with the L_0 measurements were submitted to the statistical analysis in order to verify statistical differences among the finish lines, using the Student's t-test. The values of L_0 and L_1 were also compared with the t-test in each experimental group in order to verify the influence of the treatment with Rocatec in its marginal gap. The analysis among the groups after they've received the treatment of the internal surfaces (L_1) was accomplished with the analysis of variance test (ANOVA). All the tests were accomplished with the aid of the software Statistix for Windows 7.0 (Analytical Software Inc.) with significance level of 5%.

Picture 1 - Division of the experimental groups in function of the finish lines and of the surface treatment it interns with application of Rocatec

Groups		n	Rocatec application
Finish Line	FL/Application		
Deep Chamfer (DC)	DCa DCt	10 10	preserving the borders of crowns total application
Round Shoulder (RS)	RSa RSt	10 10	preserving the borders of crowns total application

RESULTS

Mean marginal discrepancy values were observed (L_0) of 42,37µm for Deep Chamfer and 33,35µm for the Round Shoulder (Table 1 and Figure 3). These averages were submitted to the statistical analysis with the Student's t-test, with a significance level of 5%, not being observed significant statistical differences among the finish lines.

The L_0 and L_1 values were compared in each one of the experimental groups with the Student's t-test. Significant statistical differences were observed in the groups DCa and DCt. In the group RSt statistical differences were not observed, with level of significance of 5%, but it presented extremely close values at this level (p=0,055) (Table 2 and Figure 4).

Two criteria analysis of variance test (ANOVA) were accomplished to compare the obtained values of L_1, not being observed difference statistics among the groups (p=0,05).

Discussion

The use of metal free prostheses permits a great opening of applications inside of the modern Dentistry, due to its biocompatibility and capacity to reproduce, in a clinical condition, extremely pleasant esthetic aspects in the oral rehabilitation (CHRISTENSEN[6], 1999). But the success of any restorative procedure in Dentistry is intimately linked to the precision of adaptation of the substitute material to the tooth. This way, the evaluation of the ceramic crowns marginal adaptation is absolutely important for the scientific proof of clinical situations.

This work evaluated the marginal adaptation of In-Ceram copings instead of concluded crowns, therefore some works in literature affirm that the

Table 1 - Descriptive statistics of the measuring data of L_0 - Deep Chamfer x Round Shoulder (μm)

n=20	L_0	
Deep Chamfer	DC = 42,37±18,78	A
Round Shoulder	RS = 33,35±20,08	A

Averages followed by the same letter in the column do not differ one from the other at 5% level of significance.

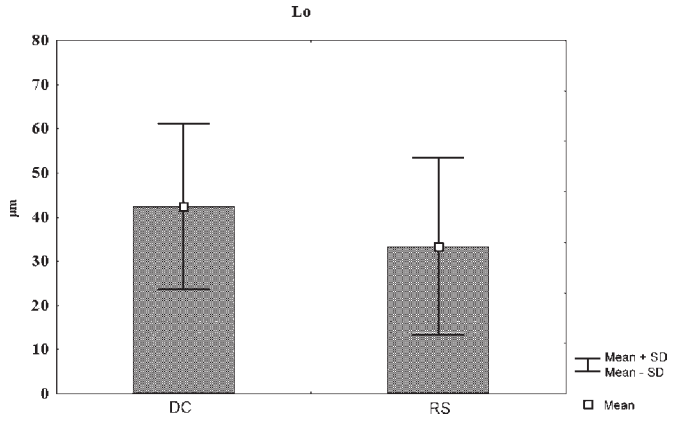

FIGURE 3 – Graphic presentation of marginal gap averages for the initial measurements (L_0).

Table 2 – Descriptive statistics of the measuring data of L_0 and L_1 depending on finish lines and surface treatment

	n=10	L_0	L_1	
Deep Chamfer	DCa	36,87 (±16,42)	46,62 (±21,27)	A
DCt		47,87 (±20,19)	52,65 (±19,61)	A
Round Shoulder	RSa	38,48 (±21,53)	35,02 (±25,12)	A
RSt		28,20 (±18,20)	39,50 (±32,30)	A

Averages followed by the same letter in the column do not differ one from the other at 5% level of significance

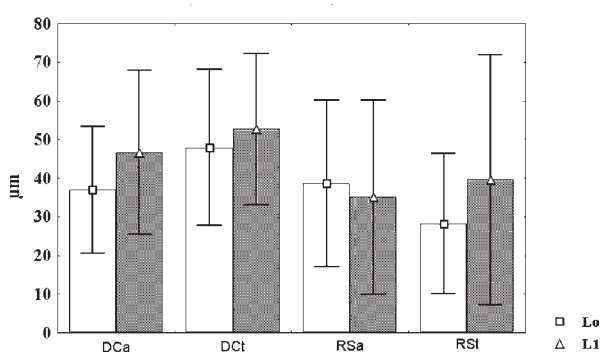

FIGURE 4 – Graphic presentation of marginal gap averages for the initial and final measurements.

marginal modification in In-Ceram, due to the several covering ceramic firing cycles, is not considered significant (PERA et al.[22], 1994; SHEARER et al.[25], 1996; GROTEN et al.[7], 1997; SULAIMAN et al.[27], 1997). Two types of finish lines were used, deep chamfer and the round shoulder, because they are the most recommended in the literature (PRÖBSTER & DIEHL[23], 1992; SHEARER et al.[25], 1996) for the confection of metal free crowns. This is due to its horizontal configuration, once the bevel is contraindicated in this prosthesis type, because thin margins tend to fracture with easiness in ceramic restorations.

Two metallic master models, in substitution to natural teeth, were used in this study and on them accomplished the tests. Beschnidt & Strub[1] (1999) report that natural teeth present great variation considering the age, individual structures and time of storage, making the standardization of the pillars difficult. Therefore, several authors have employed metallic models or resin ones for measurement of the marginal fidelity (PERA et al.[22], 1994; RINKE et al.[24] 1995; SHEARER et al.[25], 1996; GROTEN et al.[7], 1997; SULAIMAN et al.[27], 1997; NAKAMURA et al.[20], 2000; TINSCHERT et al.[28], 2001) with some advantages. Among them, the easy reproduction achieving and the few present variables. Groten et al.[7] (1997) affirm that, in in vitro studies, clinical faults and disturbing parameters not related to the confection technique can be avoided or reduced as much as possible, and using an only steel master model turns possible the making of all samples up in a same initial situation.

Another point of relevance is the aspect that concerns to the cementing of the copings. Some authors make use of it (CHAN et al.[4], 1989; SORENSEN[26], 1990), because they believe that the most important inadaptability is the one that occurs in vivo, when the crowns are already cemented. In our studies, as well as in Rinke et al.[24] (1995), Groten et al.[7] (1997), Sulaiman et al.[27] (1997), Nakamura et al.[20] (2000), Tinschert et al.[28] (2001), this was not accomplished. Tinschert et al.[28] (2001) affirm that, when we cement the crowns, we lose the precision of the primary adaptation, being the influence of the cement type, viscosity and cementation techniques well-known. We believed that when compared crowns construction systems and modifications that will influence in the precision of primary adaptation; the cementation should not be used.

In the values observed before the application of the sandblasting (L_0), related only to the finish lines preparations, we didn't notice significant statistical differences between the two types, being observed values of mean marginal discrepancy of 42.37μm for deep chamfer and 33.35μm the round shoulder. In literature mean values of marginal gap were observed inside of a great range, since 19μm, without significant difference between deep chamfer and round shoulder (SHEARER et al.[25], 1996) up to 161mm (SULAIMAN et al.[27], 1997), being our results this range. It is still observed in our study, some standard deviations with high values, and two causes can be the most probable to elucidate this fact. The first is intrinsic to the evaluation method, where four measurements points were observed in each of the appraised copings. It is known that the values of marginal adaptation are not constant in every circumference of the cervical end, thus, if more points were confronted the tendency of the standard deviation fall will exist. Another possible reason is that these copings are handmade, and they are liable to inherent variations to the own making, for the laboratory technician.

The use of the silica cover in aluminized ceramics is a reality, considered as an effective method to improve its union to the resinous cements by the increase of the superficial silica content (KERN & THOMPSON[12], 1994; KERN & THOMPSON[13], 1995; MARAIS & HERBST[17], 1996; KERN & STRUB[10], 1998; BLIXT et al.[2], 2000).

However, the marginal adaptation of crowns or fixed partial prostheses submitted to this treatment had not been evaluated in the literature. This aspect becomes important when applied in the internal surface of the crowns, in first place, an abrasion of this surface should exist, and in second place, there is the incorporation of silica particles to the ceramic, changing the morphology of the internal surface of the treated crowns. Kern & Thompson[12] (1994) didn't obtain conclusive results to affirm that would exist an inappropriate adaptation of the prostheses, due to surface alterations caused by the sandblasting.

The obtained results, comparing the values pre and post application of Rocatec, demonstrate that this surface treatment influenced negatively in the marginal adaptation of In-Ceram crowns, in the groups DCa and DCt, and in the groups RSt and RSa significant statistical differences were not observed, with level of significance of 5%. These

found differences, in our opinion, are not limitations for the clinical use of the Rocatec system, once that all the marginal gap mean values found in this study are inside of the clinically acceptable parameters. These values of clinical acceptance are very controversial and without consensus in the literature, but they are situated among the mean values of 39µm (CHRISTENSEN[5], 1966), 50µm (PERA et al.[22], 1994), 50 to 74µm (HUNG et al.[9], 1990), 70µm (WEaver et al.[29], 1991) and 120µm (McLEAN & FRAUNHOFER[18], 1971). In our study, all the marginal gap averages in the appraised groups are in an inferior landings of 55µm, making us believe that any of the surface treatments or finish lines used in this study are susceptible to be used at the clinic.

This way, with these study limitations, we noticed that the influence of the finish line; round shoulder or deep chamfer; and the surface treatment with Rocatec are not big enough to make the adaptation of the crowns be clinically unacceptable. On the other hand, it is possible that additional sandblastings, for any reasons, disarrange the crown to the pillar tooth, owing to the cumulative effect of this procedure.

Conclusion

From the broached methodology and of the obtained results, we concluded that when analyzed the groups pre-sandblasting to each other, there were not significant statistical differences among the finish lines analyzed. In the same way, when analyzed the groups pos-sandblasting, statistical differences were not observed among them. On the other hand, when compared the values before and after the treatment of the samples, there was negative influence of the sandblasting when use the deep chamfer finish line, with relief or not in the cervical board (groups RSa and RSt).

Resumo

Este estudo avaliou a adaptação marginal de copings cerâmicos (In-Ceram, Vita) variando o tipo de término cervical e tratamento interno de superfície (Rocatec, ESPE). Para tal, foram usinados dois modelos-padrão em aço com preparo para coroa totalmente cerâmica, sendo um com término cervical em ombro arredondado (O) e o outro em chanfro largo (C). A partir de cada um deles, foram confeccionados 20 copings, e a discrepância marginal avaliada em microscópio para medição, obtendo assim uma medida inicial. Cada grupo foi dividido em dois outros, que receberam dois tipos de jateamento com sílica: (1) em toda superfície interna da coroa – CT e OT – e (2) na superfície interna, mas aliviando o bordo cervical – CA e OA. As discrepâncias foram novamente mensuradas e os dados submetidos à análise estatística. Foram observados valores de discrepância marginal média de 42,37±18,78mm para grupo C e 33,35±20,08mm para o grupo O nas medidas iniciais, sem diferença estatisticamente significante entre eles. Os valores iniciais e finais foram comparados para cada um dos grupos experimentais, sendo observada diferença estatística significante em CA e CT. Não foi observada diferença estatística entre os valores pós-jateamento. Conclui-se que ambos os términos cervicais apresentam adaptações marginais semelhantes entre si quando não submetidos a nenhum tipo de tratamento. Quando realizado o tratamento de superfície, foi observada influência negativa na adaptação marginal de alguns grupos, se comparados os valores iniciais e finais, apesar de não serem observadas diferenças entre os últimos.

Unitermos

Cerâmicas, propriedades de, tratamento de superfície, adaptação marginal, término cervical.

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Mail adress
Edson Hilgert
Av. Francisco José Longo, 777.S. Dimas
CEP 12245-000 – São José dos Campos – SP
ehilgert@yahoo.com