Influence of Melting and Casting Methods and Finish Line Design on the Marginal Discrepancy of Nickel–Chromium–Titanium Alloy Crowns

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The aim of this study was to analyze the influence of melting and casting procedures and the cervical finish line design on the marginal fit of nickel-chromium-titanium alloy crowns. Sixty standardized specimens were prepared to receive metal-ceramic crowns and were divided into two groups according to the cervical finish line: chamfer or rounded shoulder. Three melting and casting procedures were analyzed: *(1)* induction-centrifuge (IC), *(2)* gas oxygen torch–centrifuge (TC), and *(3)* induction-vacuum/pressure (IP). The marginal fit was measured with an image analysis system. Significant differences ($P = .005$) were observed among the groups, with TC showing the lowest discrepancies (45.87 μm). No significant differences were observed between the two finish lines. The accuracy of fit achieved for the groups analyzed may be regarded as within the range of clinical acceptance. *Int J Prosthodont 2010;23:443–445.*

Metal-ceramic restorations are used widely in fixed prosthodontics, although alloy selection may be a confusing process. Therefore, a wide range of materials and techniques have been developed[1,2] to improve the casting procedure.

Since titanium demonstrates low toxicity and high biocompatibility, a nickel-chromium-titanium (Ni-Cr-Ti) alloy was introduced as an alternative. It has been stated by the manufacturer that it provides satisfactory marginal adaptation, good physical and mechanical properties, and excellent biocompatibility.

The purpose of this study was to investigate the marginal discrepancy of metal-ceramic crowns made with Ni-Cr-Ti alloy and fabricated using three melting and casting techniques and two cervical finish line designs. The null hypothesis was that the cervical finish line design and melting and casting technique do not have any influence on the marginal fit.

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Materials and Methods

Sixty standardized brass specimens (5 mm in height, 5 mm in occlusal diameter, and a convergence angle of 6 degrees) were prepared to receive metal-ceramic crowns. The dies were divided into two groups (n = 30) according to the cervical finish line: chamfer and rounded shoulder. Both finish lines were prepared 1-mm deep circumferentially. Each group was divided into three subgroups (n = 10) according to the melting and casting process: *(1)* induction-centrifuge (IC) (MIE 200, Ordenta), *(2)* gas oxygen torch–centrifuge (TC) (G3, Mestra), and *(3)* induction-vacuum/pressure (IP) (CL-IG, Heraeus Kulzer).

The restorations were manufactured using the traditional lost-wax casting technique, cast with Tilite Premium Alloy (76% Ni, 13.51% Cr, 6% molybdenum, and 4% Ti; Talladium) and veneered with Vita VM 13 (Vita).

Image analysis software (Optimas 6.1, Optimas), in combination with an Olympus microscope (SZ 4045TR-CTV) with a magnification of ×40 and a charge-coupled Sony camera, was used for the measurements (Fig 1). The marginal fit was measured at the same points at the middle of the buccal, lingual, mesial, and distal surfaces and marked with an indelible marking pen. For each selected point, an area of 30 points was analyzed by the software; 120 measurements were recorded per crown.

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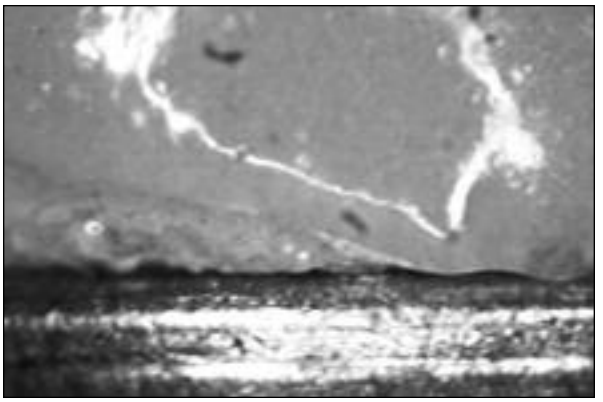

Fig 1 Photograph showing the marginal fit in a chamfer induction-vacuum/pressure specimen (magnification ×40).

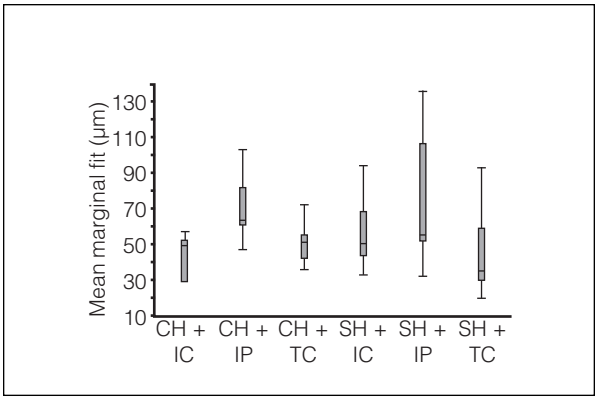

Fig 2 Box plot of mean values and standard deviations for marginal fit in all groups. CH = chamfer finish line; IC = induction-centrifuge; IP = induction-vacuum/pressure; TC = torch-centrifuge; SH = rounded shoulder finish line.

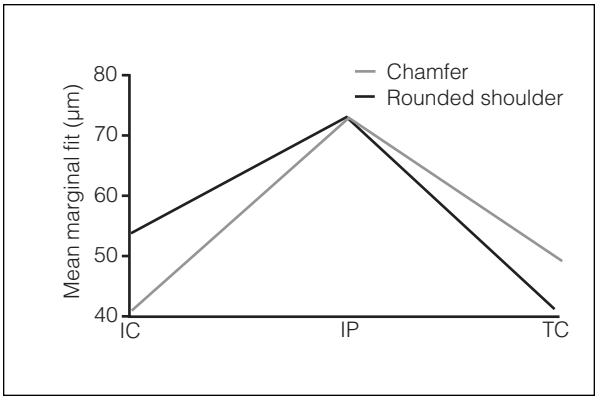

Fig 3 Interaction between the finish line design and casting method.

The fit was assessed by measuring the vertical distance between the crown margin and preparation cavosurface angle. The measurements were performed by the same researcher and taken at the same points.

Measurements were analyzed statistically using two-way analysis of variance, the Duncan multiple range post-hoc test, and the Student paired *t* test.

Results

The TC group showed the lowest discrepancies (45.87 ± 17.15 µm) while the highest discrepancies were found in the IP group (71.08 ± 26.37 µm). Significant differences were observed between IP and both of the other groups ($P = .005$). The accuracy of fit achieved for the three groups analyzed was within the range of clinical acceptance (< 100 µm).

No significant differences were demonstrated between the two finish lines.

The best marginal fit values for the chamfer finish line dies were observed for the IC group (42.27 ± 12.08 µm), while for the rounded shoulder dies, it was the TC group (42.30 ± 21.80 µm) (Fig 2). No significant interaction was observed between casting technique and cervical finish line design (Fig 3).

Significant differences ($P = .005$) were observed between the lingual surface and the other surfaces.

Discussion

Published clinical reports suggest that a marginal discrepancy of approximately 100 µm seems to be clinically acceptable for the successful longevity of restorations.[3,4] Consequently, the results of this study may be regarded as being within the acceptable standards. Moreover, to ensure relevant results, the minimum number of measurements from previous studies[4] was taken into consideration in this study's design.

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Nonetheless, it is admitted that a power analysis to determine the optimal sample number for this study would have provided a more robust research design. The best marginal fit observed for the lingual surface was reported previously.[5] No studies have been done on the marginal fit of Ni-Cr-Ti alloy in crowns because of its recent introduction, so it is impossible to compare the results obtained.

The manufacturer recommends the use of a gas oxygen flame and centrifugation to cast the Tilite alloy. These procedures correspond to the reality of most specialized technical laboratories, but one difficulty inherent in the process is the determination of the ideal time for centrifuge operation to avoid underheating or overheating the metal.[1] Although the advantages of induction are obvious, no differences were found in the present study between the TC and IC groups. Further studies must be done to determine if different cast sources could influence the alloy composition and its physical properties.

In the present research, no differences were found between the two finish lines analyzed. These results are in agreement with previous studies.[3,5]

Within the limitations of this study's design, the Ni-Cr-Ti alloy may be used as an alternative alloy with regard to the marginal accuracy of metal-ceramic restorations. Further investigations, especially ones with long-term clinical outcomes, are necessary to confirm the characteristics of the new formulation and to analyze the clinical behavior of the alloy.

Conclusions

Under the conditions of this investigation, the results indicate that the accuracy of fit achieved for Tilite alloy was within the acceptable standards, showing TC and IC as having the best marginal fit. No differences were demonstrated between both finish lines analyzed.

Acknowledgments

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References

1. Bezzon OL, Ribeiro RF, Rollo JM, Crosara S. Castability and resistance of ceramometal bonding in Ni-Cr and Ni-Cr-Be alloys. J Prosthet Dent 2001;85:299–304.
2. Carter SM, Wilson PR. The effect of die-spacing on crown retention. Int J Prosthodont 1996;9:21–29.
3. Syu JZ, Byrne G, Laub LW, Land MF. Influence of finish-line geometry on the fit of crowns. Int J Prosthodont 1993;6:25–30.
4. Gassino G, Barone Monfrin S, Scanu M, Spina G, Preti G. Marginal adaptation of fixed prosthodontics: A new in vitro 360-degree external examination procedure. Int J Prosthodont 2004;17:218–223.
5. Wöstmann B, Blösser T, Gouentenoudis M, Balkenhol M, Ferger P. Influence of margin design on the fit of high-precious alloy restorations in patients. J Dent 2005;33:611–618.

Literature Abstract

Five- year success rate of 831 consecutively placed zirconia dental implants in humans: A comparison of three different rough surfaces

The purpose of this study was to evaluate the 5-year success rate of zirconia implants with three different surfaces: coated (C), uncoated (UC), and acid-etched (ICE). One-piece zirconia dental implants with three different surfaces were used in this study. Cold zirconia implants were pressed in rods, presintered, and then turned into dental implants. The UC implants were ground mechanically with a special diamond wheel to produce a surface roughness of 0.62 µm. The C implants were coated with a bioactive ceramic to give a final surface roughness of 0.92 µm. The ICE implants were etched to give a final surface roughness of 1.16 µm. Five different designs of implants were manufactured for specific indications, each with three specific parts: the endosseous part, the transmucosal part, and the abutment part. Patients were alternately assigned implant types or surfaces. The definitive restorations were placed 4 months after surgery and all definitive restorations were left in slight infraocclusion; lateral excursions were also avoided. All-ceramic restorations were fabricated as the definitive restorations and patients were followed up for 1, 3, 6, and 12 months, and thereafter for 2, 3, 4, and 5 years. Of the 831 implants placed, there were 249 UC, 249 C, and 333 ICE. The 5-year overall survival rate for the zirconia implants was 94.95%. By group, the success rates were 92.77% for UC, 93.57% for C, and 97.6% for ICE, with statistical differences between groups UC and ICE and groups C and ICE. A total of 42 implants failed; no implants fractured. The authors conclude that CeraRoot acid-etched implants (ICE surface) showed good long-term clinical performance and might be a good alternative for tooth replacement.

Oliva J, Oliva X, Oliva JD. *Int J Oral Maxillofac Implants* 2010;25:336–344 **References:** 34. **Reprints:** Dr Josep Oliva, University of Barcelona, Josep Umbert 126, Granollers 08402 Spain. Fax: +34-938792373. Email: pepeoliva@clinicaliva.com—*Y.L. Seetoh, Singapore*

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