Short Communication

Comparative Analysis of the Fit of 3-Unit Implant-Supported Frameworks Cast in Nickel-Chromium and Cobalt-Chromium Alloys and Commercially Pure Titanium After Casting, Laser Welding, and Simulated Porcelain Firings

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This study compared the vertical misfit of 3-unit implant-supported nickel-chromium (Ni-Cr) and cobalt-chromium (Co-Cr) alloy and commercially pure titanium (cpTi) frameworks after casting as 1 piece, after sectioning and laser welding, and after simulated porcelain firings. The results on the tightened side showed no statistically significant differences. On the opposite side, statistically significant differences were found for Co-Cr alloy (118.64 µm [SD: 91.48] to 39.90 µm [SD: 27.13]) and cpTi (118.56 µm [51.35] to 27.87 µm [12.71]) when comparing 1-piece to laser-welded frameworks. With both sides tightened, only Co-Cr alloy showed statistically significant differences after laser welding. Ni-Cr alloy showed the lowest misfit values, though the differences were not statistically significantly different. Simulated porcelain firings revealed no significant differences. *Int J Prosthodont 2008;21:121–123.*

In implant dentistry, the precision of fit and passive fit will lead to treatment success. Ill-fitting implant frameworks potentially result in patient pain and sensitivity, loosening of screw joints, fatigue fractures of components, peri-implant bone loss, and even loss of osseointegration.[1] This study compared the vertical misfit of 3-unit implant-supported nickel-chromium (Ni-Cr) and cobalt-chromium (Co-Cr) alloy and commercially pure titanium (cpTi) frameworks after casting as 1 piece, after sectioning and laser welding, and after simulated porcelain firings.

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Materials and Methods

Using previously described methodology,[2] a metal matrix was machined to fix 2 internal-hex cylinder implants (3.75 × 11 mm, Master Conect AR; Conexão Sistemas de Prótese) parallel to each other. Conical abutments (3 mm in height, no. 022073, Conexão Sistemas de Prótese) were adapted over each implant (Fig 1) and tightened to 20 Ncm.[2] This matrix served as the master cast for all specimens made and as an index for measuring the accuracy of casting and soldering procedures.

Plastic cylinders were placed and retained using prosthetic screws (no. 011004, Conexão Sistemas de Prótese). Cylinder bonding was achieved with acrylic resin (Pattern Resin LS, GC America), and a 3-unit implant-supported framework was waxed (Fig 2). This first waxed framework was used as a pattern, and 3 groups were formed (6 units each): *(1)* Ni-Cr alloy (VeraBond II, Aalba Dent), *(2)* Co-Cr alloy (Remanium 2000, Dentaurum), and *(3)* cpTi (Tritan, grade 1, Dentaurum).

Specimens were evaluated for passive fit by tightening the screws to 10 Ncm.[2] The first reading of the abutment/cylinder gaps on both tightened and opposite sides was made with 1 screw tightened.[3] Next, the screw location was changed for the second reading. For the third reading, both screws were tightened. Three measurements were performed with an optical

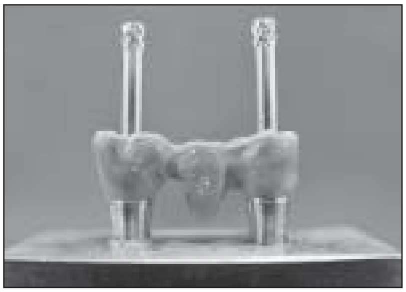
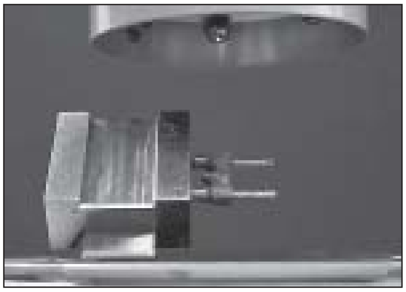


Fig 1 *(left)* Specimen base with abutments in position.

Fig 2 *(right)* Wax pattern of the screw-retained 3-unit framework.



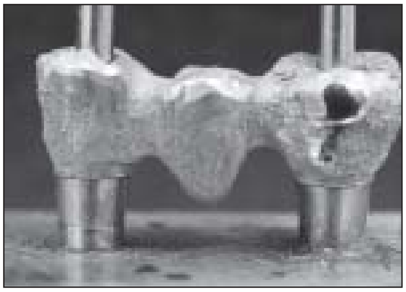


Fig 3 *(left)* The base was designed at an angle to allowing for viewing of proximal areas.

Fig 4 *(right)* Lingual view of laser-welded framework.

Table 1 Means (SDs) of the Abutment/Framework Interfacial Gaps (μm) with 1 Screw Tightened on the Tightened Side*

Material	1 piece	After laser welding	After simulated firing
Co-Cr	35.01 (27.76)	18.24 (9.19)	18.38 (15.69)
Ni-Cr	19.96 (8.14)	13.35 (2.91)	16.46 (3.58)
cp Ti	24.12 (16.37)	15.66 (9.65)	14.84 (10.61)

*Critical value = 3.25714; $P < .05$. No significant differences were found (Tukey-Kramer test).

Table 2 Means (SDs) of the Abutment/Framework Interfacial Gaps (μm) with 1 Screw Tightened on the Opposite Side*

Material	1 piece	After laser welding	After simulated firing
Co-Cr	118.64 (91.48)[a]	39.90 (27.13)[b]	26.42 (8.67)[b]
Ni-Cr	70.66 (20.88)[ab]	21.27 (7.22)[b]	28.49 (12.47)[b]
cpTi	118.56 (51.35)[a]	27.87 (12.71)[b]	28.05 (20.89)[b]

*Critical value = 3.25714; $P < .05$. Values with different letters are significantly different (Tukey-Kramer test).

Table 3 Means (SDs) of the Abutment/Framework Interfacial Gaps (μm) with Both Screws Tightened*

Material	1 piece	After laser welding	After simulated firing
Co-Cr	54.23 (37.10)[a]	21.49 (9.08)[bc]	20.10 (9.02)[bc]
Ni-Cr	25.00 (7.92)[abc]	13.10 (1.81)[c]	12.97 (2.48)[c]
cpTi	48.41 (26.69)[ab]	17.70 (11.70)[bc]	18.61 (11.32)[bc]

*Critical value = 3.25714; $P < .05$. Values with different letters are significantly different (Tukey-Kramer test).

microscope (no. 18938, Nikon) at 15× magnification at buccal, lingual, and proximal aspects, totaling 12 measurement points for each cylinder/condition (Fig 3).

Frameworks were then sectioned between the second premolar and first molar using a carborundum disk (Ultra-Thin, Dentorium), and the 2 parts of each framework were laser welded (Desktop Laser, Dentaurum) (Fig 4) according to a previous study.[4] Measurements between the reference points were then repeated.

All frameworks were exposed to simulated porcelain firing cycles (1 oxidizing, 2 opaque, 2 body [dentin and enamel], and 1 glaze) without porcelain application,[5] and a new set of measurements was taken. Analysis of variance was applied for 2 criteria (material and treatment), and the Tukey-Kramer test was used for individual comparisons ($P < .05$) when significant differences were found (JMP 6.0, SAS Institute).

Results

Table 1 shows no significant differences between the frameworks in terms of vertical misfit ($P > .05$) with 1 screw tightened. Table 2 shows that after laser welding and simulated porcelain firings, the Co-Cr alloy and cpTi showed significant differences on the opposite side compared to the 1-piece condition ($P < .05$). With both screws tightened (Table 3), after laser welding, the Co-Cr alloy group showed a significant difference ($P < .05$) compared to the 1-piece condition. Simulated porcelain firings resulted in no significant differences ($P > .05$).

Discussion and Conclusion

This study found that Ni-Cr alloy presented the lowest misfit values among the groups, though the difference was not statistically significant. Earlier studies found misfit varying from 25 to 160 μm,[5] which is in accordance with the misfit found in the present study. The 1-screw test results showed higher misfit values on the opposite side compared to the tightened side, indicating nonpassivity of 1-piece castings.[2]

After welding procedures, the lower misfit values on the opposite side showed better passivity of the frameworks, though complete passivity could not be assumed since the misfit values were still lower on the tightened side. Misfit values found after porcelain firing cycles were clinically acceptable, considering 100 μm as a maximum gap and according to previous studies.[5] The results indicate that casting 1-piece frameworks is technique sensitive, and good results can be obtained no matter which material is used. However, greater variation in the measured gaps was found for Co-Cr alloy and cpTi, despite following the same methodology.

All materials used in this study are suitable for casting implant-supported frameworks. Sectioning of the specimens followed by laser welding is an adequate procedure to achieve lower misfit values and promote better passivity. Despite the cost of the equipment, this method is becoming more accessible to dental clinicians.

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Literature Abstract

Technical complications of implant-supported fixed partial dentures in partially edentulous cases after an average observation period of 5 years

This prospective long-term study evaluated the incidence of technical complications, including screw loosening, screw fracture, framework fracture, and fracture of veneering material in implant-supported fixed partial dentures (FPDs). Seventy-six partially edentulous patients were rehabilitated with 112 implant-supported restorations (46 porcelain-fused-to-metal (PFM) single crowns, 81 splinted crowns in the form of 36 units, and 7 PFM FPDs and 23 PFM cantilever FPDs on 205 implants (3i). After a follow-up time of 5 years, the FPD survival rate was 94.5% (95% confidence interval [CI]: 90.1–98.8), and 80% (CI: 87.3–72.7) of the restorations remained free of any complication. The incidence of screw loosening (none of the screw loosening occurred with splinted crowns or FPDs) within a loading time of 5 years was 6.7% (CI: 1.8–11.5). Incidence of screw fractures was 3.9% (CI: 0.1–7.7). Fractures of the veneering porcelain (occurring only in cantilever FPDs and single crowns) occurred in 5.7% of the restorations. The probability for framework fracture was 1% (CI: 0–2.9). The lowest event-free survival rate was found for the implant-supported cantilever FPDs (68.6%; CI: 50–87.3), followed by single crowns (77.6%; CI: 53.3–100) and splinted crowns (86.1%; CI: 59.5–100). No complications were recorded for implant-supported FPDs. In this investigation, the screw-abutment connection seemed to be most susceptible to technical complications during the 81-month follow-up period. The authors concluded that technical complications occurred at low rates for FPDs supported by implants. However, implants did cause extra chair time for the patients. Therefore, patient should be informed about the possible maintenance requirements of implants. Numbers of patients dropping-out from the study significantly increased at the 72-month and 81-month reviews; from the 76 patients of the original treatment group, only 6 and 2 patients remained at these reviews, respectively.

Kreissl ME, Gerds T, Muche T, Heydecke G, Strub JR. *Clin Oral Implants Res* 2007;18:720–726. **References:** 55. **Reprints:** Dr Marion E. Kreissl. Department of Prosthodontics. University Hospital. Hugstetter Str. 55, 79106 Freiburg, Germany. Fax: 49 761 270 4925. E-mail: marion.kreissl@uniklinik-freiburg.de—*Huong Nguyen, Singapore*