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CASTING SHRINKAGE OF SOME BASE METAL ALLOYS USED IN DENTISTRY.

Paulo LEONARDI*
Dioracy F. VIEIRA**

ABSTRACT:: Measurements have been obtained through a direct method of actual casting shrinkage of three nickel-chrome based alloys in a mould at room temperature. The alloys studied presented smaller linear casting shrinkage than that reported in the literature for similar base metal alloys. "L.G." and "Gemini II" presented linear casting shrinkage not different and "Remanit GW" presented smaller linear casting shrinkage than the two others.

KEY-WORDS: Casting shrinkage; nickel-chromium alloys; base alloys.

Nickell-chrome alloys have become an alterne alloy to the conventional dental gold alloys, due to their mechanical and physical properties, corrosion resistance, and compatibility with the porcelain fused to metal. However, some difficulties still exist in their use and one of them is the lack of enough data on their casting shrinkage.

EARNSHAW (1958) showed that the linear casting shrinkage of five chromium-cobalt alloys ranged from 2,13% to 2,34%. The same author later determined the linear casting shrinkage of a 24 carat gold to be 1,74%, and working with base metal alloys he showed that: the greater the sample diameter, the greater the casting shrinkage; and that the greater the residual carbon content of the alloy, the greater the casting shrinkage. More recently, ASGAR (1974) developed some new base metal alloys, improving their mechanical properties, in comparison with conventional base metal alloys of dental use, thus making them more compatible with present casting technics.

It seemed to the authors to be of interest the study of the casting shrinkage of some of the new base metal alloys recently introduced in the dental market.

MATERIAL AND METHOD

Three nickel-chrome based alloys were used: L.G. (Gelenko, USA), Gemini II (Kerr — Sybron, USA) and Remanit GW (Dentaurum, West Germany).

The samples and the casting ring used were similar to those developed by EARNSHAW (1958); the transverse cilindrical bar used to mold the sample was 3.175 mm in diameter. The investment used was Multi-Vest (Ransom & Randolph, U.S.A) and the resultant casting mold had the shape schematically presented in figure 1.

The casting ring was heated in a furnace, in such an order that it took one hour for its temperature to reach 260°C; after this the temperature was slowly increased to 600°C where the casting ring remained for ten minutes; the heating furnace was then turned off and we waited until the casting ring cooled to the room temperature.

Casting shrinkage was determined according to EARNSHAW technic (1958).

* Disciplina de Prótese Parcial Fixa. Faculdade de Odontologia de Araraquara, UNESP, São Paulo, Brasil.

** Disciplina de Materiais Dentários. Faculdade de Odontologia, USP, São Paulo, Brasil.

The length of the external ends of the sealing screws was determined with a Mitutoyo OMC 0-150 calipers. From this length there was subtracted the sum of both screws length; there was then possible to have determined the actual length of the investment mold.

RESULTS AND DISCUSSION

Table 1 presents the data obtained as well as the dimensions of the actual length of the mold. Table 2 presents the analysis of variance for the same data, where it may be seen the significance found for the difference between the studied alloys. Table 3 presents the average linear casting shrinkage for the three alloys studied as well as for one gold alloy, and their standard deviation.

The linear casting shrinkage of the base metal alloys tested ranged from 1.71% to 1.99%. L.G. and Gemini II were not statistically different in regard to the linear casting shrinkage. Remanit GW did present a linear casting shrinkage smaller than L.G. and Gemini II. Remanit GW was not different from the gold alloy used for comparison purposes, in regard to the linear casting shrinkage. The alloys here studied presented linear casting shrinkage smaller than those presented by EARNSHAW (1958, 1960) for similar alloys.

The data here presented are valid for the methodology and the experimental conditions followed in this study. Factors such as: shape and dimensions of the samples, mold temperature, resistance of the mold investment against the free shrinkage of the metal alloy may influence the amount of linear casting shrinkage. For this reason it is not convenient to compare these data with those of other authors without paying attention to these facts.

SWARTZ (1975) said that is the case of a complete crown or a MOD inlay, the investment mold walls restrict the free shrinkage of the metal alloy in such a way that the measured casting shrinkage would be smaller than in conditions of a free solidification.

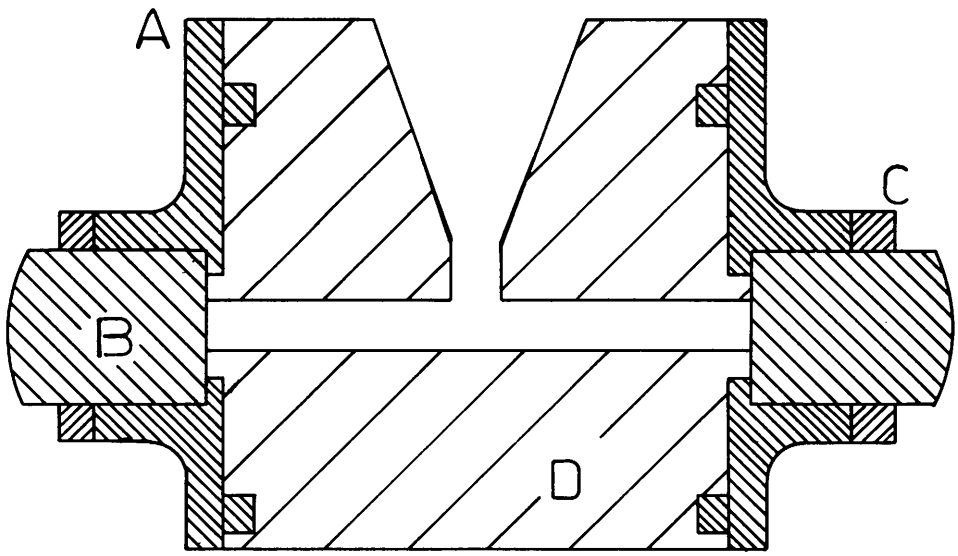

Figure 1 — Casting mold showing the steel ring (A), sealing serew (B), fixing screw (C) and investment (D).

TABLE I — Length of the molds obtained with L.G., Gemini II and Remanit GW

	JELENKO L.G.				GEMINI II				REMANIT Gw		
Sample	Length in mm	Dif. mm	%	Sample	Length in mm	Dif. mm	%	Sample	Length in mm	Dif. mm	%
1	64.52	1.24	1.88	1	64.50	1.26	1.91	1	64.64	1.12	1.70
2	64.57	1.19	1.81	2	64.47	1.29	1.96	2	64.59	1.17	1.77
3	64.38	1.38	2.09	3	64.46	1.30	1.97	3	64.62	1.14	1.73
4	64.43	1.33	2.02	4	64.51	1.25	1.90	4	64.53	1.23	1.87
5	64.55	1.21	1.84	5	64.52	1.24	1.88	5	64.48	1.28	1.94
6	64.54	1.22	1.85	6	64.47	1.29	1.96	6	64.50	1.26	1.91
7	64.53	1.23	1.87	7	64.55	1.21	1.84	7	64.58	1.18	1.79
8	64.49	1.27	1.93	8	64.45	1.31	1.99	8	64.68	1.08	1.64
9	64.53	1.23	1.87	9	64.54	1.22	1.85	9	64.63	1.13	1.71
10	64.47	1.29	1.96	10	64.46	1.30	1.97	10	64.49	1.27	1.93

Total length of the mold: 116.24 mm — Length of the sealing screw: 50.48 mn

Actual length of the mold: 65.76 mm

TABLE II — Analysis of variance

Source	D.F.	S.S.	M.S.	M.S.R.	Int.
Alloys	2	0.0942	0.0471	6.37	**
Residual	27	0.1995	0.0074		
Total	29	0.2937			

**Significant at 0.01

TABLE III — Average linear casting shrinkage (%), confidence interval 95%.

Alloys	N.° Tests	Mean	Confidence Limits	
L.G. Jelenko	10	1.91	1.84	1.98
Gemini II	10	1.92	1.85	1.99
Remanit Gw	10	1.80	1.73	1.87
Gold 24 k	5	1.74	1.66	1.82

Mean Standard Deviation = 0.03
Duncan at 5%: D_2 = 0.09

CONCLUSIONS

The tested nickel-chrome alloys presented smaller linear casting shrinkage than that presented in the literature for similar base metal alloys. L. G. and Gemini II presented linear casting shrinkage not statistically different; Remanit GW presented smaller linear casting shrinkage than L. G. and Gemini II.

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RESUMO: Nesta investigação foram feitas mensurações, pelo método direto, da contração de fundição de três ligas de níquel-cromo, em molde a temperatura ambiente. As ligas estudadas apresentaram menor contração linear de fundição do que as apresentadas na literatura para ligas-base. As ligas L. G. e Gemini II apresentaram contrações de fundição iguais e a Remanit GW apresentou menor contração do que as outras duas.

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