The Effect of Recasting on the Castability of Prepared Nickel-Chromium Dental Base-Metal Casting Alloy.

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ABSTRACT

Background:

Evaluation the effect of recasting process on the castability value of prepared Ni-Cr dental base-metal casting alloy and compare it with other conventional alloy.

Materials and methods:

The prepared Ni-Cr alloy was locally prepared in Iraq by Al-Khafagy (2003), while the CB Blando Ni-Cr was used as conventional alloy. A wax mash of 1mm opening and (10*10) segments square was invested in phosphate-bonded investment and casted by using induction casting machine. The number of complete cast segments was counted, divided by (220) and multiplied by (100) to obtain a percentage designated the castability value (Cv).

Results and discussion:

The prepared Ni-Cr alloy samples were showed lower castability values than the conventional alloy, this may be related to unalloyed silicon and manages and loss the role of these elements in improvement of castability of prepared Ni-Cr alloy. The castibility value was decreased as the percentage of used alloy increased, however, ANOVA test revealed a non significant differences within the groups. Practically, the experimental and conventional alloys could be recastd if the recasted process will not affect the other properties of such alloys.

Key word: Castbility, casting behavior, Ni-Cr alloy, recasting.

INTRODUCTION

Dental base-metal alloy is one of the most reliable materials, which is included in dentistry. Cobalt-chromium and nickel-chromium alloys find many applications in aspects of dentistry for which gold and precious-metal casting alloys have been used.

Most of the dental prosthesis constructed from alloys is obtained by casting procedure. The casting process was introduced in dentistry by Phillbrook in (1897) and popularized by Taggert ten years later (1). Casting can be defined as an object formed by the solidification of fluid that has been poured or injected into a mold (2). It involves heating the material until it becomes molten, then it can be forced into an investment mold which has been prepared from a wax pattern (3).

Casting behavior or castability refers to the ability of a molten metal to completely occupy the mold created by the elimination of a pattern (4, 5). Baran (1983) defines castability as the ability of an alloy to faithfully reproduce the sharp detail and fine margins of a wax pattern (6).

Casting behavior is one of critical factors associated with the success of a dental base-metal restorations. Castability of dental alloys is affected by many factors including system of the alloy, pattern design, spruing technique, investment material, mold temperature, casting temperature, casting technique and direction of the casting forces (7, 8, 5, 9, 10, 11).

Furthermore, Young et al (1987) concluded that the amount and type of alloy has significant effects on castibility of such an alloy (12).

In Ni-Cr based alloys, beryllium presents a metallurgic action related to the formation of the eutectic Ni-Be phase. By presenting a lower melting point than the other phase, these eutectic phase melt first during the heating process, reducing the fusion temperature and increasing the alloy fluidity (13). However, Bezzon et al. (2001) , concluded that the presence of Beryllium in

Ni-Cr alloys was not necessary to guarantee the castability [14]. The other important element in improvement of castability are the silicon and manganese through lowering the melting temperature of the alloy [15, 16, 17].

Many studies evaluated different types of castability patterns and concluded that the polyster mesh pattern provided a predictable measure for castability [18,19]. However, in comparison between the coping technique and mesh pattern technique in evaluation of castability of dental alloys, it might be assumed that any lack of agreement between the two types of castability test does not necessarily mean that the coping type is a superior measure of casting accuracy tests are strongly influenced by the degree to which proper casting shrinkage compensation is obtained, if casting shrinkage compensation is inadequate, and undersized

coping will fail to seal fully and a poor casting accuracy score will result [20].

Recently Bezzor et al. (2001) , used the mesh of a nylon net as the casting standard to determine the castability value [14].

In our current economy it is obligatory that dentists and technicians be cost conscious about the materials they used for prosthesis. The preferential use of the precious alloys has almost been eliminated by the elevated costs of all precious metals. The subsequent demand for base-metal alloys in dental procedures has now resulted in substantial increase in the price of these once insignificant alloys, again to a point of financial concern.

In the beginning of using the base-metal casting alloys, they were so inexpensive that the new ingots were melted, casted and discarded or sold back to the supplier by the pound as scrap, even though they were purchased by the penny-weight or ounce. When using the inexpensive alloys, technicians used all new metal for each casting instead of mixing new metal with previously melted ingots. With the increased costs of the base-metal alloys, it could be economically advisable to reuse them in combination with new metal, as is the practice when using precious alloys [21].

In the light of the proceeding, this study was designed to evaluate the effect of recasting process on the castability of prepared Ni-Cr alloy and compared with conventional alloy.

MATERIALS AND METHODS

The prepared Ni-Cr alloy was locally prepared by Al-khafagy (2003) by using simple equipment and procedure based on scientific steps in preparation of such an alloys [22].

The dental Ni-Cr alloys types and compositions used in this study are listed in table (1).

Table (1). The compositions of conventional and experimental dental Ni-Cr base-metal casting alloys.

Alloy Name	Composition
CB Blando 72 *	72.8 Ni, 4.9 Cr, 12.3 Cu, others 10.0%
Prepared Ni-Cr alloy	72.9 Ni, 4.9 Cr, 0.2 Fe, 5.6 Mo, 3.96 Si, 12.3 Cu

* Hatakeyama, Japan.

Through the reviewing the different techniques for evaluating the casting behavior, it has been found that the using of polyester sieve cloth or wax mesh was more practical [23, 14, 22] because this pattern has several advantages:

1. The pattern, a square piece of the sieve or wax mesh having runner bars along two adjacent edges with a sprue attached at their junction, can be prepared with little difficulty.
2. The cast mesh pattern provides for use of a simple objective counting procedure for evaluating casting behavior.

Three samples were prepared for each group. A wax meshes of (1 mm) opening, (10*10) segments square. The mesh was oriented on V-shaped runner bars of 10 gauge round wax which rest on vertical main sprue of 6 gauge round and length was (10mm) (Fig. 1).

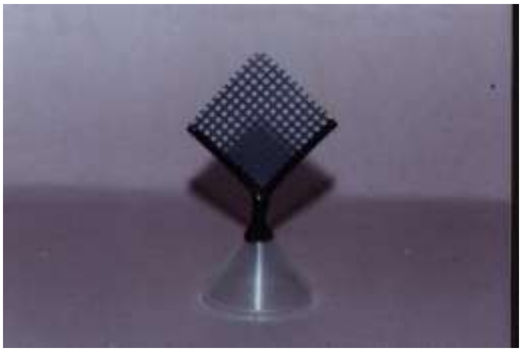

Fig. (1) Wax pattern for castability test.

The samples were invested in a medium-grain phosphate-bonded investment material without graghat (Norvest,Italy) and casted with special attention to weight of alloy to be casted, melting temperature and the pattern orientation in the casting machine, which should be in a vertical direction, because these factors were strongly affect the castability results.

The casting procedure was done by using induction casting machine (Manfredy,Italy) in which the melting temperature was determined digitally to overcome the possibility of overheating.

The procedure for assigning a numerical value for “Castability” to the cast specimen is as follows: the wax mesh, which was used in this study, provides a grid with 100 open squares and 220 segments. The number of complete cast segments is counted, divided by 220, and multiplied by 100 to obtain a percentage designated the castibility value (Cv) [24].

$$Cv = \frac{\text{Complete sigments}}{220} * 100$$

For determining the number of completed and incomplete segments in the complete sandblasted specimens, a direct examination method with 4x magnifying hand-lens was used (Fig 2).

Segments are considered incomplete if they do not completely extend from the far edge of one crossing segment to the far edge of the next one, (Fig. 3).

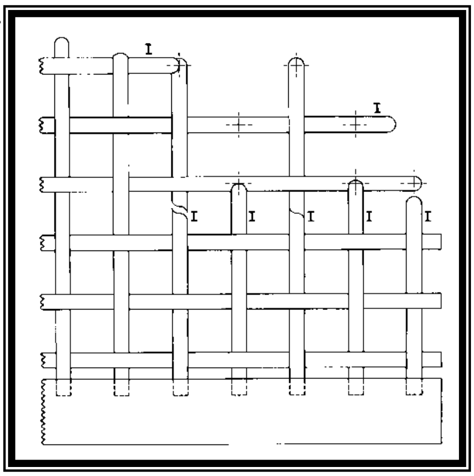

Figure (2) Schematic representation for labeling incomplete casting segment (I). Hinman et al (1985).

The samples are grouped according to the weight percentage of new and used alloy into ten groups regarding control and experimental alloys as shown in table (2).

Table (2). The weight percentage of new and used alloys of the experimental and conventional sample groups.

CB Blando 72		Prepared Ni-Cr alloy	
code	Wt %	code	Wt %
B1	100% new alloy	L1	100% new alloy
B2	75% new +25% used	L2	75% new +25% used
B3	50% new +50% used	L3	50% new +50% used
B4	25% new +75% used	L4	25% new +75% used
B5	100% used alloy	L5	100% used alloy

RESULTS

The samples were counted by using Hinman et al (1985) method (figure 3).

Table (3) represents the mean and standard deviation for the percentage of the castability value for conventional and experimental Ni-Cr alloys. The mean value represents the average of three castings of each tested group.

ANOVA test revealed non-significant differences within the groups regarding the experimental and conventional alloys as shown in table (4).

Table (3) The mean and standard deviation of the experimental and conventional alloys.

Alloys	Mean	S.D.
CB Blondo 72	98.180	2.408
	96.060	3.531
	98.787	1.051
	94.847	0.693
	97.570	2.049
Prepared Ni-Cr	95.450	4.550

alloy	**93.177**	**2.275**
	92.417	**2.627**
	91.453	**1.608**
	90.693	**1.868**

Table (4) ANOVA test for the experimental and conventional alloys.

Alloys		**Sig.**
CB Blondo 72	**Between Groups**	**0.244**
	Within Groups	**NS**
	Total	
Prepared Ni-Cr alloy	**Between Groups**	**0.335**
	Within Groups	**NS**
	Total	

Table (5). The t-test between the experimental and conventional alloys.

CB Blando 72		Prepared Ni-Cr alloy		t-test			
Mean	S.D.	Mean	S.D.	t	df	p	Sig.
98.180	2.408	95.450	4.550	0.919	4	0.410	NS
96.060	3.531	93.177	2.275	1.189	4	0.300	NS
98.787	1.051	92.417	2.627	3.900	4	0.018	S
94.847	0.693	91.453	1.608	3.358	4	0.028	S
97.570	2.049	90.693	1.868	4.295	4	0.013	S

DISCUSSION

Lower castability values of experimental alloys Ni-Cr when compared with conventional alloys, may be related to unalloyed silicon and manganese and loss the role of these elements in improvement of castability of these alloys. This explanation agrees with Sheffick, 1993; Graig & Marcus, 1997; Bezzon et. al., 2001; Al-Khafagy, 2003 (23, 17, 14, 22). Regarding the effect of recasting on the castability it has been showed a decrease in the castibility value as the used metal ratio was increased, however there was non significant differences within the group. Regarding the casting behavior and from practical point of view, the experimental and conventional Ni-Cr alloys could be recasted if the recasted process could not affect the other properties of such alloys.

Fig (3) Casted mesh.

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