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Casting accuracy of base-metal alloys.

Stanley G. Vermilyea, B.S., D.M.D., M.S.*

Michael J. Kuffler**

James J. Tamura, B.S.***

U.S. Army Institute of Dental Research, Walter Reed Army Medical Center,
Washington, D.C., 20012.

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Commercial materials and equipment are identified in this report to specify the experimental procedure. Such identification does not imply official recommendation or endorsement or that the materials and equipment are necessarily the best available for the purpose. Furthermore, the opinions expressed herein are those of the authors and are not to be construed as those of the Army Medical Department.

*Lieutenant Colonel, U.S. Army; Chief, Division of Dental Materials.

**Dental Laboratory Technician, Division of Dental Materials.

***Specialist 5th Class, Physical Science Assistant, Division of Dental Materials.

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Continued fluctuations in the price of gold and other metals has prompted intense interest in the use of alternative alloys devoid of precious constituents. Over the past decade numerous base-metal alloys designed for use in the ceramo-metal technique have been marketed. Results of studies designed to assess the composition, microstructural features, mechanical properties, biological features and manipulative characteristics of a broad spectrum of base-metal alloys have appeared throughout the dental literature.¹⁻⁴ From the available data, it would appear that these alloys possess mechanical characteristics suitable for their use in fixed prosthodontics; however, the inability to fabricate consistently well fitting fixed prostheses from base-metal alloys⁵⁻⁷ limit the routine use of these materials.

Heretofore, investigations for the determination of the casting accuracy of base-metal alloys have employed investing materials designed for use with the expensive high fusing golds.^{6,7} Recently, however, investment materials and techniques marketed specifically for the casting of base-metal alloys have become commercially available.

This report is based upon observations of the apparent fit of cast base-metal copings fabricated with the use of these current state-of-the-art procedures and materials.

MATERIALS AND METHODS

A die was machined from brass to receive a full coverage casting (Fig. 1). A beveled cervical margin and tapered ($\sim 10^\circ$) axial walls were developed during the machining process. An indentation was placed on the top surface of the die to aid in casting orientation. Final polishing of the brass die was accomplished with an aqueous slurry of flour of pumice and a wet rag wheel.

Three molds of the completed die were fabricated from an industrial grade silicone.⁺ Ultimately each of these molds was used to produce twenty-five

⁺RTV-77, General Electric Co., Waterford, NY, 12188.

stone[#] replicas of the brass die. A coping of the desired contour was waxed on the brass die and a mold of this coping-die assembly was made from the aforementioned silicone material. During the study, wax patterns of consistent size and shape were constructed in the following manner. The mold of the brass die and coping was filled with molten inlay wax.[§] Then a stone die was inserted into the mold and stabilized until the wax solidified. After withdrawal from the mold, the margin of the pattern was refined with a carving instrument. The integrity of the wax-stone die phase boundary was confirmed with the aid of a stereoscopic microscope at 3 X magnification.

A preformed wax sprue with reservoir was attached to the point on the circumferential junction of the "occlusal" (top) and axial walls of the pattern at an angle of forty-five degrees to the long axis of the coping. Each sprued wax pattern was luted to a sprue former and surface tension reducing agent[¶] was applied to the internal and external surfaces of the coping. Excess agent was removed with the use of a dry artist's brush.

The study was designed to assess the influence of three investment materials^{||} on the fit of copings cast from five base-metal alloys.[§]

[#]Silky Rock, Whip-Mix Corp., Louisville, KY, 40217.

[§]Maves Inlay Wax, Maves Co., Cleveland, OH, 44144.

[¶]Debubblizer, Kerr Manufacturing Co., Romulus, MI, 48174.

^{||}Ceramigold 2 Investment and Hi-Temp Casting Investment, Whip-Mix Corp., Louisville, KY, 40217 and Neoloy Hi-Heat Crown and Bridge Investment, Neoloy Products, Inc., Posen, IL, 60469.

[§]Biobond, Dentsply International, York, PA, 17404; Ceramalloy II, Ceramco, Inc., East Windsor, NY, 08502; Unibond, Unitek, Inc., Monrovia, CA, 91016; Biocast, Jeneric Gold Co., Wallingford, CT, 06492; and Neobond II, Neoloy Products, Inc., Posen, IL, 60469.

The completed wax patterns were invested as prescribed by the manufacturers of the respective investment materials. Compensatory setting expansion of the freshly poured investments was achieved either by allowing the molds to bench-cure (Neoloy Hi-Heat Crown and Bridge Investment) or to cure while immersed in 100°F water (Ceramigold 2 and Hi-Temp Casting Investment). Twenty-five molds were made from each investment material. Burnout of the cured molds was accomplished in accordance with the respective alloy manufacturers' instructions. A like number of molds were cast in each alloy. An additional five wax patterns were invested in each material and cast in a gold-palladium alloy⁺⁺ to monitor investing and casting technique. All of the alloys were melted and cast with the aid of an automatic induction casting machine.^{##} The cast molds were allowed to cool to room temperature prior to divestment. Then the castings were retrieved from the molds and sandblasted to remove residual investment and oxide films. Following debridement, the castings were placed on their respective stone dies and examined for marginal integrity and fit with the aid of a stereomicroscope at 3 X magnification. The alloy from which a particular coping was fabricated was unknown to the examiner. Castings were subjectively judged as adequate, oversize or undersize.

RESULTS

The apparent accuracy of the castings is shown in Fig. 2. As a group, the base-metal castings failed to fit their respective dies. The distribution of scores for the group was as follows: adequate, 8 percent;

⁺⁺Olympia, J. F. Jelenko and Co., New Rochelle, NY, 10801.

^{##}Electromatic III, Howmedica Inc., Chicago, IL, 60652.

oversize, 23 percent and undersize, 69 percent. Base-metal copings fabricated from Neoloy investment molds were consistently undersize as were 80 percent of those cast in the gold-palladium alloy, Olympia. On the other hand, 100 percent of the Olympia castings from Hi-Temp and 80 percent of those from Ceramigold 2 molds were judged as adequate. Twenty percent of the Olympia castings fabricated from Ceramigold 2 molds were oversize.

Ceramalloy II, Biocast and Unibond cast into Hi-Temp investment molds were the only alloys from which adequate copings were produced. With Ceramigold 2 investment castings of Biobond and Ceramalloy II were predominantly oversize; whereas, castings of Unibond, Biocast and Neobond II were undersize.

DISCUSSION

Previous studies have suggested the sensitivity of base-metal alloy to conventional laboratory procedures.^{6,7} The present data also may be indicative of alloy "technique sensitivity"; however, the preponderance of oversize and undersize castings is attributable mainly to alloy-investment interaction. The discrepancy in the number of oversize to undersize castings produced from the three investment materials would appear to support this premise.

Although the investment materials employed in this study are marketed for use with base-metal alloys, it would appear that alteration of manufacturers' recommended investing techniques is required to enhance the fit of base-metal castings. From the available data, the greatest potential for improvement of fit of base metal casting alloys lies in the modification of recommended techniques for Hi-Temp and Ceramigold 2 investment materials. Studies designed to assess the effects of manipulative

variables on the compensatory expansion of investment materials and the subsequent fit of base-metal castings are in progress.

SUMMARY

The effect of investment material on the casting accuracy of five base-metal alloys was evaluated. Overall, the fit of the test castings was poor. Individual alloy-investment interaction appeared significant. Although marketed for use with base-metal alloys, it would appear that alteration of the investment manufacturers' recommended techniques are required to enhance the fit of base-metal restorations.

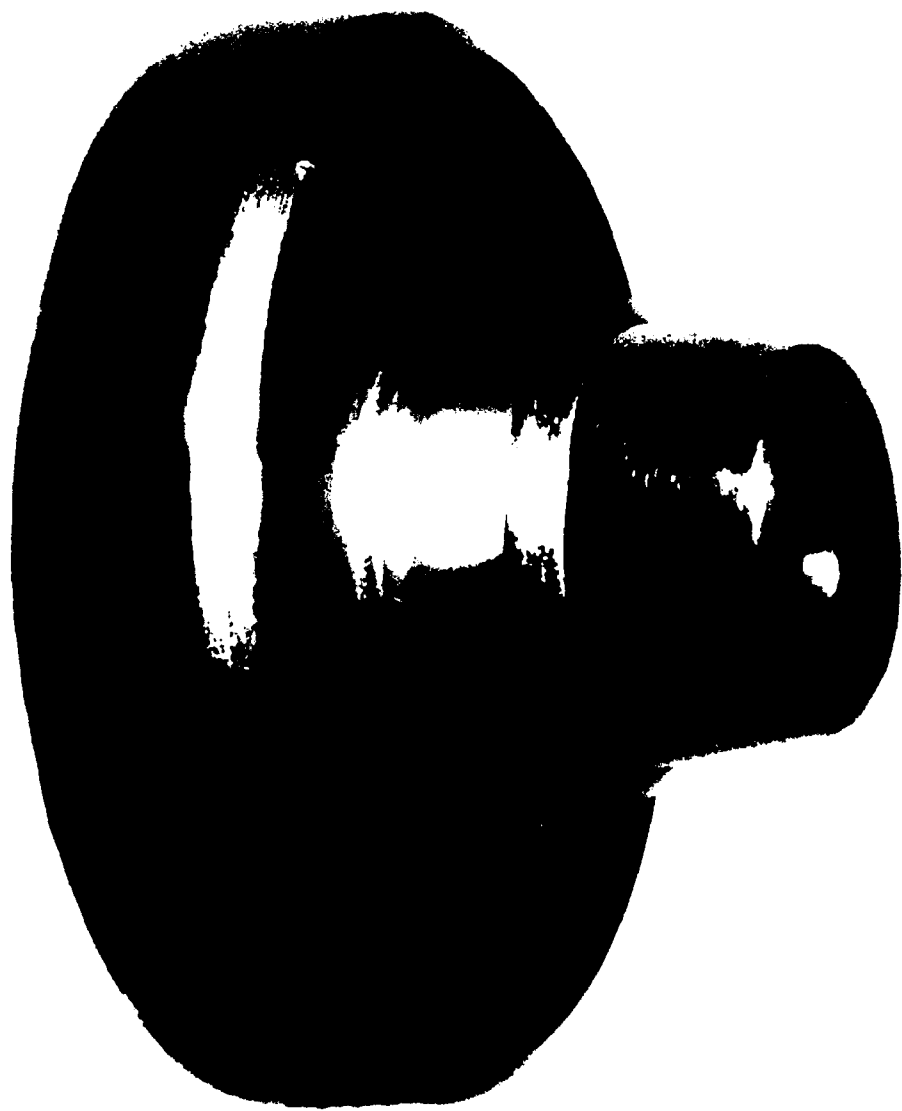
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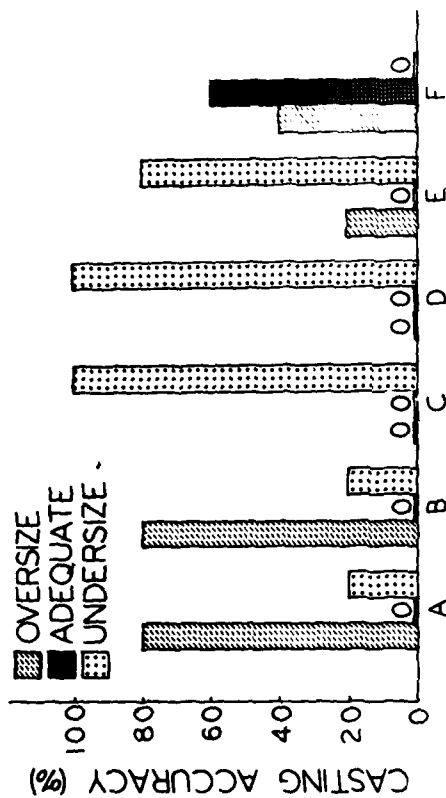
LEGENDS FOR FIGURES

Figure 1. Machined brass die.

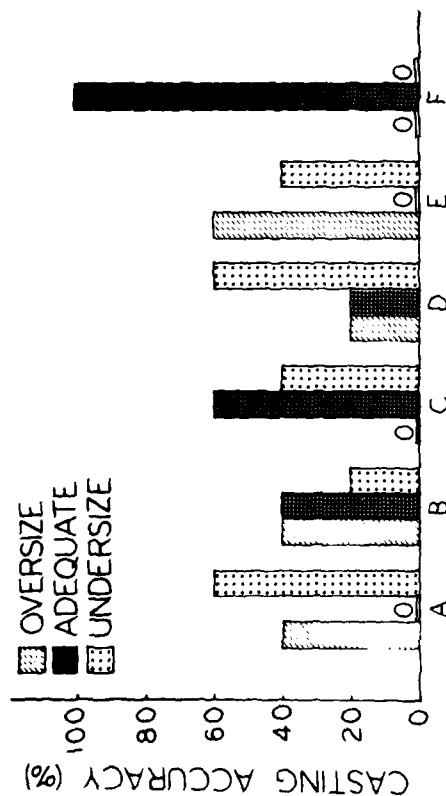
Figure 2. Apparent casting accuracy. A, Biobond; B, Ceramalloy II;
C, Unibond; D, Biocast; E, Neobond II and F, Olympia.



CERAMIGOLD 2



HI-TEMP



NEOLOY

