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Techniques for the accurate casting of base-metal alloys have been assessed. Employment of these techniques may enhance the potential of the test alloys for routine use in military dental practice. The long term biological effects of the use of these alloys remains to be studied.

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TECHNIQUES FOR THE ACCURATE CASTING OF BASE-METAL ALLOYS

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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.

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TECHNIQUES FOR THE ACCURATE CASTING OF BASE-METAL ALLOYS

In light of the escalating costs of precious metals, many manufacturers have introduced a number of alloys totally devoid of precious constituents. Nickel and chromium are the major components of most available products although nickel-free materials based upon a cobalt-chromium binary have become available. Previous USAIDR in-house laboratory investigations have suggested that the inability to accurately cast clinically acceptable restorations from these materials is not an infrequent occurrence.[1,2] Data from these efforts have indicated the potential for modification of manufacturer-recommended techniques to produce consistently well fitting restorations from base-metal alloys.

This report is based upon the effects of modifications of current state-of-the-art investing techniques with three investment materials**** on the fit of castings from four base metal casting alloys.*****

Materials and Methods

A mandibular first molar and premolar were prepared to receive a veneered full coverage restoration. A wax pattern of the casting was fabricated on the prepared teeth and a counterreplica of the waxed preparation fabricated in an industrial grade silicone.****** A similar durable mold was

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**** High-Temp, High-Temp 2 and Ceramigold 2 Casting Investment. Whip-Mix Corp., Louisville, KY 40217.

***** Unibond, Unitek, Inc., Monrovia, CA 91016; Ceramalloy II, Ceramco, Inc., East Windsor, NY 08502; Biocast, Jeneric Gold Co., Wallingford, CT, 06492 and Neobond II, Neoloy Products, Inc., Posen, IL 60469.

****** RTV-77, General Electric, Waterford, NY 12188.

made of each prepared tooth. Ultimately these molds were used to produce 96 stone dies+ of each preparation. Fabrication of casting patterns was accomplished by filling the mold of the waxed preparation with molten inlay wax. Each die was inserted into the appropriate mold and stabilized until the wax solidified. Subsequent to withdrawal of the die-wax specimen from the mold, the cervical margin of the wax pattern was refined and trimmed to the die margin with hand carvers. Continuity of the die-wax boundary was confirmed with the use of examiing loupes.

Preformed wax sprues with reservoirs were attached to the bulkiest portion of the lingual surface of each pattern. Then each pattern-sprue couple was luted to a sprue former. A proprietary surface tension reducing agent++ was applied to all surfaces of the pattern and sprue. Excess agent was removed with a dry artist's brush.

The completed wax patterns were invested as prescribed by the manufacturers of the respective investment materials using a double layer of asbestos ring liner. Initially, compensatory expansion of the freshly poured investments was accomplished hygroscopically by immersion of the mold in a 100°F water bath and by alteration of the recommended special liquid-water ratio (High-Temp) or use of Hi-Temp or Ceramigold special liquid at various dilutions with High-Temp 2 and Ceramigold 2 investments respectively. The degree of fit of castings from an alloy using a particular expansion technique dictated subsequent investment modifications for

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\+ Artificial Dental Stone, Whip-Mix Corp., Louisville, KY 40217.

++ Debubblizer, Kerr Manufacturing Co., Romulus, MI 48104.

the alloy-investment combination. The investment molds were burned out in accordance with the respective alloy manufacturer's instructions.

All of the alloys were melted and cast with the aid of an automatic induction casting machine.[+++] The cast molds were permitted to cool to room temperature prior to divestment. The castings were sandblasted to remove residual investment and oxide films and any nodules removed from the interior surfaces with a round bur. The castings were placed on their respective dies and examined for marginal integrity and degree of fit with the aid of examining loupes. Castings were judged as oversize, adequate or undersize based upon retention and marginal integrity. Adequate castings exhibited contiguous margins forming a continuous junction with the die and/or remained in place when the die was inverted. Oversize castings extended over the die margin and/or were loose on the die. Castings judged as undersize failed to seat completely. Final assignment of a score of adequate was based upon both marginal integrity and retention. The alloy from which a particular casting was made was unknown to the examiner.

Results

The distribution of scores for the total sample is shown in the Figure. When casting size was the determining factor, the scores for the distribution were: oversize, 49 percent; adequate, 32 percent and undersize 19 percent. When marginal integrity was considered the scores for the total sample were: oversize, 21 percent; adequate, 22 percent and undersize, 57 percent.

The effects of investing technique modifications on the apparent fit of the base metal castings are shown in the Table. Hi-Temp investment used with 62 percent special liquid in a hygroscopic technique produced consistently

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+++ Electromatic III, Howmedica, Inc., Chicago, IL 60632.

well fitting castings with Unibond and Biocast. The use of a single layer of asbestos ring with the aforementioned technique produced predominantly well fitting castings with Ceramalloy II. With Hi-Temp 2 investment none of the technique modifications studied produced well fitting castings routinely. On the other hand, with Ceramigold 2 investment mixed with 23 percent special liquid using a non-hygroscopic expansion technique, 100 percent and 83 percent of the respective castings from Unibond and Biocast were judged as adequate. None of the technique modifications produced consistently well-fitting castings from Neobond II alloy.

Discussion

The data suggest that the production of base-metal castings of a size facilitating complete seating of a crown on a die is a relatively simple task. In this study, 81 percent of the castings were of a dimension that would permit the restoration to seat on the die without internal modification. Although the authors do not advocate the clinical use of castings exhibiting poor retention form (i.e. oversize) it is apparent that compensation for the high casting shrinkage of these alloys may be accomplished by modification of investing techniques without resorting to the use of electrostripping of the casting or augmentation of the dimensions of the die of the prepared tooth.

However, critical to the success or failure of a cast restoration is the integrity and approximation of the the tooth-alloy phase boundary. When marginal integrity was evaluated only 43 percent of the castings could be considered potentially useful clinically.

The data on the effects of investing technique modification (Table) reflects significant alloy-investment interaction. Identical technique modifications with a given investment produced drastically different responses among the test alloys. Furthermore, with any given alloy, increases or decreases in special liquid concentrations did not produce corresponding increases or decreases in the number of oversize or undersize castings. This may also be indicative of the sensitivity of the base metal alloys to dental laboratory procedures or to minor batch variations among investments and/or alloys. It has been observed previously that different batches of the same investment material often require minor changes in technique to produce satisfactory results.[3]

It must be emphasized that no single investing technique is applicable to all alloys of seemingly similar composition and mechanical characteristics. Experience gained from the use of one alloy and investment may not be indicative of that to be expected with another. Successful laboratory use of a specific alloy and investment requires initial experimentation to ascertain the technique that produces the desired results followed by meticulous attention to the details of that technique. Variations in procedures, particular brand of alloy or investment or perhaps batches of materials may drastically reduce the rate of success and require reestablishment of a viable investing procedure. The successful investing methods emanating from this study have been used in the fabrication of castings for an on-going clinical investigation to determine the efficacy of base-metal casting alloys. However, variation in technician skill level often found in large dental laboratories may dictate the need for additional procedural modifications.

Summary

Techniques for the accurate casting of base-metal alloys have been assessed. Employment of these techniques may enhance the potential of the test alloys

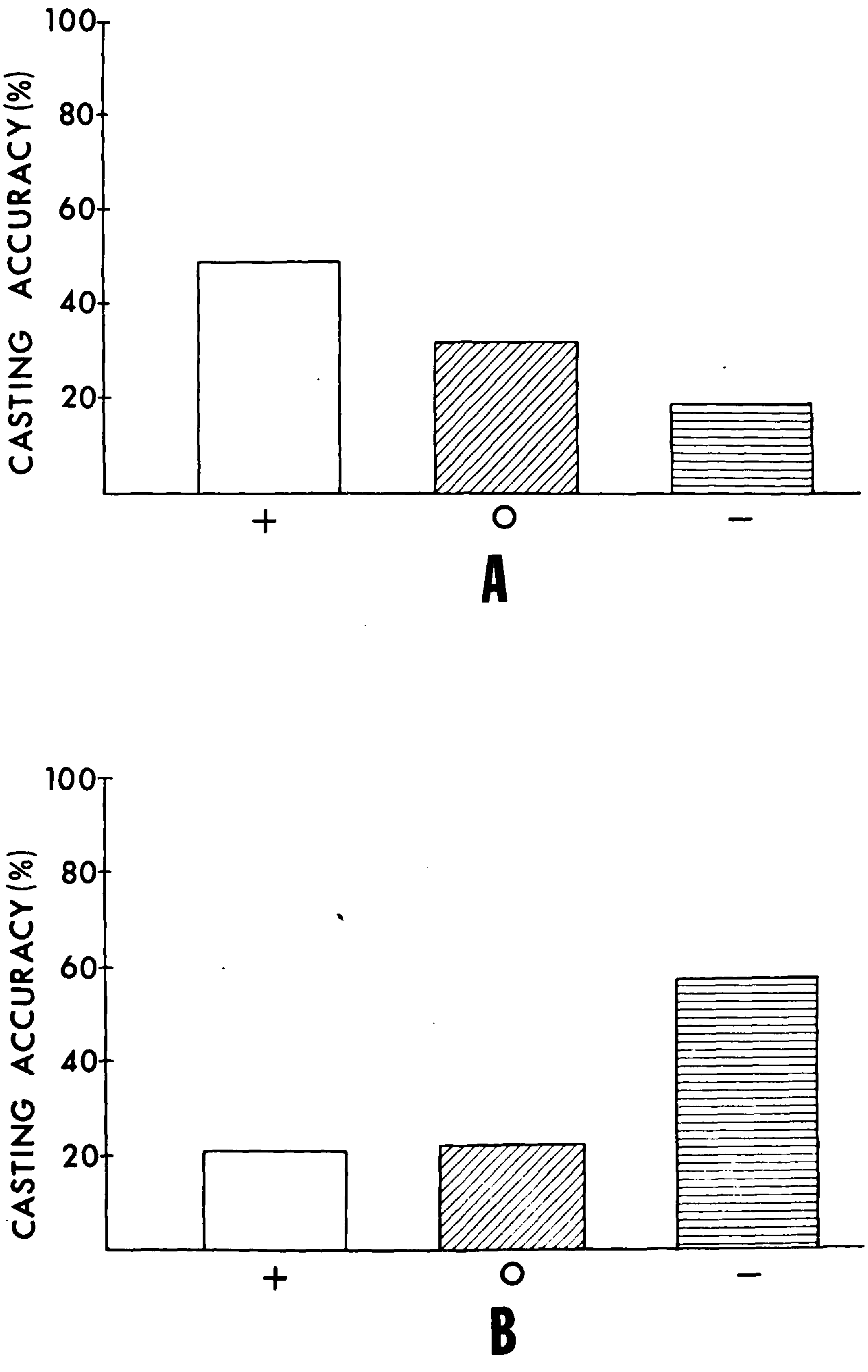
for routine use in military dental practice. The long term biological effects of the use of these alloys remains to be studied.

Publications

1. Huget, E. F., Vermilyea, S. G. and Kuffler, M. J.: Accuracy of small base metal casting. J Milit Med, 146:764-766, November 1981.
2. Vermilyea, S. G., Kuffler, M. J. and Tamura, J. J.: Casting accuracy of base-metal allovs. J Prosthet Dent (in press).
3. Vermilyea, S. G.: Unpublished data.

Legend for Figure

Figure. Apparent casting accuracy of base-metal alloys evaluated with: A, casting size and B, marginal integrity as the determining criterion.


CASTING ACCURACY (%)
100
80
60
40
20
+
O
−
A
CASTING ACCURACY (%)
100
80
60
40
20
+
O
−
B

TABLE

APPARENT FIT OF BASE-METAL CASTINGS AS A FUNCTION OF INVESTMENT AND TECHNIQUE

Alloy	Hi-Temp			High-Temp 2			Ceramigold 2	
	Hygroscopic Technique L-W Ratio			Hygroscopic Technique L-W Ratio			Hygroscopic Technique L-W Ratio	Non-hygroscopic Technique L-W Ratio
	80	69	62	46	38	23	23	23
Unibond#								
+	67	83	0	0	67	0	67	0
o	0	0	100	67	0	0	0	100
-	33	17	0	33	33	100	33	0
Ceramalloy II								
+	83	67	67 17*	0	50	0	67	0
o	0	0	33 83	0	0	0	0	0
-	17	33	0 0	100	50	100	33	100
Biocast								
+	67	0	17	0	0	0	50	0
o	17	17	83	17	17	50	0	83
-	17	83	0	83	83	50	50	17
Neobond II								
+	0	25	0	0	0	0	0	0
o	0	8	50	0	0	0	0	33
-	100	67	50	100	100	100	100	67

+ = oversize

o = adequate

- = undersize

* Single layer of asbestos ring liner.

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