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LABORATORY EVALUATION OF DENTAL AMALGAM ALLOYS,(U)

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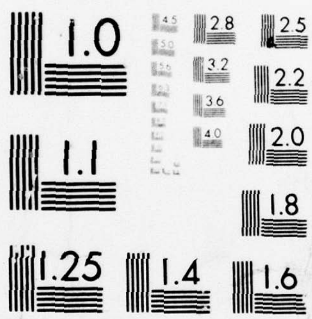

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Five newly developed high-copper amalgam alloys were evaluated in a laboratory study to determine their suitability for use in military dentistry. Measured property values of these materials were compared to those of eight conventional alloys which presently enjoy wide usage in the dental clinics of the United Stated Uniformed Federal Services.

Setting expansion or contraction was a characteristic feature of the amalgamates. Ten of 13 alloys exhibited contraction, whereas 3 showed expansion.

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Early (15-minute) tensile strengths of ternary high-copper materials were higher than those of either a dispersed phase product or the conventional alloys. Early tensile strengths ranged from 340 psi for one conventional material to 1,200 psi for an indium-containing high-copper alloy. The ranges of mean tensile and compressive strengths at 24-hours were relatively narrow. Static creep (deformation under constant load) of the high-copper alloys was low (0.21 to 0.71 percent).

The high-copper alloys evaluated to date merit consideration for procurement and routine use in military dentistry. However, the use of these products will not guarantee superior dental treatment. Numerous manipulative variables play prominent roles in determination of the character of the finished amalgam restoration. Also, the importance of good cavity preparation cannot be overstated. It is likely, however, that the availability of improved materials would encourage the military dentist to extend his best efforts toward production of better restorations for the maintenance of the oral health of his patients.

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LABORATORY EVALUATION OF DENTAL AMALGAM ALLOYS

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LABORATORY EVALUATION OF DENTAL AMALGAM ALLOYS

Silver amalgam is the most commonly used material for the restoration of carious and damaged posterior teeth. Approximately three out of four restorations of individual teeth are of amalgam. The emergence of this unique substance as dentistry's most popular restorative material is a reflection of many remarkable metallurgical achievements.

Over the years, the formulation of conventional dental amalgam alloys has been based upon a metallurgical system of silver (~70 percent), tin (~25 percent) and copper (~5 percent). Recently, however, several proprietary products containing copper in excess of 10 percent, by weight, have become available for clinical use. The feature most responsible for the marketability of the so-called high-copper alloys has appeared to be the tendency for reduced production of the weak and corrodible tin-mercury (gamma 2) phase exhibited by their amalgamates.[1]

Five newly developed high-copper amalgam alloys were evaluated in a laboratory study to determine their sutiability for use in military dentistry. Measured property values of these materials were compared to those of eight conventional alloys which presently enjoy wide usage in the dental clinics of the United States Uniformed Federal Services

Materials and Methods

High-copper alloys marketed under the trade names of Dispersalloy,*

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* Johnson & Johnson Dental Products Co., East Windsor, NJ.

Aristaloy CR,[+] Tytin,[#] Optalloy II[§] and Indiloy[¶] were obtained from proprietary sources. Conventional alloys were procured through normal federal supply channels and through direct purchase from commercial outlets. These products included Aristaloy,[+] New True Dentalloy,[#] Velvalloy,[#] 20th Century Microcut,[§] 20th Century Fine Cut,[§] Optaloy,[§] Caulk Spherical,[§] and Spheraloy.[ζ]

Amalgam mixtures were made as directed by manufacturers' instructions regarding mercury-alloy portions and trituration times. Trituration was accomplished with the use of a mechanical device.[**] Amalgamates used for the production of test specimens were packed into steel molds by the all-mechanical procedure prescribed by American Dental Association Specification No. 1.[2] Specimens for determination of compressive strength were 1/4-inch X 1/2-inch cylinders. Discs of 1/4-inch diameter and 1/16-inch thickness were used for measurement of tensile strength. Specimens for determination of dimensional change on setting and static creep were 1/8-inch X 1/4-inch cylinders. All specimens with the exception of those

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\+ Baker Dental Dept. of Engelhard Industries, Engelhard Minerals and Chemicals Corp., Carteret, NY.

\# S. S. White Div., Pennwalt Corp., Philadelphia, PA.

§ The L. D. Caulk Co., Division of Dentsply International, Inc., Milford, DE.

¶ Shofu Dental Corp., Menlo Park, CA.

ζ Kerr Manufacturing Co., Division of Sybron Corp., Romulus, MI.

** Wig-L-Bug, Crescent Dental Mfg., Co., Lyons, IL.

fabricated for measurement of dimensional change on setting, were stored at 37C and 100 percent relative humidity prior to use.

Dimensional change on setting was determined according to American Dental Association Specification No. 1.[2] The procedure described by Mahler and Van Eysden[3] was used for measurement of 7-day static creep. Compressive strength of 24-hour old specimens was determined with the use of a constant strain rate testing machine.++ Tensile strength was obtained by diametral compression of 15-minute and 24-hour old specimens.[4] All tests for assessment of strength characteristics were accomplished with a testing machine crosshead speed of 0.02-inch per minute.

Results and Discussion

Some laboratory properties of 13 dental amalgam alloys are summarized in the table.

Setting expansion or contraction was a characteristic feature of the amalgamates. Ten of 13 alloys exhibited contraction, whereas 3 showed expansion. There is, at present, no evidence to suggest that contraction or expansion of the order of magnitude demonstrated by the test materials would be significant clinically.

Early (15-minute) tensile strengths of the ternary high-copper materials were higher than those of either the dispersed phase product or the conventional alloys. Early tensile strength ranged from

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++ Instron Universal Testing Machine, Instron Corp., Canton, MA.

340 psi for one conventional material to 1,200 psi for an indium-containing high-copper alloy. High early strengths appeared to be manifestations of fast rates of hardening. The ranges of mean tensile and compressive strengths at 24-hours were relatively narrow.

Static creep (deformation under constant load) of the high-copper alloys was low. Improved integrity of the margins of amalgam restorations made from alloys having low creep values has been observed.[5-8] Therefore, the property creep has been adopted as an indicator of the clinical durability and longevity of amalgam restorations. It must be pointed out, however, that the relationship between low creep and improved clinical performance is not understood completely.

Conclusions

The high-copper alloys evaluated to date merit consideration for procurement and routine use in military dentistry. However, the use of these products will not guarantee superior dental treatment. Numerous manipulative variables play prominent roles in determination of the character of the finished amalgam restoration. Also, the importance of good cavity preparation cannot be overstated. It is likely, however, that the availability of improved materials would encourage the military dentist to extend his best efforts toward production of better restorations for the maintenance of the oral health of his patients.

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SOME PROPERTIES OF DENTAL AMALGAM ALLOYS

Alloy	Dimensional Change on Setting %	15-Minute Tensile Strength PSI	24-Hour Tensile Strength PSI	24-Hour Compressive Strength PSI	7-Day Static Creep %
Conventional Products					
Aristaloy	-0.16±0.02	340±30	8,400±60	54,000±1,500	2.50±0.30
20th Century Microcut	+0.15±0.03	590±80	8,700±900	58,000±1,200	3.63±0.40
20th Century Fine Cut	-0.21±0.04	500±50	8,500±800	56,000±1,900	2.44±0.22
New True Dentalloy	-0.12±0.01	430±30	8,700±400	57,000±2,000	2.20±0.20
Velvalloy	-0.15±0.02	670±40	8,800±400	63,000±1,900	1.30±0.10
Spheraloy	-0.17±0.05	550±50	9,300±700	61,000±1,400	1.40±0.18
Caulk Spherical	-0.16±0.03	680±30	9,300±600	60,000±1,100	0.92±0.10
High-Copper Products					
Dispersalloy*	+0.19±0.04	520±20	7,300±400	60,000±2,000	0.42±0.10
Aristaloy CR +	-0.09±0.02	1,090±120	9,200±900	70,000±3,000	0.29±0.07
Tytin+	-0.08±0.01	1,050±80	7,900±400	67,000±2,000	0.30±0.07
Optaloy+	+0.14±0.03	960±70	8,000±700	60,000±3,000	0.71±0.21
Indiloy#	-0.08±0.01	1,200±200	10,000±900	72,000±4,100	0.21±0.66

* Admixture: Lathe-cut particles and spherical eutectic (Ag-Cu) Dispersant.

\+ Spheriodal Ag-Sn-Cu ternary alloy.

\# Spheriodal Ag-Sn-Cu ternary alloy: Contains Indium (~3.6 percent).