T H E U N I V E R S I T Y O F M I C H I G A N

SCHOOL OF DENTISTRY

Terminal Technical Report

DENTAL MATERIALS

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ORA Projects 03102 and 06786

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ABSTRACT

This study has dealt with the determination of characteristic physical and mechanical properties of restorative dental materials, and effect of manipulative variables on these properties. From the study an entirely new dental gold inlay casting technic was developed, based on the principle of controlled water added hygroscopic technic. The method has had successful dental applications and is a recognized method of dental inlay casting procedure. Evaluations have been made also, of the microstructure and casting procedures for cobalt base alloys used for partial denture restorations. Investigation was made of the casting of gold alloys to embedded metals, as well as an evaluation of the properties of dental gold alloy wires. Additional studies were made on denture base resins, impression materials, and dental amalgam alloys. These studies have contributed to an improved understanding of the technics of manipulation necessary to develop the maximum quality in the finished restorations. Results have been described in twenty-four technical publications in the periodical dental literature.

TERMINAL TECHNICAL REPORT ON CONTRACT NO. N6onr-232(08)

Report Prepared By: Floyd A. Peyton

Period of Contract: 15 November 1947 to 31 May 1964

Contract Number: N6onr-232(08)

Project Number: NR 105-360

Contractor: The University of Michigan
School of Dentistry

Principal Investigator: Floyd A. Peyton

Title of Project: A Study of Dental Materials

Objectives of Project:

The objective of this project was to cover research on the development of the best possible combination of materials and techniques for the production of:

(A) Dental gold inlay castings
(B) Partial and complete dentures

Such studies lead to the improvement of quality of the restorations and as a result, better dental health service for the patient.

Summary of Progress:

Since the initiation of this project, annual summary technical reports have described regularly the progress made on this contract. Through this project numerous problems of dental materials and their technique of use have been investigated with the result that services have been given to various phases of restorative dentistry. Such studies have lead to the improvement in the selection of various materials, and the control of processing techniques, which in turn has lead to the improvement in quality of dental restorations.

In the report for 1961, it was stated in part that "through this project, we have been able to attack different problems of dentistry and thereby offer our services to all phases of restorative dentistry." Fourteen of the different areas investigated in restorative materials are as follows:

1. Dental amalgam alloys
2. Complete dentures
3. Properties of dental gold alloy wire
4. Casting of gold inlays
5. Removable partial denture materials
6. Impression materials
7. Resins for dentures
8. Gypsum materials
9. Investment and hygroscopic expansion
10. Microstructure of cobalt base alloys
11. Analysis of human teeth
12. Sulfide contamination of embedded metals during casting
13. Bond strength of porcelain fused to gold alloys
14. One piece castings of multi-unit bridges

These studies have resulted in twenty-four technical publications related to the evaluation and manipulation of various materials for restorative dental practice. These technical publications are listed at the end of this report. In addition, these studies have included many principles of materials science evaluation, microscopic examination, physical and mechanical test methods which have been applied to other areas of study in dental materials.

These publications have all carried acknowledgement to the Office of Naval Research for the financial assistance given. Reprints of these publications have been distributed to those offices and laboratories whose addresses were supplied by the Office of Naval Research.

The listing of areas investigated and the technical reports published does not give a complete indication of the full benefits resulting from the studies supported by this contract. It is believed that the development of research trained personnel with the assistance given from this contract has been a major benefit. Two persons have received support that enabled them to meet requirements for the Ph.D. degree. Both persons continue to be engaged in research and teaching activities at major universities. One is Dr. David Mahler, Head of Dental Materials Program at the University of Oregon School of Dentistry in Portland. The other is Dr. Kamal Asgar, Professor of Dentistry, University of Michigan School of Dentistry. In addition, several persons received assistance and guidance for studies leading to the Master of Science degree. This support and assistance therefore, has led to the training of qualified research investigators in this field where there is a serious shortage of personnel.

From the studies on chromium-cobalt alloys, the American Dental Association Research Group at the National Bureau of Standards was able to adapt test procedures to develop an American Dental Association Specification Number 14 for this type of alloy. In addition, an accurate and reproducible technique known as the "controlled water added technic for casting gold inlays" was developed from studies completed under this contract. It is known also that on numerous

occasions certain manufacturers have altered and improved their products for the benefit and welfare of the dental profession as the result of studies presented from this investigation. In a similar manner, other evaluations which have been recorded have been helpful to the government services, dental profession, and the dental trade.

The cooperation and assistance of the Office of Naval Research in supporting these contributions to dental science, is recognized and appreciated. Without this assistance the studies might not have been completed.

Published Articles:

1. Taylor, N. O., Sweeney, W. T., Mahler, D. B., and Dinger, E. J., The effect of variable factors on crushing strength of dental amalgam. J. Dent. Res., 28:228-241, 1949.

2. Taylor, N. O., Sweeney, W. T., and Mahler, D. B., Some mechanical characteristics of amalgamators. J. Dent.Res., 29:396-400, 1950.

3. Taylor, D. F. and Peyton, F. A., A comparison of the tensile and bending properties of dental gold wires. J. Dent. Res., 30:290-301, 1951.

4. Bush, S. H., A statistical analysis of the mechanical properties of cast and wrought gold dental alloys. A.S.T.M. Bulletin, Oct. 1952.

5. Bush, S. H. and Peyton, F. A., The effect of section size on the mechanical properties of wrought gold wires. J. Dent. Res., 30:745-752, 1951.

6. Dinger, E. J. and Peyton, F. A., Distortion of gold partial denture castings. J. Pros. Dent., 1:443-453, 1951.

7. Mahler, D. B., Inarticulation of complete dentures processed by the compression molding technique. J. Pros. Dent. 1:551-559, 1951.

8. Mahler, D. B. and Asgarzadeh, K., The volumetric contraction of dental gypsum materials on setting. J. Dent. Res., 32:354-361, 1953.

9. Peyton, F. A., Shiere, H. B., and Delgado, V. P., Some comparisons of self-curing and heat-curing denture resins. J. Pros. Dent., 3:332-338, 1953.

10. Asgarzadeh, K., Mahler, D. B., and Peyton, F. A., The behavior and measurement of hygroscopic expansion of dental casting investment. J. Dent. Res., 33:519-530, 1954.

11. Asgarzedeh, K. and Peyton, F. A., Physical properties of corrective impression pastes. J. Pros. Dent., 4:555-567, 1954.

12. Asgar, K., Mahler, D. B., and Peyton, F. A., Hygroscopic technique for inlay casting using controlled water additions. J. Pros. Dent., 5:711-724, 1955.

13. Suffert, L. W. and Mahler, D. B., Reproducibility of gold castings made by present day dental casting technics. J.A.D.A., 50:1-6, 1955.

14. Peyton, F. A., Mahler, D. B., and Asgar, K., Controlled water-added technic for hygroscopic expansion of dental casting investment. J.A.D.A., 52:155-161, 1956.

15. Asgar, Kamal, Chemical analysis of human teeth. J. Dent. Res., 35:742-748, 1956.

16. Myers, G. E., Wepfer, G. G., and Peyton, F. A., The thiokol rubber base impression materials. J. Pros. Dent., 8:330-339, March 1958.

17. Asgar, K., Lawrence, W. N., and Peyton, F. A., Further investigations into the nature of hygroscopic expansion of dental casting investments. J. Pros. Dent., 8:673-684, July 1958.

18. Asgar, K. and Peyton, F. A., Pits on inner surfaces of cast gold crowns. Submitted for publication, J. Pros. Dent., August 1958.

19. Asgar, K. and Peyton, F. A., Effect of microstructure on the physical properties of cobalt-base alloys. J. Dent. Res., 40:63, 1961.

20. Asgar, K. and Peyton, F. A., Effect of casting conditions on some mechanical properties of cobalt-base alloys. J. Dent. Res., 40:73, 1961.

21. Asgar, K. and Peyton, F. A., Flow and fracture of dental alloys determined by a microbend tester. J. Dent. Res., 41:142-153, Jan.-Feb. 1962.

22. Asgar, K. and Peyton, F. A., Casting dental alloys to embedded wires. J. Pros. Dent., 15:312, March-April 1965.

23. Gilson, T. D., Asgar, K., and Peyton, F. A., The quality of union formed in casting gold to embedded attachment metals. J. Pros. Dent., 15:464, May-June 1965.

24. Allan, F. C., Asgar, K., and Peyton, F. A., Microstructure of dental amalgam. J. Dent. Res., 44:1002, Sept.-Oct. 1965.

TERMINAL TECHNICAL REPORT ON CONTRACT NO. NONR-1224(50)

Report Prepared By: Floyd A. Peyton

Period of Contract: 1 June 1964 to 31 October 1965

Contract Number: NONR-1224(50)

Project Number: NR 105-360

Contractor: The University of Michigan
School of Dentistry

Principal Investigator: Floyd A. Peyton

Title of Project: Dental Materials

Objective:

The objective of this project was:
(A) To direct the program of research toward biophysical studies by initiating surveys of:

(1) Properties and behavior of polymer-ceramic implant materials, and
(2) radiation contamination effect on various restorative materials.

(B) To continue to conclusion studies in progress related to dental castings and other restorative materials.

Summary of Progress:

A summary of the results of these studies reveals the following information: (1) physical properties: a comparison was made between the elastic, tensile and compressive properties of bone and ceramic material for implant purposes. The plastic impregnated porcelain was found to be stronger and stiffer than the porous porcelain without plastic. The poor physical properties of the unimpregnated porcelain would exclude its use where a body supporting function is involved. Bone and the impregnated porcelain are similar in stiffness in compression but in tension the porcelain material is almost twice as stiff as bone. Wet bone has nearly twice the resistance to transverse bending of impregnated porcelain. The impact strength of wet bone is slightly superior to the plastic filled porcelain, acrylic plastic and dry bone. The impregnated porcelain has adequate strength for selected bone implant applications.

Biologic tolerance: The qualities of functional physical properties combined with inert biologic tolerance are the fundamental objectives of such a material for tissue substitution. Bone marginal reactions in zones contacted by the alloplast were thought to be most important. Implantations in soft tissues of the same animal warrant investigation for variations in the tissue bed reactions of bone and soft tissue to the implant materials. Four mongrel dogs were utilized in the study. The materials studied included: (a) impregnated ceramic, (b) Teflon, (c) Silastic, and (d) autogenous bone. All synthetic materials were fabricated into suitable sizes and shapes for the trephine plugs and mandibular segments. They were cleaned and sterilized prior to implantation. The specimens were left in position for an average period of 100 days before the animals were sacrificed. The results were evaluated on the basis of clinical observations, radiographic and histologic evaluation for the segmented alloplasts for resected mandibles, mandibular trephine implants, femur trephine implants and intramuscular implants.

From the study it can be concluded that tissue tolerance in canine bone defects indicated that plastic filled porcelain generated responses of inflammation and resorption to a greater degree than Teflon and Silastic. Surface characteristics of all inert alloplastic materials probably play an important part in biologic tolerance, and may offer a key to tolerance characteristics. The problem of epithelial migration around any alloplast material exposed to the oral environment is a biologic barrier to implant prosthodontics and other applications of alloplasts in dentistry. Further investigation of the means to limit or control this phenomenon offers an important challenge. A technical report was prepared describing in detail the biologic results obtained. (2) The radiation studies of various dental materials has been initiated, using the radiation from a reactor, consisting of approximately 70% neutron flux plux 30% gamma radiation. Samples of dental amalgam, silicate cement, tooth filling plastic and dental gold alloys have been irradiated at levels as high as a lethal dose of 50%. The degree of radiation contamination and the influence of the radiation on physical characteristics of the material was investigated. Although differences in response of the four materials is evident, no significant effect has been observed on the properties of the materials studied other than what might be predicted from the basic understanding of the materials involved.

No publications resulted from this project, although technical reports were prepared to describe the results.

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13. ABSTRACT

This study has dealt with the determination of characteristic physical and mechanical properties of restorative dental materials, and effect of manipulative variables on these properties. From the study an entirely new dental gold inlay casting technic was developed, based on the principle of controlled water added hygroscopic technic. The method has had successful dental applications and is a recognized method of dental inlay casting procedure. Evaluations have been made also, of the microstructure and casting procedures for cobalt base alloys used for partial denture restorations. Investigation was made of the casting of gold alloys to embedded metals, as well as an evaluation of the properties of dental gold alloy wires. Additional studies were made on denture base resins, impression materials, and dental amalgam alloys. These studies have contributed to an improved understanding of the technics of manipulation necessary to develop the maximum quality in tne finished restorations. Results have been described in twenty-four technical publications in the periodical dental literature.

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