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SHELL CASTING OF PARTIAL DENTURE FRAMEWORKS AND UNIVERSAL AQUEOUS ACRYLAMIDE DUPLICATING GEL

Final Report

by

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I. Introduction

This final report is a summary of work done between the period of May 1, 1958 and March 31, 1968. The title of the initial contract was, "A Study of Factors Influencing the Behavior of Hydrocolloid Duplicating Materials". As a result of information gained in the initial work more attention was given to formulating a universal duplicating material and in 1961 the title of the contract changed to "Development of a Universal Duplicating Material". Again in 1963 the direction of the contract changed and the title more appropriately named, "Simplification of Dental Laboratory Procedures Related to Cast Removable Partial Dentures". In 1965 the title of the contract changed to, "Shell Casting of Partial Denture Frameworks and Universal Aqueous Acrylamide Duplicating Gel". In 1966 the direction of the work changed towards developing a technic and designing a mandibular implant that could be fabricated and inserted during one surgical appointment. The contract number, however, remained the same to the termination of the contract on March 31, 1968.

Each of the above mentioned areas were summarized in previous progress reports with the exception of the last area dealing with the mandibular implants. It will be the intent of this report to summarize briefly all previous reports and publications. The references will provide a detailed description of this work and related work.

There have been no publications to date on the technic and design of mandibular implants, however, a manuscript has been submitted and it is anticipated that a publication will be forthcoming. A more detailed report, therefore, will be provided in this area. In addition, one copy of a 16 mm. color movie of the surgical and laboratory procedures related to the construction and placement of a mandibular implant has been prepared and sent to the Research and Development Officer in charge of U.S. Army contracts in the field of dentistry.

II. A Study of Factors Influencing the Behavior of Hydrocolloid Duplicating Materials

The study can be divided into four units each of which has its respective publication. For detailed information on specimen preparation, product, manufacturer, and method of testing, consult the appropriate publication.

A. Physical Properties of Elastic Duplicating Materials.[1]

The study was conducted on elastic duplicating materials and consists of a comparison of the properties of duplicating materials with agar impression compounds. The physical properties of compressive strength, tear strength, stress-strain properties, per cent set, crushing time, impression qualities, and gelation temperature were

measured. In addition, the properties of a number of experimental agar gels were determined to examine the effect of the agar source and composition on physical properties.

The basic composition of the agar impression compounds is much the same as the agar duplicating compounds. The principal difference is that the impression compounds may contain 10-15 per cent agar, while the duplicating materials may contain only 5 per cent agar. The strength properties of the duplicating materials were, therefore, lower than those of the impression materials as a result of the lower agar concentration.

The duplicating compounds could be divided into three groups with respect to physical properties. The reversible plastic gel had the highest strength properties, the agar duplicating compounds diluted 1-1 with water had intermediate properties, and the agar compounds diluted with 2 or 3 parts water had the lowest strength properties.

The compressive and tear strengths of both the impression and duplicating compounds were shown to be a function of deformation rate. Maximum values were obtained at a deformation rate of 10 inches/minute. These data are further substantiation of the practice of a "snap" removal of the impression or cast.

The stress-strain curves clearly indicated that the agar impression compounds were stiffer and had a higher proportional limit than the agar duplicating compounds. This result would be expected because the agar duplicating compounds are more dilute than the agar impression materials. Also, the shape of the stress-strain curves was different from those previously reported in the literature. This can be explained by the difference in the rate of loading. The stress-strain information obtained in this study was determined by deforming the specimen at a rate of 10 inches/minute. In this manner, a complete stress-strain curve was obtained in less than 3 seconds. Previous data appearing in the literature was obtained at a slower loading rate and the tests required 10-17 minutes to complete.

The per cent set test was found to be a rather insensitive test, but it was able to show large variations in agar material. It should be pointed out that per cent set values will vary depending on the time allowed for the specimen to recover after deformation. The reversible plastic gel duplicating material could show misleading values because of their slow rate of recovery. In the practical use of these duplicating materials 10 minutes usually elapses between the removal of the master cast and the pouring of the refractory cast so sufficient recovery probably occurs to provide an accurate duplication when employing reversible plastic gels.

The crushing time was found to be the most sensitive test for evaluating differences in agar materials, probably because it measures both elastic and viscoelastic characteristics. The compressive strength and per cent set tests do not evaluate this combination of qualities.

Any of the duplicating materials tested had adequate elastic properties to provide a rupture-free impression of the master model.

Of all the properties of agar duplicating and impression materials, the property of gelation temperature was the most constant. The gelation temperature varied between 35° and 38° C and did not change appreciably with agar concentration.

The Portuguese, Spanish, and Japanese agar gels showed more variation between batches than did the American agar gels. The Spanish and Portuguese agar gels were stronger than the Japanese and American. The American agar gels were intermediate in compressive strength while the Japanese agar gels were the weakest.

B. Dimensional Changes in Duplicated Investment Casts. (2)

This study was made to resolve the question of whether inaccuracies in the duplication process are one of the primary causes of inaccurate dental castings. To help resolve this question measurements were made in both the vertical and horizontal dimensions on gypsum-bonded refractory investments as a result of the duplication procedure.

The results showed that the duplicating procedure may be used to obtain various amounts of dimensional change in the refractory cast depending on the duplicating compound, investment, and technic used.

The amount of expansion of gypsum-bonded investments could be increased by: (1) increasing the ratio of water to the duplicating compound, (2) decreasing the ratio of water to powder in the investment mix, (3) using a master stone cast at room temperature for duplication, (4) keeping the pouring temperature of the agar duplicating compound between 125° and 140° F., and (5) allowing the investment to set under humid conditions.

Phosphate-bonded investments may or may not expand during duplication, depending on the investment material used. In the investment that did expand, the amount of expansion depended on how much time elapsed between mixing and pouring the investment into the duplicating mold. The maximum expansion was obtained with short manipulation times.

Silica-bonded investment casts tended to shrink slightly in a horizontal direction during setting, although after a cast was thoroughly dried-out it expanded and was slightly larger than the master stone cast.

Measurements of vertical dimensions showed that those investments that do expand during setting expanded slightly more vertically than horizontally, and the silica-bonded investments that contract during setting contracted considerably more vertically than horizontally.

C. Aging Characteristics of Elastic Duplicating Compounds. (3)

The first purpose of this study was to evaluate the changes in physical properties as a result of aging changes in a number of commercial duplicating compounds after storage at elevated temperatures for periods up to 60 days, and after repeated boiling and cooling cycles.

The second purpose of the study was to examine the effect of secondary components and manipulative variables on the aging changes of agar duplicating compounds. The components normally present in agar compounds and possible impurities present as a result of the duplicating procedure were added to experimental agar compounds in order to establish their effect on the aging of these materials. The effect of manipulative variables, such as grinding of the agar gels and ultrasonic treatment of the agar sols on the physical properties of duplicating compounds also was investigated.

The per cent set values were found to be quite insensitive to numerous reboiling cycles and to reasonably long storage times at a temperature of 135° F. This is in conflict with per cent set values reported by others working in this area, however it is felt that the difference is due to variations in the water content of the agar materials due to reboiling rather than aging of the duplicating compounds. In this study the melting cycles of the duplicating compounds were performed in sealed jars to eliminate loss of water. The variation in water content is also the possible reason for the variations in their strain in compression measurements. When the duplicating compounds were subjected to sufficient reboiling cycles, usually 15 or more, the per cent set began to increase indicating aging changes.

The results of the crushing time test were a direct function of the aging of the duplicating compounds accomplished by reboiling or storing at elevated temperatures. The plots of the crushing time versus number of reboiling cycles for the various duplicating compounds suggested that two mechanisms may be involved in the degradation of the viscoelastic properties. The initial rapid decrease in the crushing-time values may represent hydrolysis of the agar, while the latter, more gradual decrease may result from agglomeration of the agar micelles.

A comparison of the crushing times after daily reboiling and storage at 135° F. illustrates that reboiling, in general, caused more degradation than did storage in the sol state at 135° F. Daily reboiling of the agar duplicating compounds, however, appeared to degrade the materials about the same amount as did continuous storage at 150° F. These data would favor the preparation of a duplicating compound that could be stored for extended periods at 135° F. without the occurrence of noticeable amounts of gelation.

The effect of adding various chemicals to the agar materials indicated that borax had a beneficial effect on the strength of the

aged duplicating compounds. The presence of potassium sulfate or preservatives of the benzoate type did not alter the properties of the agar compound, but several commercial duplicating compounds could use more adequate protection against the growth of molds.

The presence of calcium sulfate accelerated the aging of the agar only after 5 or more reboiling cycles and resulted in lower strength properties. These data indicated that the investment adhering to the agar duplicating material should be washed off prior to reboiling in order to prolong the useful life of these materials.

The shearing and compression of the agar gel that took place during the grinding of the gels did not have any measurable effect on the resulting physical properties. The important feature in the grinding of agar gels was that some of the liquid phase held in the fibril network was squeezed out. If grinding is used to subdivide large pieces of agar then the liquid must be collected in order to maintain the properties of the gel.

The brief study of the effect of ultrasonics on the aging of agar duplicating compounds produced variable results for several possible reasons. Several different batches of agar were used which may have had considerably different micellar structures in the sol state and thus were more or less susceptible to ultrasonic treatment. Also, variations in the rate of hydrolysis of the different agar materials would have masked the effect the dispersion of the agglomerates. Ultrasonic treatment did not, in general, improve the resis tance of the agar materials to aging as a result of reboiling or storage at elevated temperatures.

D. Compatibility of Duplicating Compounds and Casting Investments. (4)

Of considerable importance is the compatibility of the duplicating material with the refractory investment material used in casting. This compatibility may be reflected in the surface reproduction and detail, by the hardness of the surface of the investment after the duplication procedure, and by the effect of the duplicating compound on the setting and thermal expansion of the investment.

The measurements of surface reproduction and detail showed that none of the commercial duplicating compounds investigated were compatible with all of the investments tested. The presence of glycerine or glycols in the duplicating materials rendered them incompatible for use with gypsum-bonded investments. The phosphate-bonded investments were compatible in some instances with agar duplicating materials and in other cases with the plastic type duplicating material. The silicate-bonded investments were compatible with the agar duplicating compounds but not with the plastic duplicating material.

The resistance of the investment surfaces to indentation was a more critical test of compatibility. Considerable variation was

observed when gypsum-bonded investments were poured against some agar materials and the plastic duplicating compounds. The surfaces of the phosphate-bonded investments were harder when produced against the plastic duplicating material. Much lower resistance to indentation was observed when the specimens were dried by heating according to the manufacturer's directions. The silicate-bonded investments were so weak that the resistance to indentation could not be measured.

The thermal expansion measurements indicated that some variation in expansion could occur using various duplicating compounds with a single gypsum-bonded or phosphate-bonded investment. No variation in thermal expansion was observed with the silicate-bonded investments formed in molds of the various agar duplicating compounds.

III. Development of a Universal Duplicating Material

There has been some doubt among investigators studying the behavior of casting investments, whether the setting, hygroscopic, and thermal expansions obtained on separate specimens is indicative of the true expansion of the investment mold prior to casting. This investigation led to the development of a method to determine the dimensional changes of a refractory cast from the time of pouring to the time of casting on one specimen. A casting was then made, and its accuracy determined, and compared to the total compensating expansion of the mold used to make the casting.

As a result of the development of this method, a further investigation of the variables affecting the accuracy of partial denture castings was possible. Also, the compressive strength of some casting investments was determined before and after heating in an attempt to correlate the compressive strength of an investment with the effect on the accuracy of casting.

A. Influence of Investments and Duplicating Procedures on the Accuracy of Partial Denture Castings. (5)

It was possible to record dimensional changes occuring to the refractory cast as a result of setting expansion, drying, soaking in water prior to investing, application of a paint-on-layer, investing in the outer layer of investment, and the thermal expansion, by the use of inductance transformers positioned at the end of quartz rods and tubes.

Tests were conducted using the manufacturer's recommended duplicating material and a substitute to determine what effect a change in duplicating material would have on the accuracy of the final casting. Also, this method was able to detect dimensional changes between the base of the refractory cast and the anatomical area.

Two calcium sulfate base refractory investments were tested and it was observed that the setting expansion, drying, soaking in water, paint-on-layer, outer layer of investment, and thermal expansion, can have some effect on the dimensions of the refractory cast. The setting expansion through the anatomical area (molar to molar) was less than the corresponding area through the base of the cast. The effect of each of the conditions mentioned above may cause an expansion of the cast of 0.10 to 0.20 per cent. The net effect of these variables may effect the total compensating expansion as much as 0.40 per cent, which in turn is reflected in the accuracy of the casting.

The same experiments were conducted using two phosphate bonded refractory investments. Changing duplicating materials had no appreciable effect on the setting expansion of one investment but doubled that of the other. Also, the phosphate investments experienced no effect as a result of soaking and investing. The total compensating expansion was low and produced undersized castings.

The two silicate bonded investments differed from the calcium sulfate and phosphate bonded investments in that they contracted upon setting. There was no appreciable effect on the refractory cast as a result of soaking or investing. Also, the total compensating expansion was low, which resulted in undersize castings.

The accuracy of the castings made in this study indicated that most castings of the chrome-cobalt type, are 0.4 to 0.8 per cent undersize. In three instances oversize castings were obtained, using calcium sulfate bonded investment, which ranged between 0.10 to 0.70 per cent oversize.

The difference in compressive strength of the refractory casting investments measured at room temperature 2 hours after pouring, and again at the recommended casting temperature 24 hours after pouring, indicated that the calcium sulfate bonded investments decreased in strength between 72 per cent and 86 per cent upon reaching the casting temperature with the exception of one investment which increased 22 per cent. The fired compressive strength of one of the phosphate investments remained the same and two others increased 144 and 173 per cent. There was a great difference in the silicate investments with one increasing 273 per cent and the other decreasing 29 per cent.

Some additional conclusions of the study are:

1) The total compensating expansion through the base of the refractory cast may not be equal to the expansion through the anatomical or tooth portion of the cast. More dimensional change is expected through the base than through the anatomic portion.

2) The selection of a duplicating material can effect the accuracy of the final casting.

3) The dimensional changes of the silicate bonded investments

tested were restricted considerably through the anatomical portion of the cast as a result of the confinement of the duplicating material.

4) The total compensating expansions of calcium sulfate bonded investments are increased by soaking the refractory cast in water for 15 minutes, applying a paint-on-layer, and by investing in the outer layer of investment.

5) The total expansion that was necessary to compensate for the shrinkage of the alloys tested, and the type of pattern cast, was between 1.6 and 2.1 per cent.

IV. Simplification of Dental Laboratory Procedures Related to Cast Removable Partial Dentures

The standard procedures for casting a chrome-cobalt partial denture framework require about 400 grams of casting investment and approximately 3 to 4 hours for the burnout cycle. This time is necessary because the large volume of investment needed per casting will not permit uniform heating during a short heating cycle. Also, the high water content of most refractory investments prevents rapid heating. It therefore seemed possible, and became the object of this study, to develop an abbreviated casting technic that would require less time to complete and use less refractory casting investment.

A. Simplification of the Chrome-Cobalt Partial Denture Casting Procedure.[6,7,8,9,10]

A technic was developed that was patterned after industrial shell casting methods. A thin layer of refractory material was applied to the waxed-up pattern and without any additional supporting medium the metal alloy was cast into the refractory mold. The shell layer had sufficient strength properties and thermal characteristics to provide a smooth surfaced, finless, accurate casting.

The shell investment is a two component system. The first component is a slurry composed of sodium silicate for a binder, water, wetting agent, and refractory materials for control of thermal expansion.

The second component is a dusting powder composed of mono-ammonium phosphate as a jelling agent for the sodium silicate in the first component. Magnesium oxide is added to combine with some of the mono-ammonium phosphate to provide strength at room temperature for the shell investment, and a variety of refractory materials are incorporated for the control of thermal expansion.

The use of this shell investment material involves a change in the dental investing procedure. The waxed-up pattern on the refractory cast is dipped into the slurry and all surfaces of the pattern are wetted. The excess slurry is allowed to drain off, and then the pattern is dusted immediately with the powder. This operation is repeated until five layers of shell have been applied to the wax pattern and adjacent refractory cast. The cast is then placed into a desiccant for 25 minutes to absorb the excess moisture. After drying, the shell mold is ready for elimination of the wax pattern.

The burnout cycle varies depending on the type of alloy and refractory cast being used. If the cast is a phosphate or silicate bonded type, and the alloy being cast requires a high-heat burnout, then the shell mold is placed directly into a preheated oven at 2,000° F. and heated for 30 minutes to burn out the wax. If the cast is made of a calcium sulfate bonded investment the burnout cycle is slower. A satisfactory heating cycle is to place the shell mold into a preheated oven at 500° F. for 30 minutes. The temperature is then increased to 1350° F. over a period of an hour, allowing at least 15 minutes for the investment to "heat-soak" at 1350° F. A standard casting machine (inductance type) was used in this study, however, it was necessary to provide a special cradle to support the irregular-shaped shell mold.

The accuracy data obtained from castings made with this technic of casting and the conventional technics was statistically analyzed and no significant difference between the methods was found. The accuracy of a partial denture casting is determined primarily by the refractory cast, and this shell casting technic requires the same cast as that used in other methods.

The rapid hardening of each successive shell layer is unique in the area of shell casting because successive layers of shell investment can be applied to the pattern without waiting for drying to occur. The rapid hardening requires a minimum of time spent in investing and also the small amount of refractory material involved allows the burnout cycle to be accomplished in a relatively short time. Approximately 30 grams of shell dusting powder is required for the average partial denture casting and represents an approximate saving of 90 per cent in investment material. This reduction of material also would lead to further saving in storage and shipping costs of large quantities of materials, and no casting or flasking rings are required which offers even greater savings.

V. Universal Duplicating Material

In this investigation a further attempt was made to simplify dental laboratory processing technics. Agar duplicating compounds require approximately 30-45 minutes for melting, 10-15 minutes for tempering, and 30-60 minutes for jelling. An additional 30-60

minutes is required for hardening of the refractory cast, depending on the type of refractory material being used. The total time required for a duplicating operation using agar is approximately 2-3 hours. An attempt was made to find a substitute for the agar hydrocolloids that would provide more rapid duplication and be compatible with gypsum, phosphate, and silicate types of investments.

A. Aqueous Acrylamide Gel. (11)

An aqueous acrylamide gel can be prepared from a mixture of two organic monomers, acrylamide and N, N', methylenebisacrylamide in water. The mixture when catalyzed forms a transparent gel by a crosslinking polymerization reaction. This material showed considerable promise as a duplicating compound because it could be catalyzed to form a gel within seconds of mixing or retarded for many hours. The basic material, however, exhibited an adherence to the master cast and most refractory investments, and was not as firm or rigid as the agar duplicating compounds. The addition of a synthetic calcium silicate increased the rigidity and a potassium alginate provided separation of the resulting gel making the system a satisfactory duplicating compound.

In order to make the acrylamide duplicating compound compatible with all three types of refractory investments (calcium sulfate, phosphate, or silicate bonded) mold washes are required for the calcium sulfate and phosphate bonded types.

The properties of the acrylamide gel duplicating material are either as good as, or better than, the properties of the other materials tested, except for the property of per cent strain. The value of 24 per cent strain observed on the acrylamide was higher than those of the agar materials (12-20%). It should be noted that there is no specification for duplication materials and no upper limit known for the per cent strain. It was noted in the determination of the per cent strain of the agar materials that one material broke during the test procedure, yet it is being used successfully as a duplicating material.

The physical properties of this material in comparison with other commercial duplicating materials are sufficiently similar that it can be used as a substitute for agar hydrocolloids. It is a material that can be used to make a mold from a master cast within 15 minutes after mixing and the entire duplicating procedure can be accomplished in approximately one hour, depending on the type of refractory investment being used.

VI. Immediate Custom Implant for the Mandible. (12)

The short time required to obtain castings of chrome-cobalt alloys employing the shell casting technic suggested this technic

could be further abbreviated and adapted to the fabrication of chrome-cobalt implants for the mandible which are needed as a result of tramma, malignant involvement, or a gun-shot wound. The implant is fabricated, employing the shell casting technic, while the patient is undergoing surgery. The advantages of such a method are: 1) fabrication and insertion of the implant during one surgical operation, 2) custom fabrication of the implant for the patient, and 3) obtaining a casting for the abutment attachment of near precision tolerance for final attachment to the mandible.

In order to simplify the fabrication process, and provide a method of aligning the implant within the wound, a three piece implant (two abutment castings and one space maintainer) was designed. A number of space maintainers were fabricated prior to the operation in lengths differing by 2 mm. The approximate length was determined from radiographs but additional space maintainers were made to provide the surgeon with a selection. Each space maintainer was designed with a 3/16 inch diameter hole on each end. The holes are needed to receive a 1/4 inch diameter ball on each abutment casting.

The two abutment castings are cast at the time of the surgical appointment and fabricated to accurately fit stone casts of the mandibular abutments. Each casting is made with a 1/4 inch ball attached that seats into the 3/16 inch hole on each end of the space maintainer. By placing a long flat washer, also with a 3/16 inch hole on the opposite side of the ball, and held in place by an Allen bolt, a universal joint assembly is created between each abutment casting and the space maintainer. These universal joints allow the surgeon freedom to align the implant within the wound and they eliminate any alignment during the fabrication process. The balls are electrically welded, under an argon atmosphere, to the space maintainer to make a one-piece implant. The washer and bolt are removed after welding and the site of the weld is polished.

Several implants of this design were inserted using dogs as subjects. After gaining proficiency, a mandibular implant was inserted in a human male patient who had lost the left half of his mandible from the symphisis posterior to the angle of the ramus as a result of a gun-shot wound. A bone graft had been performed on this patient at the time of the accident (approximately 6 years earlier), however, the graft was unsuccessful and the decision then was made in favor of the metallic implant technic developed under this contract.

The method was as follows. After the wound was exposed an impression in dental compound was taken of each mandible abutment. The impression was accomplished by softening the compound in sterilized water at 133° F. and then adapting it to the bone abutment using finger pressure. No impression tray was needed as the impression site was small. Impressions were taken of both the anterior and posterior abutments of the mandible and models were prepared in dental impression plaster. The short setting time of this material

allows early removal of the resulting models. Wax patterns were prepared directly on the plaster models. The wax pattern was designed with a bar on the buccal surface of the mandible and another on the inferior boarder at a 90° angle to the buccal bar. In addition, one short flat finger was waxed on the lingual surface to engage the lingual corner of the abutment, which prevented the abutment casting from being displaced in a buccal direction. This design provided maximum support for the implant with minimum metal contacting the bone. Holes were drilled and countersunk in the wax pattern to receive Vitallium bone screws. The screws used on the buccal bar were long enough to engage both cortices of the bone while the screws for the inferior bar engaged only the inferior cortex. It was believed that positioning the bone screws 90° to each other provided more support with a minimum number of screws. A 1/4 inch acrylic (lucite) ball was attached to the wax pattern by means of a short 10 gauge wax rod to the approximate center of the pattern. This ball will later seat in the 3/16 inch hole at each end of the space maintainer.

The wax patterns were removed carefully from the plaster models and sprued to a casting base preformed of phosphate refractory investment. The patterns were painted with a surface tension reducing agent and then a thin layer of phosphate refractory investment was applied. The shell casting investment material (described previously in this report) was applied to this layer of investment. Five layers of shell investment were applied within 3-5 minutes. The shell mold thus formed was immediately placed into a preheated oven at 2000° F. for 25 minutes and a casting made using Vitallium Surgical Alloy. The castings were sandblasted, electrolytically stripped, and then finished and polished.

The two abutment castings then were returned to surgery, sterilized, and positioned on the bone abutments using only one bone screw on each abutment. The purpose of the single screw was to hold the casting in position while the surgeon selected the proper length space maintainer and made the necessary alignment using the two ball-joint assemblies. After the alignment was assured and the ball-joints locked into position, the entire implant was removed and returned to the laboratory for welding of the ball-joints. The welding was done electrically under an argon atmosphere, and no welding rod used. The welding was accomplished by fusing the Vitallium alloy ball to the space maintainer. In this manner the three pieces (two abutment castings and one space maintainer) were united as one piece minimizing the chance of electrolytic reaction in the area of the weld which could take place in the presence of dissimilar metals. The area of the weld was then polished and returned to surgery for sterilization and final fixation. The entire casting operation, pouring of models to polishing of abutment castings, took approximately two hours. The following welding procedure and related finishing process took an additional 40 minutes.

The speed at which this procedure was accomplished allows for the fabrication and insertion of a custom made Vitallium implant in one surgical appointment. The three piece design of the implant provides the surgeon with a great deal of freedom to extend, shorten, and align the implant. Also, the design of the abutment casting is such that maximum support is obtained by positioning the bone screws at 90° to each other with minimum metal contacting the bone.

To date the implant has been retained for eleven months with marked improvement in function.

VII. Publications Resulting From This Contract

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2. Craig, R.G., Anthony, D.H. and Peyton, F.A., Dimensional Changes in Duplicated Investment Casts, Dent. Prog., 2: 35-45, Oct., 1961.

3. Craig, R.G., Gehring, P.E. and Peyton, F.A., Aging Characteristics of Elastic Duplicating Compounds, J. Dent. Res., 41: 196-206, Jan.-Feb., 1962.

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10. Dootz, E.R., Craig, R.G. and Peyton, F.A., Simplification of the Chrome-Cobalt Partial Denture Casting Procedure, J. Pros. Dent. 17: 464-71, May, 1967.

11. Dootz, E.R., Craig, R.G. and Peyton, F.A., Aqueous Acrylamide Gel Duplicating Material, J. Pros. Dent., 17: 570-7, June, 1967.

12. Dootz, E.R., Craig, R.G. and Peyton, F.A., Immediate Custom Implant for the Mandible. (Submitted for Publication to J. Biomechanics)

VIII. Abstract

Factors influencing the behavior of hydrocolloid duplicating materials were studied. Emphasis was placed on determining the physical properties of available duplicating materials, dimensional changes of duplicated investment casts, aging characteristics of duplicating compounds, and compatibility of duplicating compounds and casting investments. A study of the influence of investments and duplicating procedures on the accuracy of partial denture castings also was completed.

This investigation led to the development of an aqueous acrylamide gel duplicating material of the irreversible type. The physical properties of this material indicate that it can be used as a substitute for agar duplicating compounds. The gel is compatible with gypsum, phosphate, and silicate bonded investments when appropriate mold washes are used. The mold can be produced in 15 minutes, which allows the duplicating procedure to be completed in about one hour.

In addition, a shell casting technic was developed which allows a chrome-cobalt casting to be made within one hour from the time investing is started. The technic reduces the quantity of investment about 90 per cent thus reducing the cost of storage and shipment. A short burnout cycle offers additional reduction of cost to operate the burnout furnaces.

The shell casting technic was abbreviated so a custom made Vitallium mandibular implant could be fabricated and inserted in one surgical appointment. A three-piece design of the implant provides the surgeon with freedom to extend, shorten, and align the implant. The design of the implant offers maximum support with minimum metal contacting the bone abutments.

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10. AVAILABILITY/LIMITATION NOTICES

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	U.S. Army Medical Research and Development Command, Office of the Surgeon General, Washington, D.C.

13. ABSTRACT Factors influencing the behavior of hydrocolloid duplicating materials were studied. Emphasis was placed on determining the physical properties of available duplicating materials, dimensional changes of duplicated investment casts, aging characteristics of duplicating compounds, and compatibility of duplicating compounds and casting investments. A study of the influence of investments and duplicating procedures on the accuracy of partial denture castings also was completed.

This investigation led to the development of an aqueous acrylamide gel duplicating material of the irreversible type. The physical properties of this material indicate that it can be used as a substitute for agar duplicating compounds. The gel is compatible with gypsum, phosphate, and silicate bonded investments when appropriate mold washes are used. The mold can be produced in 15 minutes, which allows the duplicating procedure to be completed in about one hour.

In addition, a shell casting technic was developed which allows a chrome-cobalt casting to be made within one hour from the time investing is started. The technic reduces the quantity of investment about 90 per cent thus reducing the cost of storage and shipment. A short burnout cycle offers additional reduction of cost to operate the burnout furnaces.

The shell casting technic was abbreviated so a custom made Vitallium mandibular implant could be fabricated and inserted in one surgical appointment. A three-piece design of the implant provides the surgeon with freedom to extend, shorten, and align the implant. The design of the implant offers maximum support with minimum metal contacting the bone abutments.

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Unclassified

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Hydrocolloid Agar-agar Acrylamide Gel Shell Casting Implant, mandibular						

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