



1979

## A Comparison of the Accuracy and Dimensional Stability of Putty-Wash Impression Materials

Rafael Cherem Amkie  
*Loyola University Chicago*

Follow this and additional works at: [https://ecommons.luc.edu/luc\\_theses](https://ecommons.luc.edu/luc_theses)



Part of the [Oral Biology and Oral Pathology Commons](#)

---

### Recommended Citation

Amkie, Rafael Cherem, "A Comparison of the Accuracy and Dimensional Stability of Putty-Wash Impression Materials" (1979). *Master's Theses*. 3008.  
[https://ecommons.luc.edu/luc\\_theses/3008](https://ecommons.luc.edu/luc_theses/3008)

This Thesis is brought to you for free and open access by the Theses and Dissertations at Loyola eCommons. It has been accepted for inclusion in Master's Theses by an authorized administrator of Loyola eCommons. For more information, please contact [ecommons@luc.edu](mailto:ecommons@luc.edu).



This work is licensed under a [Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 License](#).  
Copyright © 1979 Rafael Cherem Amkie

101

A COMPARISON OF THE ACCURACY AND DIMENSIONAL STABILITY  
OF PUTTY-WASH IMPRESSION MATERIALS

by

Rafael Cherem Amkie, D.D.S.

A Thesis Submitted to the Faculty of the Graduate School of  
Loyola University of Chicago in Partial Fulfillment  
of the Requirements for the Degree of  
Master of Science

April

1979

## DEDICATION

To my lovely wife, who with patience, encouragement and faithful attachment, made from this thesis a successful and unforgettable experience in our lives.

To my parents Abraham and Frida who patiently have encouraged not only my professional education but all the meaning of my life.

To my parents-in-law, whose confidence and energy have been giving me the incentive to succeed in my professional career.

## ACKNOWLEDGMENTS

I am very thankful to Dr. James L. Sandrik who, as my advisor in this research, offered me guidance, enthusiasm and support during the realization of this investigation.

I wish to thank Dr. William F. Malone for his help, guidance and teaching not only in the elaboration of this research, but in the improvement of my dental education.

I also wish to express my appreciation to Mrs. Marie R. Feng for her assistance and sincere encouragement.

## VITA

The author, Rafael Cherem Amkie, son of Abraham B. Cherem and Frida A. de Cherem was born April 19, 1952, in Mexico City. He was the sixth of seven children.

His elementary education was obtained in the Colegio Hebreo Sefaradi in Mexico and he began his formal dental studies at the Universidad Tecnologica de Mexico. He graduated in August, 1974, obtaining a Dental Surgeon Degree.

After three years of private practice, he came to the United States of America in 1977 and began his graduate studies in the department of Oral Biology of Loyola University School of Dentistry, Chicago Il.

Specialty training was in the department of Fixed Prosthodontics under the direction of Dr. William F. Malone.

TABLE OF CONTENTS

	Page
DEDICATION . . . . .	ii
ACKNOWLEDGMENTS . . . . .	iii
VITA . . . . .	iv
LIST OF TABLE . . . . .	vi
LIST OF FIGURES . . . . .	vii
Chapter	
I. INTRODUCTION . . . . .	1
II. LITERATURE REVIEW . . . . .	4
A. Accuracy of Silicone Impression Materials . . . . .	4
B. Effect of Viscosity on Silicone Impression Materials . . . . .	7
C. Tray Influence in Elastomer Impression Materials. . . . .	11
III. METHODS AND MATERIALS . . . . .	13
A. Part I . . . . .	13
B. Part II . . . . .	20
IV. RESULTS . . . . .	23
V. DISCUSSION . . . . .	34
VI. CONCLUSIONS . . . . .	38
BIBLIOGRAPHY . . . . .	39

LIST OF TABLES

Table	Page
1. Name, batch number and manufacturer of each impression material . . . . .	14
2. Statistical Data for time dependent functions of accuracy and dimensional stability of wash impression materials compared to the master die (2.4992 cm) . . . . .	24
3. Statistical Data for time dependent functions of accuracy and dimensional stability of putty-wash impression materials compared to the master die (2.4992 cm) . . . . .	27

LIST OF FIGURES

FIGURE	Page
1. Top view of the die . . . . .	15
2. The die with the glass and cellophane held together with the "c" clamp in the mouth simulator . . . . .	17
3. Gaetner traveling microscope . . . . .	18
4. The die with the glass, custom tray bonded to the putty material held together with a "c" clamp . . . . .	21
5. The die on top of putty-wash impression material bonded to the tray and two lateral stops on the mouth simulator . . . . .	22
6. Graphical comparison of all wash impression materials evaluated . . . . .	26
7. Graphical comparison of all materials evaluated with the use of a tray bonded to the putty and a thin layer of wash . . . . .	29
8. Graphical comparison of Accoe wash "vs" Accoe putty-wash bonded to the tray . . . . .	30
9. Graphical comparison of Citricon wash "vs" Citricon putty-wash bonded to the tray . . . . .	31
10. Graphical comparison of Xantopren wash "vs" Optosil and Xantopren bonded to the tray . . . . .	32
11. Graphical comparison of President wash "vs" President putty-wash bonded to the tray . . . . .	33

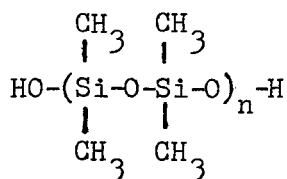


CHAPTER I  
INTRODUCTION

Various types of dental impression materials have been developed over the past one hundred years, Wax, plaster, molding compound, zinc oxide eugenol paste, agar hydrocolloid, polysulfide rubber, silicone rubber and polyethers are among the materials currently utilized to make impressions of various areas of the dental arch. Agar hydrocolloid, alginate hydrocolloid, polysulfide rubber, silicone rubber and polyether were all capable of exhibiting an elastic behavior. However this research will be limited to a comparison, accuracy evaluation of silicone Putty-Wash systems.

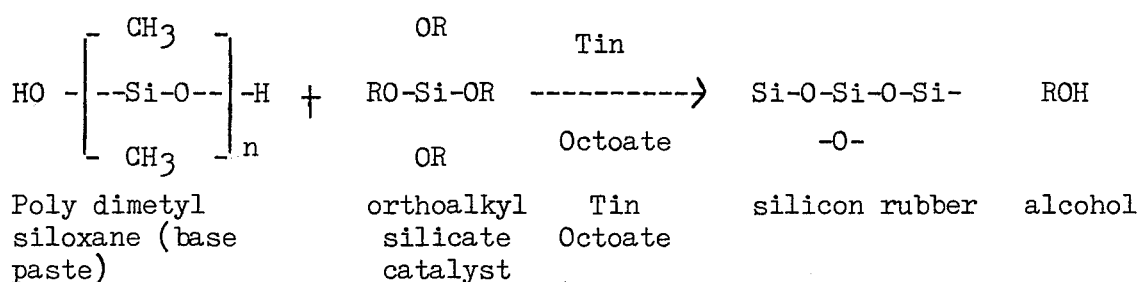
The silicones were originally developed for industrial use, as a result they were not introduced to the dental profession until late 1950's. They are classified according to the viscosity of the paste formed as very high, high, medium and low viscosity (A.D.A. Specification No 19. 1977).

According to Skinner & Phillips (1973), Obrien & Ryge (1978), the chemistry of the silicone impression material which polymerized by condensation reaction, consisted of difunctional poly(dimethyl siloxane).



Cross linking occurred through a reaction with tri and tetrafunctional alky silicates, such as triethyl silicate, in the presence of tin octoate  $\text{Sn}(\text{C}_7\text{H}_{15}\text{COO})_2$ .

The formation of the elastomer resulted through a cross linkage between terminal groups of the silicone polymer and the alkyl silicate which formed a three dimensional network.



Alcohol was a by product of the reaction and responsible to a large degree for the polymerization shrinkage associated with the silicone impression materials. (Craig 1978).

The silicone putty wash materials were initially developed to overcome a demonstrable dimensional instability as well as substitute for the custom tray technique. The putty had a silica filler content of 75% while the wash had only 25 to 30% filler (Craig 1977). The dimensional change on setting was substantially lower for the putty, but the wash had a dimensional change comparable to regular silicones.

The catalysts were usually liquids similar to the regular products. The putty wash silicones were customarily used with a double impression

technique, and the actual dimensional change was reduced by using the putty which had a low dimensional change, and by using a thin layer of wash material which had a high dimensional change.

The most recent introduction into the field of rubber impression materials was a silicone rubber which polymerized by an addition reaction. The material was supplied as two paste system. One paste contained a low molecular weight silicone with terminal vinyl groups, reinforcing filler, and chloroplatinic acid catalyst. The second paste contained a low molecular weigh silicone with terminal silane hydrogens and reinforcing filler, with no by product being formed during polymerization. The advantages of this system according to Craig (1977) were low permanent deformation, low flow and very low dimensional change after setting, having rather a short working time and low flexibility.

The specific purpose of this research is to compare the accuracy and dimensional stability of four different putty wash systems.

Studies have been done measuring the free standing material. Additional impression material bonded to an acrylic tray was evaluated. This study will measure the impression material bonded to a putty which in turn is bonded to an impression tray.

## CHAPTER II

### LITERATURE REVIEW

#### ACCURACY OF SILICONE IMPRESSION MATERIALS:

John W. McLean (1958) studied three different types of silicones. He noted the silicone rubber impression materials were supplied as partially polymerized pastes containing filler such as zinc oxide. The shelf life of the pastes appeared to be very short; after three months or more the consistency of the material was adversely affected. It was known the silicone rubber continued to polymerize for as long as two weeks after the initial set occurred in the mouth. This situation could be controlled with the addition of a liquid activator, sacrificing working time.

Another problem of the earlier brands of silicone rubber was the release of hydrogen gas during polymerization which caused excessive pitting of the stone model surfaces. In order to overcome this problem, the impression was placed in a vacuum, at 28 inches of mercury for 10 minutes and then washed in detergent before pouring.

McLean demonstrated silicone exhibited a mean range of linear contraction at fifteen minutes set of 0.04 to 0.027%, and at two weeks storage 0.036 to 0.82%. He recommended pouring the impression within the first hour to combat the linear distortion.

Anderson (1958) and Skinner (1958) reported the silicones showed more elasticity than the polysulfide rubbers; but at the same time they believed the polysulfides exhibited greater dimensional stability.

Thompson (1959) and Eberle (1959) also reported silicones to be accurate if poured within the first 30 minutes after the impression was removed from the mouth.

In 1959, seven silicone impression materials were studied by Gilmore and Schnell. They concluded the most accurate results can be obtained only when the impression is poured immediately; the distortion increased with additional pouring of models. They theorized this was due to the general lack of dimensional stability of the materials. The accuracy of some of the products tested was slightly improved by curing longer in the mouth and by employing a uniform thin layer of silicone of about 2 mm.

Myers and Peyton (1959) reported when silicone impression materials were carefully handled within the inherent limitations of the material (short working time, gas production, aging of the materials) the clinical accuracy of the restorations appeared to be acceptable.

In 1964 Custer further evaluated the accuracy of silicone impression materials. He believed the problem and undesirable properties shown in the initial use of the materials could be solved. Custer demonstrated the setting time can be accurately controlled by varying the amount of catalyst. The temperature did not seem to change the setting time or accuracy significantly. It was generally agreed by clinicians that the manipulation of the silicone materials was easier and cleaner than the mercaptan rubber.

There was no evidence of gas production or surface tackiness in the silicone impressions made on a silver plated model.

Also the impressions poured within 30 minutes were still accurate while after 1 hour some changes were noted. After 24 hours period the material showed considerable distortion.

In 1973 David Brown stated the factors affecting the dimensional accuracy are as follows:

- 1) Thermal effects. The difference between room temperature and the mouth temperature.
- 2) Water absorption while taking the impression. This absorption may cause either an expansion or a contraction of the impression space.
- 3) Elastic recovery effects. If the set impression was withdrawn from undercut regions the deformation which was necessary should be entirely elastic, and the ideal material should show no delay in returning to the equilibrium position, but it should not return or recoil beyond this position.
- 4) Continuing polymerization. This phenomenon was applicable only to the elastomeric materials; they continue to polymerize for long periods of time and the associated shrinkage is time dependent.
- 5) Loss of volatile constituents. This loss cause contraction of the impression.
- 6) Setting expansion of the stone.

The permanent deformation of the elastomer impression material currently used were studied in Greece in 1973 by Kaloyannides. The results showed that ten minutes after mixing the silicone and polyether impression materials, they exhibited significantly less permanent deformation than the mercaptan products.

In 1974 Kaloyannides studied the permanent deformation of certain mixtures of elastomeric impression materials of the same group. The mixtures of silicones exhibited much lower permanent deformation than those of mercaptan materials.

Hosea F. Sawyer and coworkers (1974) compared the accuracy of one polysulfide, five silicones and two polyethers elastomer impression materials. A close analysis showed some of the silicone impression material were equal to the best in accuracy in this study. The shrinkage of the silicones was 0.04 inches in 30 minutes. The shrinkage of the polysulfide was 0.015 inches in 30 minutes. The most accurate casts were produced from the polyether impression material and the next most accurate casts from the silicones.

#### EFFECT OF VISCOSITY ON SILICONE IMPRESSION MATERIALS:

M.H. Reisbick (1973) tested the effect of viscosity on the accuracy and stability of elastic impression materials. Viscosity is considered one of the most important during the placement of impression. If the viscosity of the material was low, the material would either run out of the tray or would not be held in intimate contact with the impression site.

If the viscosity was too high elastic strains could be induced which on release would result in a distorted or inaccurate impression.

Some of these strains would be released immediately, which others would be released during storage of the impression. In this study either high or low viscosity produced the same degree of accuracy and

stability when reversible hydrocolloid, polysulfide, or silicone impression material were tested. The stability after 1 hour storage showed the elastomers were more stable than agar hydrocolloid. The descending order of accuracy was polysulfide, silicones, and reversible hydrocolloid.

In 1973, Skinner described the heavy body silicones as a rapid curing putty or dough like material, which can be used in a stock tray as preliminary impression using a thin resin rubber sheet as a spacer, or cutting away some of the tray silicone; this area was then filled with a wash silicone (low viscosity). In this study, he pointed out the advantage of rapid curing.

Reisbick (1975) studied the accuracy of casts made from impression that utilized the new putty like silicone systems. Because their high filler content, this putty like silicones should show less dimensional change than ordinary silicones with less filler. Once the preliminary set was made, a mix of low viscosity silicone was used to line or correct the initial impression. System 1 (Optosil & Xantopren) provided good accuracy as well as low variability. However this system 1 did not bond well to the tray. System 2 (Citricon) seemed to be easier to use and provide uniform consistencies and setting times. System 3 (Coltene Ag) in Reisbick study were found to be less accurate than the other two systems, and the only one which displayed surface porosity. This test proved to be as accurate as other standard impression materials. This study supported the use of the class IV silicones (high filler content) for dental duplication procedures when such materials were used in



conjunction with a corrective wash.

Mansfield and Wilson (1975) developed a method of measuring dimensional stability in which the specimen of impression material underwent temperature changes during normal clinical conditions. They tested 15 polysulfides, 21 silicones and one polyether impression material. They believed, the low viscosity silicones were the least stable of the material tested. The high viscosity silicones had dimensional change values similar to those of the high viscosity polysulfides. However, they were more stable than the low and medium viscosity. Higher viscosity materials were generally considered more stable. Their high filler content was considered the ingredient responsible for this stability.

The medium viscosity silicones, when compared with the polysulfides, were not found as serviceable as the polysulfides. The high viscosity putty like silicones and low viscosity wash pastes were added to the range of elastomers. When these two materials were used in conjunction with one another they were better than the medium viscosity silicones. The results of this investigation indicated, when these materials are used together, the more accurate results were obtained if the amount of low viscosity silicone was kept to a minimum.

Robert Craig (1977 1978) compared several rubber impression materials. He pointed out several advantages of the silicones: low viscosity, prompt setting, low permanent deformation during removal, low flow after 1 hour mixing and reasonable tear strength with no staining. He also noted the disadvantages; e.g., large dimensional changes from

setting, aging of the catalyst and difficulty with some products with respect to silverplating. In this study the working times were longer for the polysulfides, followed by the silicones and finally the polyethers. The dimensional change registered during polymerization was largest for condensation reaction type silicones. Polysulfides and polyethers had intermediate values for dimensional change.

The silicone polymerized by addition exhibited the least deformation followed by polyether and the silicone polymerized by condensation. The undesirable dimensional change with the silicones has been reduced by the application of the putty wash silicones systems in this study; the bulk of the wash was reduced so that the actual dimensional change was very small. The elastic qualities of addition silicones were superior to any other rubber impression material. It possessed a moderately short working time and was fairly rigid at the time of removal from the mouth.

According to O'Brien & Ryge (1978) the stability of the silicones increased when the filler content is raised to 75 %. The putty silicone which was used to form trays for the final wash impression with a light body silicone was an example of increased filler content.

The shrinkage caused by the polymerization and evaporation of the alcohol associated with traditional silicones has been overcome with the development of addition polymerized systems.

In 1978 Lacy did a study of seven conventional silicones; four polysulfides, one polyether and a new addition polymerization silicone.

With one exception, the putty wash method were more accurate in the immediate results, and suffered less dimensional change with time than the custom tray systems. Most of the dies became larger with the time. The addition polymerization silicone was found to be the most accurate and stable in this study. A putty wash polysulfide was the least accurate and least stable.

#### TRAY INFLUENCE IN ELASTOMER IMPRESSION MATERIALS:

In 1960 Rubinstein and Fairhurst tested seven brands of silicone impression materials. He concluded a perforated tray seemed to have a retentive power in a bucolingual direction but not mesiodistally.

Phillips in 1962 stated: The accuracy of rubber impression materials depended on the use of a minimum thickness of the material. The proper adhesive which bonded the material to the tray was also an essential ingredient for stability and accuracy. The use of tray adhesives with the rubber impression materials has been advocated by several authors.

Phillips in 1973 stated: Every single rubber impression material needed its own adhesive which reduced excessive shrinkage of the material and dislodging of the impression material from the tray.

Davis in 1976 recommended a rough surface in the tray and suggested the adhesive should be painted into the tray between 15 minutes to 72 hours prior to taking the impression.

James Ciesco (1978) compared two polysulfides, two silicone, (one condensation polymerization and one addition reaction polymerization) and one polyether. He measured the accuracy and dimensional stability

of those materials with and without adhesive and custom tray. In his results he pointed out the immediate accuracy of all materials tested was improved significantly when the adhesive and custom tray were employed. The dimensional change of these materials at one week were also considerably improved by using a custom tray.

## CHAPTER III

### METHODS AND MATERIALS

#### PART I

A total of four putty wash silicone impression materials were evaluated: (Table I lists brands, names and manufacturers). Three condensation polymerization and one addition polymerization.

A new round die which is currently the A.D.A. standard specification die for testing dental impression materials was utilized to compare the specimens. (Specification No. 19).

The new apparatus included only those lines required for detailed reproduction (three horizontal ruled lines). It provided cross lines which were used for determination of dimensional stability of impression materials (see fig. I).

The horizontal ruled line widths were: line "x" =  $50 \pm 8 \mu\text{m}$ ; line "y" =  $20 \pm 4 \mu\text{m}$ ; line "z" =  $50 \pm 8 \mu\text{m}$ . All lines had a  $90^\circ$  included angle. The length of the lines between the cross lines was 2.4992 mm. The die has a highly polished surface; this eliminated the need for a separator and minimized cleaning operation which could damage the ruled surface of the die. The die also had a ring which fit around the periphery of the ruled measuring surface. It acted as a tray or container for the dental impression material. The die was cleaned in an ultrasonic cleaner\* with toluene.

---

\*Fisher Scientific Ultrasonic Cleaner.

## T A B L E I

NAME, BATCH NUMBER AND MANUFACTURERS  
OF EACH SILICONE IMPRESSION MATERIAL

<u>MATERIAL</u>	<u>MANUFACTURER</u>	<u>BATCH NUMBER</u>
Accoe	Coe Laboratories, Inc. Chicago IL.	Putty
		Base 070278
		Cat 070178
		Wash
		Base 070378
		Cat 070278
Citricon	Kerr Romulus, Mich	Putty
		Base 051778
		Wash 1153
		Cat 1123
Optosil & Xantopren	Unitek	Putty
		Base 1276 T022878
		Wash 05613090677
		Cat 46111033078
President	Coltene Switzerland	Putty
		Base 01805
		Cat 01805
		Wash
		Base 13802
		Cat 13802

The room temperature and the relative humidity were recorded with a glass thermometer and a hygrometer. The settling time was measured by the use of a chronometer.

Manufacturers were requested to send freshly manufactured materials.

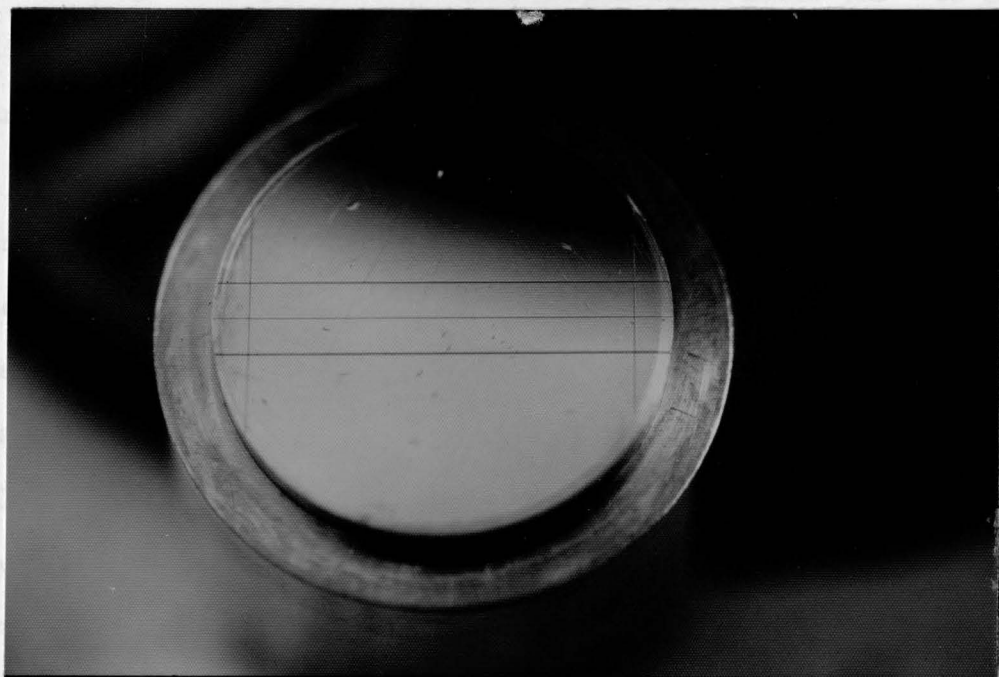


FIG. 1

\*\*\* Ohaus Scale Corporation. Top view of the die

\*\*\*\* Blue H Electric Company, Blue Island, Ill.

\*\*\*\*\* The Götting Scientific Corporation, Chicago, Ill.

The room temperature and the relative humidity were recorded with a glass thermometer and a hygrometer. The setting time was measured by the use of a chronometer.

Manufacturers were requested to send freshly manufactured materials. The batch numbers were recorded. The impression materials were weighed on a centogram triple beam ( $\pm 0.05$  gr.) balance model 311\*\* to control ratio between base and catalyst. All materials were mixed according to manufacturer instructions.

The wash material were put on the die and a sheet of polyethylene was placed over the impression material. Any excess would be extruded. The polyethylene acted as a separator for easy removal from the glass slab. The glass and the die were maintained together by using a "c" clamp (fig. 2) and placed in a Blue M\*\*\* full visibility jar water bath filled with deionized water and maintained at 32°C to polymerize for the time specified by the manufacturer plus 2 minutes to insure complete set of the material.

The measurments were made with the use of a Gaetner traveling microscope\*\*\*\* graduated in 0.01 mm. increments with a magnification of 32x (fig. 3). Five samples of each material were evaluated. The specimens were tested at intervals of immediate removal from the bath, one

---

\*\* Ohaus Scale Corporation.

\*\*\* Blue M Electric Company, Blue Island, Il.

\*\*\*\* The Gaetner Scientific Corporation, Chicago, Il.





FIG. 2

The die with the glass and cellophane held together with the "c" clamp in the mouth simulator.

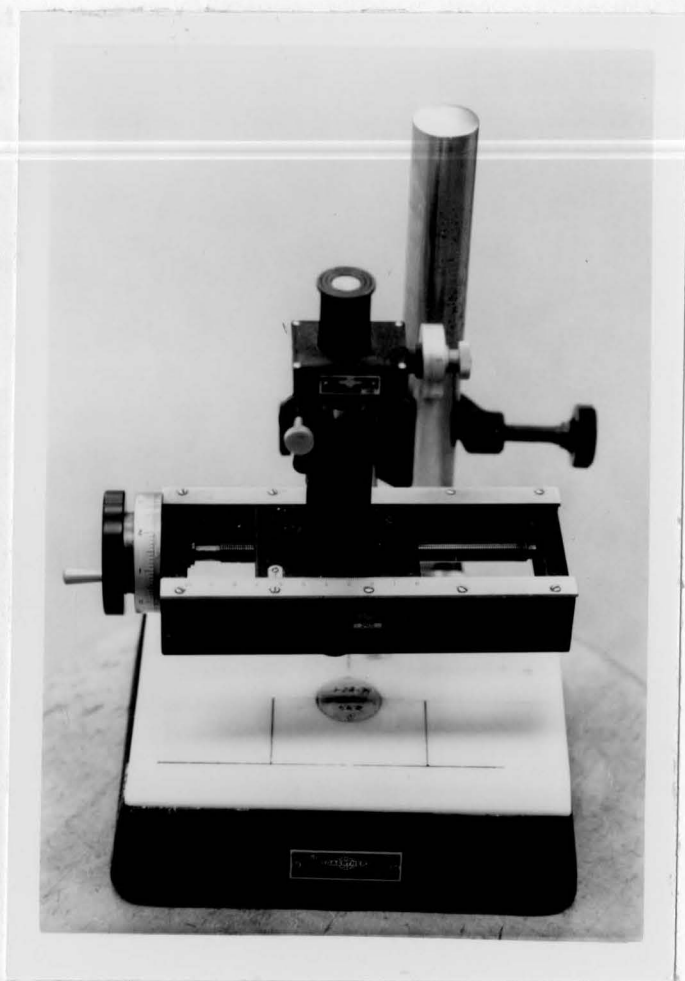


FIG. 3

Gaetner traveling microscope

hour, 24 hours, 72 hours and one week after set.

Talc was placed on the base of the microscope to aid in the ease of manipulation while recording of the wash specimens.

Between readings, all specimens were put in a clean box with talc and stored in a dust-free cabinet.

## METHODS AND MATERIALS

### PART II

The second part of this research was to determine the influence of the manufacturer's adhesive and custom tray with the putty material and a thin layer of the wash (0.46 mm). Plexiglas plates  $\frac{1}{4}$  inch thick and 2 inch square were used to simulate an intraoral custom tray.

The surface was roughened with abrasive paper (240 grit SiC) to mimic the surface of clinical custom tray. The manufacturer's adhesive was painted on the trays and allowed to dry for 15 minutes (Davis 1976).

A circular sheet of teflon was placed on the surface of the die as a spacer between the putty material on the custom tray and the surface of the die. The same procedures followed in part I were carried out in this series. The impression materials were carried to the die with the sheet of teflon on the bottom of the die, only this time the Plexiglas custom plates were clamped to the die (fig. 4). A glass slab was again used over the Plexiglas plate so that distortion was not transmitted to the plastic when the clamp was tightened. After the putty material was set the wash material was mixed and placed over the putty material.

The die was placed over the material without the ring to allow the material to flow laterally to the impression. Two lateral aluminum strips were placed as a stop to maintain uniform thickness on the wash material (fig. 5). The same procedures followed in part I were carried out in this series for the polymerization and evaluation of the materials.



FIG. 4

The die with the glass, custom tray  
bonded to the putty material held  
together with a "c" clamp

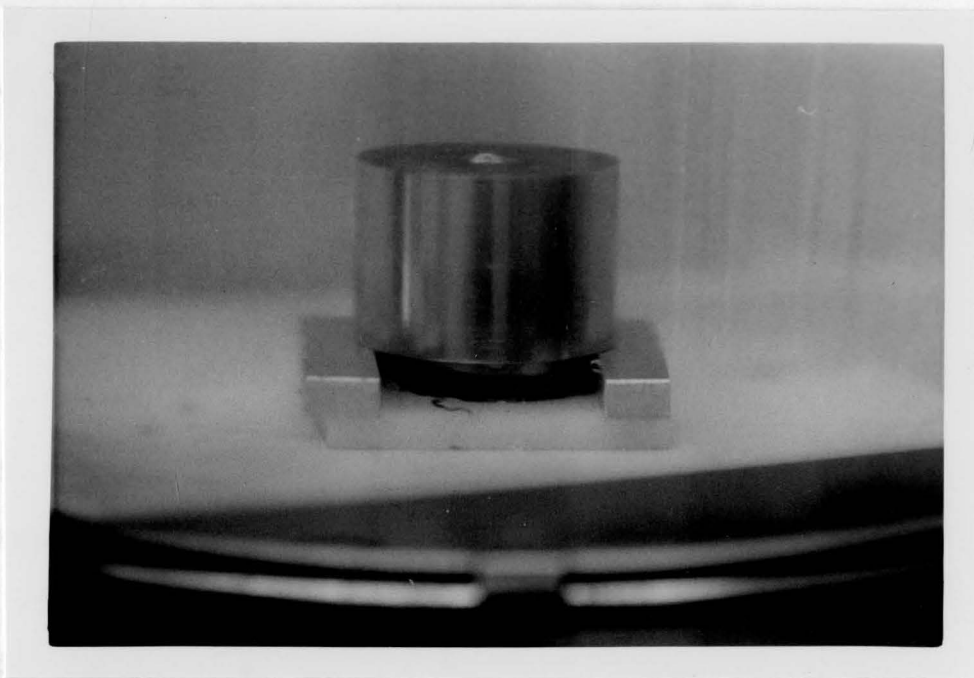


FIG. 5

The die on top of putty-wash impression material bonded to the tray and two lateral stops on the mouth simulator

## CHAPTER IV

### RESULTS

All materials evaluated in this study, were mixed at approximately the same conditions of room temperature and humidity and were allowed to set in a water bath at 32°C.

The five measurements of five samples of each material (of each method) were recorded for statistical analysis. The mean, standard deviation, percentage accuracy compared to the standard die, and percentage dimensional stability for all wash impression materials as a function of time are presented in Table II. Statistical analysis of the data was performed using the Walter Duncan K ratio and T test at 0.05 level of significance.

All wash impression materials, when compared statistically to the standard A.D.A. die, showed a significant difference in respect to immediate accuracy and dimensional stability over all time periods.

The dimensional stability of the materials when compared to the immediate accuracy of the same material, showed significant difference in the three condensation reaction silicones, (Accoe, Citricon, Xantopren).

President, addition reaction silicone was the only one which did not differ significantly between the immediate reading and one hour time period.

Comparison was done to evaluate the dimensional stability of the wash materials between the immediate accuracy up to one week time periods, and the results obtained from this data were that all the mate-

T A B L E 11

STATISTICAL DATA FOR TIME DEPENDENT FUNCTIONS OF ACCURACY AND DIMENSIONAL STABILITY OF SILICONE WASH IMPRESSION MATERIALS COMPARED TO THE MASTER DIE (2.4992 cm).

MATERIAL		TIME (hours)				
		0	1	24	72	168
Accoe	$\bar{x}$	2.4920	2.4885	2.4848	2.4843	2.4841
	s	0.0033	0.0037	0.0041	0.0032	0.0033
	a	0.28	0.42	0.57	0.59	0.60
	S	-	0.14	0.28	0.30	0.31
Citricon	$\bar{x}$	2.4923	2.4870	2.4813	2.4806	2.4828
	s	0.0007	0.001	0.001	0.001	0.001
	a	0.23	0.48	0.71	0.74	0.65
	S	-	0.21	0.44	0.46	0.38
Xantopren	$\bar{x}$	2.4932	2.4901	2.4807	2.4794	2.4769
	s	0.0007	0.001	0.002	0.001	0.003
	a	0.24	0.36	0.74	0.79	0.89
	S	-	0.12	0.50	0.55	0.65
President	$\bar{x}$	2.4940	2.4940	2.4918	2.4923	2.4924
	s	0.001	0.001	0.001	0.001	0.001
	a	0.20	0.20	0.29	0.27	0.27
	S	-	0.0	0.08	0.06	0.06

$\bar{x}$  = mean specimen dimensions

s = standard deviation

a = percentage of accuracy (compared to standard die).

S = percentage of dimensional stability (compared to immediate value).



rials after one hour were statistically differente from the immediate accuracy.

President was the only one which appeared to be close to the immediate accuracy at each time period.

The percentage accuracy (compared to the A.D.A. standard die ) as a function of time for each individual wash impression material has been plotted and is presented in Fig. 6.

The accuracy of all wash materials evaluated was improved significantly when the adhesive and a custom tray were bonded to the putty and a thin layer of wash impression material was used.

The mean, standard deviation, percentage accuracy and dimensional stability of each putty wash system, as a function of time, are presented in Table III.

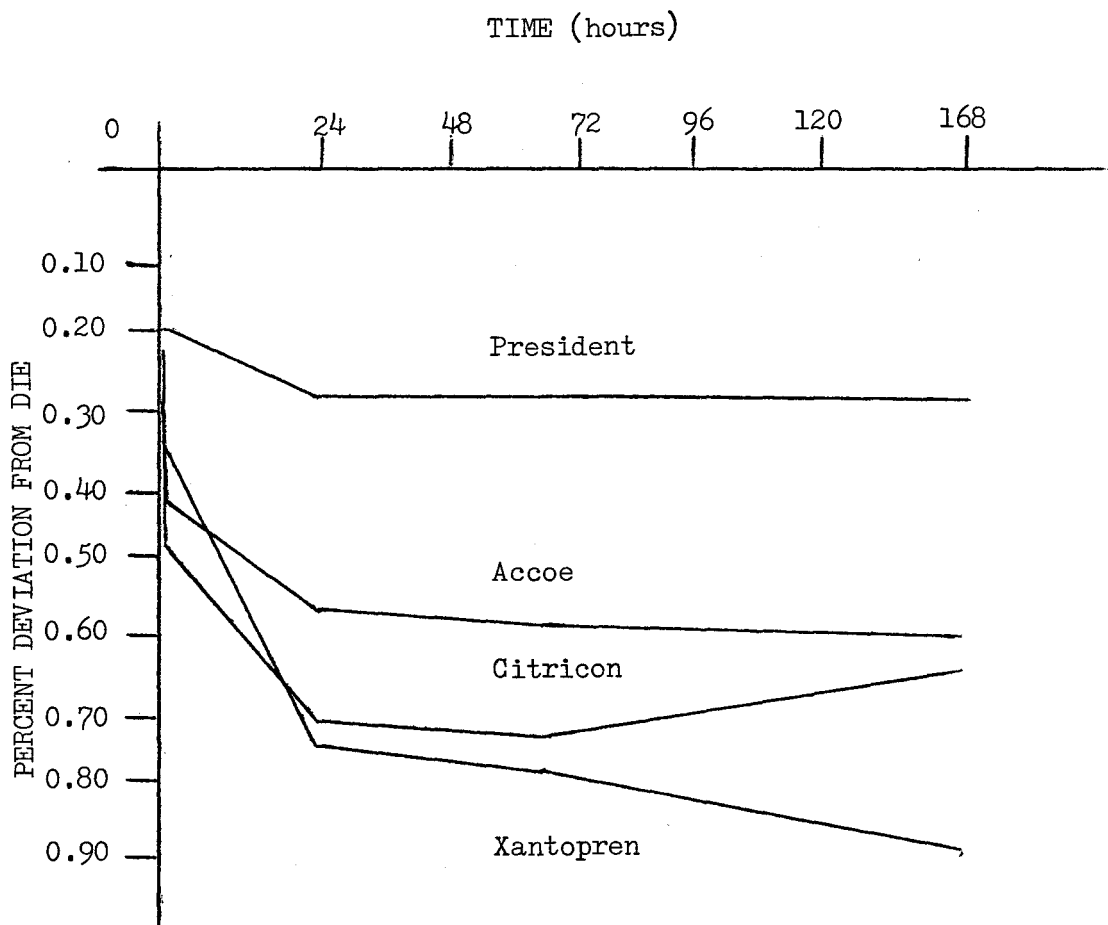
The means of five readings of five samples of each of four brands at each time period were statistically analyzed.

All putty-wash systems, when compared statistically to the standard A.D.A. die, showed a significant difference in respect to accuracy and dimensional stability over all time periods.

The same results were obtained when all time periods were compared to the immediate accuracy of the putty-wash systems.

All putty-wash systems, when compared statistically to each other, showed a significant difference in accuracy and dimensional stability over all time periods from President and the condensation polymerization silicones ( Accoe, Citricon, Optosil & Xantopren ).

FIG. 6



Graphical comparison of all wash materials evaluated.

T A B L E III

STATISTICAL DATA FOR TIME DEPENDENT FUNCTIONS OF ACCURACY AND  
 DIMENSIONAL STABILITY OF SILICONE PUTTY-WASH IMPRESSION  
 MATERIALS COMPARED TO THE MASTER DIE (2.4992 cm.)

TIME (hours )

MATERIAL		0	1	24	72	168
ACGOE	$\bar{x}$	2.4981	2.4958	2.4880	2.4864	2.4844
	s	0.0005	0.0005	0.001	0.0004	0.0009
	a	0.04	0.13	0.44	0.51	0.59
	S	-	0.09	0.40	0.46	0.54
CITRICON	$\bar{x}$	2.4979	2.4964	2.4894	2.4870	2.4856
	s	0.0003	0.0008	0.003	0.003	0.002
	a	0.05	0.15	0.39	0.48	0.54
	S	-	0.10	0.34	0.43	0.49
OPTOSIL XANTOPREN	$\bar{x}$	2.4988	2.4964	2.4933	2.4941	2.4915
	s	0.0005	0.0007	0.001	0.001	0.001
	a	0.016	0.11	0.23	0.20	0.30
	S	-	0.09	0.22	0.18	0.29
PRESIDENT	$\bar{x}$	2.4986	2.4966	2.4956	2.4937	2.4898
	s	0.0003	0.0006	0.001	0.001	0.001
	a	0.02	0.10	0.14	0.22	0.37
	S	-	0.08	0.12	0.19	0.35

$\bar{x}$  = mean specimen dimensions

s = standard deviation

a = percentage of accuracy (compared to standard die).

S = percentage of dimensional stability (compared to immediate value).

President seemed to be more dimensionally stable after one hour of removal from the mouth simulator and up to one week thereafter.

The percentage accuracy, compared to the A.D.A. die, as a function of time for each individual putty-wash impression material, has been plotted and is presented in Fig. 7.

The percentage accuracy (compared to standard die) as a function of time for each individual wash and putty-wash impression material, has been plotted and is presented in figures 8 thru 11.

The immediate accuracy and dimensional stability over a period of one week had improved considerably when a custom tray was employed and the putty and wash were used together in all the materials tested in this study.

FIG. 7

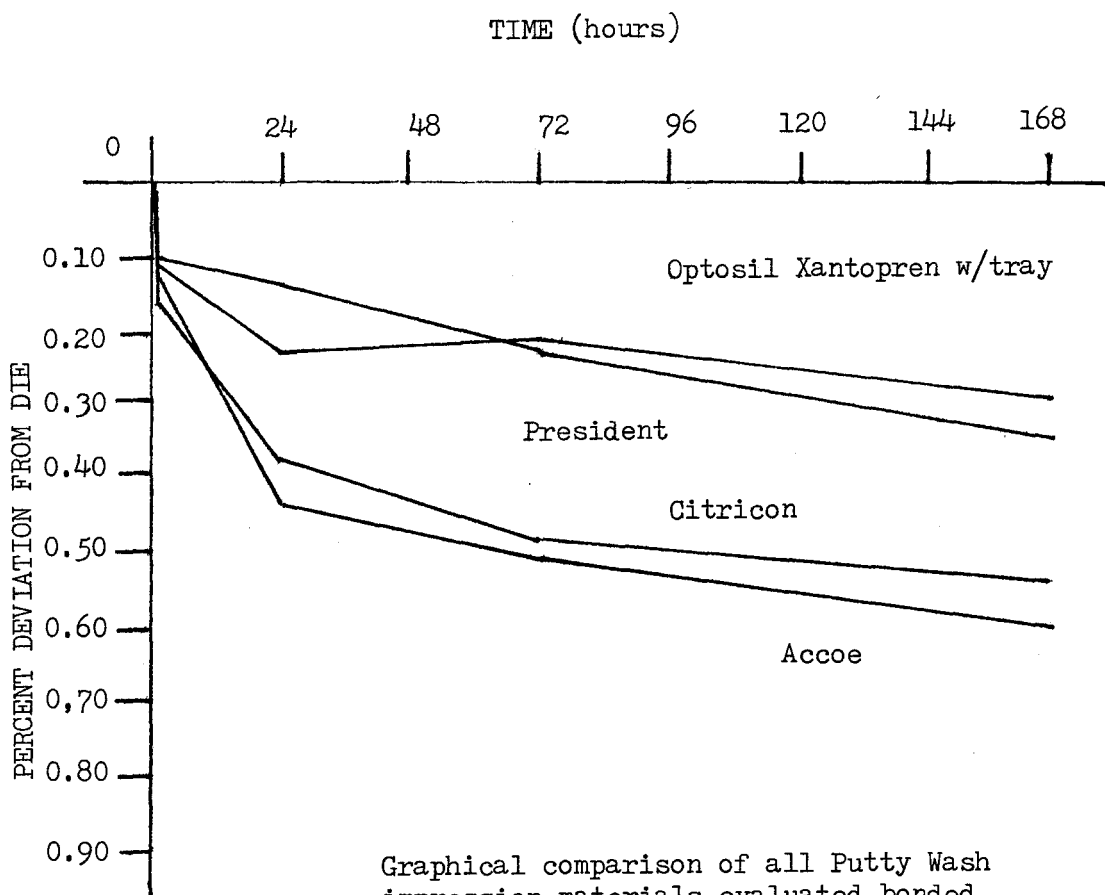


FIG. 8

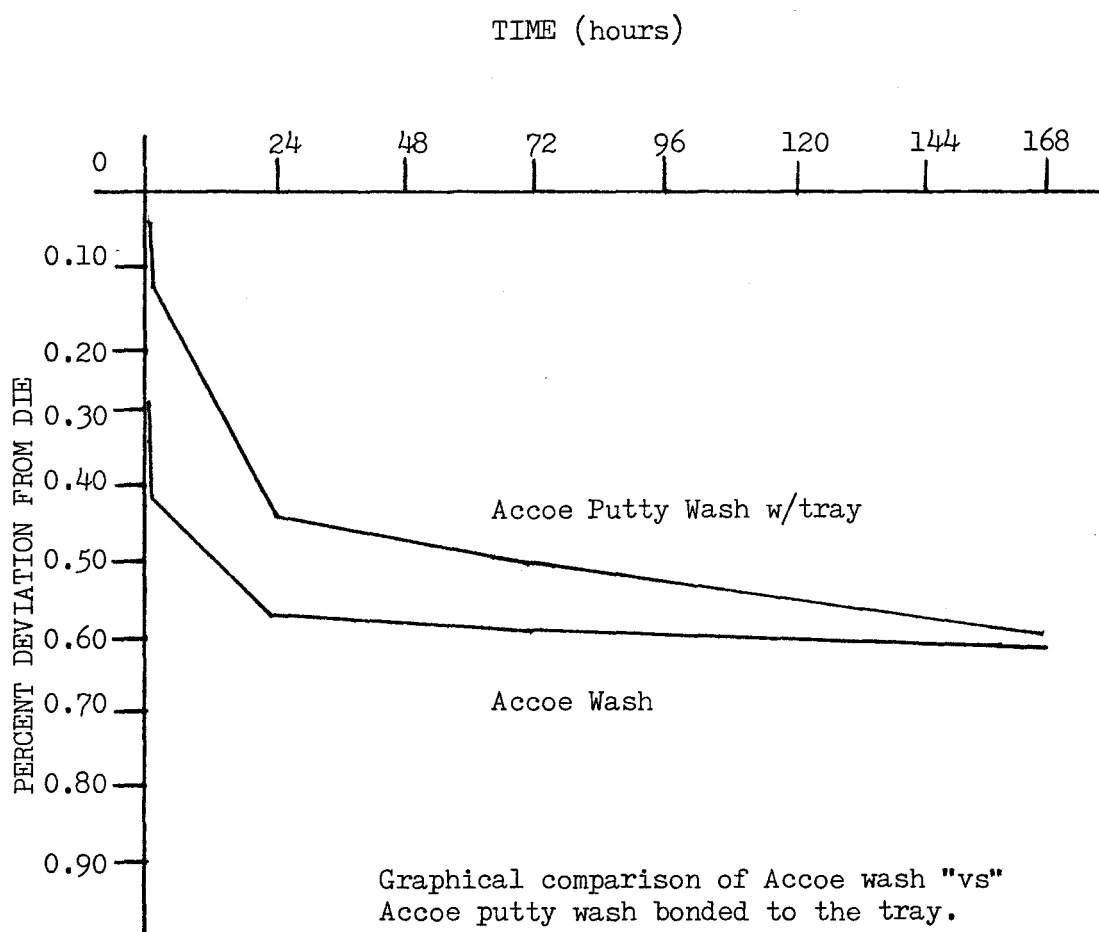


FIG. 9

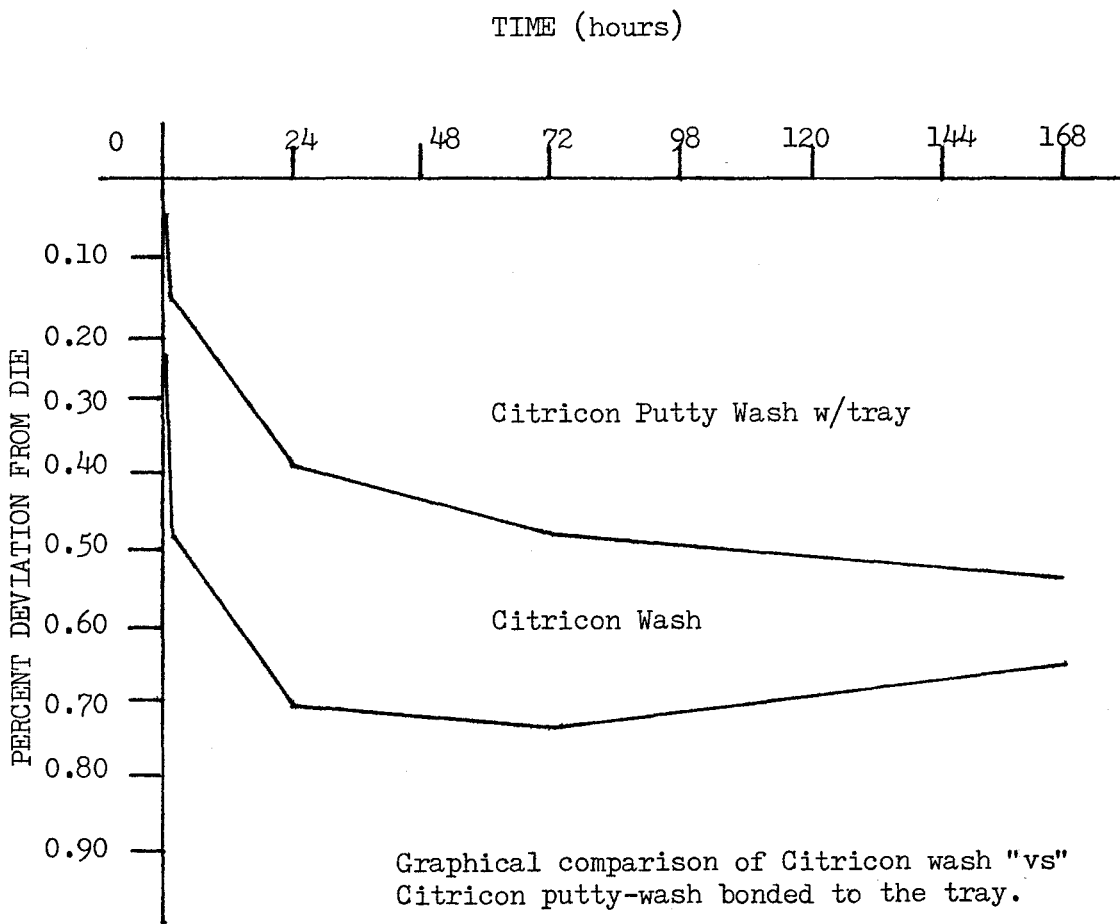


FIG. 10

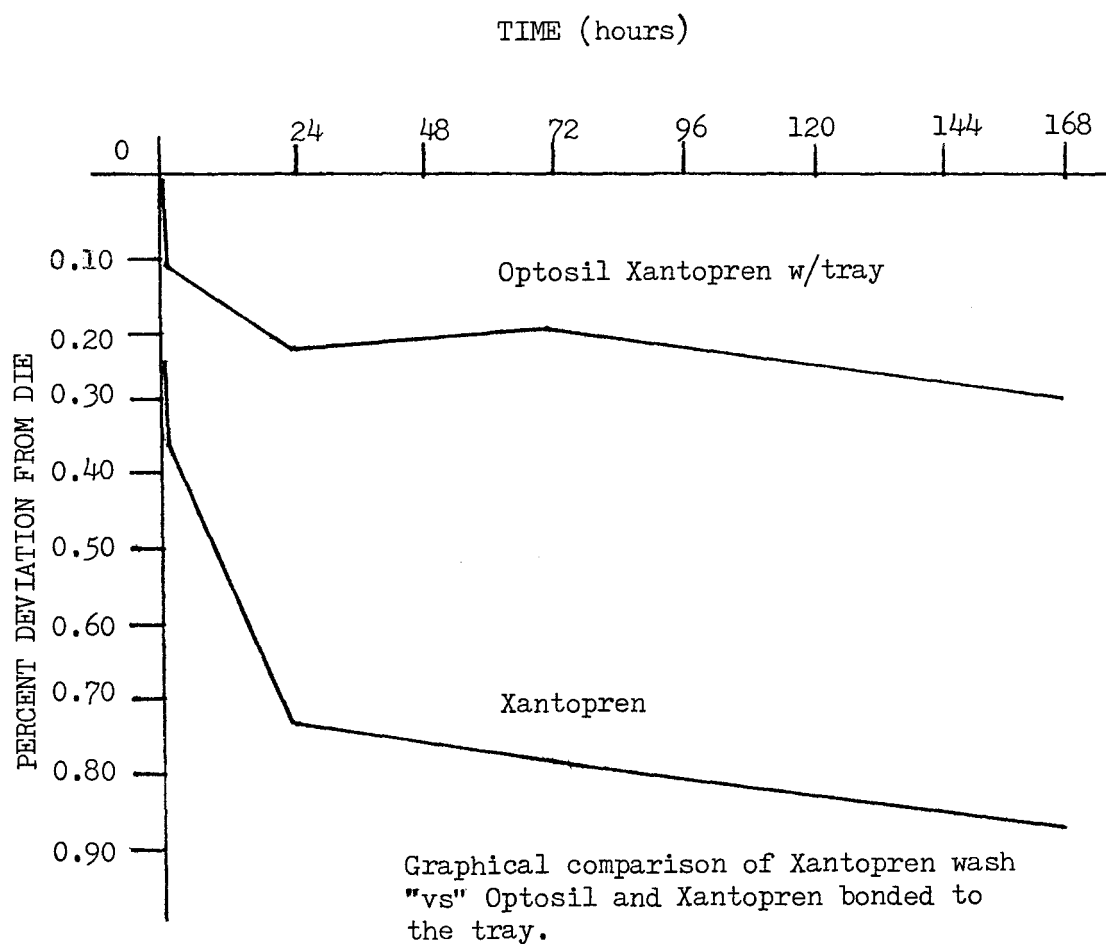
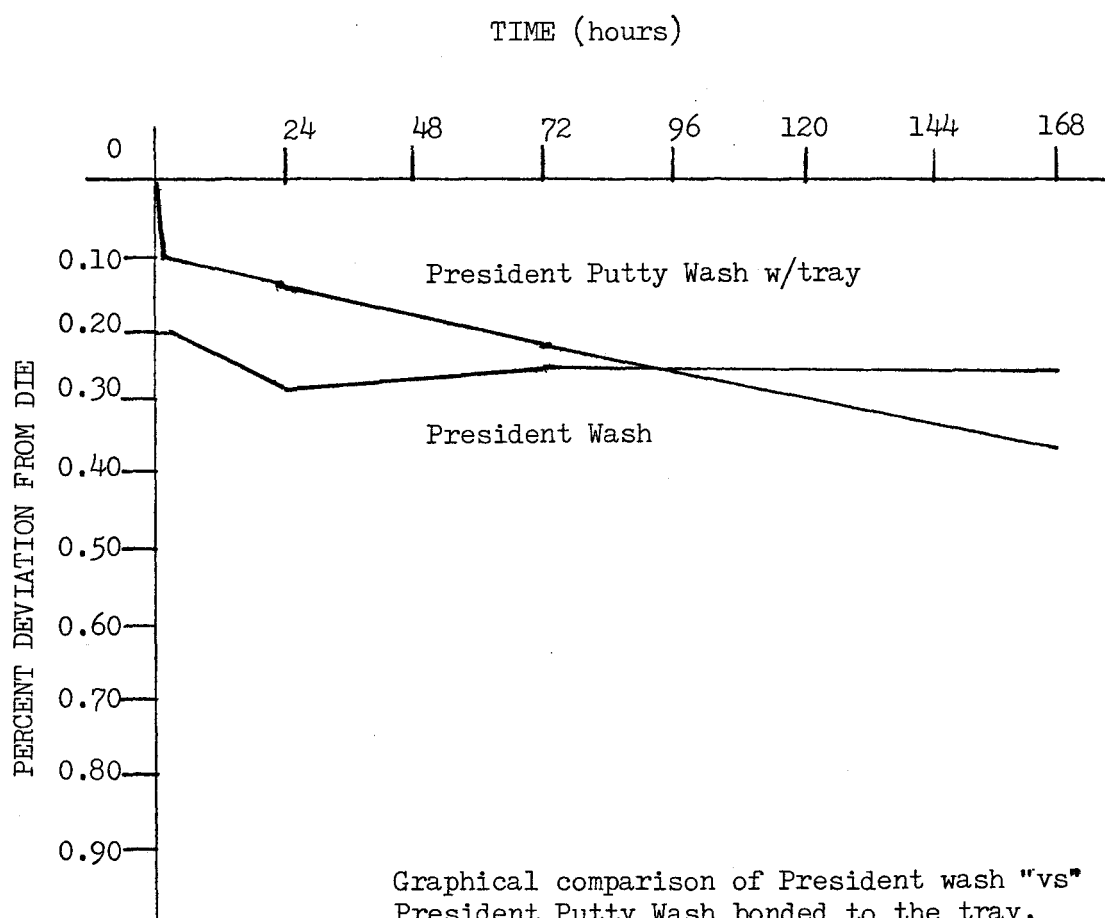




FIG. 11



## CHAPTER V

## DISCUSSION

The purpose of this study was to compare the accuracy and dimensional stability of four putty-wash silicone dental impression materials listed on Table I.

A round die (A.D.A. specification) was used to evaluate these materials. All materials were weighed and mixed according to the manufacturer's specifications. The mixed materials were then placed in a mouth simulator at 32°C, which is considered the approximate mouth temperature during taking of the impression. (A.D.A. specifications # 19).

All materials were measured at different time periods; namely from the moment they were removed from the mouth simulator until one week later, at staggered time intervals.

This research was divided in two parts:

1. Wash impression materials were evaluated according to the specifications described above.
2. Impression materials were evaluated in a custom tray. The putty like material was bonded to the tray with the use of an adhesive. A thin (0.46 mm) layer of wash impression material was used.

The methodology for this research was described in detail in Methods and Materials.

Table II represents the mean, standard deviation, percentage accuracy and percentage dimensional stability of all wash impression mate-

rial samples.

Table III shows the mean, standard deviation, percentage of accuracy, and percentage of dimensional stability of all samples obtained with the use of a tray and the putty-wash system.

Of significant notation was the fact the addition reaction silicone (President) was statistically superior to all other silicones tested. Those findings have been supported by Craig (1977) and Ciesco (1978).

It is noteworthy, when the putty was bonded to the tray and a thin layer of wash was used, the accuracy and dimension stability was significantly improved at 0.05 level of significance in all the materials tested.

The positive influence in accuracy and dimensional stability of the adhesive and the tray in elastomeric impression materials, has been supported by Phillips (1962), Davis (1976) and Ciesco (1978). These investigators agreed that it was important to apply the adhesive on the tray at least 15 minutes prior to making the impression. It was equally important to roughen the surface of the tray to increase the bond strenght between the tray and the impression material.

These precautions were believed to be of tremendous value in holding the impression material static during manipulation. This prevented excessive alteration in the dimensional stability of the material.

The increased accuracy and dimensional stability of the putty-wash system can be attributed also to the thin layer of wash impression material by itself. This again has been supported by several authors.

(Reisbick 1975, Mansfield & Wilson 1975, Craig 1977,1978, Obrien & Riege 1978). They, in turn agreed with this study to the increased accuracy and dimensional stability when heavy filler silicones (putty-like) were used in conjunction with a thin layer of wash.

All materials tested were accurate if they were measured immediately after mixing. From these findings the assumption can be made: if care is taken in preparing materials to be used in impression taking and if the manufacturer's directions are followed, all impression materials would yield similar results when they were poured immediately. In this study President was significantly superior in accuracy and dimensional stability if measurements were taken after one hour. This could be due to the absence of by-products in the addition reaction silicone, which evaporates and causes the impression material to shrink in the condensation reaction silicones (Accoe, Citricon, Optosil & Xantopren).

The manufacturer's setting times were found to be insufficient, so additional time for setting was advocated to insure a greater measure of success and more complete polymerization of all the materials. Principally with Accoe, due to the manufacturer's specifications to polymerized this material at 37°C.

Shortcomings of this experiment were the use of a traveling microscope which could introduce some error in the data, and was left to the researcher's ability and interpretation. This research was done simulating mouth conditions and impression techniques as close as possible to a clinical situation. The size and form of the impression material

samples were all the same; situation that is very rare to obtain in real clinical conditions.

The most important clinical implication could be the use of a tray bonded to the putty material and a very thin layer of wash, and the fact that all materials should be poured immediately. If this were followed, all impressions regardless of the material used, yielded superior results. If for any reason, prolonged storage before pouring the impression is necessary, the use of President, addition polymerization silicone would be the elastomer of choice.

Finally due to sample size and number of observations, no permanent conclusion can be established. Further research is necessary to compare different addition reaction silicones as well as to compare those materials with other kinds of impression materials such as polyethers and polysulfides. Further research in this matter is necessary.

## CHAPTER VI

### CONCLUSIONS

A total of four silicone elastomeric impression materials were evaluated. Three condensation polymerization and one addition reaction polymerization type.

Two techniques were studied; all materials were evaluated initially without using a tray and a putty like material. A second evaluation was performed using putty material bonded to a tray and a thin layer of wash. Both techniques were statistically evaluated.

1. All materials evaluated using a putty-wash system bonded to a custom tray, consistently demonstrated superior results in comparison to those tested without the putty material and the tray.
2. There was no appreciable difference between the materials when compared immediately after initial set using a putty-wash system with the tray.
3. Of the four materials evaluated, President addition reaction silicone was the most accurate and dimensionally stable when it was evaluated with the putty material and the tray or when it was evaluated alone.

## BIBLIOGRAPHY

- Anderson, J.N. 1958. "The Dimensional Stability of Three Silicone Base Impression Materials". *Dent. Pract. Dent. Res.* 8:368-372.
- Brown, D. 1973. "Factors Affecting the Dimensional Stability of Elastomeric Impression Materials". *Journ. Dent.* 1:265-274.
- Ciesco, J.N. 1978. "A Comparison of the Accuracy and Dimensional Stability of Five Elastomeric Impression Materials" Thesis for M.S. Loyola University of Chicago.
- Combe, E.C. 1975. "Notes of Dental Materials". Second Ed. Churchill Livingston.
- Craig, R.G. 1977. "A Review of Properties of Rubber Impression Materials". *Journ. of Mich. Dent. Association.* Vol. 59: 254-260.
- Craig, R.G. 1978. "Dental Materials, A Problem Oriented Approach" C.V. Mosby. 90-101.
- Custer, F. Updegrove, B.A. and Wars, M. 1964. "Accuracy and Dimensional Stability of a Silicone Rubber Base Impression Material". *Journ. Prosth. Dent.* 1115-1121.
- Davis, G.B. Moser, J.B. Brinsden, G.I. 1976. "The Bonding Properties of Elastomer Tray Adhesives". *Journ. Prosth. Dent.* 36:278-285.
- Eberle, W.R. 1959. "Comparative Dimensional Stability and Versatility of Rubber Base Impression Materials". *Dent. Dig.* 65:536-541.
- Gilmore, W.H. Schnell, R.J. and Phillips, R.W. 1959. "Factors Influencing the Accuracy of Silicone Impression Materials." *Journ. Prosth. Dent.* 9:304-314.
- Kaloyannides, T.M. Christidon, L. 1975. "Elasticity of Impression Materials. IV Permanent Deformation as a Function of Time" *Journ. Dent, Res.* 54: 168-173.
- Kaloyannides, T.M. Kapari, D.J. 1974. "Mixture of Elastomer Impression Materials". *Journ. Dent. Res.* 53:809-813.
- Lacy, A.M. Bellman, T. and Jendresen, M.D. 1978. "Time Dependent Accuracy of Elastomeric Impression Materials". *Abstr. No* 36:83.

- Mansfield, M.A. Wilson, H.J. 1975. "Elastomeric Impression Materials: A Method for Determining Dimensional Stability". Br. Dent. Journ. 139: 267-272.
- McLean, J.W. 1958. "Silicone Impression Materials". Br. Dent. Journ. 104: 441-445.
- Myers, G.E. and Peyton, F.A. 1959. "Clinical Evaluation and Physical Studies of the Silicone Rubber Impression Materials". Journ. Prosth. Dent. 9: 315-324.
- O'Brien and Ryege. 1978. "An Outline of Dental Materials". W.B. Saunders. 122-136.
- Phillips, R.W. 1962. "Elastic Impression Materials: A Fourth Report". Journ. Calif. Dent. Association. 30: 19-20.
- Phillips, R.W. 1968. "Physical Properties and Manipulation of Rubber Base Impression Materials", Journ. Ont. Dent. Association. 45: 236-239.
- Phillips, R.W. 1973. "Skinner's Science of Dental Materials". W.B. Saunders. Co.
- Reisbick, M.H. and Matyas, J. 1975. "The Accuracy of High Filled Elastomeric Impression Materials". Journ. Prosth. Dent. 67-72.
- Reisbick, M.H. 1973. "Effect of Viscosity on the Accuracy and Stability of Elastic Impression Materials". Journ. Dent. Res. 52: 407-417.
- Rubenstein, C.W. Fairhurst, C.W. and Ryege, G. 1960. "A Comparative Study of Silicone Impression Materials". Journ. Dent. Res. 39: 766.
- Sawyer, H.F. Dilts, W.E. Aubrey, M.E. and Neiman, R. 1974. "Accuracy of Casts Produced From Three Classes of Elastomer Impression Materials". J.A.D.A. 89: 644-648.
- Skinner, E.W. 1958. "The Properties and Manipulation of Mercaptan Base and Silicone Base Impression Material". Dent. Clin North. Amer. 685-697.



APPROVAL SHEET

The thesis submitted by Rafael Cherem Amkie has been read and approved by the following committee:

Dr. James L. Sandrik, Director  
Assistant Professor, Dental Materials, Loyola

Dr. William F. Malone  
Director of Post Graduate Prosthodontics, Loyola

Mrs. Marie Feng  
Assistant Professor, Dental Materials, Loyola

The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the thesis is now given final approval by the Committee with reference to content and form.

The thesis is therefore accepted in partial fulfillment of the requirements for the degree of Master of Science.

Date

April 4, 1979

Director's Signature

James L. Sandrik