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The Accuracy of Elastic Impression Materials

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THE ACCURACY OF ELASTIC IMPRESSION MATERIALS

by

Manuel Perez-Alvarez

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

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DEDICATION

To my mother and father, Ofelia and Manuel, for offering the greatest support and encouragement throughout my first twenty-seven years of life and making me what I am.

To my wife Silvia, for her love, devotion and patience.

To my sister Guadalupe and my brothers, Carlos and Fernando.

AUTOBIOGRAPHY

Manuel Perez-Alvarez was born on May 17, 1949, in Mexico D.F. Mexico to Manuel Perez-Negrete and Ofelia Alvarez Ramos. He was the first of four children, having one sister, Guadalupe and two brothers, Carlos and Fernando.

In 1970, he graduated from Academia Hispano Mexicana. He began his formal dental studies at the Universidad Tecnologica de Mexico in 1970, and graduated in 1974 with a Doctor of Dental Surgery degree.

His graduate studies began in the Department of Oral Biology of Loyola University School of Dentistry, Chicago College of Dental Surgery, in 1974. Specialty training was in the Department of Fixed Prosthodontics under the Director of Graduate Fixed Prosthodontics, Dr. William F. Malone.

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CHAPTER I

INTRODUCTION

Wax as a dental impression material has been used in Dentistry since the eighteenth century.

Plaster and modeling compound have also been reported early in the dental literature as impression materials. Some years later in the mid 1920's, agar hydrocolloid impression material was introduced as the first elastic impression material. Plaster and modeling compound are not elastic and do not permit the registration of undercut areas in the mouth. These materials also have other undesirable properties. Plaster has to be fractured to be removed from the mouth and later reassembled for a complete impression, whereas modeling compound has never possessed sufficient accuracy for acceptable multiple cast restorations.

The introduction of agar hydrocolloid was a great contribution to dentistry and this versatile material has been used for impressions of preparations from 1925 to the present time.

During the early 1940's alginate was introduced as a new hydrocolloid. It was called alginate. Alginates are a combination of water and powder that was mixed and results in an irreversible gel. Agar and alginate were well accepted by the profession as elastic impression materials.

Both agar and alginate are currently used extensively in dentistry but possess obvious disadvantages. The principle disadvantage is that they lose water upon standing, and rapidly undergo dimensional changes.

During the 1950's another group of materials called elastomers were developed. The first and most popular was polysulfide rubber. The silicones were developed in the later 1950's and possessed an improved odor and color. The most recent elastomer is the polyether. These types of elastomers are excellent but nevertheless many controversies in the literature can be observed concerning viscosity, permanent deformation, and elasticity. Their increased accuracy has been studied by many authors. The accuracy of polyether type elastomers will be the subject of this investigation. Other impression materials commonly used in dentistry will be used as a comparison, namely silicones and polysulfides rubbers.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

Ever since the dental profession started to preserve the natural dentition by placing restorations from the indirect method, the necessity for an ideal impression material was the object of intense research. As a result, much research has been devoted to measuring the accuracy of elastic impression materials. The most significant work in this area since 1966 is reviewed below.

Current Impression Materials

Reisbick¹ stated either high or low viscosity materials produced the same degree of accuracy and stability. In hydrocolloid, polysulfide or silicone, the molar crown preparation was the most sensitive to differences between the materials. Stability after one hour of storage disclosed that elastomers were more stable than agar hydrocolloid and silicones. This was because their rapid rate of physical setting would decrease accuracy and stability due to latent strain release.

Mansfield² believed the silicones have much lower tension set values than polysulfides. Silicone materials showed less dimensional change than polysulfide as the duration of the strain and the manipulation period was increased.

Schwindling³ stated the linear changes of a silicone impression material were critical for a period of 48 hours.

In additional investigations he showed the contraction values of the impression material which results from controlled preheating (after various storage times) can be reversed. Thus it is possible to obtain more accurate models if you control and monitor the temperature.

Chong⁴ preferred the polysulfide material because it possessed a slightly longer working time than the silicones and the polyether products. However, the silicone and polyether were obviously set much quicker than the polysulfides. Silicones and polyether products were shown to set in almost 1/2 the time than the polysulfides. However, in the dimensional stability, all the samples listed had undergone a contraction during the setting of the bulk of the materials. This was particularly true for the polysulfides changes which occurred within the first 30 minutes. It was noteworthy that while most of the contractions in polysulfide impressions had taken place almost immediately after setting, there remained some dimensional change evident up to 24 hours. In addition there was still some changes after 72 hours although these were not very significant in proportion to earlier dimensional changes. In regard to permanent deformation, silicone and polyether materials are more favorable than the polysulfides. However the dimensional stability for the polysulfides and polyether material consistently exhibited less change than the silicones.

Combe⁵ believed the polysulfides, in general, could be recognized as an accurate and easily manipulated impression material capable of reproducing fine detail. Dimensional inaccuracies can occur through

polymerization and thermal shrinkage although polysulfides are dimensionally more stable than most other impression materials. The silicones are recognized as being less stable dimensionally than polysulfides because the alcohol formed as a by-product of the setting reaction lost during evaporation. This could result in a volumetric shrinkage of 0.8 percent. Polyethers on the other hand, have water absorbant properties. However, the expansion associated with this absorption appears to be offset by the extraction of water-miscible material from the rubber. The polyether still possessed better dimensional stability than the other elastomers.

Ferguson⁶ took 250 thiokol impressions. These were inspected under magnification. A surprising finding was none of the impressions were entirely free of bubbles. Nevertheless, the percentage that caused demonstrable inaccuracy was relatively small; roughly about 6%.

Inspection under magnification also revealed rounded depressions in the surfaces of the dies. These irregularities would be a source of corresponding protuberances on the interior surfaces of the crowns causing the cast restorations to be inaccurate.

Thiokol impressions sectioned in the corresponding area also had bubbles close to the surface, which had obviously expanded, displacing a thin wall of impression material inward against the die. Air bubbles, in most of the impressions were elongated in the direction of the flow lines of the impression materials. This suggests that the bubbles were under stress in this direction. As a result air bubbles were considered

to be a direct factor in the distortion of any rubber impression.

Brown⁷ suggested the dimensional accuracy he observed was due to the lead-dioxide-cure polysulfide impression material and the polyethers are least affected by the strain accompanying their withdrawal from undercut regions. Polyethers and polysulfide also showed that during storage, if this is necessary after the impression has been taken, the lead-dioxide-cured polysulfides are the least susceptible to both water absorption and solvent loss where as the polyether must be kept dry if it is to retain it's accuracy. The silicone polymers and the hydrocolloid materials do not maintain their accuracy during long storage.

Ellam⁸ reported the strength of the adhesive bond obtained with two polysulfides impression materials on cold curing acrylic special tray material. The strength in tension and shear was also measured. Scania rubber base and Kerr's permalastic were chosen because their adhesives appeared to possess different properties. The latter gave superior bonding probably because of lower mobility of the adhesive.

Observations were also made on the rigidity of the composition at mouth temperature and the setting characteristics of the polysulfides.

Hannah⁹ reported all polysulfide impression materials gave satisfactory results up to and including 24 hours after the impression, before pouring in Vel-mix stone.

In some cases errors became apparent at 48 hours. The minimum bulk of material supported by a rigid tray is considered to limit distortion caused by continuing polymerization.

The silicone elastomers were found to be less reliable clinically. More satisfactory results were obtained with silicones after standing for one hour before pouring models. The most interesting observation was that the relatively rigid polyether material gave consistently better results than all other impression material tested.

Bell¹⁰ believed all impression materials were more accurate if they had an increase of 50 per cent over the setting times recommended by the manufacturers. Custom trays are preferable to stock trays and should be used wherever possible. The trays should provide as uniform a thickness of impression materials as possible. A thickness of about 2-4 mm appears to be the optimum. The special tray should be rigid and not susceptible to distortion. Ideally, the impression should be kept for about 30 minutes to permit elastic recovery to occur and then be poured. This is particularly important for the silicone materials. If delay is unavoidable the polyether material would appear to be the most stable over long periods provided that it is stored under dry conditions.

There appears to be little difference between the use of double mix and the reline techniques. Second pour casts are always less accurate than the first cast no matter which technique is used. The second cast should only be used for purposes other than accuracy. The margins of crowns should be carefully finished on the first die.

High humidity or water contamination of the unset material accelerates setting. The effect of ambient and storage humidity on the accuracy of the impression does affect the set material. This is an important factor in the accuracy of the stone models, particularly if the

impression has been kept for some time before drying. In conditions of high humidity, the material of choice would appear to be those of the lead-dioxide-cured polysulfide group. Polyether impressions should never be stored in conditions of high humidity.

It must be remembered that if impressions are stored in a sealed plastic bag and any moisture is present, high humidity conditions can develop rapidly. Polyether impressions should never be placed in any sealed container.

Storage of the silicone material in damp conditions appears to prevent the loss of volatile constituents and the polymerization shrinkage is more than compensated for by the water absorbed. Extremes of humidity are to be avoided by storage in dry conditons.

Sawyer¹¹ conducted an investigation to determine the comparative accuracy of stone casts produced from nine different elastomeric impression materials. Five impressions of each material were made and poured in a die stone. Each impression was permitted to set for 15 minutes without pressure at 38°C and was then poured in die stone. Another series of five impressions in a polyether rubber were made but the dies were poured one week after the impressions were made. Each stone cast was measured in both horizontal and vertical dimensions and mean deviations from the master die for each group were then calculated. In all instances the most accurate casts were produced from the polyether impression elastomers. The next most accurate die measured were from the silicone impression elastomers. The measurements of the cast pro-

duced from the polyether impressions which were poured one week later, varied only slightly from those poured immediately.

Sawyer¹² reported an optimum time for mercaptan rubber base to polymerize before removal of an impression. A stainless die was constructed for comparative measurements of horizontal and vertical dimensions to .0001 inch. Forty die stone casts were produced from mercaptan rubber impressions which had set on the master die for varying periods of time. Horizontal and vertical deviations from the master die for each set of casts were determined. Results demonstrated the die stone cast produced from which had set 15 minutes after insertion on the master steel die, was the most accurate reproduction.

Sawyer¹³ showed that the investigation was conducted to determine the comparative accuracy of stone dies produced from seven different rubber impression materials. Five stone casts were produced from each impression material. Each impression was permitted to set for 15 minutes without pressure at 38°C and was immediately poured in die stone. Horizontal and vertical dimensions for each die stone cast were measured and mean deviations from the master die for each study group were calculated. The most accurate casts were produced from the polyether material and the second most accurate casts were produced from a nonlead peroxide-material.

Goldberg¹⁴ also worked with this problem and showed the characteristics of the viscoelastic properties of nine polysulfide silicone and polyether impression materials. These materials demonstrated linear viscoelastic behavior during deformation. All three components of de-

formation were studied; instantaneous elastic, retarded elastic, and viscous flow. A decrease during continued polymerization and cross linkage of the materials were demonstrated. Permanent deformation in these materials was a result of lack of recovery of the elastic components of deformation as well as viscous flow.

The polyether material and one silicone material most closely approach ideal elastic behavior, this characteristic is desirable for it minimizes dimensional change due to stresses encountered during handling, shipping and storage of the impression. The silicone materials in general exhibit less belated elastic deformation than the polysulfide materials.

Craig¹⁵ reported the dimensional stability of polyethers is intermediate to the values for silicone and polysulfide but the 24 hour value of 0.30% is much closer to that of 0.25% for the regular-bodied polysulfide rubber. The stability of the polyether impressions in water is not as reliable as the silicones or polysulfides so electro plating is not recommended for materials available at this time. The viscosity of the mixes can be reduced by the use of thinners, which are sometimes recommended when impressions for edentulous areas are to be made. The incorporation of thinners however, retards the setting reaction and alters the mechanical properties.

Combe¹⁶ reported there is a small contraction on setting of these elastic materials (silicone, polysulfide, polyether) due to polymerization shrinkage. Contraction also occurred on cooling the impression from mouth to room temperature. The coefficient of thermal expansion of these

materials resulted in this order, polyether>silicone>polysulfide. The magnitude of the thermal shrinkage is reduced by the adhesion of the material to the tray. On storage a small contraction can occur due to further polymerization shrinkage and evaporation of volatile constituents. Silicones may show a slightly greater shrinkage than the polysulfides.

Pfannenstiel¹⁷ compared polysulfides, polyether, and silicone and showed the polyether impression material (Impregum) to be superior. However, using a rigid tray and following the manufacturer's instructions accurately are recommended. The products used most frequently served as the test material test pieces measured 50 x 8 x 3 mm. A precise optical method was used to make three measurements of each specimen. Measurements were made at 15 and 30 minutes, 1,2,3,4,5,6, and 24 hours and 3 and 8 days. The polyether base (Impregum) showed the best dimension stability.

Stackhouse¹⁸ made laboratory tests. His method was used to measure stone dies made from four rubber elastomers (three silicones and one polysulfide). Dies obtained at different impression bench set times demonstrated the dimensional changes of the elastomers during aging. The subsequently poured stone dies seemed to indicate that hourly dimensional changes of the elastomers were greater than specified by A.D.A. specification 19. Generally more uniform dies were produced from the silicone impression material than from the mercaptan rubber base.

Phillips¹⁹ showed there are a number of sources of dimensional change. All rubbers contract slightly during curing as has been seen

during setting, the silicone rubbers lose alcohol and this is accompanied by a shrinkage. Similarly, the loss of volatile accelerator components causes a marked contraction in hydroperoxide polysulfide rubbers, although both silicone and polysulfide rubbers are water-repellent, the polyether polymers absorb water, a process complicated further by the simultaneous extraction of the water-soluble plasticizer. This results in dimensional changes if such materials are exposed to water for a prolonged period of time. There is usually incomplete recovery after deformation because of the visco-elastic nature of rubbers.

Hembree²⁰ studied a polyether impression material to determine the effect of repouring, washing and using a body modifier on dimensional accuracy. Impressions were made of a stainless steel model utilizing custom trays. Within the conditions of this study it was demonstrated a polyether impression could be poured three times before a dimensional inaccuracy occurred. It was also shown the use of body modifier, relining or washing of the polymerized impressions material had no significant effect on the dimensional stability of the material.

Bell²¹ stated the dimensional changes of four currently used elastomeric impressions materials have been investigated under three different relative humidity conditions. It was found the dimensional changes of these materials could be markedly affected by their storage conditions. Although no material was found to be completely stable, under particular conditions some materials were superior to others. It was also found the curing system used for polysulfide materials profoundly effects their behavior, while the presence of a thinner in a polyether material also

has a strong influence on it's behavior.

Comparison of elastomeric materials at high humidity exhibited a weight gain and most showed a corresponding expansion over the period of 72 hours. Impregum and Impregum plus thinner exhibited the greatest dimensional change due to water uptake at high humidities. The Xantopren/Optosil system absorbed less water than Impregum or Mim.

Comparison of materials in the medium humidity environment showed that the polyether materials Impregum and Impregum plus thinner and lead-dioxide cured polysulfide material Unilastic absorbed water. The silicone materials Xantopren/Optosil and the organic hydroperoxide cured polysulfide Mim both lost weight and distorted giving the most inaccurate stone models after 72 hours.

A comparison of materials in the low humidity environment was studied. All the materials lost weight and shrunk when unrestrained. The result was undersized models. The polyether materials again were the most accurate, followed by the Xantopren/Optosil system (silicone), and Unilastic (lead-dioxide-cured polysulfide).

CHAPTER III

METHODS AND MATERIALS

A total of six different impression materials were tested; two polysulfides, one polysulfide nonlead-cure, two silicones, and one polyether. (Table 1 lists the brand names and manufacturers.) All materials were regular body consistency.

Specimens were prepared for the test at room conditions and 100% humidity, using a new round die. The new apparatus includes only those lines required for detail reproduction and compatibility with gypsum, and provides cross lines which are used for determination of dimensional stability of impression materials (see Fig. 1). The ruled line widths are line "d" $.075 \pm .008$ mm, the line "b" $.020 \pm .004$ mm. Both lines have 90° included angle. The lines "d" are the extreme lines that cross the other three lines. Line "b" is that line in between the three lines. The length of this line is 24.990 mm. Also, the die has a highly polished surface. This eliminates the need for a separator and minimizes cleaning operations which may result in damage to the ruled surface. It also has a ring that will act as a tray or container for dental impression material (Fig. 1,2).

The manufacturers were requested to send fresh materials. All materials were mixed according to manufacturer's instructions. The impression materials were weighed on a cento-o-gram, triple beam ($\pm 0.05g$)

TABLE I

Name and manufacturers of each elastomer

<u>Material</u>	<u>Manufacturers</u>
Permalastic	Kerr, Romulus, Michigan
Coe-Flex	Coe Laboratories Inc., Chicago, Illinois
Impregum	Premier Dental Products Co., Philadelphia, Pa.
Omniflex	Coe Laboratories Inc., Chicago, Illinois
Elasticon	Kerr, Romulus, Michigan
Impredent	Viar Especialidades Químicas, Mexico City

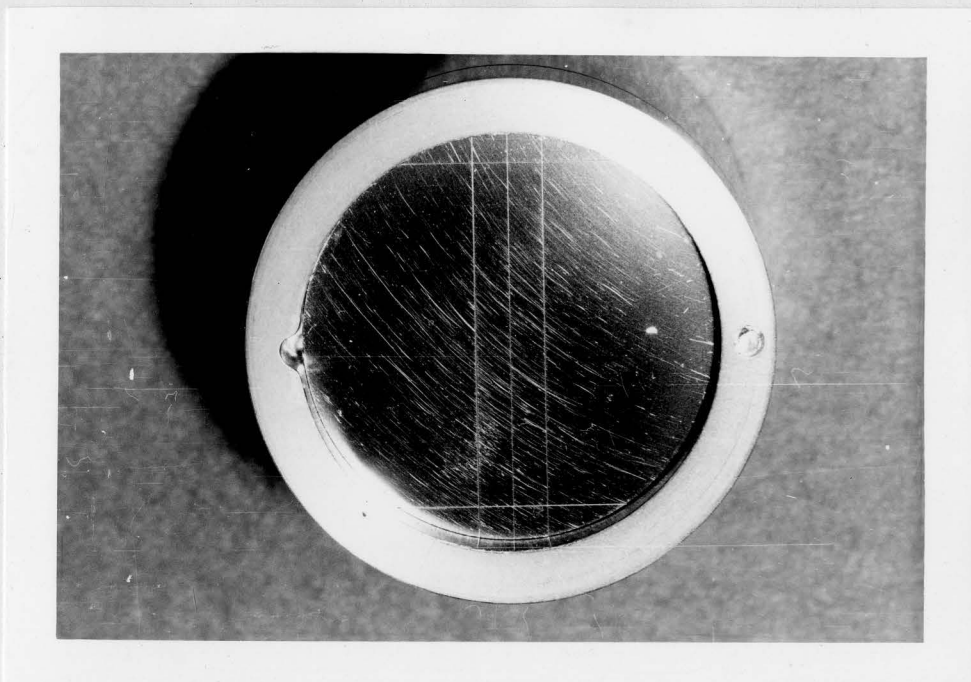


Fig. 1

Top view of the die with the ring on



Fig. 2

Complete set of the die

balance model 311*. A glass plate was pressed against the die so excess material would be extruded. The glass and the die were maintained together using a "c" clamp (Fig. 3).

The die was cleaned with an ultrasonic cleaner⁺ and with toluene. The temperature was recorded as well as the relative humidity with a micro hygrometer[°] and glass thermometer (Fig. 4). The time was controlled by use of a chronometer.

The readings were made with the use of a Gaetner traveling microscope[^] graduated in 0.01 mm increments with a magnification of 32 x (Fig. 5). The water bath was a full visibility jar bath, Blue M[†] (Fig. 6) and was filled with de-ionized water.

The impression materials were weighed and mixed according to the manufacturer's instructions. The material was put in the die and a piece of cellophane was placed on the material for easy removal from the glass slab. The glass was put on the material covered with cellophane. This assembly was held together with the "c" clamp and was placed in a 32°C water bath for two minutes from the start of the mix. The specimens were removed from the water bath after the minimum time suggested by the manufacturer for an interval impression. The specimen was tested at intervals of 2 min, 30 min, 24 hours, and 72 hours.

* Ohaus Scale Corporation

+ Fisher Scientific Ultra Sonic Cleaner

° The Microhygrometer by Air Guide

^ The Gaetner Scientific Corporation, Chicago, Ill.

† Blue M Electric Company, Blue Island, Ill.

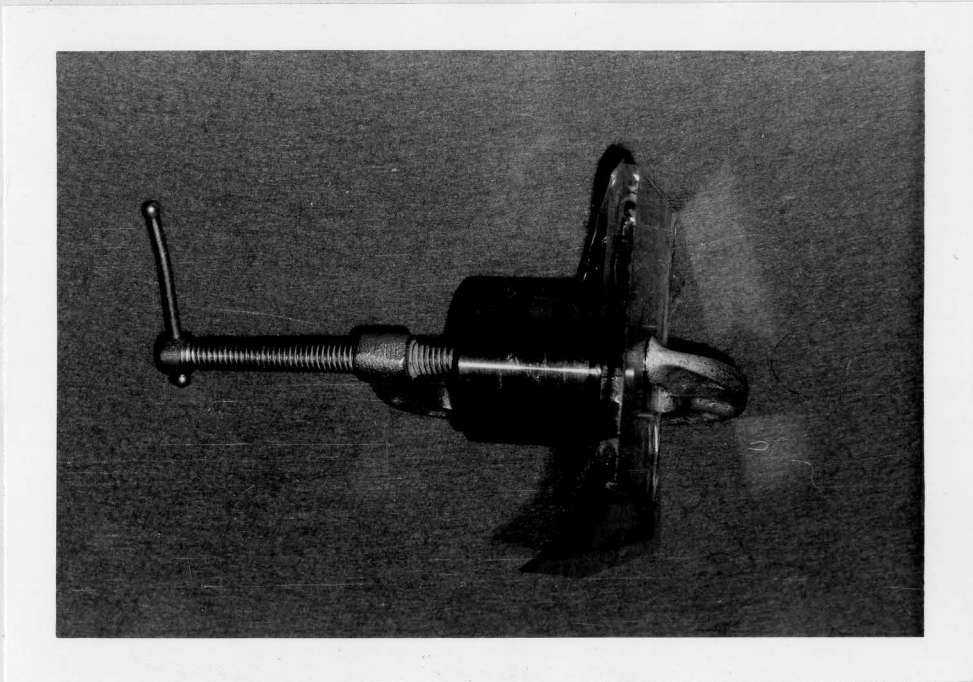


Fig. 3

The die with the glass and cellophane
held together with the "c" clamp



Fig. 4

Hygrometers and glass thermometer

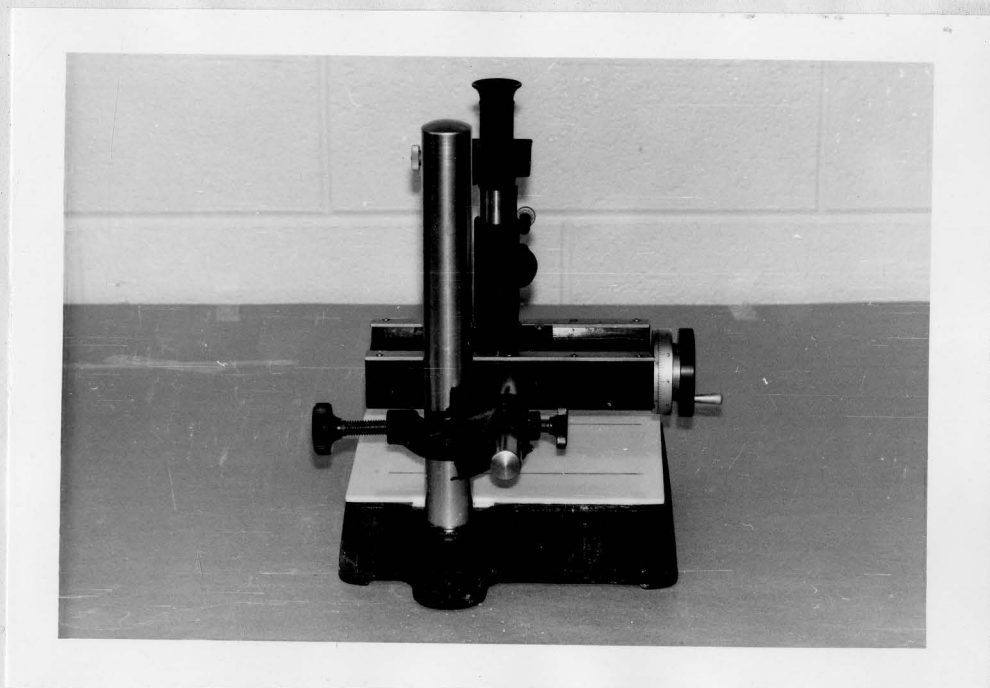


Fig. 5

Gaetner traveling microscope



Fig. 6 Constant temperature
water bath with die in place

Talc was used on the base of the microscope to prevent deformation of the specimens. For testing the materials at room temperature, the procedure was the same but the setting time was different. Each specimen was measured at 2 min, 30 min, 24 hours, and 72 hours after mixing. Between each reading all the specimens were put on a plastic slab with talc on the surface. All the specimens were stored in a dust free cabinet.

CHAPTER IV

RESULTS AND DISCUSSION

The dimensional changes of each material at different times is indicated in tables 2 and 3: the values are in percentage of dimensional change and the recorded times were at 2 minutes, 30 minutes, 24 hours and 72 hours. Table 2 shows the dimensional change when the specimens were recorded at 100% humidity and table 3 shows the results when the materials were noted at room conditions. Table 4 shows the standard deviation at 100% humidity and table 5 shows the standard deviation at room conditions.

All materials were tested at the same conditions of room temperature and humidity, and in a water bath set at 32°C (Fig. 6) to stimulate the mouth temperature as the impression is taken in a clinical situation. The mean room conditions were 23°C and relative humidity of 36.5%.

The temperature had less influence on the setting time of the silicone and polyether than the polysulfides. The time suggested by the manufacturers for polysulfide to be left in the mouth is not sufficient for the complete set of the material when tested at 32°C.

Table 2 shows that the silicones are the most unstable at 100% humidity and 32°C followed by the polysulfides. The most stable material in all aspects was the polyether. The most accurate material is polysulfide when measured at 2 and 30 minutes. The polyether material is the

Table 2

Percentage Dimensional Stability (contraction)
of Elastomers Set Under Water at 32°C

Time						
	Impregum	Permalastic	Coe-Flex	Omniflex	Elasticon	Impredent
2 minutes	0.14	0.06	0.11	0.18	0.27	0.33
30 minutes	0.17	0.12	0.12	0.22	0.40	0.68
24 hours	0.22	0.25	0.19	0.41	0.76	0.97
72 hours	0.14	0.31	0.23	0.54	0.81	1.01

Table 3

Percentage Dimensional Stability (contraction)
of Elastomers Set at Room Conditions*

Time				
	Impregum	Permalastic	Coe-flex	Elasticon
2 minutes	0.10	-0.02	0.008	0.18
30 minutes	0.08	-0.008	-0.02	0.29
24 hours	0.10	-0.06	0.04	0.60
72 hours	0.15	-0.05	0.02	0.58

* Room temperature and humidity

Table 4

Standard Deviation of Data from Table 2

Time						
	Impregum	Permalastic	Coe-Flex	Omniflex	Elasticon	Impredent
2 minutes	± .0081	± .0116	± .0067	± .0069	± .0184	± .0199
30 minutes	± .0047	± .0065	± .0151	± .0064	± .0102	± .0136
24 hours	± .0043	± .0221	± .0165	± .0088	± .0132	± .0082
72 hours	± .0134	± .0279	± .0173	± .0089	± .0124	± .0282

Table 5

Standard Deviation of Data from Table 3

Time				
	Impregum	Permalastic	Coe-flex	Elasticon
2 minutes	± .0049	± .0175	± .0183	± .0121
30 minutes	± .0047	± .0373	± .0183	± .0130
24 hours	± .0077	± .0416	± .0233	± .0190
72 hours	± .0052	± .0394	± .0240	± .0237

second must accurate and the best after 24 or 72 hours. Silicones were less accurate than either the polysulfides or polyethers.

At room conditions the materials behave differently as shown in table 3. The polyether is the most accurate and stable, followed by silicones and polysulfides. This phenomenon could be due to normal fluctuations of room conditions. The influence of the dry field and the set of the materials are very inconsistent but nevertheless, the polyether and silicones are less affected by these factors.

Taking into consideration such factors as the room temperature, the relative humidity, thermal effects, water absorption while taking the impression, elastic recover effects, continuing polymerization, loss of volatile constituents, water absorption during storage, setting expansion of the stone and impression expansion. The following points can be recommended: a custom tray with the proper adhesive, the brand recommended by the manufacturer ; uniform thickness of the material from 2 to 4 millimeters; mix the materials as recommended by the manufacturer using the proper proportions and time; and finally the impression has to be fully set before it is removed from the mouth. For all three types of elastomeric materials it would appear the manufacturer's recommended setting time is too short. The optimum setting time in the mouth was found to be 15 minutes for the polysulfide impressions while the silicones and polyethers were found to be 12 minutes to be sure that all material is fully set. The impression should be pulled slowly to break the seal and then removed in a single stroke. The impression should be rinsed with cold water but prolonged exposure to water should be avoided.

Impressions should be dried immediately after washing because the ambient humidity does affect the set material.

The most important factor however, is that the impression should be poured immediately. The polyether impressions should never be stored in conditions of high humidity. The ideal storage conditions for polyether would be under medium or low humidity conditions. In general, impressions of polysulfides and silicones should be stored under high rather than low humidity. There appears to be little difference between the use of double mix and the reline techniques, provided that adequate spillways are used with the respective techniques. Impressions, that the dentist sends to the laboratory by mail may be unusable as work bases because of unfavorable time lapse and climate, second pour casts are always less accurate than the first cast no matter which technique is used. The second casts should only be used for positioning on the articulator or temporization. The margins of crowns or any other preparations should always be finished on the first poured die.

Typically it requires approximately 30 minutes to prepare an impression to be poured (weigh stone, dowel pins) and keeping in mind that the best results are obtained when the impression is poured immediately (table 2). In the first two readings at 2 minutes and 30 minutes the polysulfides are the most accurate followed by polyethers and nonlead-cure polysulfide, and the least accurate were the silicones.

The results are not in full agreement with the results obtained by Dr. Sawyer in 1973. His percentage of shrinkage for the polysulfides

was 0.15%, for the polyethers 0.12%, and for the silicones +0.015%.

This result for silicone can be explained as an expansion of the material and for this phenomenon the silicone appears as the second most accurate. Comparing the results of the polyethers in Dr. Sawyer's papers and the present thesis it appears there are not significant differences in the percentage of contraction. However the polysulfides illustrated a larger discrepancy because in Dr. Sawyer's work the polysulfides had 0.15% of shrinkage compared with 0.06% found in this study. It was therefore concluded that the polysulfides are more accurate than polyethers but not as stable.

Dr. Craig¹⁵ found the shrinkage that occurred at 24 hours to be: polysulfide, 0.25%; silicone, 0.58% and polyether 0.30%. Compare these figures with the data in table 2. It should be noted that Craig¹⁵ cured the impression at 37°C as opposed to 32°C.

Some suggestions below are made for the use of elastomers in a clinical situation. Polysulfides are ideal when the case presents multiple abutments and the preparations are extra coronals. The polysulfides have the longest working time and also are accurate for extra coronal preparations.

Silicones are indicated for small bridges with 2 or 3 units and for it's ability to reproduce intracoronar preparations. Also the silicones could be the ideal material for operative procedures.

Polyethers are more indicated for single units or small bridges.

These few indications are due to the rigidity of the material. Some problems have occurred during removal of the impressions from the mouth and also when we remove the working model from the tray.

CHAPTER V

SUMMARY

A total of six impression materials were tested; two polysulfides, one nonlead-cure polysulfides, two silicones and one polyether.

The materials were subjected to two environments; in the first place the materials were tested in a water bath at 32°C to simulate a clinical situation. In the second place the materials were tested at room temperature and humidity.

The results in the water bath showed that polysulfides were the most accurate material at 2 minutes and 30 minutes, followed by polyethers and the nonlead-cure polysulfide. Silicones were shown to be the least accurate in this study. At 24 hours the most accurate material was also the polysulfide but showed less dimensional stability than the polyethers. The results at 72 hours indicated the most stable material was the polyether followed by polysulfides while the least stable material was the silicones.

At room conditions the materials behaved differently, the polyethers are the most accurate and stable followed by silicones and polysulfides. This phenomenon is due to the influence of temperatures on setting time. The influence of the dry field on the set of the materials is very inconsistent but nevertheless, the polyether and silicones are less affected by these factors than the polysulfides.

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APPROVAL SHEET

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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.

September 30, 1976
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