SOME PROPERTIES OF ELASTOMERIC IMPRESSION MATERIALS USED IN FIXED PROSTHODONTICS

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SUMMARY: Impression materials used in the various phases of denture construction may be classified as being rigid, thermoplastic, or elastic substances. Elastic impression materials are those that remain in an elastic or flexible state after they have been removed from the mouth. The elastic impression materials are most generally used for the making of impressions for removable partial dentures, immediate dentures, and crowns and fixed partial dentures when tooth and tissue undercuts and surface detail must be recorded with accuracy. Properties of clinical interest are (1) toxicity, (2) color of the base and accelerator, (3) time required for mixing, (4) working time, (5) consistency, (6) permanent deformation during removal, (7) dimensional stability, (8) flow after setting, (9) flexibility, (10) reproduction of detail, (11) compatibility with die and model materials and (12) deterioration during storage of the unmixed material. These properties are important in choosing a material.

Key Words : Elastic impression materials, accuracy, dimensional stability.

INTRODUCTION

Historically, various materials have been used to make impressions for removable and fixed prosthodontics. Early materials included rigid and semi-rigid compositions such as plaster, zinc-oxide eugenol, compound and waxes; these materials still have limited uses in dentistry (28).

The requirements of satisfactory impression material for constructing inlays, crowns and bridges by the indirect method are that at the following three stages it should : (11, 12, 15, 28, 44).

Stage 1: Mixing and insertion

a. be easy to proportion and mix

b. be biocompatible (i.e. be non-toxic and non-irritant to, patient, dentist, assistant and technician)

c. flow readily around the tissues when inserted in the mouth but not when the impression tray is inverted prior to placement in the mouth.

d. stop following when pressure is removed

e. have a long working time

Stage 2: Setting and removal from the mouth

a. have a short, snap set

b. have a low setting shrinkage

c. have a low thermal shrinkage

d. be flexible enough to be easily withdrawn without putting undue stress on mobile teeth

e. be completely elastic in its recovery after deformation

f. resist tearing (have a high tear resistance)

Stage 3: Storage and die production

a. be dimensionally stable, neither losing nor gaining volatile constituents on storage

b. be stiff enough to resist distortion when filled with die material.

c. be chemically compatible with all die materials.

Needless to say, no current material meets all these requirements, however, the materials available with

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properties approaching these requirements fall into two groups, the rubber-like elastomers and the hydrocolloids (9,28).

Four types of elastomeric impression materials are available for crowns and fixed partial denture impressions : addition silicone, condensation silicone, polysulfide and polyether (18,21,28).

In the 1950s the rubber base materials, first in the form of the polysulfide and later the silicone, began to be used as dental impression materials (9). The fabrication of a casting requires an impression material that produces an accurate negative likeness of the oral tissues. Impression detail is influenced by factors such as viscosity, Wettability (1, 13, 35-37, 53), handling properties (7, 8, 43, 44), and the presence of voids (13, 26, 38, 51, 52). Two principal characteristics of the impression material are accuracy and dimensional stability (15, 20-22). The major factors affecting the dimensional change of the impression are thermal contraction, polymerization shrinkage, and contraction due to the loss of volatile by products (31).

To achieve an accurately fitting casting, precision must be maintained from the impression to the casting procedure. This involves five steps : impression, die, vax pattern, investment, and gold casting. The impression material is used in the first phase, and any inaccuracy is carried through to the finished casting (15).

The accuracy and dimensional stability of elastomeric impression materials have been the subject of numerous investigations (15, 21, 23, 24, 29, 45, 48-50, 56). Research on dimensional stability of impression materials commonly has concentrated on the accuracy of individual dies (6, 10, 14, 15, 17, 32, 49, 54) and quadrant fixed partial denture abutments (2, 33, 40, 41, 46, 54). Few studies have reported the accuracy of complete-arch impressions (19,47).

Addition reaction silicones; (poly(vinylsiloxanes), vinyl(polysiloxanes))

Addition curing silicones have the least amount of shrinkage on setting making them the most accurate class of rubber impression material (9). The poly(vinylsiloxanes) are characterized by excellent dimensional accuracy and long-term dimensional stability (5, 30, 31, 50, 55). Their great stability means that accurate dies can be poured for up to a week after they have been removed from the mouth (44). If delay in pouring for making dies is anticipated, the addition silicones are the best choice of the rubber impression materials.

Addition silicone impression materials have a polymerization shrinkage lower than condensation silicone impression materials (5,30,31). It is similar in many respects to condensation silicone expect that it has much greater dimensional stability (equivalent to polyether polymer) (39).

The set material is less rigid than polyether (though stiffer than polysulfide). These materials have moderately high hardness making them more difficult than the polysulfides or condensation silicones to remove from the mouth (9,39).

Condensation curing silicones; (polysilixone)

The conventional silicone impression materials are also known as condensation reaction silicones (42). The main disadvantage of silicone, its poor wetting characteristics. The prepared teeth and gingival sulci must be completely free of moisture for a defect-free impression. Their hydrophobic nature requires their use in a dry, clean field. Pouring without trapping air bubbles is also more difficult than with other impression materials and a surfactant may be needed (9,39).

The condensation silicones have more shrinkage on setting than other rubber impression materials. Its dimensional stability is less than that of polysulfide although greater than that of reversible hydrocolloid. Condensation silicone and polysulfide have a dimensional instability that is due to their mode of polymerization (9,39).

Silicone impression materials are supplied in viscosities labeled as light-, regular-, and heavy-bodied and silicone putty (16).

The setting times of the silicone materials are generally shorter than those for the polysulfide materials. Permanent set is in the range of 1% to 2%, and the strain values are between 2% and 3%. The dimensional in 24 hours may be as low as -0.1% on as high as -0.3%. The silicone impression materials are not so sensitive to changes in temperature and humidity as are the polysulfide products (16).

Polysulfide impression materials (mercaptan, thiokol)

These were the first really accurate elastomeric materials to be introduced into general use in the early 1960s (44). Polysulfide materials had better dimensional stability and tear strength than hydrocolloid. They must be poured as soon as possible after impression making, delays of over an hour resulted in clinically significant dimensional change, and it has improved dimensional stability over hydrocolloid (inferior to polyether and addition silicone) (9,28,39,42).

Polysulfides have a long working and setting time, which is an advantage when impressions are being taken of multiple preparations, but a disadvantage when only one or two teeth have been prepared. Its disadvantage of a long setting time in the mouth induces poor patient acceptance (especially in view of its unpleasant sulfide odor) (44).

There is a slight contraction of polysulfide during polymerization. The high tear resistance and enhanced elastic properties of polysulfide facilitate impression making in sulcular areas and pinholes. Because of the hydrophobic nature of this material, special care must be taken to insure that there is no moisture on the preparation when the impression is taken (39,42). Polysulfides flow well and are useful in making impression of deeper sub-gingival areas. After setting, they are easily removed because of their flexibility. They are available in three viscosities; light, regular and heavy (9,44).

Polyether impression materials

It has excellent dimensional stability because no volatile by product is formed. With the high dimensional stability of polyether, accurate casts can be produced when the material is poured more than a day after the impression has been made. This is especially useful when it may be impossible or inconvenient to pour the impression immediately (15, 27, 41, 42).

Polyether has a dimensional change similar to polysulfides (16). Polyether provide good accuracy and surface detail as well as low shrinkage upon setting. Its flexibility is also very low and stiffness is high (3,12). One is the stiffness of the set material, which causes problems when separating a stone cast from the impression. Thin and single teeth, in particular, are liable to break unless the practitioner uses great care. Its resistance to tearing upon removal is roughly equal to that of silicone and less than that of polysulfide (3, 4, 34, 39, 42).

A further advantage of polyether is its short setting time in the mouth (less than half the time required for polysulfide). The disadvantages of the material are that it absorbs water, so that it must be washed and dried as soon as it is removed from the mouth. Also polyether is stable only if stared dry, for it will absorb moisture and significantly change dimensionally. Also it produces on allergic response in a significant number of people (39,44).

The advantages and disadvantages of the elastic impression materials are summarized in Table 1. There

Table 1: Elastic impression materials.

	Advantages	**Disadvantages**	**Recommended uses**	**Precautions**
Polysulfide polymer	High tear strenght Easier to pour than elastomers	Messy Unpleasant odor Long setting time Stabiliy only fair	Most impressions	Pour with in 1 hour Allow 10 minutes to set
Addition Silicone	Dimensional stability Pleasant to use Short setting time	Hydrophobic Poor wetting Expensive Some materials release H2	Most impressions	Delay pour of some materials care to avoid bubbles Care to avoid bubbles
Condensation silicone	Pleasant to use Short setting time	Hydrophobic Poor wetting Low Stability	Most impressions	Pour immediately Care to avoid bubbles
Polyether	Dimensional stability Accuracy Short setting time	Set material very stiff Imbition short working time imbibition	Most impressions	Care not to break teeth when separating cast

are very much studies which shown advantages and disadvantages of elastomeric impression materials. Some are following :

Johson and Craig (21) were studied the accuracy of four types of elastomeric impression materials as a function of model location, time of pouring, and repetition of pouring. There was little change in dimension among abutment preparations for all materials, for all times of pour, and with a repeat pouring. The addition silicone and condensation silicone products demonstrated the best recovery from undercuts and the least change in dimensions between an initial and second pour of an impression. The addition silicone and polyether were the least affected with delays of 1, 4, and 24 hours in pouring the impression.

Henry and Harnist (19) compared the accuracy of 14 different impression materials by using a four-pasted, silver plated, full arch model. They concluded that polyethers were the most reliable. A study of full-arc impressions of two machined aluminum alloy dies (24) found addition silicones the most stable, followed by polyethers. Both concluded that polyethers, followed by addition silicones, produced the most accurate working casts (25,47).

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