

A Review on Hydrocolloids-Agar and Alginate

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Abstract

Aim:

To provide information on the hydrocolloids-agar and alginate used in dentistry.

Objective:

To know about the various uses, advantages, disadvantages and proper selection of the hydrocolloid impression materials.

Background:

A colloidal system consists of two phases; the dispersed phase and the dispersion phase. If the dispersion phase of the colloidal system is water, it is called hydrocolloid. Hydrocolloid impression materials are based on the colloidal suspension of polysaccharide in water. •In sol form: there is random arrangement of polysaccharide chain. •In gel form: the long polysaccharide chains become aligned and material becomes viscous and develops elastic properties. Based on the mode of gelation, they are classified as: reversible hydrocolloids e.g. agar, irreversible hydrocolloids e.g. alginate. Agar hydrocolloid was the first successful elastic impression material to be used in dentistry. It is an organic hydrophilic colloid extracted from certain types of seaweed. Alginates were first isolated by Stanford by alkaline extraction of brown algae a process used for iodine extraction. Alginate impressions are taken to obtain diagnostic study models, which are the positive reproductions of the teeth and surrounding structures. They are also used to fabricate bleaching trays and mouthguards.

Reason: To provide a detailed review on the composition, uses, manipulation, gelation process, properties of agar and alginate impression materials.

Keywords: hydrocolloid, impression, setting time, composition.

INTRODUCTION

Impression materials are used to record intraoral structures for the fabrication of definitive restorations. Accurate impressions are necessary for construction of any dental prosthesis. The accuracy of these final restorations depends greatly on the impression materials and techniques. Impression materials that are currently popular include polyethers, addition silicones, polysulfides and hydrocolloids (1). An ideal impression material should have the following requirements: pleasant taste & odor, not contain any toxic & irritating ingredients, adequate shelf life, easy to disinfect without loss of accuracy, compatible with die and cast material, dimensional stability, good elastic properties, easy manipulation, adequate setting characteristics, high degree of reproduction details, adequate strength and economical. Impression materials should reproduce hard and soft tissues accurately to obtain biologically, mechanically, functionally, and aesthetically acceptable restorations (2). Hydrocolloids have a high hydrophilic nature that allows this material to capture accurate impressions in the presence of some saliva or blood. It has a low wetting angle so it easily captures full arch impressions. It has moderate ability to reproduce detail and costs relatively little compared with other impression materials. It is not accurate enough for fixed partial dentures but is used for partial framework impressions (3).

HYDROCOLLOID IMPRESSION MATERIALS

The two types of hydrocolloids used in dental impressions are agar and alginate. Agar is a reversible hydrocolloid because it can pass repeatedly between highly viscous gel and low viscosity sol simply through heating and cooling. However, alginate once converted to the gel form cannot be converted back into the sol, and is therefore said to be irreversible hydrocolloid material (4).

ALGINATE

Alginate, an elastic, irreversible hydrocolloid impression material has been the staple of most dental practices for many years. The general use of irreversible hydrocolloid far exceeds that of any impression material, because of its various advantages such as hydrophilicity, pleasant taste and odor, non-staining, inexpensive, ease of mixing and effective use in the presence of saliva. Alginate is used to generate gypsum casts for numerous applications such as in making diagnostic casts, provisional crowns and bridges, orthodontic study models, sports mouth guards, bleaching trays, and fabrication of removable prosthesis.(5,6,7)

Types

Type 1 –fast setting 1-2min

Type 2-normal setting 2-4mins

Composition

Potassium or sodium alginate 15%

Calcium sulphate 16%

Zinc oxide 4%

Diatomaceous earth 60%

Potassium titanium fluoride 3%

Sodium phosphate 2% (8)

Chemistry and setting

Retardation of the setting reaction: $2\text{Na}_3\text{PO}_4 + 3\text{CaSO}_4 \rightarrow \text{Ca}_3(\text{PO}_4)_2 + 3\text{Na}_2\text{SO}_4$

Setting reaction of alginate: $\text{Na alginate} + \text{CaSO}_4 \rightarrow \text{Ca alginate} + \text{Na}_2\text{SO}_4$

On mixing the powder with water, a sol is formed, a chemical reaction takes place, and a gel is formed. Sodium alginate reacts with calcium sulfate, resulting in sodium sulfate and calcium alginate. This reaction occurs too quickly often during mixing or loading of the impression tray. Hence it is slowed down by the addition of trisodium phosphate to the powder. Trisodium phosphate reacts with calcium sulfate to produce calcium phosphate, preventing

calcium sulfate from reacting with sodium alginate to form a gel. This second reaction occurs in preference to the first reaction until the trisodium phosphate is used up, and then alginate sets as a gel (9).

Dispensing

Alginate powder is supplied in packages for single impressions or in bulk. Paste type of alginate is also available. Paste form is available in two viscosities, tray and syringe viscosities. The paste-type material has a shorter gelation time than the powder-type material. The best surface quality can be obtained with the paste-type material (10). It has been recommended to dispense the powder by fluffing it by rotating and tumbling the can, dipping the scoop, tapping the scoop gently with the spatula, and levelling the powder in the scoop with a spatula (11).

Mixing and loading the tray

Mixing is initiated by adding measured quantity of water to clean flexible rubber bowl. This is followed by sifting the measured quantity of powder into the water. This technique of adding powder to the water is known as sifting and it ensures that the powder particles are wet evenly. Colder water can be used if longer working time is desired. Mixing should be rapid with a wide-bladed spatula. A vigorous figure of eight motion by swiping or stropping the mixture against the sides of the bowl is recommended. The resultant mix should be creamy in consistency but must not drip off the spatula when lifted from the bowl. Mixing time is 60 seconds for hand spatulation and 15 seconds for mechanical. The required amount of material is loaded onto the tray. The tray must be filled with the impression material up to the tray borders and any excess unsupported material at the periphery must be removed with the mixing spatula. The surface of the alginate is smoothed with a wet gloved finger (12).

Impression making

Impression tray is positioned in the mouth by retracting the patient's lips on one side with a mouth mirror/gloved finger; and on the other side, by rotating the tray into the mouth. The tray has to be centered in position in the mouth; and with light pressure, impression is held in place. The soft tissues, especially labial flange, should be relieved and manipulated for the alginate to flow into the sulci and record the details. When tray is seated, pressure should be released immediately and the tray should be held lightly in place to prevent unseating. Alginate materials start setting from the tooth surface to the impression tray. Pressure will cause impression to set under strain. Once set, the impression has to be removed with a firm, quick snap. The impression should not be rocked or twisted before or during removal of the impression. This is to minimize the time for which the set material is distorted as it moves over the teeth. (13)

Storage and disinfection

Set alginate undergoes imbibition and syneresis if left in a normal clinical environment. After being removed from the

mouth, alginate impressions should be washed with a water spray and dried until the shine just disappears. The impression has to be covered with damp gauze and left in a zip-lock plastic bag until the cast is poured. Distortion can be a problem if disinfection guidelines are not strictly adhered to. Hydrocolloids are hydrophilic in nature; hence they swell if immersed in water or disinfectant. Immersion disinfectants like 1% sodium hypochlorite or 2% glutaraldehyde can result in changes of 0.1%, and hence the quality of the impression surface may not be impaired if the recommended period of time (10mins) is strictly followed. (14)

Advantages

1. Non toxic and non irritant
2. Good surface detail
3. Ease of use
4. Cheap and good shelf life
5. hydrophilicity

Disadvantages

1. Poor dimensional stability
2. Low tear strength
3. Messy to work with
4. Porosities on the surface of the poured models (15).

Recent developments

Dust-free alginate impression material
Antiseptic alginate impression material
Chromatic colour changing alginate

AGAR

Agar-agar is an organic colloid derived from the cell wall of red seaweed (16). It is essentially a hydrophilic, emulsoid polysaccharide (17). Reversible hydrocolloid was introduced to the dental profession in 1925 by Alphons Poller, an Austrian as impression material (18). Agar was first introduced into dentistry for recording crown impressions in 1937 by Sears (19) and was the first elastic impression material available.

Composition

Borates 0.2 – 0.5%
Water 85.5%
Agar 13-17%
Sulfates 1 – 2%
Fillers (diatomaceous earth, silica, wax rubber) 0.5 -1%
Bactericide; thymol & glycerin are used
Color & flavour (20)

Chemistry and setting

Agar provides a thermoreversible gel and the sol-gel formation is reversible and depends on temperature. This material forms a colloid after absorbing water, which liquefies between 71°C and 100°C and sets to a gel again between 30°C and 50°C, depending on concentration of the agar (21). The setting of the reversible hydrocolloid is called gelation.

Manipulation

At first reverse the hydrocolloid gel to the sol stage. Boiling water is a convenient way of liquefying the

material. The material must be held at this temperature for a minimum of 10mins. Propylene glycol can be added to the water to obtain 100 degrees. There are three compartments in the conditioning unit, making it possible to liquefy, store and temper the material. The hydrocolloid is usually supplied in two forms: syringe and tray materials. After it has been liquefied, the material must be stored in the tray. The impression trays are rim locked with water circulating device. This type of tray allows a space of 3mm occlusally and laterally and extends distally to cover all the teeth (22).

Impression making

The syringe material is taken directly from the storage compartment and applied to the prepared cavities. It is first applied to the base of the preparation and then the remainder of the tooth is covered. By the time the cavity preparation and adjoining teeth have been covered, the tray material has been properly tempered and is now ready to be placed immediately in the mouth to form the bulk of impression. Gelation is accelerated by circulating cool water, approximately, 18 – 21 degrees through the tray for 3 – 5 minutes.

Disinfection

For disinfecting the impression, iodophor, bleach or gluteraldehyde can be used. The hydrocolloid may be disinfected by 10 minute immersion in/or spraying with the antimicrobial agent such as sodium hypochlorite and gluteraldehyde without sufficient dimensional change (23).

Recent techniques

Wet field technique

The oral tissues are flooded with warm water. The syringe material is then injected in to the surface to be recorded. Before syringe material gels tray material is seated. The hydraulic pressure of the viscous tray material forces the fluid syringe material down in to the areas to be recorded. The motion displaces the syringe material as well as blood and debris throughout the sulcus.

Laminate technique

The general procedure is to heat the agar to be placed into re-usable syringes for about six min in boiling water. The agar is stored for at least 10 min at 65°C before being syringed around the preparations. A mix of alginate containing 10% more water than normally recommended is placed in a tray and it is immediately seated over the agar syringe material. The cool mix of alginate helps gel the agar, and when the alginate has set, the combined impression is removed. The technique simplifies the use of agar and provides an impression surface that allows for preparation of stone casts acceptable for crown and bridge applications (24).

Advantages

Inexpensive
No odors
Nontoxic
Nonstaining

Disadvantages

Complexity of the technique
Lower-than desirable tear strength.

PROPERTIES

Dimensional stability

Irreversible hydrocolloid impression material has dimensional changes as a result of synergists or evaporation of water when exposed to air(25).Storage medium such as 2% potassium sulphate solution or 100% relative humidity in a storage chamber, is suggested to reduce the dimensional change of agar impressions.

Strength

Alginate; Compressive strength- 5000-8000gm/cm²

Tear strength - 350-700gm/cm² (26).

Agar; Compressive strength- 8000gm/cm²

Tear strength- 7000gm/cm² (27).

Flow & distortion

This material does not readily flow into areas in which the tray does not extend. If distortion occurs, it cannot be corrected (28).

Agar is sufficiently fluid to allow detailed reproduction of hard & soft tissue. If the material is held rigidly to the tray, then the impression material shrinks toward the center of its mass. Rapid cooling may cause a concentration of stress near the tray where gelation first takes place.

Compatibility with gypsum

The sodium sulphate that was formed as a by-product of the setting reaction of the alginate is a gypsum setting retarder at high concentrations and thereby produce poor surfaces (29). Agar impression material contains borax, which is a retarder for setting of gypsum. This can be overcome by immersing the agar impression in a solution containing a gypsum accelerator or by incorporating a gypsum surface hardener.

Accuracy

Most alginate impressions are not capable of producing finer details as much as obtained with other elastomeric impression materials (30).

Agar produces an accurate impression. The combination of agar and alginate appears to produce excellent results and detailed accuracy.

CONCLUSION

Making impressions is an important part of indirect restorations that is often overlooked. The increased use of agar impression material as a result of the development of the agar alginate combination technique should level off and continue at a modest level. Increased development of dustless and higher tear strength alginates should be expected as well as increased efforts to re-formulate alginates to produce products with better reproduction of detail and compatibility with gypsum products. With the selection of an appropriate impression material and impression technique, impression taking is reliable and reproducible, with consistent successful results.

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