Alginate Impression Material : From Then Till Now...

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Introduction

Alginate is an elastic, irreversible hydrocolloid impression material originally developed in the 1930s and has been used in dentistry for over 50 years.[1]. During World War II, due to a shortage of raw materials for reversible hydrocolloids, irreversible hydrocolloids were introduced, and their use subsequently exploded.[2] Irreversible hydrocolloids, more commonly known as alginates, were developed from seaweed during World War II. Commercial varieties of alginate are extracted from seaweed, including the giant kelp Macro-cystispyrifera, Ascophyllum-nodosum, and various types of Laminaria.[3] Alginate form an inseparable part of indirect restorations and it is one of the most frequently used dental materials as it is a simple, cost-effective, their hydro-philicity, ability to record finer details, sufficient elastic recovery.[4]Irreversible hydro-colloid can be used in preliminary impressions, provisional crown-and-bridge impressions, study models, opposing dentition impressions. Alginates are used for impressions in orthodontic models, sports mouth guards, and bleaching trays.[5]

History

Algin was discovered in 1881 by an English chemist, E. C. C. Standford, who obtained a viscous mucilage by extracting Laminaria-stenophylla (Laminariaceae) with alkali. He called the product "algin". He further found that, if a mineral acid was added, a gelatinous precipitate was obtained, which dried to a hard, horny substance. He identified this as a new acid, which he named "alginic acid". He then carried out extensive investigations on the properties and possible uses of his products.[6] In England 40 years later another chemist, Sir William Wilding received a basic patent for use of algin as a dental impression material**.** Irreversible hydro-colloids have been used since 1947 for the making of impressions for fixed prostheses; the impression techniques were similar to today's

Conventional Alginate

Alginic acid is a linear polymer of sodium salt of anhydro beta d-mannuronic acid and it is insoluble in water but some of its salt like sodium, potassium are soluble.[8].When alginic acid (prepared from a marine plant) reacts with a calcium salt (calcium sulfate), it produces an insoluble elastic gel called calcium alginate. When mixed with water, the alginate material first forms a sol. The following chemical reaction forms a gel to create the set impression material. Irreversible hydro-colloids have a high hydrophilic nature that allows this material to capture accurate impressions in the presence of some saliva or blood.[9,10] 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 [9, 11]

Problems with Alginate

However, alginate is one of the most commonly used impression material but there are few disadvantages of this material as-

- It has poor dimensional stability (imbibition or dessication is a problem), must be poured within 10 to 12 minutes of impression making or distortion becomes a major issue, and is good for onlyone pour per impression [12,13,14,15]
- Tear strength of hydrocolloids is low, it may capture subgingival contours and anatomy but may tear upon removal.[9]
- Alginate have tendency to stick to teeth, which occurs when alginate radicals in the impressionmaterial form chemical bonds with hydroxyapatite crystals of theenamel. On removal of the impression, the alginate tears.[16]
- It consist of silica dust in the form of diatomaceous earth and other components like lead, cadmium in its composition which are higly toxic.[8,17]
- Poor adhesion with tray

Advances in Alginate Impression Material

To overcome problem of alginate various advancement have been done

1. Extended-pour Alginate: Alginate impressions should generally bepoured immediately or until 12 minutes in 100 percentage humidity at room temperature. If the irreversible hydro-colloidwas poured within 15 min, it could be used as a final impression material but if not poured it can cause dimensional changes. Cavex Color-Change [extended-pour alginate] is designed for use with alginate impression material which enables to delay pouring up impression under specified storage conditions. A recent investigation reported that storage ofalginate up to 100hr did not result in significant dimensional changes[18,19,20]**.** Another option would be to use Extend-A-Pour from Van R that reportedly preserves the alginate impression for up to four weeks**.** [18, 19, 20]

2. Trayadhesive for Alginate: Conventional alginates do not exhibit retention to the impression trays and hence perforated trays are generally employed to achieve retention .Recently, a tray adhesive in form of liquid and spray containing polyamide or Diethylenetriamine polymer, ester gum and rosin in isopropyl alcohol or a combination of isopropyl alcohol with ethyl acetate has been introduced. Application of such adhesives prior to the loading of alginate was found to improve the bond strength of alginate to the metaland plastic trays.[21]Along with that Fix Solvent is a spray to remove any remaining adhesive from the impression tray after impression taking and casting

3. Dust Free Alginates: Conventional alginates contain silica in the form of fine particles as filler. It was reported that silica particles after prolonged inhalation was reported to cause silicosis,. In an attempt to avoid or minimize the dust during manipulation, alginate powder is coated with de-dusting agent to agglomerate the powder to a more dense form, with glycerin, glycol, polyethylene glycol and/or polypropylene glycol are used as de-dusting agents. Sepiolite, a natural mineral fiber containing magnesium silicate about 20% was added to alginate as a substitute when added traps the alginate particles thus reducing dust generation. Tetrafluoroethylene, on the other hand, traps the alginate particles by forming cow-web like structure due to the stresses applied during manipulation.[8, 22, 23, and 24]

3. High Viscosity Alginates: Conventional alginates shows slow permeation speed of water with respect to powder of alginate, it takes much time to permeate water to whole powder. By incorporation of hydrophobic material (0.01 0.1 wt %) & Surfactant 0.05 0.1 weight permeation speed of water increases, kneading time is shortened. Further, by incorporation of polysaccraides problem of gagging is solved[25]

4. Color Changing Alginate : Conventional alginates were simply modified with the addition of pH indicators. However, most pH indicators show a color change at an early stage before actual gelation time. This is because most pH indicators show a color change slightly above pH 8 which is the pH immediately after mixing.[26] However, during the gelation pH of the mix decreases below eight and the pH indicator does not show any color change at this pH. Further, the pH indicators are poorly soluble in water during mixing. To overcome this problem, a combination of inorganic and/or organic pigment (Cresol Red, á naphtholphthalein, Tropaeolin OOO, Thymol blue) along with pH indicator has been incorporated. In such cases, the initial color of the alginate soon after mixing is a combination of pigment and pH indicator whereas the color of alginate after setting is the color due to pigment alone.[27]

5. Two Paste Form : Conventional

alginate form used 2 component system of powder &water havetendency to evolve dust during manipulation, inconsistency in dispensing accurate amount of powder, separation of ingredients and contamination of the powder during storage. To counter these disadvantages, alginate in the form of two-paste system has been introduced which is quite convenient to mix.[30] Base paste contains a mix of soluble alginate, water and fillers mixed with a paste formingmaterial. Polysaccharides such as carrageenan and gum Arabiccan be used to form a paste without the separation of components of alginate paste.[30,31] The reactor or catalyst paste contains calcium salt mixed with a viscous liquid that is non-reactive towards calcium salt such as liquid paraffin. A pH-stabilizing agent such as magnesium hydroxide is also added.[28,29,30]

6. Infection Free Alginates : Disinfection of alginates by either immersion or spraytechnique was found to cause dimensional inaccuracies, although reports are available supporting the disinfection of alginates without clinically significant dimensional changes. To avoid dimensional inaccuracies associated with disinfection process, manufacturers have incorporated disinfectant materials into the alginate such as quaternary ammonium compounds, bisquanidine compounds, chlorhexidine, didecyldimethyl ammonium chloride without altering its properties.further studies have shown that Epimax showed the highest disinfection action after 10 minute[31,32,33,34]

7. Mixing Device : A mixer for alginate has a rotatable bowl and one or more nozzles positioned above the opening of the rotatable bowl for injecting water into the bowl.Furtherdual-chamber package for the constituent materials for preparing an alginate dentalimpressionpaste includes a first chamber containing a pre-measured volume of water, and a second chamber, attached to and isolated from, the first chamber, and containing a pre-measured quantity of alginate powder, wherein the quantity of powder and the volume of water are in a pre-determined ratio for making a dentalimpression paste when mixed together.[35,36,37]

8. Use of Alginate Waste : Since alginateimpressionmaterial contains silica and calcium salts, we aimed to synthesize calcium silicate cement from alginate impression material. Firing the set blend of pre-fired set alginate impression material and gypsum at 1,200°C revealed that the featured porous structures of diatomite as an alginate impression material appeared useful for synthesizing calcium silicates which when mixed with phosphoric acid solution and set by depositing the brushite.[38]

Conclusion

Alginate is most commonly used impression material for partial dentures. Advanced alginates are better than conventional alginates. Still studies are going on to develop superior alginates to overcome its disadvantage and for better clinical performance

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