Impact of Storage Environment and Temperature on Dimensional Stability of Alginate Impression

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ABSTRACT

BACKGROUND

Alginate impression materials have been extensively used in dentistry. After making an impression, the final alginate structure is very sensitive to condition which can change the amount of trapped water in fibrillar structure; thus, the dimensional stability of alginate impression is highly vulnerable to weather and moisture conditions and any change in it will lead to distortion of impression. The purpose of this study is to assess the dimensional changes of alginate impression by weight loss method by storing the specimens in 0.02% of NaCl solution and 0.05% K₂SO₄ solution at room temperature and at 8 ± 2 °C for 24 hours.

METHODS

The study was done in Department of Prosthodontics, Sharad Pawar Dental College, Sawangi (Meghe), Wardha, India. Alginate impressions were made with ivory tooth mounted in dental stone and the impressions were stored at atmospheric conditions in 0.02% of NaCl solution in zip lock polythene sachets, at atmospheric conditions in 0.05% K₂SO₄ solution in zip lock polythene sachets, in zip lock polythene sachets at 8 ± 2°C in 0.02% NaCl solution, in zip lock polythene sachets at 8 ± 2°C in 0.05% K₂SO₄ solution. The following materials were used- alginate impression material, cylindrical ring, glass slab, ivory tooth mounted in dental stone, zip lock polythene sachets, refrigerator, 0.02% NaCl and 0.05 % K₂SO₄ and Blotting paper.

RESULTS

The 0.02% Sodium chloride solution showed lesser weight loss during storage of irreversible hydrocolloid impression material as compared to potassium sulphate.

CONCLUSIONS

For maximum dimensional stability, theoretically the cast should be poured immediately. If it is not possible, the impression can be stored in 0.02% NaCl at 8 ± 2 °C solutions preferentially followed by 0.05% of K₂SO₄ at 8 ± 2 °C solutions, in a sealed polythene sachet for about 24 hours.

KEY WORDS

Alginate, Impression, Moisture, Distortion, Impression

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BACKGROUND

Alginate impression material is frequently used in dentistry. Alginates are commonly used as a two-component system of powder and water. The powder contains sodium and potassium alginates (soluble alginates), diatomaceous earth acting as filler particles, calcium sulphate as a reactor, a fluoride as an accelerator, and sodium phosphate as retarder. In alginate structure, gel fibrils are held together by primary bonds occurring due to substitution of sodium ions by calcium ions on two neighbouring molecules.¹ Gel forms a complex entangled structure which traps sodium alginate which has not reacted with calcium salt, excess water, charged particle and reaction by products.² Under these condition the final alginate structure is very sensitive to condition which can change the amount of trapped water in fibrillar structure thus, the dimensional stability of alginate impression is highly vulnerable to weather and moisture conditions during storage before it is used to make model.² To avoid this ideally Alginate impression should be poured immediately into cast.¹ Spraying the disinfectant to disinfect the cast is very handy however it can affect various mechanical properties of the material.³ After disinfection it is very important that impression remains dimensionally stable.⁴ As it is very tricky job for all the dentist to restore a structurally compromised tooth.⁵ In this study the dimensional changes of alginate impression were studied by weight loss method by storing the specimens in sodium chloride and potassium sulphate in atmospheric condition and in zip lock polythene sachets at $8 \pm 2^\circ\text{C}$.¹

METHODS

The study was done in Department of Prosthodontics, Sharad Pawar Dental College, Sawangi (Meghe), Wardha, India. The study materials used were Alginate impression material, Cylindrical ring, Glass slab, Ivory tooth mounted in dental stone, Zip lock polythene sachets, Refrigerator, 0.02% NaCl and 0.05 % K_2SO_4 , Blotting paper.

Irreversible hydrocolloid impression material (imprint alginate) was used in study. Alginate powder was dispensed for manipulation as per manufacturers recommendation. The metallic cylindrical ring (diameter 4 cm and height 2 cm) and was placed on a clean glass slab applied with Vaseline. The mixed alginate was poured in cylindrical ring. Impression were taken by ivory tooth mounted in dental stone (Type III) block having specific markings corresponding to the diameter of the ring which help in orientation of the tooth mounted on the stone block over the cylindrical ring. Once the impression sets dental stone block with ivory tooth was carefully removed and the set alginate was separated out from cylindrical ring after wiping the impression with blotting paper it was weighed immediately and the weight of specimens were recorded.

Then the specimen was stored in lower concentration of 0.02 % NaCl and 0.05% of K_2SO_4 solution in sealed polythene sachets labelled with type of solution, time of weighting and its weight. The specimens were stored in following conditions; at atmospheric condition in 0.02% of NaCl solution, at atmospheric conditions in 0.02% of NaCl solution in zip lock

polythene sachets, at atmospheric conditions in 0.05% K_2SO_4 solution in zip lock polythene sachets, in zip lock polythene sachets at $8 \pm 2^\circ\text{C}$ in 0.02% NaCl solution, in zip lock polythene sachets at $8 \pm 2^\circ\text{C}$ in 0.05% K_2SO_4 solution.. Then the samples were weighed again after 24 hours and the differences in the weight of specimen were calculated and further analysed.

RESULTS

In 0.02% of NaCl solution at atmospheric condition the mean pre-weigh was 20.33 ± 0.13 and post weight mean 18.95 ± 0.10 considering the standard error the significant p-value was 0.001. With 0.02% of NaCl solution in zip lock polythene sachets at $8 \pm 2^\circ\text{C}$ the mean pre-weigh was 20.45 ± 0.13 and post weight mean 19.71 ± 0.27 considering the standard error the significant p-value was 0.001 (Table. 1).

Graph 1. Difference in Pre-Weight and Post-Weight of Samples in Gram Wherein Pre-Weight is Depicted by Blue Colour and Post Weight is Depicted by Red Colour

Variables		Mean	N	Std. Error Mean	p-Value
NaCl Sample AT Room Temperature	Pre weight	20.33 ± 0.13	10	.04224	0.001
	Post weight	18.95 ± 0.10	10	.03215	
NaCl Sample AT $8 \pm 2^\circ\text{C}$	Pre weight	20.45 ± 0.13	10	.04234	0.001
	Post weight	19.71 ± 0.27	10	.08757	
K_2SO_4 Sample AT ROOM Temperature	Pre weight	20.44 ± 0.23	10	.07552	0.001
	Post weight	19.20 ± 0.33	10	.10711	
K_2SO_4 Sample AT $8 \pm 2^\circ\text{C}$	Pre weight	20.37 ± 0.11	10	.03488	0.001
	Post weight	19.47 ± 0.23	10	.07446	

Table 1. p-Value

With 0.05% K_2SO_4 solution at atmospheric condition the mean pre-weigh was 20.44 ± 0.23 and post weight mean 19.20 ± 0.33 considering the standard error the significant p-value was 0.001. With 0.05% K_2SO_4 solution the solution in zip lock polythene sachets at $8 \pm 2^\circ\text{C}$ mean pre-weigh was 20.37 ± 0.11 and post weight mean 19.47 ± 0.23 considering the standard error the significant p-value was 0.001 (Table. 1).

DISCUSSION

In distilled water the sample initially expands then after few hours negative effect starts that is loss of weight from the sample due to substitution of heavier ions of gel by lighter ions such as H^+ ions of water. This results into decrease in pH of distilled water and loss of water from the sample. The effects of storage in NaCl and K_2SO_4 salt solutions can be understood by Hofmeister or lyotropic series in which ions of metallic salts can be arranged in order of their decreasing ability to precipitate lyophilic substances from colloidal dispersion (Anion order: $SO_4^{2-} > C_2H_3O_2^- > Cl^- > NO_3^- > ClO_3^- > I^- > CNS^-$; cation order: $Mg^{+2} > Ca^{+2} > Sr^{+2} > Ba^{+2} > Li^+ > Na^+ > K^+$).⁶ As the coagulation power/ extent of coagulation/precipitation of gel is high (Because of high concentration of ions/electrolytes), volume will decrease and thus shrinkage takes place. Although dimensional changes can be slowed by certain storage conditions, Temporary surface stabilization can be achieved by immersion in dilute aqueous solution of 0.02% NaCl and 0.05% of K_2SO_4 for 24 hours in zip lock polythene sheets in refrigerator at $8 \pm 2^\circ C$. Some studies have shown that impression can be stored in of 0.02% NaCl and 0.05% of K_2SO_4 for 24 hours and in humidity chamber or zip lock polythene sachets in refrigerator at $8 \pm 2^\circ C$ up to 6 hours¹. Graph 1 depicts the difference in pre-weigh and post -weight of samples in gram wherein pre-weight is depicted by blue colour and post weight is depicted by red colour. Table 1 shows the significant p-value for the experiment.

CONCLUSIONS

For maximum dimensional stability, theoretically the cast should be poured immediately. If it is not possible, the impression can be stored in 0.02% NaCl at $8 \pm 2^\circ C$ solutions preferentially followed by 0.05% of K_2SO_4 at $8 \pm 2^\circ C$ solutions, in sealed polythene sachet for about 24 hours, as it shows minimum distortion and facilitates shifting to distant laboratories from the clinics.

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