ORIGINAL ARTICLE

PARTICLE SIZE VARIATIONS IN THE GLASS COMPONENT OF GLASS-IONOMER DENTAL CEMENTS

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Background: Glass polyalkenoate cements (glass ionomer cements) are widely used in restorative dentistry and now a day the material of choice for bone cements. The aim of the study is to examine the variations produced by exposure to acid for dental Glass Ionomer Cement (GIC) glass particles of different composition. It also involves the study of the effect of replacing Ca by Sr in glass ionomer glasses on the particle size distribution. **Methods:** This study was carried out in a Malvern Mastersizer/E. This uses LASER-diffraction and was in reverse-Fourier mode (0.1–80 µm). Ultrasound was used to break up any agglomerates. Also, some samples were treated as above but instead of particle size analyser, the slurries were centrifuged and the glass washed and dried to constant weight to determine mass loss. **Results:** The mass loss for LG26Sr in acid washing was comparatively greater whereas LG26 showed less mass loss. When statistically evaluated LG series and AH2 were found to differ significantly p=0.008. There was, however, no significant difference between other combinations of glasses in acid was treatment. The pseudo-cement formation in all the glasses suffered significant mass loss p=<0.008. **Conclusion:** By changing the different chemical composition of glass ionomer glasses the mass loss was substantially greater during the cement formation process as compare to acid washing.

Keywords: Glass ionomer cement, Components of glass ionomer cement, Restorative material, Luting material.

INTRODUCTION

Glass polyalkenoate cements (glass ionomer cements) are widely used in restorative dentistry as luting cements, bases, anterior filling materials and increasingly as posterior filling materials and bone cements.[1] The vast majority of the literature on glass ionomer cements (GICs) deals with the properties of commercial products of unknown composition and microstructure. Only a few studies attempt to correlate glass composition with cement properties.[2–5] Fibre reinforcement increased the diametral tensile strength, hardness, flexural strength, flexural modulus, and fracture toughness of the conventional glass-ionomer restorative material.[6,7]

Particle size of the glass powder is an important factor in the clinical performance of GICs. It is obvious that, other thing being equal, finer particle size (i.e., greater specific surface of the powder), the faster the setting reaction would be. To achieve the film thickness of 20 µm as demanded for a luting agent, a fine grained glass has to be used.[8] The tendency over the years has been to use fine grained powders for restorative materials. In all composite structures the filler particle size distribution affects the mechanical properties. Calcium may be replaced wholly by strontium which is another alkaline earth metal and partly by barium, also an alkaline earth metal, or lanthanum, a rarer earth metal, to give a radio-opaque glass. Microhardness results prove the fact that the niobium addition would improve the mechanical properties of cements.[9] Variations in the phosphorus concentration within the glass strongly affect the material properties, particularly if it is intended for use in glass ionomer cement. Increasing the concentration of phosphorus prolongs the work time during the "trapping reaction" and increases the hardness which resulted in materials with distinct properties, useful in dental and medical applications.[10]

The aim of the present study is to examine the variations produced by exposure to acid for GIC particles of different composition. It also involves the study of the effect of replacing Ca by Sr in glass ionomer glasses on the particle size distribution.

MATERIAL AND METHODS

Four types of commercially available glass ionomer glasses, i.e., AH2, LG125, LG26Sr and LG26, were selected for use in this study (Table-2). AH2 is a commercially available glass obtained from Advanced Health Care Ltd. The LG series of glasses were obtained from EU Ultraset Programme.

Table-1: Chemical composition of the four commercial types of GIC glasses

GLASS	Si,	Al	Ca,	P	F	O	Sr	Na
LG125	√	√	√	√	√	√	√	×
LG26Sr	√	√	√	√	√	√	√	×
LG26	√	√	√	√	√	√	×	×
AH2	√	√	√	√	√	√	×	√

Initial characterization of the glass particle size of glass ionomer glasses obtained from the manufacturer was carried out by using a laser diffraction particle size analyser. This was confirmed by viewing the computer screen and adjusting the alignment of the optical measuring unit, using the focal length adjusted to 45 mm lens, recommended for measurement of particle size less than 20 µm. Cement forming glasses normally have particle sizes less than 20 µm. Therefore, the glass particles used in the experiment were adjusted to have a particle sizes less than 20 µm, and the following procedure adapted.

Two grams samples of each glass were weighed accurately. The samples were treated with 5% and 35% acetic acid for washing and cement formation, respectively. Different ratios of glasses and acetic acid solutions were used for preparing the samples, as given in Table-2. In the case of acid washing the glass was weighed which varied from 1.95–2.05 g. However the glass used for pseudo-cement was weighed with weights varying from 1.5048–1.5080 g. Gravimetric assessment, after making the cement, the friable material was left for 24 hours. The fluid was filtered off and then glass residues were placed into an oven and dried the glasses to a constant weight. These glasses were then used to measure their mass and then compared it with that of the untreated glass samples to evaluate the final mass loss after acid treatment.

Table-2: Acetic acid treatment of different types of GIC glasses for washing and the cement formation

Acetic acid Solutions	Types of GIC Glasses used AH2, LG26, LG26Sr, LG125
5% solution	Acid washing 2 g of powder was mixed with 1 ml of 5% acetic acid solution and 7 ml of de-ionised water
35% solution	Cement formation 1.5 g of the powder was mixed with 0.75 g of 35% acetic acid solution and 5 ml of de-ionised water

Statistical analysis of the data was carried out using a non-parametric test (Mann Whitney).

RESULTS

Four types of commercially available glasses show the variation in their chemical compositions. All LG series of GIC glasses contained Si, Ca, P, F, and O except LG26 Sr, whereas Na is not present in all LG series except AH2. In acid washing LG26Sr showed greatest mass loss as compared to the other three glasses (Table-3). LG26 behaves differently and the loss in mass was the lowest among the four glasses. The total mass loss in LG125 and AH2 are more than LG26 but less than LG26Sr after 5 percent acid treatment. The acid washing results in a partial leaching of the outer surface of the glass particles. Thus, inducing a delay of leaching process, so it controls the initial acid reactivity which permits the adjustment of the setting and working time.[11]

Figure-1 shows the percentage mass loss after acid wash and pseudo-cement formation. According to statistical data the difference between LG series and AH2 was found to be highly significant p=0.008, whereas no significant difference was observed between other combination of glasses in 5% acid wash treatment. In the case of pseudo-cement formation the percentage of mass loss was found highly significant difference p=<0.008 in all four glasses.

Table-3: Mass loss after acid washing and pseudo-cement formation

Mass loss after 5% acid-washing			
	Mean	**SD**	**% CV**
AH2	0.95	0.46	48.69
LG26	0.07	0.08	129.89
LG26Sr	1.20	0.05	4.38
LG125	1.11	0.38	33.82
Mass loss after pseudo-cement formation			
AH2	3.16	0.20	6.29
LG26	1.27	0.20	16.17
LG26Sr	2.37	0.18	7.7
LG125	0.31	0.34	109.77

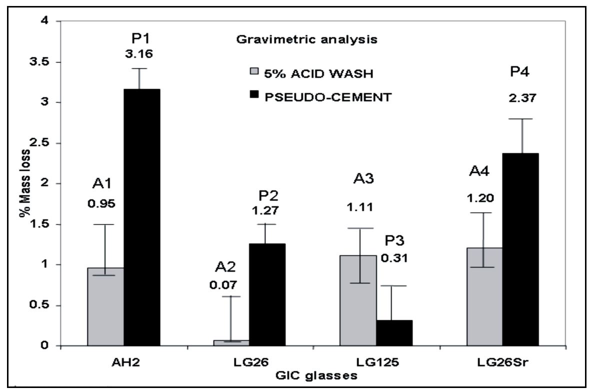

Figure-1: Percentage mass loss after acid wash and pseudo-cement formation

DISCUSSION

These above chemical composition may be affected during acid washing and cement formation, since some of the elements are more vulnerable to acid attack and may leach out more readily. Glass polyalkenoate cements are formed from complex fluoro-alumino-silicate glasses that often contain calcium, phosphorus and sodium. In addition they may also contain strontium, zinc and lanthanum, which are added to confer radio-opacity.[3]

Among all four glasses, the mass loss in AH2 was greater then LG series in pseudo-cement formation. AH2 which is known to be a commercial glass consisted of all elements including sodium and three times more fluorine than LG series, whereas LG series do not contain sodium. This could be one of the reasons to the loss of the mass during the cement formation. However, sodium, calcium, and aluminium ions induce more basic sites in the glass which are more susceptible to the acid attack than a pure silica network.[12] Increase in density, specific surface area and glass transition temperature, which is directly proportional to concentration of Sr in the glass composition.[13]

CONCLUSION

The effects of the oral environment on conventional glass ionomer cement may include dissolution and degradation. Washing and cement formation greatly affect by the chemical composition of glass ionomer glasses. Mass loss was substantially greater during the cement formation process as compared to acid washing.

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