A COMPARATIVE IN-VITRO STUDY ON WEIGHT CHANGE OF CONVENTIONAL GLASS IONOMER, RESIN MODIFIED GLASS IONOMER CEMENT AND COMPOSITE RESIN

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ABSTRACT

Objective: *To compare the weight change of two commercially available variants of each; conventional GIC, RMGIC & resin composite when stored at 100% humidity at mouth temperature (37˚C).*

Materials and Methods: *The samples of Fiji IX, Chemfil Rock, and Fuji plus were allowed to set for 15 minutes. Light cured Fuji II LC were polymerised for 20 seconds, kept in an incubator for 60 minutes and for storage in deionized H2O at temperature of 37°C as per instructions of the company. Weight changes were for all the sample were carried out using an analytical balance at two intervals; Pre and post immersion of samples in the said medium. The weight changes were recorded at 24 hours, 4 days, 1 week, 2 weeks, 3 weeks, and 4 weeks. Surface water was blotted post immersion for every sample and weighed. For all samples the average and standard deviation evaluated & t test stats to see any important differences.*

Results: *At 24 hours, on an average the maximum wt% change was noted for self-cure Fuji Plus (3.350 ± 0.0034%) this weight change was significantly higher when p value was considered significant at 0.05. At 4 weeks the average wt% change remained highest for self-cured rein modified glass ionomer (4.250 ± 0.0049%).*

Conclusion: *RMGIC had maximum variation in weight when stored at 37˚C in deionized water as compared to conventional GIC and dental composite materials.*

Keywords: *weight changes, conventional GICs, RMGICs, Composite Resin*

INTRODUCTION

Glass ionomer cements (GIC) were introduced by Wilson and Kent in 1973 as a replacement for silicate cements. Till date GIC have the stand of being one of the tooth colored, bulk filled, self-adhering and bioactive restorative materials. GIC are the brittle salts form by acid base reaction between organic acid and alkaline glass with innate moisture sensitivity.[1] When the polyalkenoate/ polyacrylic acids and tartaric acid reacts with the fluoroaluminosilcate glasses, the metallic cations like calcium and aluminum help cross link the polyalkenoates.[2] GIC being more of a brittle natured shows insignificant expansion thus more comparable to tooth tissue.[10]

Resin modified glass ionomer (RMGI) are hybrid materials that have dominant acid-base setting reaction second by photo-polymerization of hydrophilic resin. Resin modification of conventional GIC

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was intended to improve mechanical properties.[3] Additionally the resin content renders RMGI longer working time with faster setting, translucent appearance and less microleakage.[4]

Although the composition of RMGI are complex due to modification of poly acids and introduction of photo initiators, they are liable to be more water sensitive. RMGI act like hydrogels cause of hydroxy ethyl methacrylate (HEMA), a component of resin matric. They uptake water during storage in moist environment.[5] The water sorption is associated with potential compensation for polymerization shrinkage and stress relaxation.[6] On the other hand there is a change in the pattern of fracture, a change of being fully brittle to plastic behavior that decreases its compression properties.[11,12]

Literature agree on use of a biomimetic sealants beneath permanent restorations like composites as they have compromised marginal sealing due to its contraction during polymerization.[7,8] GIC is recommended as long term temporary restoration as well as a lining beneath the composites. The RMGIC is replacing GIC due to its added advantage of having resin in its matrix.[9,10] Present study is conducted to assess the effect of storage time on the water sorption of commercially available GIC and RMGIs in comparison to the composites at mouth temperature.

MATERIALS AND METHODS

A total of 35 cylindrical samples were made according to ISO 7486: 1986 with 6 samples in 5 groups. The samples made were of 6mm height and 4mm diameter of each material [14] as listed in table 1. These samples were made in a metal split mould that could be screw adjusted to the specified dimensions. The mould were thoroughly cleaned with acetone/ ethanol followed by rinsing with distal water to remove any impurities or dust particles. The split mold was covered with a glass cover strip in order to obtain a smooth surface.

Sample preparation:

For chemical activated Fuji Plus, Chemfil Rock and Fuji IX a Roto Mix (3M ESPE) was used according to manufacturer instructions specific to each material keeping a temperature for mixing at room temperature (RTP). The mix cement mass was extruded from the capsule into the clean split mould with a help of an extruder. Excess cement was initially removed with help of acetone strip under slight figure pressure. This was immediately followed by application of a metal cover slip with firm pressure under clams. The split mould along with mixed cement, under clamped pressure plates were placed for 15 minutes at 37˚C in an incubator [13].

For the photo initiated Light cured RMGIC samples, polymerization was done for 20 sec (according to manufacturer's instruction). Light emitting diode (LED) of 3M at 1200mW/cm2 was used. Prior to each curing, the LED irradiance was check using radiometer (Demetron-kerr). After removing the samples from the standardized moulds they were stored at 100% humidity incubators for 1 hr.

All the samples were visually inspected for any surface defects, air bubbles trap chipped corners. The defect free samples were tested for weight change.

Weight change test:

All the defect free samples were weighed (Wo) on analytical balance with precession up to 0.001 gms (manufacturers recommendation) (Ohaus Explorer Analytical Balance). These samples were stored in a 50ml centrifuge tube in deionized water at 37˚C [15]. The weight change for samples in each group were measured at six time intervals if 1day, 4days, 1 week, 2 week and 4 week time. Before weighing each sample on particular days, they were blotted by keeping them on filter paper to absorb water present on the surface for 1 minute. Each sample was then re weighed (Wt).

Calculation of weight change in terms of Percentage was done by considering the equation given below [15];

Considering time zone "t" the Percentage weight would be equal to = (Wt – Wo) / Wo x 100

Where; Wo is the primary weight and Wt is at time "t"

Data analysis:

For weight changes simple descriptive percentage analysis were made. The mean and standard deviations were calculated for the GICs and resin composite at a period of 24 hours and 4 weeks (Table 1). The data was analysed using paired t test between the two tested time intervals for the possibility of average percentage weight changes amongst the samples of conventional GICs, RMGICs and resin

composite.

RESULTS

At 24 hours, on an average the maximum wt% change was noted for Fuji Plus (3.350 ± 0.0034%) as shown in figure 7. Values found were very near for the light activated RMGIC (2.780 ± 0.0020%). Quick reduction was observed for both the conventional GICs i.e. Fuji IX (0.820 ± 0.0028%) & Chemfil Rock (0.610 ± 0.00048%). On average minimal percentage weight change was observed for the XRV Herculite Enamel Resin Composite (Table 2). The weight changes were highly significant for all the materials except amongst the two types of GIC (Table 3 for paired T test).

At 4 weeks the average wt% change was highest for self-cured rein modified glass ionomer (4.250 ± 0.0049%) as shown in figure 7. Values observed were very near for the light polymerised resin modified glass ionomer (3.770 ± 0.0040%). After that sudden drop observed by conventional GICs i.e. Fuji IX (1.180 ± 0.0027%) & Chemfil Rock (0.890 ± 0.0015%). Minimal average wt% was observed for dental composite (0.410 ± 0.00055%) depicted in table 2. At 4 weeks the difference in wt% was highly significant amongst the different group of materials; i.e, wt% change was significant when comparing GIC to RMGC (0.001-0.004) or conventional composite (0.00) but no significant when comparing the two GIC used in this study of different suppliers (0.06). Similarly a non-significant wt% change was observed between the two RMGC (0.12) (Table 4 for paired T test). This implies that the observed weight change over 4 week time was dependent on the chemical nature of material type but independent of supplier/ manufacturing variation.

Likewise, substantially significant difference ($P < 0.05$) was observed amongst the times of 24 hours and 4 weeks amongst conventional GICs, RMGICs & resin composite. Similarly less significant difference was observed in between the two type of GIC (0.05/ 0.63) and the light cure RMGIC ($P = 0.08$) after 4 weeks. Chemical cure RMGIC and conventional Composite showed significantly different weight

Table: 1 List all the materials

S. No.	Samples	Available by Commercial nomenclature	Manufacturer/ supplier	Batch No.
1	Conventional GIC	Fuji IX Capsules	GC Japan	01306181
2	Conventional GIC	Chemfil rock	Dentsply Germany	01211000687,01310002004
3	Light Cured RMGIC	Fuji II LC Capsules	GC Corporation Tokyo Japan	1309211, 1304236, 1312040
4	Self-Cured RMGIC with UDMA	Fuji Plus Capsules	GC Corporation Tokyo Japan	1306241
5	Dental composite material	XRV HERCULITE ENAMEL	Kerr	05108402
6	Total-Etch Adhesive	Optibond	Kerr	05114123

Table: 2 Average % Weight Changes conventional GICs, RMGICs & Dental composite at 37°C

Samples	No of Samples	1 day		4 weeks	
		Mean %	Standard Deviation (SD)	Mean %	SD
Fuji IX	Six	0.820	0.002895	1.180	0.002789
Chemfil Rock	Six	0.610	0.000484	0.890	0.001549
Light cured resin modified glass ionomer	Six	2.780	0.002034	3.770	0.004061
Self-cured resin modified glass ionomer	Six	3.350	0.003417	4.250	0.004984
Resin Composite	Six	0.140	0.00071	0.410	0.00055961

Table: 3 T-Test regarding sample's "changes in weight" at 37°C (24 Hours Period)

Group No.	Main Group Description (i)	Comparison Group (j)	Significance
1	Fuji IX	Chemfil rock	0.14
		Light cured resin modified glass ionomer	0.001
		Self-cured resin modified	0.004
		Resin composite	0.00
2	Chemfil rock	Light cured resin modified glass ionomer	0.001
		Self-cured resin modified	0.004
		Resin composite	0.00
3	Light cured resin modified glass ionomer	Self-cured resin modified	0.01
		Resin composite	0.00
4	Self-cured resin modified	Resin composite	0.00

Table: 4 T-Test regarding sample's "changes in weight" at 37°C (4 weeks Period)

Group No.	Main Group Description (i)	Comparison Group (j)	Significance
1	Fuji IX	Chemfil rock	0.06
		Light cured resin modified glass ionomer	0.001
		Self-cured resin modified	0.000
		Resin composite	0.00
2	Chemfil rock	Light cured resin modified glass ionomer	0.001
		Self-cured resin modified	0.004
		Resin composite	0.00
3	Light cured resin modified glass ionomer (24 hr)	Self-cured resin modified	0.12
		Resin composite	0.00
4	Self-cured resin modified (24 hr)	Resin composite	0.00

Table: 5 T-Test regarding sample's "changes in weight" at 37°C between 24 hrs and 4 weeks

T-Test	Fuji IX (24 hrs)	Chemfil rock (24 hrs)	Light cured resin modified glass ionomer (24 hrs)	Self-cured resin modified glass ionomer (24 hrs)	Resin composite (24 hrs)
Fuji IX (4 weeks)	0.050	0.000	0.000	0.000	0.000
Chemfil rock (4 weeks)	0.010	0.630	0.000	0.000	0.000
Light cured resin modified glass ionomer (4 weeks)	0.000	0.000	0.080	0.000	0.000
Self-cured resin modified (4 weeks)	0.000	0.000	0.000	0.010	0.000
Resin composite (4 weeks)	0.020	0.000	0.000	0.000	0.000

Fig 1: Fuji IX

Fig 2: Chemfil Rock

Fig 3: Fuji II Light Cured

Fig 4: Fuji (Self-Cured) Plus

Fig 5: Resin Composite

Fig 6: Bonding Material

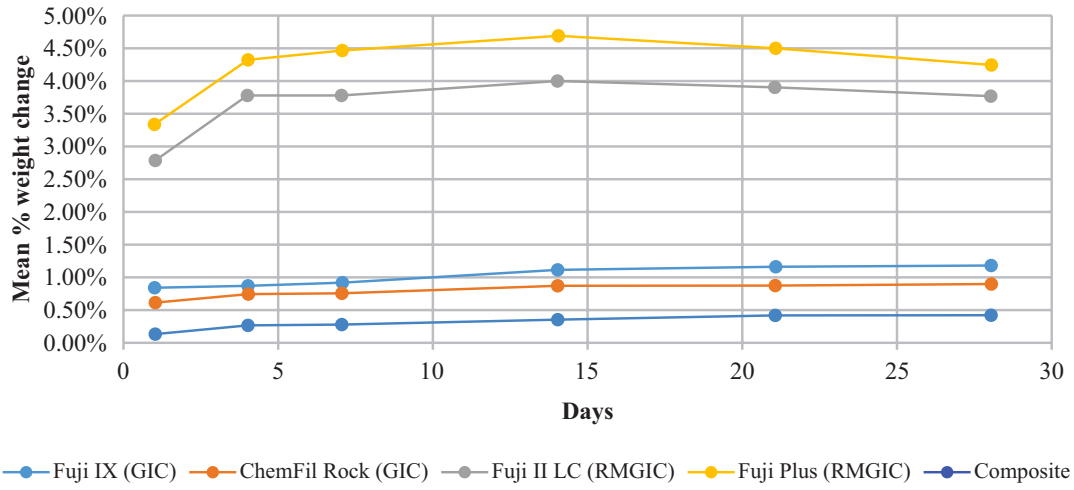

Fig 7: Scatter graph of conventional GICs, RMGICs and Dental composite

changes from the rest of materials as well as an unprecedented different weight change from itself after time 4 week time (Table 5 paired t test).

DISCUSSION

RMGCs in the present study showed highest value of mean weight change at both day 1 and 4 weeks' time. These values were significantly higher than GIC. The present findings are in line with various studies previously conducted by Nicholson, et al.[11] Akashi, et al., 16 Cattani-Lorente, et al.[17] Chan, et al.[18] and Yap.[19] Literature shows that present findings are due to HEMA that absorbs water[16,17] and ultimately lower compressive strength of restoration.[18,19] Results achieved in this study had small standard deviation thus were accurate. But, there were certain limitations in this study when media for test is to be considered. Secondly, complete drying of the specimens could have been achieved by other means and not just blotting with a paper. Sulaiman et al (2019)[20] reasoned that since the solubility and sorption test as defined by ISO 4049 is mainly been proposed for resin containing composites. Although RMGICs have resin but they also have water as by product of chemical reaction. Thus the water sorption and solubility results might give exaggerated results and need extra caution when interpreting.

As oppose to RMGICs, composite showed the least change at both day 1 (0.14%) and 4 weeks (0.41%). A study by Chutinan, et al., (2004)[21] reported that the dental composite immersed in distilled water following a period of 24 hours, 2 weeks, and 8 weeks presented variation in volume. The average values for them were 0.08 %, 0.35 %, and 0.76 % respectively. Accordingly reduction in weight occurs, when non-cured monomer or the particles of fillers are solubilized and leaks out of the specimen in water. As a consequence of leaking out of these constituents, it could primarily effect the clinical behaviour, the optical features of filling, and even the biocompatibility of dental composite. Sideridou, et al., (2007)[22] explained that the bond between filler and the resin matrix is mainly responsible for the phenomenon of aging in water. The filler degradation causes water clustering between filler and matrix that leads to crack formation and propagation through the matrix. This intern reduced the physical properties of the composites. Harhash et al[23] pointed out that composites with variation in each company composition is not only matrix to filler ratios but also the type of resin matrix that can in turn affect the water uptake. The hydrophilicity of different component resins from one another such that TAGDMA being the most, followed by BisGMA and UDMA being the least water loving. According to them it wasn't the time of submersion that effect the weight change but the composition of resin matrix and its amount. Where as in the present study a highly significant change in the weight was observed between 24hr and week 4 (table 5).

A low mean percentage weight change values was observed for Fuji II LC in this study at 1 day and 4 weeks and were 2.78% and 3.77%. Comparison with literature for the present study findings were difficult due to variation in sample dimensions, storage medium, temperature and duration, variation in suppliers and composition etc. Camargo et al (2018), reported 1.7 to 11.7% weight change for various types of GICs in control group within 7 days. Although the two studies varied a lot in methodology still the present study 4 week weight loss is way less as compared to reported literature. Two other studies with similar methodology reported a very high value to weight loss of 8.9% at 1 week 25 and 3.4- 11.3% at 1 day.[17] Reason for such unpredictable and poor reproducible results are contributed to the lack of ISO specific for GICs.[26] This can be confirmed from the present study findings (Table 3, 4 and 5) as the conventional GIC weight change were significant on first day and 4th week from RMGIC as well as composite at mouth temperature. The two conventional GICs in the present study showed non-significant weight changes irrespective of storage time.

CONCLUSION

Though RMGIC are recommended as filling material in pediatric dentistry, in the present In-vitro experiment they had maximum variation in weight when stored at 37˚C in deionized water as compared to conventional GIC and dental composite resin.

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