#079

Fluoride Release into Water for the Riva GIC Products Compared with Competitor Products

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Background:

Following a discussion with Mr Joshua Gheetham "The Operation/ R & D Director of SDI" and Leon Prentice "Product Development Engineer" whom I had the honour of meeting during the 2nd European Conference on GICs which took place in May/04, I was asked "via e-mails" to conduct two experiments on fluoride release. One included using three glass ionomer restorative cements one of which is a new SDI product "Riva SC", while the other was to compare three glass ionomer luting cements: a new SDI luting cement "Riva luting" and two other competitors (Fuji I and Ketac-Cem). Both experiments were carried out at the same time with aim of finishing them and presenting the data "Abstract" at the coming IADR Conference March / 05.

Hypothesis:

The null hypothesis for this study was that there is no significant difference in the amount of fluoride release between all materials tested.

Materials and Methods:

- Plastic moulds were used to make 5 disc specimens (with 15 mm diameter and 1 mm thickness) from each one of the following glass-ionomer restorative cements (**Experiment 1**):
  - Riva SC
  - Fuji IX GP
  - Ketac-Molar

  "The materials were supplied by the SDI"

- All specimens were stored for 24 hrs at 100% humidity and 37°C.

- After lapping, the specimens' measurements and weights were recorded.

- Each disc specimen was placed in a test tube with 3 ml of de-ionised distilled water.

- The storage temperature was 37°C and the storage media were replaced daily. All specimens were rinsed with de-ionised distilled water and dried with soft tissue paper before being placed in fresh solutions.

- A mixture of 3 ml of the storage solutions and 0.3 ml of the total ionic strength adjustment buffer III (TISAB III, Orion Research Inc., Beverly, MA, USA) were prepared and the fluoride ion selective electrode (combination electrode 96-09BN; Orion Research Inc.) attached to an ion meter (model 720A, Orion Research Inc.) to an accuracy of 0.1 ppm, was used to carry out the required fluoride measurements.

- The fluoride measurements were recorded on a daily basis up to a week and then on day 10, 14, 17, 21, 24 and 28.

- At the end of the experiment, the specimens' weights were recorded and the fluoride release was calculated in micrograms / square cm ($\mu g/cm^2$).

The same steps were followed using this time a group of glass ionomer luting cements (**Experiment 2**) as follows:

Riva Luting
- Fuji I GP
- Ketac-Cem

"The materials were supplied by the SDI"

Experiment one: The fluoride release of the glass ionomer restorative cements "Mentioned above".

Results:

Daily fluoride release (µg / cm²):

The daily fluoride release (µg / cm²) from all materials are given and shown in (Table1 and Fig.1). The release was the highest on the first day of the experiment, decreasing gradually with time. Throughout the experiment the daily fluoride release from Riva SC was more than double that of the other two materials.

Table 1

Days	Fuji IX	K-Molar	Riva-SC
1	11.3	9.8	21.8
2	5.3	4.3	14.2
3	4.0	3.0	10.4
4	3.0	2.4	8.4
5	2.6	2.1	7.0
6	2.1	1.8	5.8
7	2.0	1.8	5.2
10	1.5	1.3	3.7
14	1.1	1.1	2.7
17	1.1	1.0	2.5
21	0.9	0.9	2.2
24	0.9	0.9	2.1
28	0.8	0.8	1.8

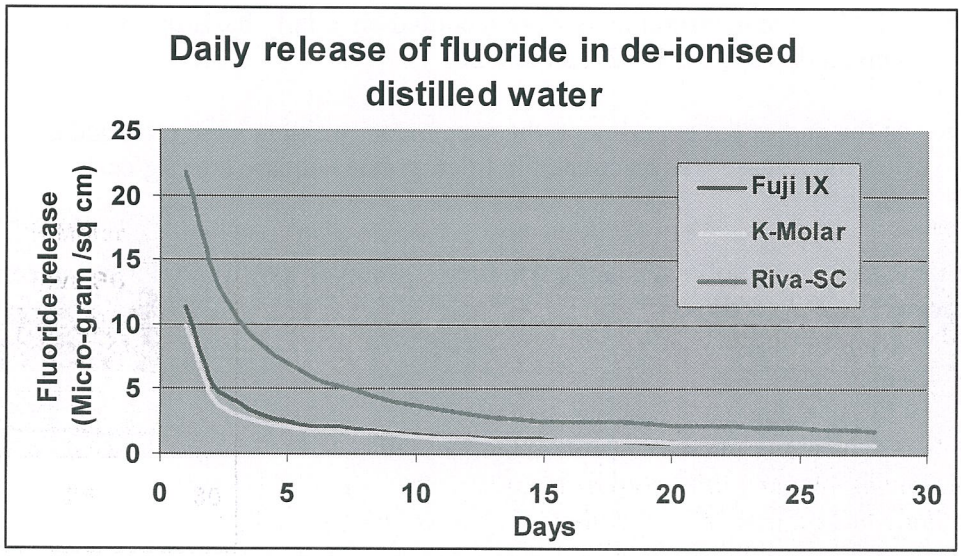

Fig. 1

Cumulative fluoride release (µg / cm²):

Table2, Fig.2 and Fig.3 show the cumulative fluoride release (µg / cm²) from the materials tested. The mean cumulative fluoride release (±SD) from Riva SC (127.8±6.2) was found to be significantly higher than that of both Fuji IX and K-Molar (53.5±3.2) and (46.7±1.9) respectively ($P<0.05$, one way ANOVA and Tukey's pair wise comparison).

The differences in the material composition would be the primary reason behind differences in the various properties of different materials. Changing the amount of different elements in the glass powder and the use of different acids in the liquid component of a material would be factors of prime importance when discussing differences in fluoride release. Compared to the other materials, Riva SC with its low initial pH during the initial reaction plus a newly developed surface treatment for the glass particles might have been the reason behind its high fluoride release.

When the cumulative fluoride release was plotted against square root of time (Fig.4) the release appeared to fall on a straight line except for the first few days for the Riva-SC. It suggests the release to be diffusion controlled for all materials tested except for the first few days for Riva SC which could be a symbiosis of diffusion and dissolutions.

Table 2

Days	Fuji IX	K-Molar	Riva-SC
1	11.3	9.8	21.8
2	16.7	14.2	35.9
3	20.6	17.2	46.3
4	23.6	19.6	54. 7
5	26.1	21.7	61.7
6	28.2	23.5	67.5
7	30.3	25.3	72.6
8	32.0	26.8	77.1
9	33.6	28.2	81.1
10	35.1	29.5	84.7
11	36.5	30.7	88.2
12	37.8	31.9	91.3
13	39.0	33.0	94.3
14	40.1	34.1	97.0
15	41.2	35.1	99.6
16	42.3	36.1	102.2
17	43.4	37.1	104.7
18	44.5	38.1	107.1
19	45.5	39.0	109.5
20	46.5	40.0	111.8
21	47.5	40.9	113.9
22	48.4	41.8	116.1
23	49.3	42.7	118.2
24	50.2	43.5	120.2
25	51.0	44.3	122.2
26	51.9	45.1	124.1
27	52.7	45.9	126.0
28	53.5	46.7	127.8

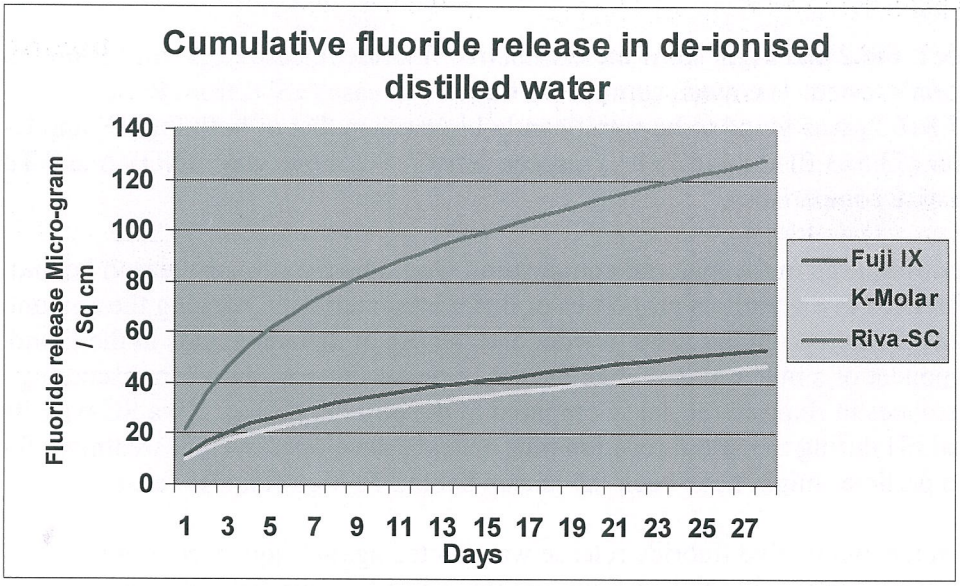
Cumulative fluoride release in de-ionised distilled water
Fluoride release Micro-gram / Sq cm
140
120
100
80
60
40
20
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27
Days
Fuji IX
K-Molar
Riva-SC

Fig. 2

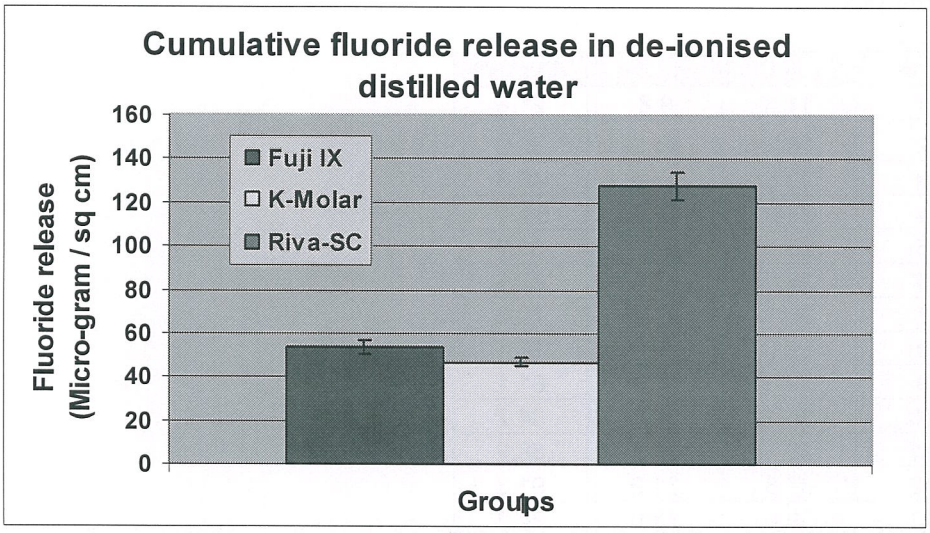
Cumulative fluoride release in de-ionised distilled water
Fluoride release (Micro-gram / sq cm)
160
140
120
100
80
60
40
20
0
Fuji IX
K-Molar
Riva-SC
Groups

Fig. 3

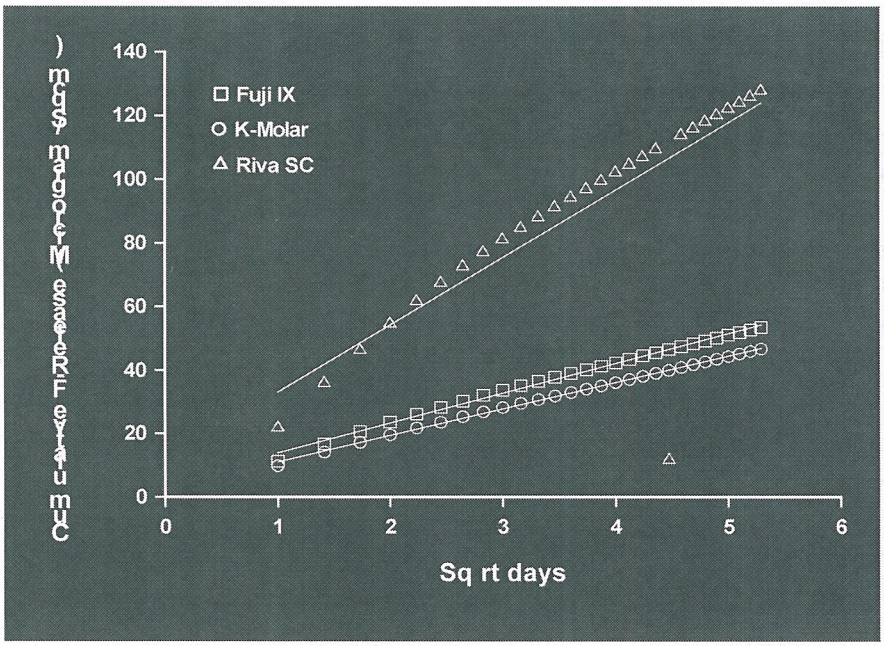

Fig. 4

Change in weight (mg):

In this experiment, when the weight measurements were carried out at the end of the experiment (Table3 and Fig.5) all the specimens experienced an increase in weight. Regression analysis of the weight gain against the cumulative fluoride release showed a significant positive relation (ANOVA, $P<0.05$ and R-sq=31%).

Table 3

	Fuji IX	K-Molar	Riva-F
Mean	6.38	5.24	6.72
SD	0.62	0.41	0.83

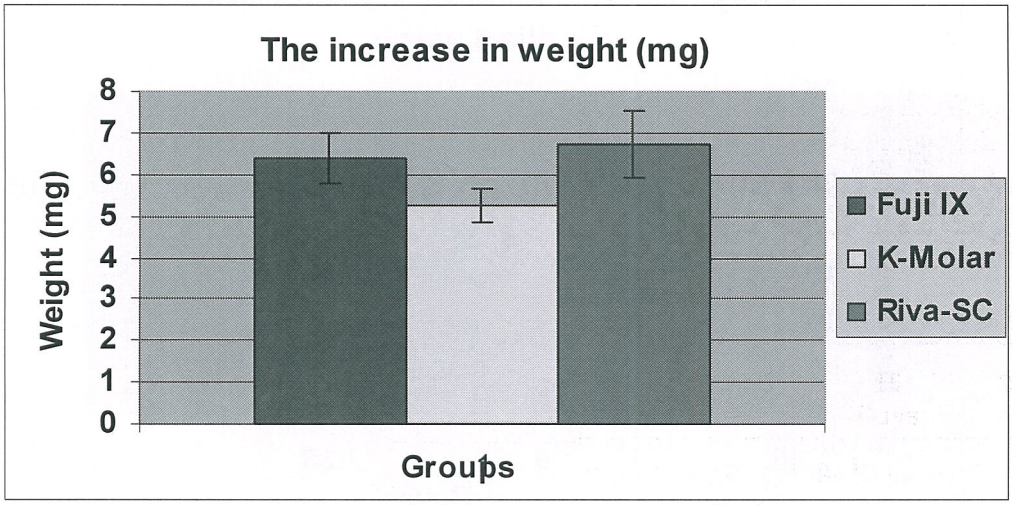

Fig. 5

Experiment two: The fluoride release of the glass ionomer luting cements "Mentioned in the materials and methods".

Results:

Daily fluoride release (µg / cm²):

The daily fluoride release (µg / cm²) from all luting materials tested are shown in (Table4 and Fig.6). The release was the highest on the first day of the experiment, decreasing gradually with time. Throughout the experiment the fluoride release from Riva L was found to be higher than both Fuji I and K-Cem luting materials.

Table 4

Days	Fuji I	K-Cem	Riva-L
1	25.9	28.9	32.8
2	14.6	18.0	22.2
3	10.8	12.9	17.1
4	8.9	10.3	14.4
5	7.7	8.8	12.9
6	6.7	7.5	11.3
7	6.3	7.0	10.7
10	5.0	5.5	8.5
14	3.9	4.3	6.8
17	3.7	4.1	6.2
21	3.1	3.6	5.4
24	2.9	3.3	4.9
28	2.6	2.9	4.2

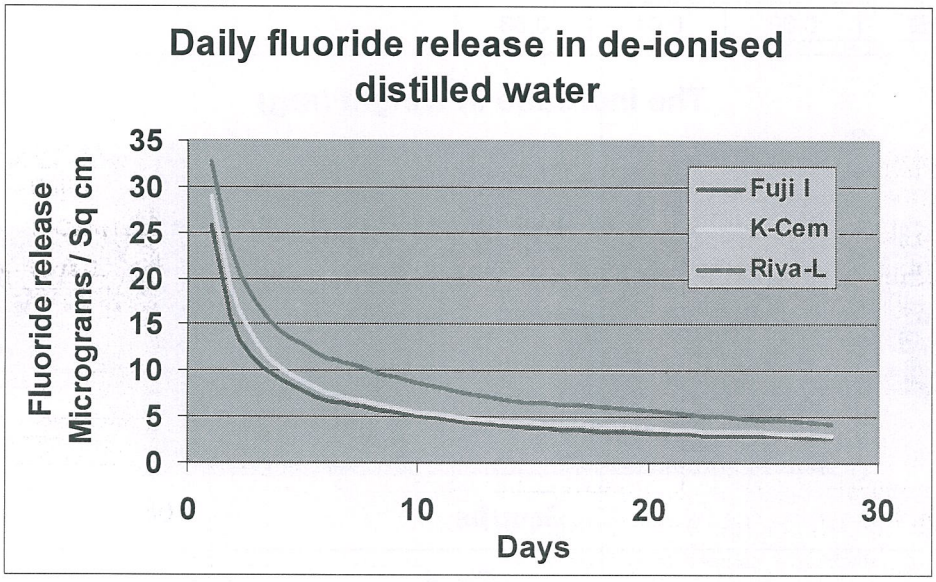

Fig. 6

Cumulative fluoride release (µg / cm²):

Table5, Fig.7 and Fig.8 show the cumulative fluoride release (µg / cm²) from the materials tested. The mean cumulative fluoride release (±SD) from Riva L (252.9±8.5) was found to be significantly higher than that of Fuji I (180.0±5.2) which in turn was significantly higher than K-Cem (148.2±5.1), ($P<0.05$, one way ANOVA and Tukey's pair wise comparison).

When the cumulative fluoride release of all the materials tested was plotted against square root of time (Fig.9) the release appeared to fall in a straight line for all the materials. It suggests the release to be diffusion controlled.

Table 5

Days	Fuji I	K-Cem	Riva-L
1	25.9	28.9	32.8
2	40.5	46.9	55.0
3	51.3	59.8	72.1
4	60.3	70.1	86.4
5	68.0	78.9	99.3
6	74.7	86.4	110.6
7	81.0	93.4	121.3
8	86.6	99.7	130.9
9	91.9	105.6	139.9
10	96.9	111.1	148.5
11	101.6	116.3	156.5
12	106.0	121.2	164.2
13	110.1	125.8	171.4
14	114.1	130.2	178.2
15	117.8	134.4	184.7
16	121.6	138.5	191.0
17	125.2	142.6	197.3
18	128.7	146.6	203.3
19	132.1	150.4	209.1
20	135.3	154.1	214.7
21	138.4	157.6	220.1
22	141.4	161.1	225.2
23	144.4	164.4	230.2
24	147.3	167.8	235.1
25	150.2	171.0	239.8
26	152.9	174.1	244.3
27	155.6	177.1	248.7
28	158.2	180.0	252.9

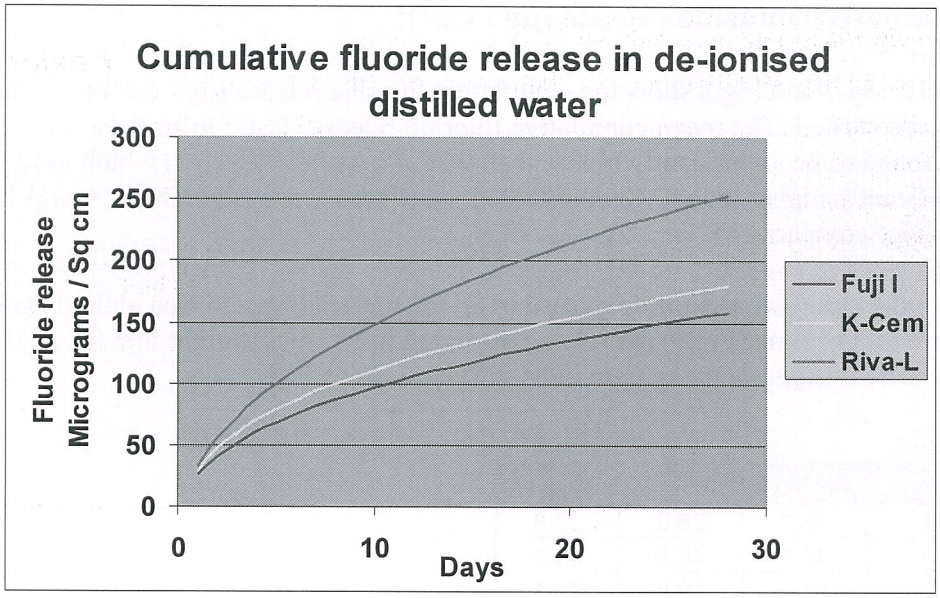
Cumulative fluoride release in de-ionised distilled water
Fluoride release Micrograms / Sq cm
300
250
200
150
100
50
0
0
10
20
30
Days
Fuji I
K-Cem
Riva-L

Fig. 7

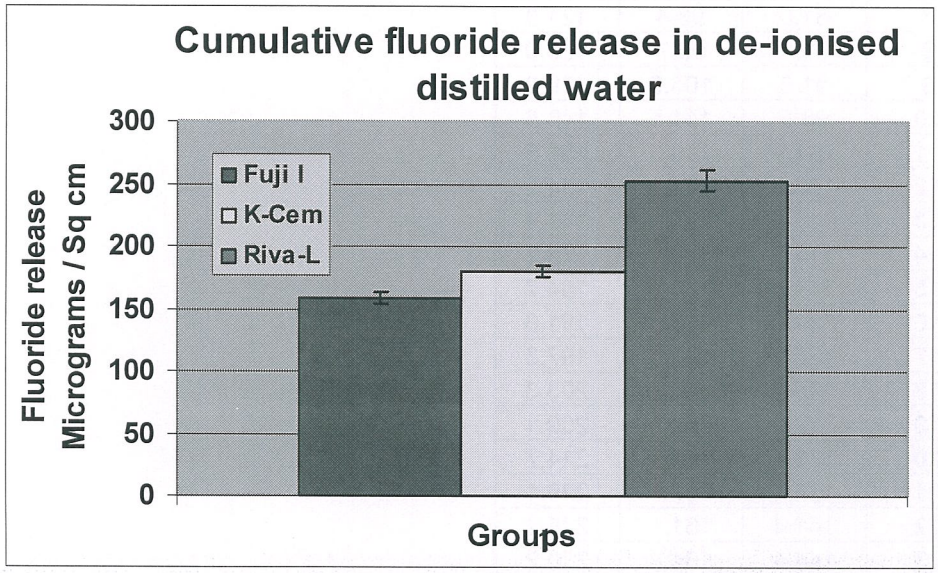
Cumulative fluoride release in de-ionised distilled water
Fluoride release Micrograms / Sq cm
300
250
200
150
100
50
0
Fuji I
K-Cem
Riva-L
Groups

Fig. 8

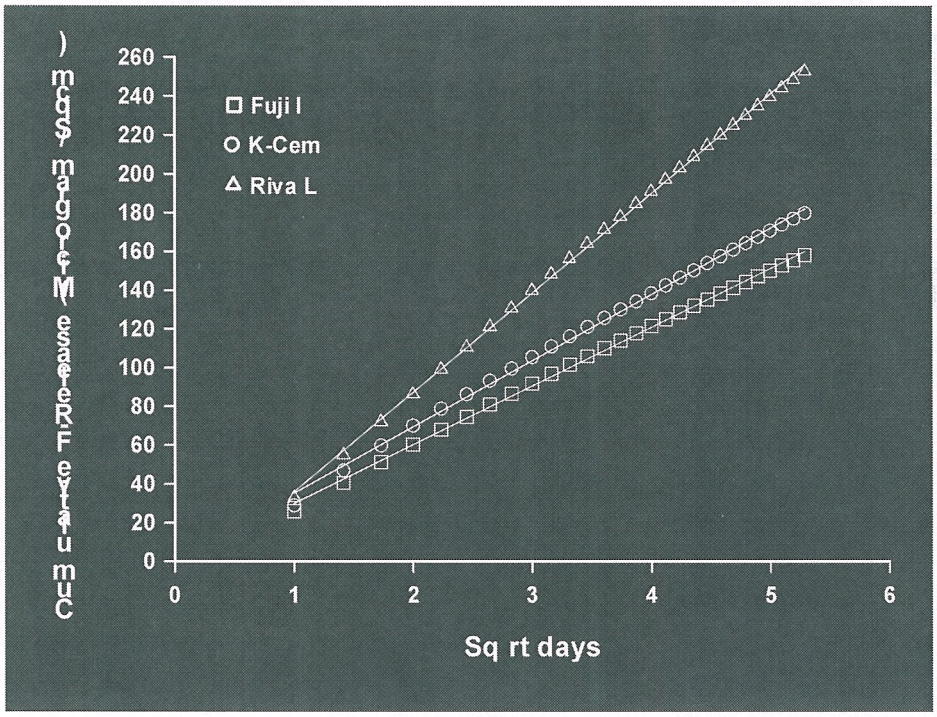

Fig. 9

Change in weight (mg):

The weight measurements were carried out at the end of the experiment. All the specimens experienced a mean increase in weight (Table6 and Fig.10). Regression analysis of the weight gain against the cumulative fluoride release showed a significant negative relation (ANOVA, $P<0.05$ and R-sq=64.8%).

Table 6

	Fuji I	K-Cem	Riva-L
Mean	4.62	5.1	3.16
SD	0.08	0.43	0.69

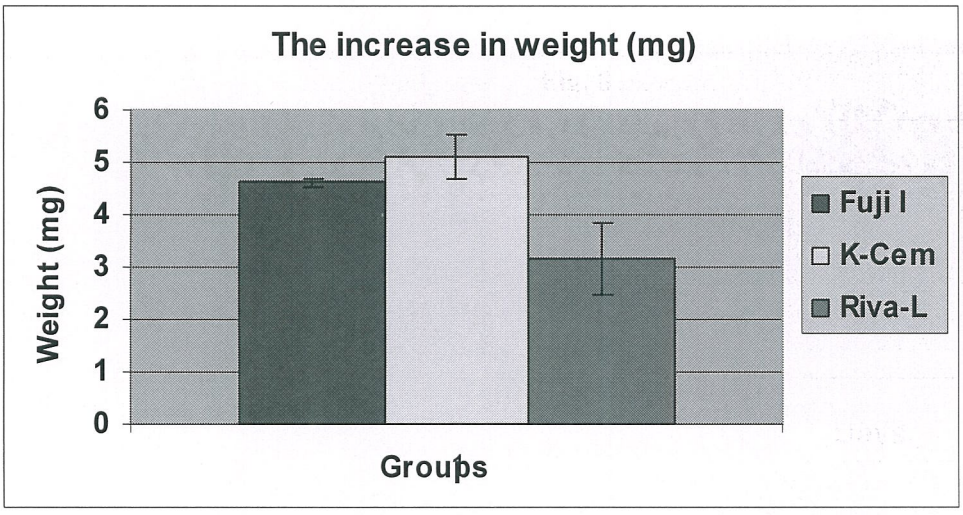

Fig. 10

Conclusions:

Both Riva glass ionomer cement materials released significantly greater amounts of fluoride than the other materials tested.

The newly developed powder formulations, powder surface treatment and the low initial pH of the setting reaction may have produced the high fluoride release of both Riva SC and Riva Luting GICs.