VARIA

In vivo disintegration of luting cements

Bashir M. Saad, Toros Alcan

Istanbul, Turkey

Summary

The aim of this study was to evaluate the 3-month in vivo disintegration rate of 4 different types of luting cement, multi cure glass ionomer orthodontic band cement (3M Unitek Monrovia, USA), composite resin (ultra band-lok - Reliance ortho product), transbond plus light cure band adhesive (3M Unitek), and MR lock LC visible light cure band cement (American orthodontics). Headgear tubes (1.2 mm in diameter and 3 mm in length) were filled with the cements (one cement for each tube) and the tubes were placed on the four first molar orthodontic bands.
Nine patients, 6 females and 3 males with a mean age of 15.6 years, were selected for this study. All patients had fully erupted no-caries permanent first molars.
Although two of the tested cements (multi cure glass ionomer cement and MR LOCK LC) showed variable amount of vertical cement loss and the other two tested cements (ultra band lok and transbond plus) showed variable amount of swelling, analysis of the disintegration rate with one-way ANOVA test demonstrated no significant difference existing between the tested cements. Also, application of paired t test to determine the effect of the location on the disintegration rate was not significant.

Keywords: disintegration, luting cement, solubility.

Introduction

Dental cements in general are employed as cementing (referred to as luting) agents for fixed cast restorations or orthodontic bands, as thermal insulators under metallic restorations, for temporary or permanent restorations, as root canal sealants, and for pulp capping.

Certain other cements, however, are used for specialized purposes in the periodontology and surgical fields of dentistry.

When the properties of dental cements are compared with those of other restorative materials such as amalgam, gold or porcelain, the cements are seen to exhibit less favorable strength, solubility and resistance to the conditions within the oral cavity. As a result the general use of cements for restoration exposed to the oral environment is quite limited. [1]

From the proceeding part it is obvious that the main application of dental cements is luting. Therefore in this study particular emphasis will be placed on the dental cements as luting agents in orthodontic banding.

There are certain criteria for luting cements in terms of being ideal:

1. The cement should have a certain compressive strength because the retention of crown, inlay, or bands is directly related to the compressive strength.
2. All cements should have film thickness of 25 micrometer. If they do not it may be too thick.
3. It should not cause harm to the pulp and adjacent gingival tissues.

4. It should be easy to manipulate.
5. Should have long working time with rapid set at oral temperature.
6. Should have high proportional limit.
7. Should be adhesive to tooth structure and metals.
8. Should have anti-cariogenic properties.
9. Should be translucent and radiopaque. [2,3,4,5,6].

The most important aims of luting cements in orthodontics are to prevent the bacteria and oral fluids from penetration to the enamel surface as well as retention of the orthodontic band in position without failure.

The following cements are the most often used luting cements in orthodontics as well as in fixed prosthodontics [7]:

- Zinc phosphate cements
- Zinc polycarboxylate cements
- Glass ionomer cements
- Resin cement
- Hybrid ionomer cements
  - Resin modified glass ionomer cements
  - Polyacid modified resin cements

According to ADA specification No. 8, the mechanical and physical properties of the luting cement should have the following values:

	Setting time (min)	**Compressive strength 24 H MPa**	**Film thickness μm**	**Solubility in H2O (% in 24 hours)**
Luting cement	5 Min 9 Max	68.7	25	0.01-0.2 %

Probably the property of greatest clinical significance is the solubility and the disintegration of the cement. This property is one of the most important considerations in use and selection of any dental material. In fact, solubility of the cement is of utmost signification in cementation of the appliances.

Other than errors in the cementation procedure, cement solubility is probably the main factor contributing to caries around the appliances. Every precaution must be taken to produce an accurately fitting appliance that minimizes the layer of exposed cement and then to handle the material in such manner that its solubility is as low as possible.

Solubility is measured by immersion of a cement disk in distilled water for 25 hours, in accordance with ADA specification No. 8. The specimen is then removed, the water evaporated, and the weight of nonvolatile solubility products determined. In this test the maximum allowable solubility for zinc phosphate cement is 0.2 %.

Studies indicated that all cements except resin are soluble in the oral cavity. Solubility of zinc phosphate cement and polycarboxylate cement are high and increase by time.

Glass ionomer cements are evidently less soluble than conventional cements in optimal condition, although clinical studies show that cementation of the appliances with glass ionomer cement have more marginal defect than appliances cemented with zinc phosphate cement. This situation may be due to the sensitivity of the glass ionomer cement to moisture in early period.

Moisture sensitivity of glass ionomer cement in the early period is due to two reasons [7]:

1. When water exists, the calcium and aluminum ions may be removed from the matrix.
2. Sodium ions and anions form (salt soluble in water).

If this happens, the resulting set cement is more soluble and weak in physical properties. Because of this sensitivity it is recommended that the margins of the appliance should be covered with water resistant gels, to prevent the early contamination in the early stage of setting. Also, to overcome these problems, new brands of glass ionomer cements are marketed; in these cements, the liquid is dried up and added to powder, and distilled water is used as the cement liquid.

Solubility is also affected by powder-liquid ratio; clinical study of the solubility of three powder-liquid ratios of polycarboxylate cement demonstrated a threefold increase in the solubility for the lower powder-liquid ratios.

In general, the solubility of the luting cements in dilute organic acids is much higher than in distilled water and it increases when the pH of the medium is lowered.

History of the in vivo cement solubility

Norman, in 1969 [8,9] started an *in vivo* research by filling a relatively large window on the lingual side of lower frame prosthesis, worn during 30 days by 8 patients. Every few days the appliances were weighed and the loss of cement calculated in mg.cm².

In this research three types of cements were evaluated: silicate cement, zinc phosphate cement and zinc oxide eugenol cement.

1. Silicate cement proved nearly insoluble in this period;

2. The loss of zinc phosphate cement varied from 5-30 mg.cm²;

3. The loss of zinc oxide eugenol varied from 20-100 mg.cm².

Richter and Ueno, in 1975 [10] filled holes (approximately 3 mm in diameter and 2 mm deep) in the pontic of bridge with silicophosphate, a zinc phosphate, a zinc polycarboxylate and a zinc oxide eugenol-EBA cement. Impression of the cement surfaces were made at the start and after one year, silver-plated and photographed. The ranking was done by comparison. In this research, silicophosphate cement was the most durable cement, followed by zinc phosphate cement; the two other cements ranked even.

Osborne, in 1978 [11] filled small holes (0.82 mm in diameter, 1.5 mm deep) in crowns of 15 patients with the same cements and measured cement loss directly with a micrometer after six months. In this research, the average depth of loss was: 7.6 μm for silicophosphate cement, 43 μm for polycarboxylate cement, and 127 μm for zinc phosphate cement. Zinc oxide eugenol cement disappeared almost completely.

Mitchem and Groans, in 1978 [12] placed the same cements, plus for the first time glass ionomer cements, in the sample holders with holes (2 mm in diameter, 2 mm deep) fitted in denture and worn by 10 patients. After six months an impression of the sample holder surface was made and measured directly with a micrometer. The amount of cement loss ranged from 200 micrometer for glass ionomer cement, 350 micrometer for silicophosphate cement, 600 micrometer for zinc phosphate cement to 930 micrometer for polycarboxylate cement.

In 1981 Mitchem and Groans [13] repeated the experiment with more glass ionomer, silicophosphate and zinc phosphate cement. The result was comparable to the first study.

Sidler and Strub, in 1983 [14] tested two glass ionomer and one zinc phosphate cement by filling small holes (0.8 mm in diameter, 3 mm deep) in mesio-distal inlay on wisdom teeth. After 14 months, teeth were extracted and the depths of the holes were calculated by measuring three points on the edge of each hole and three points on the bottom. The result was 500-micrometer cement loss for zinc phosphate cement, 100-micrometer loss for one brand of glass ionomer cement and 40 micrometer loss for the other.

Mesu and Reedijk, in 1983 [15] compared one zinc phosphate, one polycarboxylate, one fortified zinc oxide eugenol and two glass ionomer cements in vitro as well as in vivo. In this study round plane parallel glass plates (7 mm in diameter) were cemented upon stainless steel bottom plates. 20 micrometer of cement layer was exposed to the oral cavity. In this study zinc oxide eugenol showed the highest and glass ionomer cement the lowest dissolution rate.

L. J. Pluim et al, in 1984 [16] measured the disintegration rate of glass ionomer cement and zinc phosphate cement. In this study cement samples were placed in the holes (1.3 mm in diameter and 3 mm depth) on the enamel surface of freshly extracted bovine incisors located on the side of full prosthesis and worn in the mouth for up to 6 months. In this study the solubility rate of glass ionomer cement was 2 micrometer per week and 80 micrometers for zinc phosphate cement, after 3-6 weeks.

Ralph W. Phillips et al, in 1987 [17] filled wells (0.8 mm in diameter and 0.9 to 1.3 mm depth) placed on the full crown restoration of 20 patients, four on the mesial surface and four on the distal surface, worn during 12 months. Measurements were done at 6 and 12 months. The cements tested were glass ionomer cement, zinc phosphate cement, silicophosphate cement, and polycarboxylate cement. They found that during a 12-month period, glass ionomer and silicophosphate cement showed the lowest rates of disintegration, followed by polycarboxylate cement prepared with a high powder-liquid ratio. Zinc phosphate cement showed significantly more disintegration than the other three cements.

J. W. Osborne and M. S. Wolff, in 1991 [18] filled holes prepared on the mesial and distal surfaces of a single unit-cast restoration with three different powder/liquid ratio of durelon polycarboxylate cement (1.5:1, 1.25:1 and 1:1). After 6 months they found that the highest solubility was at 1:1 powder/liquid ratio and they suggested that the higher powder/liquid ratio 1.5:1 is preferable when minimal solubility is a primary requirement.

As observed in literature, the solubility studies were done in oral environments with fixed or removable prosthesis, but not fixed orthodontic appliances. Since the orthodontic bands exist in mouth together with braces or other types of fixed appliances, the solubility of band cement should be tested in such an environment. So, the aim of our study is to test the solubility of 4 different band luting cements in oral environments with fixed orthodontic appliances.

Materials and Method

Luting Cements:

Four different types of light-activated luting cements were selected for clinical comparison in this study.

1. Multi cure glass ionomer orthodontic band cement:

(3M Unitek Monrovia. USA REF 712-051)

It is a two-part, powder/liquid glass ionomer cement for orthodontic banding. The powder consists of a radiopaque, fluoroaluminosilicate glass. The liquid is a light sensitive, aqueous solution of a modified polyalkenoic acid. The chemical properties of the glass ionomer cements in general are such that fluoride leaches out from the material. It has a cherry flavor and it will set by exposure to visible light. MCGIC has both light and chemical curing property, and adheres to the tooth structure chemically and mechanically. 40 seconds are needed for light curing while 5 minutes are required for chemical curing.

2. Ultra band-lok:

(Reliance Ortho. USA REF - UBLP 1-800323-4348)

Ultra Band-Lok, light-cured glass ionomer cement, requires no mixing and, unlike most dual-cure composites, provides significantly extended working time when needed. This allows more accurate band placement as well as easier removal of excess cement.

Ultra Band-Lok, which is available in either a tooth-color or a blue paste, is a compomer cement that releases fluoride. The blue paste contrasts with the enamel surface to make cleanup even easier. Ultra Band-Lok can also be used to bond brackets, lingual retainers and large acrylic appliances. When bonding these appliances, you must first etch the enamel surface. It is a unique combination of resin and glass ionomer technology.

3. Transbond plus light cure band adhesive:

(3M Unitek Monrovia. USA REF 712-080)

It is a single paste, no mix adhesive with a rapid 30 second set time to reduce the risk of moisture contamination. Furthermore, Transbond Plus banding adhesive contains and releases fluoride, and has the ability to replenish its fluoride ions when exposed to other fluoride containing systems like fluoride-containing water or toothpaste. As a single paste, the major advantage of Transbond Plus light cure band adhesive is the elimination of mixing, resulting in reduced clean-up, more consistent adhesive performance, increased office efficiency, and less chair time.

4. MR LOCK LC visible light cure band cement:

(American Ortho. Sheboygan USA REF 001-975)

It is visible light cure one-step band cement. Smooth flowing and fluoride releasing Direct-to-band capsules provide accurate cement placement and can be recapped for future use.

Bands:

36 stainless steel orthodontic molar bands (3M Unitek dental product Monrovia, CA 91016 USA) with headgear tubes which were cemented to the upper and lower first molars of 9 patients (3 males and 6 females) were used in this study. The upper molar bands had preadjusted headgear tubes (1.2 mm in diameter and 3 mm in depth), while same size headgear tubes were soldered to the buccal surfaces of the lower bands, and these tubes were used as the sample holders.

Patients were selected according to the following criteria:

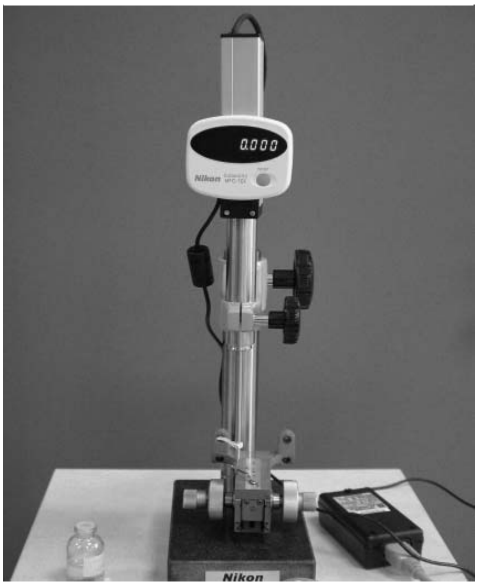
1. Fully erupted upper and lower permanent first molars without any signs of demineralization or caries;
2. Who are not indicated for headgear or lip bumper treatment;
3. Good oral hygiene;
4. Highly cooperative.

Measuring device:

Digital height gauge (DIGIMICRO MF-501 NIKON. USA) (*Figure 1*) is a compact digital micrometer with measuring length equal to 50 mm and accuracy of 1 micron at 20 ºC, and can read as small as 0.1 micron or even 0.01 micron, depending on the counter (MFC-101 or TC-101). Digimicro can operate at temperature ranged from 0-40 ºC with response speed of 500 mm/sec or less. Two measuring forces can be used, down direction 115 to 165 gf (variable to about 30 gf); lateral direction 65 to 125 gf.

At the first appointment, separating elastics were placed mesially and distally to the first permanent molars and left in situ for 3 days before the placement of bands. At the second appointment, stainless steel orthodontic first molar bands were selected and carefully adapted to the crown of each tooth. After the bands with headgear tubes had been fitted on the tooth and pressed firmly into place, they were removed from the patient mouth, cleaned with water and cotton wool rolls, and dried with an air syringe. Once the bands had been selected accurately, cements were mixed, filled into the tubes and light-cured according to the manufacturer's instruction.

Figure 1. Digital height gauge (DIGIMICRO MF-501 NIKON. USA)



Cements were placed inside each headgear tube until the tube was over filled. When the cements were hardened, the surfaces were finished as flush as possible with the surface of the metal at the periphery of the headgear tube by using a waterproof adhesive paper (P 220 eagle) which is coated with uniform, well-prepared abrasive grain to assure the best possible finishes. It has a sharp cutting edge, which provides faster and cooler sanding.

Before cementation, the tooth was checked for complete dryness and bands were cemented with multi cure glass ionomer cement and positioned with a band seater. Excess cement was wiped from the margins with a cotton roll and the occlusal surface was exposed to visible light for 40 seconds with a light gun.

For every patient, four bands were cemented on the upper and lower first permanent molars. Each headgear tube of these bands was filled with one type of the tested cements. In all cases upper and lower bands were placed at the same visit.

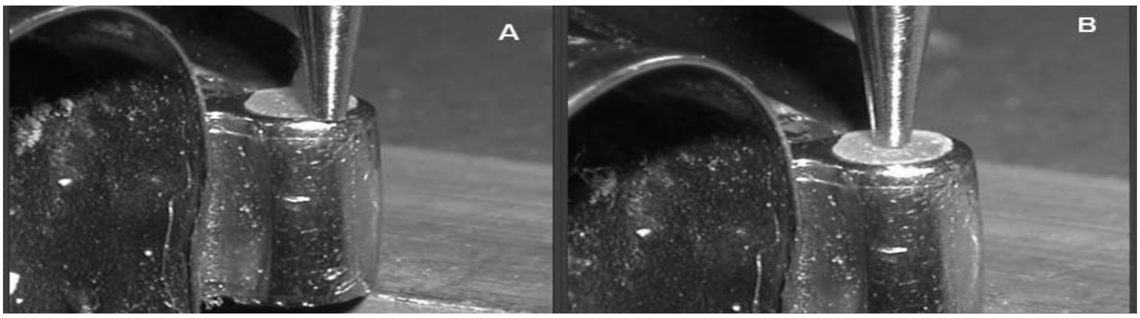
After three months of band placement all the patients were called for band removal. The bands were removed carefully to avoid any damage to the tested cements by using band remover; all bands were brushed and cleaned by smooth dental brush under water, dried by air syringe and placed in glass bottles which had been filled by distilled water for 24 hours.

The bottles were labeled by the patient's name and the location of cement (eg: UL = Upper left). Then the specimens were taken out from the bottles one by one for measurements.

Digital height gauge was used as our measuring device as the following method indicates.

The edge of the headgear tube was taken as the reference point for the measurement and the measuring machine was adjusted and calibrated accordingly (*Figure 2A*). On this reference point the measuring machine reading was zero microns, and then three measurements (to minimize the measurement error) were recorded on the cement surface of all kinds of the tested cements at room temperature (*Figure 2B*). For every measurement calibration was repeated and the reference point was taken into consideration.

Figure 2. A) Calibration of measuring device on the edge of the molar tube
B) The surface measurement of the cement in the molar tube



Results

The data were first examined by means of paired t test to determine if a difference existed in the disintegration rate of specimens of individual cement as compared to location, such as upper tubes compared with lower tubes. No significant difference was found for any of four cements.

The vertical cement loss (μm) measured for 4 different cements tested is shown in *Table 1*. In this table, the negative values indicate a loss of the substance and positive values indicate a gain in the volume of the material. It can be seen that from the 36 specimens of tested cements, 20 specimens showed an initial swelling, this effect could be water absorption and 16 specimens showed vertical cement loss.

Table 1. Vertical cement loss (μm) measured for 4 different tested cements.

Cement type	Pt	Measurement 1	Measurement 2	Measurement 3	Mean
GLASS IONOMER CEMENT	1	-.0970	-.0760	-.0930	-0.0886
	2	-.1080	-.1090	-.0880	-0.1016
	3	.0100	.0080	.0440	0.0206
	4	-.0270	-.0180	-.0240	-0.0230
	5	-.0060	-.0040	-.0020	0.0026
	6	-.0370	-.0330	-.0300	-0.0330
	7	.0010	.0020	.0010	0.0013
	8	.0840	.0900	.0890	0.0876
	9	.0390	.0410	.0440	0.0413
MR-LOCK LC-BAND CEMENT	1	-.0590	-.0780	-.0870	-0.0746
	2	.0920	.1010	.0990	0.0973
	3	-.0900	-.0590	-.0600	-0.0696
	4	.0330	.0330	.0300	0.0320
	5	-.0320	-.0210	-.0310	-0.0280
	6	.0400	.0450	.0440	0.0430
	7	-.0170	-.0190	-.0200	-0.0186
	8	.0020	.0070	.0060	0.0050
	9	.0090	.0110	.0140	0.0113
TRANSBOND PLUS CEMENT	1	-.0640	-.0640	-.0700	-0.0660
	2	.0970	.1030	.1110	0.1036
	3	.1140	.1210	.1300	0.1216
	4	-.0530	-.0490	-.0520	-0.0510
	5	-.0320	-.0290	-.0280	-0.0296
	6	.0040	.0040	.0020	0.0030
	7	.0050	-.0010	.0010	0.0060
	8	-.0060	-.0010	-.0050	-0.0040
	9	-.0600	-.0500	-.0900	-0.0667
ULTRA BAND-LOK	1	-.1040	-.0950	-.0920	-0.0970
	2	.0360	.0410	.0570	0.0446
	3	.0150	.0170	.0220	0.0180
	4	.0550	.0300	.0330	0.0393
	5	-.0460	-.0480	-.0440	-0.0460
	6	.0440	.0420	.0390	0.0416
	7	.0410	.0470	.0430	0.0436
	8	.0160	.0110	.0120	0.0130
	9	.0080	.0070	.0120	0.0090

For multi cure glass ionomer cement, 5 specimens showed vertical cement loss and 4 specimens showed expansion.

For ultra band-lok cement, 3 specimens showed vertical cement loss and 6 specimens showed expansion.

For transbond plus cement, 4 specimens showed vertical cement loss and 5 specimens showed expansion.

For MR LOCK LC cement, 5 specimens showed vertical cement loss and 4 specimens showed expansion.

The mean disintegration rate of 4 cements as based on the vertical loss of materials after 3 months are compared in *Table 2*.

Multi cure glass ionomer cement showed more vertical cement loss than the other tested cement but not significant.

Then the data were subjected to one-way ANOVA. Although there were variable amounts of vertical cement loss and variable amounts of swelling between the participants, one-way ANOVA showed no significant difference between the tested materials. The statistical analysis is summarized in *Table 3*.

Table 2. Mean values of vertical cement loss

Cement type	No	Minimum	Maximum	Mean	Std. deviation
Multi cure Glass Ionomer Cement	9	-.1016	.0876	-0.010	0.0598393
Ultra Band-lok	9	-.0970	.0046	0.00734	0.0484493
Transbond Plus	9	-.0660	.1216	0.0171	0.0667947
MR Lock LC	9	-.0746	.0973	-0.00041	0.0547928
Valid N (listwise)	9				

Table 3. ANOVA test

	Sum of squares	df	Mean square	f	Sig.
Between groups	0.003644	3	0.001215	.363	.780
Within groups	.107	32	0.003348		
Total	.111	35			

Discussion

The solubility of cements in the oral cavity has long been considered as a primary cause of failure of bands and/or cast restorations, contributing to white spots, recurrent caries and finally loss of retention.

Because of the relatively poor correlation of *in vitro* solubility tests to *in vivo* solubility, especially when comparing different cement systems, it becomes imperative to evaluate new and improved cements for solubility and disintegration in a clinical environment.

This study appears to present a means of evaluating clinical solubility under oral conditions that are very close to clinical orthodontic usage.

This method appears to afford several advantages. These are:

1. Several materials can be tested simultaneously in the same patient; thus the variable differences in the environment condition is reduced;

2. The problem of patient acceptance and cooperation, which often arises with use of removable appliances, is eliminated;

3. Direct measurement of the vertical cement loss is easily accomplished, repeated and recorded.

One precaution in employing this test is to exercise care in the insertion of the cement into the tube to avoid the trapping of voids and bubbles.

The only disadvantage of our method is that we have to remove the bands for the measuring procedure.

In this study nine patients – 6 females and 3 males – were selected from clinical intake of orthodontics department, four different types of luting cements were inserted for every patient. For this reason the upper head gear tube (1.2 mm in diameter and 3 mm in length) was cut and soldered to the buccal surface of the lower anatomically stainless steel orthodontic band to simulate the tube as that placed on the upper one.

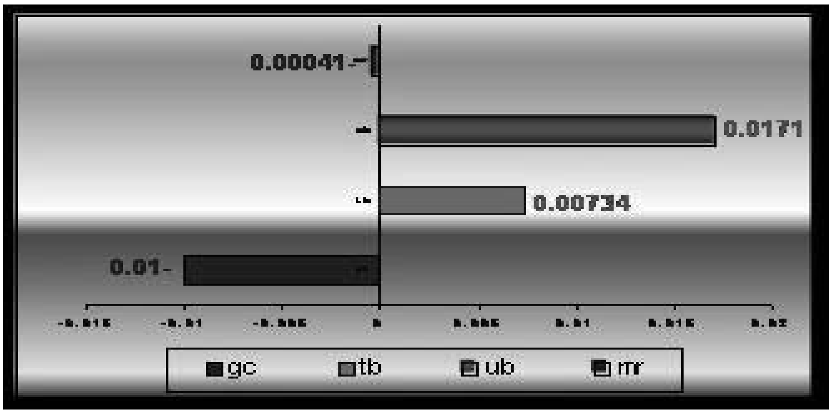
From the total of 36 tested cements, five specimens of multi cure glass ionomer cement were inserted into the headgear tubes of the upper bands and four specimens were inserted into the headgear tube of the lower bands. Five specimens of ultra band lok cements were inserted into the upper headgear tubes and four specimens were inserted into the lower tubes.

Four specimens of transbond plus cement were placed on the upper tubes and five specimens were placed on the lower tubes. Four specimens of Mr Lock LC cement were placed on the upper tubes and five on the lower tubes. This was done to determine the effect of the location on the disintegration rate of the luting cement.

After three months of band placement, all the specimens were removed and stored in distilled water for 24 hours. Then with the use of digital height gauge measuring device, all measurements were taken and recorded. For every specimen three measurements were taken and the mean of these three measurements was calculated and recorded to minimize the measurement error.

For every specimen, the first measured point was the reference point at the edge of the headgear tube (*Figure 3*), which was calibrated at Zero level on the digital height gauge measuring machine. After those three measurements, the surface of each specimen was measured and recorded, and the reference point was taken in consideration for every measured point.

Figure 3. Showing the mean values of vertical cement loss for the tested cements



gc represents multi cure glass ionomer cement; **tb** represents transbond plus cement
ub represents ultra band lok cement; **mr** represents MR LOCK LC cement

As in the previous published studies [10,12,15,19,20,21,22,23,24] it became obvious when evaluating the data that some patients produced more loss of cement than the others. However, the order of cement loss within each patient remained fairly constant.

A total of 9 specimens of multi cure glass ionomer cement, 5 specimens (3 in the upper tubes and 2 in the lower tubes) showed vertical cement loss and 4 specimens (2 in the upper tubes and 2 in the lower tubes) showed swelling.

A total of 9 specimens of ultra band lok cement, 3 specimens (2 in the upper tubes and 1 in the lower tubes) showed vertical cement loss and 6 specimens (3 in the upper tubes and 3 in the lower tubes) showed swelling.

A total of 9 specimens of transbond plus cement, 4 specimens (2 in the upper tubes and 2 in the lower tubes) showed vertical cement loss and 5 specimens (2 in the upper tubes and 3 in the lower tubes) showed swelling.

A total of 9 specimens of Mr Lock LC cement, 5 Specimens (2 in the upper tubes and 3 in the lower tubes) showed vertical cement loss and 4 specimens (2 in the upper tubes and 2 in the lower tubes) showed swelling.

These values were all statistically not significant, although the findings show some vertical cement loss or swelling. The reason for not finding any significant changes might be due to 3 main reasons:

The experiment time was 3 months in our study, whereas most of the studies about solubility of cements showed an experimental time of 6 to 14 months. 3 months might not be an adequate time to detect solubility of these four cements. [10,11,12,13,15,18]

The needle of the measurement device was not small enough in diameter, so it could not detect small-disintegrated area. In order to measure those small craters, a volumetric measurement technique is required, instead of vertical linear measurement as we used in this study.

Another reason to this result would be the position of sample holder tubes. The tubes were located at the vestibular sulcus lying in horizontal position. This position prevented the cement surface from the vertical attritional forces.

From this preceding part an important but not unexpected finding was the highest vertical cement loss of multi cure glass ionomer than the other tested cements. Although not statistically significant, the mean values of disintegration rate of MCGIC during the three-month period were -0.0171μm, followed by Mr Lock LC, which was -0.00041. On the other hand, the other two tested cements, ultra band lok and transbond plus showed swelling, this could be due to the water absorption of these cements [24]. Although not statistically significant, the mean values of disintegration rate of ultra band lok cement were 0.0171, followed by Transbond plus cement, with 0.00734.

Konbloch. et al. [25] suggested that water absorption of the resin-modified glass ionomer cements may result in hygroscopic expansion, which could lead to significant outward force against both tooth structure and the cemented appliances. This suggestion, support our finding about the swelling of ultra band lok and transbond plus cements.

All the tested cements were subjected to paired t test one by one to show the effect of location on the cement loss. Although the result was not significant, multi cure glass ionomer cement exhibited more vertical cement loss in upper tubes as compared to the lower tubes and the opposite was the Mr Lock LC cement.

The data were subjected to one-way ANOVA, the analysis of variance, and the evaluation of mean values shows that no significant variation exists between the individuals and between the tested cements.

Conclusion

The intraoral disintegration of four luting cements was measured directly on 9 patients. During a three-month period, two of the tested cements showed variable rates of disintegration, while the other two tested cements showed swelling (expansion), where none of these changes were significant. As a summary:

1. Multi cure glass ionomer cement showed the highest rates of disintegration, followed by Mr Lock LC.
2. Ultraband lok showed higher expansion rates than Transbond plus.
3. According to the paired t test, the effect of the location on the disintegration rate was not significant.

This study should be continued in the future, to investigate the variance of *in vivo* samples for long period of time with large sample size.

References

1. Craig RG. Restorative dental material. Eighth edition, C.V. Mosby, 1989; 189-220.
2. Combe EC. Notes on dental material. Fifth edition, Longman G.L., 1986; 126-141.
3. Gladys S, van Meerbeek B, Braem M, Lambrechts P, Vanherle G. Comparative physico-mechanical characterization of new hybrid restorative materials with conventional glass-ionomer and resin composite restorative materials. *J Dent Res* 1997; **76**: 883-894.
4. Mayhew JT, Windchy A, Sleet HW, Gettleman L. Effect of sealant cement and irrigation agents on dentatus post retention luted with Panavia 21 [Abstract]. *J Dent Res* 1996; **75**: 55.
5. Ralph W. Phillips: Skinner's Science of dental material. Eighth Edition, W. B. Saunders, 1982; 452-478.
6. Smith DC. A new dental cement. *Br Dent J* 1968; **125**: 381-384.
7. Ergin Ş. Retentive properties of different luting cements on base and noble metal crowns. PhD Thesis, Marmara University (2001) Istanbul.
8. Mitchem JC. Clinical evaluation of cement solubility. *Journal of Prosthetic Dentistry* 1978; **40**(4): 453.
9. Norman RD. A comparison of the intraoral disintegration of three dental cements. *JADA* 1969; **78**: 777-782.
10. Pluim LJ. The solubility of dental luting cement. A combined in vivo/invitro investigation. Doctorate Thesis, University of Groningen, 1985: 11-26.
11. Osborne JW, Swartz ML, Goodcre CJ, Phillips RW, Gale EN. A method for assessing the clinical solubility and disintegration of luting cements. *J. Prosthet. Dent*. 1978; **40**: 413.
12. Mitchem JC, Gronas DG. Clinical evaluation of cement solubility. *J. Prosthet. Dent*. 1978; **40**: 453.
13. Mitchem JC, Gronas DG: Continued evaluation of clinical solubility of luting cement. *Dent*. 1981; **45**: 289.
14. Sidler P, Strub JR. In vivo-untersuchung der löslichkeit und des abdichtungsvermögens von drei befestigungszementen. *Dtsch. Zahnarzt*. 1983; Z. **38**: 564.
15. Mesu FP, Reedijk T. Degradation of luting cement in vitro and in vivo. *J. Dent. Res.* 1983; **62**: 1236.
16. Pluim LJ, Arends J, Havinga PW, Jongebloed L, Stokroos I. Quantitative cement solubility experiments in vivo. *J of Oral Rehabilitation* 1984; **11**: 171-179.
17. Phillips RW, Swartz ML, Lund MS, Moore BK. In vivo disintegration of luting cement. *JADA* 1987; **114**: 489-492.
18. Osborne JW, Wolff MS. The effect of powder/liquid ratio on the in vivo solubility of polycarboxylate cement. *The journal of prosthetic dentistry* 1991; **66**(1): 49-51.
19. Pameijer CH, Nilner K. Long term clinical evaluation of three luting materials. *Swed Dent J* 1994: **10**: 69-67.
20. Pameijer CH. On the clinical performance of a glass ionomer cement. Biological, technological and clinical assessments of luting cement. *Sweden Dent J* 1992; **80**: 10-26.
21. An *in vivo* study on the merits of two glass ionomers for the cementation of orthodontic bands. *Am J Orthod Dentofac Orthop* 1991; **99**: 162-167.
22. , . In vivo inhibition of demineralization around orthodontic brackets. Am *J Orthod Dentofac Orthop* 2003; **123**: 10-14.
23. Robertello FJ, Coffey JP, Lynde TA, King P. Fluoride release of glass ionomer-based luting cements in vitro. *J Prosthet Dent* 1999; **82**: 172-176.
24. Richter WA, Ueno H. Clinical evaluation of dental cement solubility. *J. Prosthet. Dent*. March, 1975; **33**(3): 294-299.
25. Konbloch LA, Kerby RE, McMillen K, Clelland N. Solubility and sorption of resin-based luting cements. *Operative Dentistry* 2000; **25**: 434-440

Correspondence to: Dr. Toros Alcan, DDs, PhD, Marmara University, Faculty of Dentistry, Department of Orthodontics – Buyukciftlik Sok. No: 6, 80200 Nisantasi – Istanbul, Turkey. E-mail: talcan@marmara.edu.tr; alcant@superonline.com