

# Longevity of a resin-modified glass ionomer cement and a polyacid-modified resin composite restoring non-carious cervical lesions in a general dental practice

RJ Smales,\* KKW Ng†

## Abstract

**Background:** Long-term prospective survival studies of resin-modified glass ionomer cements (RMGICs) and polyacid-modified resin composites (compomers) placed in non-carious cervical lesions (NCCLs) are lacking from general dental practice. Short-term studies have shown an unsatisfactory clinical performance for several materials.

**Methods:** One practitioner placed 87 compomer (Compoglass, Vivadent-Ivoclar) and 73 encapsulated RMGIC (Fuji II LC, GC Int.) restorations in NCCLs for 61 adults. Compoglass was placed using SCA primer, and Fuji II LC using GC Dentin Conditioner. No cavity preparation was undertaken. The Kaplan-Meier method was used for estimating the cumulative survivals for those restorations that were replaced, with the probability level set at  $\alpha=0.05$  for statistical significance.

**Results:** Restorations were judged unsatisfactory (by the practitioner and the subjects) because of surface and marginal loss of material (68.8 per cent), dislodgement (18.8 per cent) and discoloration (12.4 per cent), these modes being similar for both materials ( $P=0.35$ ). Unsatisfactory restorations were replaced in 121 (75.6 per cent) instances. After periods of up to five years, cumulative survival estimates were 14.9 (5.8 Standard Error) per cent for Compoglass and zero per cent for Fuji II LC ( $P=0.74$ ). Median survivals were 30 months for Compoglass and 42 months for Fuji II LC.

**Conclusion:** Both materials had high long-term unsatisfactory performances when placed in non-prepared NCCLs in a general dental practice.

**Key words:** Resin-modified glass ionomer, polyacid-modified resin composite, compomer, non-carious cervical lesion.

**Abbreviations and acronyms:** NCCLs = non-carious cervical lesions; RMGICs = resin-modified glass ionomer cements; SCA = single component adhesive.

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## INTRODUCTION

The occurrence of non-carious cervical lesions (NCCLs) is commonplace and increasing as people retain their teeth for longer.<sup>1</sup> The aetiology, tooth sites and appearances of NCCLs are believed to be caused by a combination of erosion, abrasion and mechanical stress factors acting with varying degrees of dominance.<sup>2</sup> Restorations are often required because of dentine hypersensitivity, an unattractive appearance of the teeth, concerns about further tooth substance loss with pulpal involvement, and even food impaction.

Various tooth-coloured materials have been used to restore NCCLs, including conventional and resin-modified glass ionomer cements (RMGICs), polyacid-modified resin composites ('compomers') and several types of resin composites. Requirements for suitable NCCL restorative materials include good aesthetics, good erosive and abrasive wear resistance, good adhesion to dentine with an ability to flex with the tooth, and ease of handling.<sup>3,4</sup> RMGICs and compomers would appear to satisfy several of these requirements.

Clinical studies over periods of up to five years of NCCLs restored with tooth coloured materials have observed darkening, marginal deterioration and staining of the restorations, especially for several of the earlier RMGICs.<sup>5-13</sup> Resin composite and compomer materials generally deteriorated less than RMGIC materials.<sup>12,14,15</sup> Restoration retention rates for RMGICs and compomers ranged from 81-99 per cent at two years,<sup>7,10,15-17</sup> and from 90-97 per cent at three years.<sup>11-13,18</sup> One small study reported an 86 per cent retention rate for Dyract (Dentsply DeTrey, Konstanz, Germany) at five years.<sup>14</sup> Almost all of these studies involved relatively few restorations, which were placed in relatively few patients for each material.

Because few of these studies were also either long-term or involved treatments in general dental practices, then the null hypothesis of the present study is that there are no significant differences in the long-term survivals and failure reasons between a RMGIC and a compomer

\*Visiting Research Fellow, Dental School, Faculty of Health Sciences, The University of Adelaide, Adelaide, South Australia.

†Private Practitioner, Hong Kong SAR, PR China.

when used to restore NCCLs in adults attending for routine treatment in a private dental practice.

## MATERIALS AND METHODS

One dentist (KKWN) placed two widely used restorative materials between June 1995 and September 1996 in 160 NCCLs. The lesions were present in 61 adult subjects who attended a metropolitan general dental practice for routine care in Hong Kong. Most of the subjects specifically requested restoration of the NCCLs. All subjects willingly consented to treatment following an explanation of the restorative procedures involved. All NCCLs were required to have the coronal margin in enamel and the other margins in root dentine. A maximum of four restorations in vital teeth was allowed for each subject.

Apart from cleaning any stains present from the enamel adjacent to the NCCLs with pumice and water in a rubber cup, no cavity prophylaxis and preparations were undertaken. Shade selection from a choice of eight shades available for each restorative material was made while the teeth were moist, before their isolation using cotton rolls and suction. The intention was to place one of the two materials alternatively in sequential subjects, with the aim of placing approximately equal numbers of each material during the study. For the compomer, Compoglass (Vivadent-Ivoclar, Schaan, Liechtenstein), the NCCLs were first brushed with Single Component Adhesive (SCA) (Vivadent-Ivoclar) for 20 seconds, which was then blown gently with air to a thin film before light curing for 20 seconds with a GHL75 Lite (Dentsply Caulk, Milford, Delaware, USA). A second layer of SCA primer was applied and immediately thinned again before light curing for another 20 seconds. Compoglass was then injected from Cavifils (Ivoclar-Vivadent) into the NCCLs and light cured for 40 seconds in 2mm increments. For the RMGIC, Fuji II LC (GC International, Tokyo, Japan), the NCCLs were first rubbed lightly with GC Dentin Conditioner (10 per cent polyacrylic acid) for 20 seconds, then rinsed for 20 seconds and gently air-dried. Encapsulated Fuji II LC (P/L ratio 3) was machine-mixed for 10 seconds and injected into the NCCLs, then light cured for 20 seconds in 2mm increments. The placement of both materials was assisted by using soft transparent cervical matrices (Kerr-Hawe, Bioggio, Ticino, Switzerland). Following polymerization, the materials were minimally trimmed and contoured using fine diamond points, and then polished using CompoSite polishers (Shofu, Tokyo, Japan) and flexible Sof-Lex discs (3M ESPE, St Paul, Minnesota, USA).

A standard form was used to collect information on the clinical handling of the two restorative materials. This included comments on the range of shades available and their ability to mask tooth discolorations, the consistency of mixes and the working time for Fuji II LC, and on trimming and polishing the restorations.

Clinical data included gender and ages of subjects, restored tooth sites, dates and modes of failure.

**Table 1. Distribution of restorations by subject age group**

Material	Age group (years)			Totals
	20-39	40-59	60+	
Compoglass	32	51	4	87
Fuji II LC	37	33	3	73
Totals	69	84	7	160

$\chi^2=3.162$ ,  $df=2$ ,  $P=0.21$

Unsatisfactory (ideally needing replacement) restorations were those with loss of material (surface wear, marginal deterioration), dislodgement, and discoloration (colour mismatching, marginal staining). As is usual in dental practice, the dentist and/or the subjects judged the condition of the restorations. The data were analyzed (RJS) using Prism 2.01 statistical software (GraphPad Software, San Diego, California, USA). Fisher's exact and chi-square tests were used for the distribution analyses, and the Kaplan-Meier method was used for the cumulative survival estimates for those restorations that were replaced. The probability level was set at  $\alpha=0.05$  for statistical significance.

## RESULTS

### Distribution of subjects and restorations

There were 33 male and 28 female subjects with a mean age of 42.1 (11.1 Standard Deviation) years, ranging from 21.1-78 years. As shown in Table 1, there was no significant difference in the distribution of the two materials among the three age groups ( $P=0.21$ ). Compoglass was placed solely in 29 subjects, Fuji II LC solely in 25 subjects, and both materials in seven subjects. One restoration was placed in 12 subjects and two restorations were placed in 17 subjects, three in 14 subjects and four in 18 subjects. As shown in Table 2, there were also no significant differences in the distribution of the two materials either between the maxillary and mandibular arches or among the three tooth sites ( $P>0.50$ ).

### Material handling

Although the shade matching of the restorative materials was not ideal, usually being slightly lighter than the adjacent root surfaces, there were no unsatisfactory colour matches at the time of restoration placement. It was more difficult to mask tooth discolorations with Fuji II LC than with Compoglass. Under the operatory light, the working time for Fuji II

**Table 2. Distribution of restorations by dental arch and tooth site**

Material	Dental arch		Tooth site		
	Maxillary	Mandibular	Anterior	Premolar	Molar
Compoglass	50	39	33	46	7
Fuji II LC	41	30	28	39	7
Totals	91	69	61	85	14

Fisher's exact,  $P=0.87$        $\chi^2=0.087$ ,  $df=2$ ,  $P=0.96$

**Table 3. Distribution of unsatisfactory restorations by failure mode**

Material	Cause of failure			Totals
	Loss of material	Dislodgement	Discoloration	
Compoglass	61	18	8	87
Fuji II LC	49	12	12	73
Totals	110	30	20	160

$\chi^2=2.100, df=2, P=0.35$

LC was much shorter than the time of three minutes, 15 seconds at room temperature stated by the manufacturer. Occasionally, the material consistency varied for Fuji II LC mixes, and Compoglass was easier to place and achieved a better polish.

### Restoration failures

The 160 restorations were followed over varying periods of up to five years. Ultimately, all restorations were judged unsatisfactory (ideally needing replacement), either by the dentist who placed them, or by the subjects whose evaluations were often more critical. Table 3 shows the distribution of the unsatisfactory restorations from loss of surface and marginal material (68.8 per cent), dislodgement (18.8 per cent), and discoloration (12.4 per cent). Secondary caries (cavitation or softness to probing) was not observed. There was no significant difference in failure modes between the two materials ( $P=0.35$ ). Although several subjects complained of dentine hypersensitivity before placing the restorations, there was no mention of this problem following either restoration placement or subsequent restoration dislodgement.

The 160 unsatisfactory restorations were replaced in 121 (75.6 per cent) instances by two ceramometal crowns, 94 resin composite restorations and 25 RMGIC restorations. The cumulative survival estimates at each yearly period are shown in Table 4. After periods of up to five years, the cumulative survival estimates were 14.9 (5.8 SEr) for Compoglass and zero per cent for Fuji II LC, ( $P=0.74$ ). Therefore, the null hypothesis was accepted. The median survival was 30 months for Compoglass and 42 months for Fuji II LC.

### DISCUSSION

In this long-term prospective clinical study of restoration longevity, the two restorative materials

were fairly evenly distributed among the subject age groups and NCCL tooth sites (Table 1, 2). Approximately half of the subjects each had either one/two, or three/four cervical restorations placed, usually with one material only for the multiple restorations.

One two-year study of Fuji II LC placed in NCCLs found a significantly lower restoration retention rate when more viscous mixes (P/L ratio of 3; as in the present study) were applied to visibly dry but not desiccated dentine, than when less viscous mixes (P/L ratio 2.25) were applied to glistening moist dentine.<sup>19</sup> However, although the occasional variable mix consistencies and short working times of Fuji II LC made the material less easy to handle than Compoglass, these problems were not reflected by a significant difference in the clinical performances of the two materials.

Most of the unsatisfactory restorations were from loss of restorative material (68.8 per cent), either from wear or from marginal deterioration that was often accompanied by marginal staining (Table 3). The high progressive uptake of moisture by RMGICs results in a decreased surface hardness<sup>20</sup> and a relatively low wear resistance.<sup>21,22</sup> RMGICs and compomers are also susceptible to erosion,<sup>23,24</sup> with a three-year clinical study finding significantly higher surface losses of material for restorations placed in NCCLs than in primary caries lesions.<sup>25</sup> Hong Kong adults favour the use of very hard tooth brush bristles and abrasive dentifrices because of tooth and restoration staining that results from drinking large quantities of black tea. Consequently, the oral hygiene of the subjects was generally good adjacent to the cervical restorations.

The dislodgement of the restorations observed (18.8 per cent), has been the principal cause of restoration failure in many other studies. Over three years, loss of restoration retention in non-prepared NCCLs varied from 3-10 per cent.<sup>11-13,18</sup> After five years, one small study reported losses of 14 per cent for Dyract.<sup>14</sup> The causes of restoration dislodgement from NCCLs have been variously ascribed to tooth flexure,<sup>3</sup> dentine sclerosis,<sup>18,26</sup> a high viscosity and perhaps a high modulus of elasticity of the restorative material,<sup>19,27</sup> gingival bleeding and moisture contamination,<sup>26</sup> the absence of enamel bevels and acid etching,<sup>28,29</sup> and the absence of adhesives.<sup>30-32</sup> The clinical performance of both materials in the present study might have been improved if the enamel margins of the NCCLs had been bevelled and the lesions etched with phosphoric acid before placing the restorations.

The discoloration of the restorations observed (12.4 per cent), has been found in many other clinical studies, especially darkening of RMGICs.<sup>5,7,10,15,16,33,34</sup> Because of their hydrophilic monomers, and the possibility of incomplete polymerization, the potential exists for increased body discoloration and surface staining of RMGICs.<sup>5,35,36</sup> Several chemicals can cause significant colour shifts and surface degradation of both RMGICs

**Table 4. Cumulative survival (standard error of the mean) %**

Period (years)	Compoglass			Fuji II LC		
	Observed	Failed	CS (SEM)	Observed	Failed	CS (SEM)
0-1	85	7	91.8 (3.0)	73	3	95.9 (2.3)
1-2	78	27	60.0 (5.3)	68	16	73.3 (5.2)
2-3	43	15	39.1 (5.6)	47	9	59.3 (6.0)
3-4	21	7	26.0 (5.5)	35	27	13.6 (4.4)
4-5	7	3	14.9 (5.8)	7	7	0.0

Logrank test; chi-square=0.1116, df=1,  $P=0.74$  (not significantly different).

and compomers.<sup>37</sup> Marginal deterioration associated with marginal staining of RMGICs and compomers has also been reported in many other clinical studies.<sup>1,6,7,10,16,17,25,38</sup> The degradation was especially noticeable when marginal adhesion to tooth structure was inadequate.<sup>11</sup>

This prospective study was undertaken in a general dental practice, and the dentist's usual clinical judgements and/or the subjects' concerns determined when restorations were deemed unsatisfactory. This determination was relevant for non-dislodged restorations, where restoration replacement decisions were subjective, based on the degree of discoloration or shade mismatches and the extent of surface and marginal losses of material. The subjects' evaluations of the restorations were often more critical than those of the dentist. In contrast to studies undertaken in institutions, those undertaken in private practices are more constrained by the dictates of the subjects who, as consumers, pay the full costs of treatments and are likely to seek further treatments elsewhere if dissatisfied. Hong Kong has a high practice turnover of patients and private dental health insurance is rare.

As is usual in dental practice, not all of the unsatisfactory restorations were replaced, usually for financial reasons and when the subjects were not unduly concerned about the appearance of the restorations or their loss when any previous cervical sensitivity had decreased. As has been shown previously, many tooth-coloured restorations deemed unsatisfactory continue to function for many years before being replaced, often for unrelated failure reasons.<sup>39</sup> Most of the replacements in the present study were with an adhesive hybrid resin composite, this being more wear resistant and aesthetic than Compoglass and Fuji II LC. Although the two restorative materials and the SCA primer used in the present study have been superseded by improved products, independent long-term clinical trials of the performances of these more recent products when placed in non-prepared NCCLs in general dental practices have yet to be published.

## CONCLUSIONS

Despite the occasional variable mix consistencies and short working times for Fuji II LC, the long-term restoration survivals for Compoglass and Fuji II LC were not significantly different when placed in non-prepared NCCLs. Unsatisfactory restorations failed from surface and marginal loss of restorative material (68.8 per cent), dislodgement (18.8 per cent) and discoloration (12.4 per cent). There were no significant differences between the two materials in these failure modes ( $P=0.35$ ). Unsatisfactory restorations were replaced in 121 (75.6 per cent) instances. After periods of up to five years, the cumulative survival estimates were 14.9 (5.8 SEr) for Compoglass and zero per cent for Fuji II LC ( $P=0.74$ ). The median survivals were 30 months for Compoglass and 42 months for Fuji II LC.

Both materials had high long-term failure rates when placed in non-prepared NCCLs in a general dental practice in Hong Kong.

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*Address for correspondence/reprints:*  
 Professor RJ Smales  
 19A Wattle Street  
 Fullarton  
 Adelaide, South Australia 5063  
 Email: roger.smales@aelaide.edu.au