SCIENTIFIC ARTICLE

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Radiation-induced root surface caries restored with glass-ionomer cement placed in conventional and ART cavity preparations: Results at two years

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Abstract

Background: There are no published studies comparing the clinical performances of more-viscous glass-ionomer cement (GIC) restorations when placed using conventional and atraumatic restorative treatment (ART) cavity preparation methods to restore root surface caries.

Methods: One dentist used encapsulated Fuji IX GP and Ketac-Molar to restore 72 conventional and 74 ART cavity preparations for 15 patients who had received cervicofacial radiation therapy. Two assessors evaluated the restorations at six, 12, and 24 months for retention, marginal defects and surface wear, and recurrent caries.

Results: After two years, the cumulative restoration successes were 65.2 per cent for the conventional and 66.2 per cent for the ART cavity preparations, without statistical or clinical significance (P>0.50). Restoration dislodgement accounted for 82.8 per cent and marginal defects for 17.2 per cent of all failures. There were no instances of unsatisfactory restoration wear or recurrent caries observed. Teeth with three or more restored cervical surfaces accounted for 79.3 per cent of all failures (P<0.0001).

Conclusions: For root surface caries restored with GIC, the use of hand instruments only with the ART method was an equally effective alternative to conventional rotary instrumentation for cavity preparation. Larger restorations had higher failures, usually from dislodgement.

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Key words: Radiation caries, glass-ionomer cement, atraumatic restorative treatment.

Abbreviations and acronyms: ART = atraumatic restorative treatment; GIC = glass-ionomer cement.

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INTRODUCTION

Single-surface occlusal conventional glass-ionomer cement (GIC) restorations placed using either conventional or atraumatic restorative treatment (ART) cavity preparation methods have shown similar satisfactory clinical performances over 24 months in primary molars[1] and 30 months in posterior permanent teeth.[2] There have been no comparable clinical studies reported for the restoration of cervical root surface caries in patients who are at either normal or high risk to caries.

The restoration of carious teeth in patients who have undergone cervicofacial radiotherapy can be extremely demanding on both patients and dentists. Tissue damage from the irradiation can result in mucositis, candidiasis, xerostomia with difficulties in speaking, eating and swallowing, and rampant caries of exposed dentine and cementum tooth surfaces.[3-5] An increased prominence of cariogenic microorganisms[6] leads to the rapid circumferential progress of cervical lesions, aided by poor oral hygiene consequent to oral discomfort and trismus. Access to the cervical lesions is often restricted, the excavation of caries might be incomplete, the cavity preparation margins can be difficult to define and the preparations might provide little mechanical retention for the restorations. Selection of the most appropriate restorative material is also difficult under these circumstances, with the more-viscous aesthetic conventional GICs appearing to offer a reasonable compromise in terms of desirable handling, adhesive, anticariogenic and physical properties.[7]

A recent publication involving the restoration of radiation-induced root surface caries found up to 30

per cent losses of restorative material for conventional GICs after two years.[8] However, there were no instances of secondary caries, and the clinical characteristics of the retained restorations were generally satisfactory. As part of the protocol for the study,[8] approximately equal numbers of carious cervical lesions were treated using either conventional or ART cavity preparation methods. The conventional method used steel burs in a slow-speed handpiece while the ART method[9] used hand instruments only for the cavity preparations. In the present study, the null hypothesis proposed is that when restoring radiation-induced root surface caries with more-viscous GICs there are no significant differences between conventional and ART cavity preparation methods on restoration performances over two years.

Table 1. Codes and criteria used to evaluate the restorations*

0 = present, correct
1 = present, slight defect at the margin and/or wear of the surface of less than 0.5mm deep; no repair needed
2 = present, defect at margin and/or wear of the surface of 0.5-1.0mm in depth; repair needed
3 = present, but gross defect at margin and/or wear of the surface of 1.0mm or more in depth; repair needed
4 = not present, restoration has (almost) completely disappeared; treatment needed
5 = not present, because other treatment has been performed for whatever reason
6 = tooth not present for whatever reason
9 = unable to diagnose

*Phantumvanit *et al*., 1996.[10] Codes 0, 1 are acceptable; Codes 2-6 are not acceptable.

MATERIALS AND METHODS

Fifteen Chinese adults (eight males, seven females) with an average age of 63 years (37-76 years) who had received cervicofacial radiotherapy were recruited from the Department of Operative Dentistry and Endodontics, School of Stomatology, Peking University. Institutional approval was obtained for the study, and all patients were informed of the nature and objectives of the study before they each signed a voluntary consent form. Inclusion criteria for participation required two or more teeth with carious root surface lesions, without clinical symptoms or pulpal involvement of the teeth. Exclusion criteria comprised teeth with symptoms of pulpal involvement, carious pulp exposures and periapical pathoses.

Each patient received an oral prophylaxis and oral hygiene instruction. Ninety-three teeth with 146 carious root surface lesions were subsequently restored by one experienced dentist (JYH). Every patient had at least one pair of conventional (control) and ART method cavities prepared. The conventional cavity preparations were made with round steel burs in a slow-speed handpiece. The ART cavity preparations were made with sharp ART hand instruments only (Code S642017, GC International Corp., Tokyo, Japan), according to instructions for this method.[9] In several instances, to avoid pulp exposures, softened dentine was left in the base of deep preparations. After isolating the preparations with cotton wool rolls, the cavities were conditioned with 10 per cent polyacrylic acid (3M ESPE, Seefeld, Germany) for 15 seconds before being washed and lightly dried. Encapsulated GICs (Fuji IX GP, GC Int. Corp.; Ketac-Molar, 3M ESPE) were machine mixed and injected into the preparations sequentially for each patient. After their initial setting, the newly placed restorations were coated with a cavity varnish (GC Int. Corp., Tokyo, Japan). Patients were provided continuing dental care as required at the subsequent recalls.

All of the GIC restorations were assessed as being clinically acceptable at the time of their placement. Further clinical assessments were made at six, 12 and 24 months using published criteria[10] (Table 1). Evidence of active caries was diagnosed by cavitation and softness of dentine to careful probing with a sharp explorer. Following an initial training period, all observations were made and agreed simultaneously by two experienced dentists (JYH, XCC).

Findings were entered into a database and analyzed (RJS) using a software package (Prism 2.01, GraphPad Software Inc., San Diego, California, USA). Clinical successes between the two treatment methods for the number of restored cervical tooth surfaces and tooth types were analyzed after two years using Fisher's exact test. Cumulative successes for each treatment method at each recall were also calculated.[11] The probability level for statistical significance was set at α=0.05.

RESULTS

All patients except two who died during the second year of the study were seen at each recall. The two GIC materials were evenly distributed between the two cavity preparation methods (Fisher's exact test,

Table 2. Number of restorations evaluated and cumulative successes at each recall

Recall (months)	Treatment Method	Number	Rating Code 0	1	2/3	4	5/6	Cumulative Success %
6	Conventional	72	71	0	0	1	0	98.6
	ART	74	70	1	0	3	0	95.9
12	Conventional	72	56	8	1	7	0	87.7
	ART	74	59	6	0	9	0	84.4
24	Conventional	60	31	14	3	12	0	65.2
	ART	65	49	3	2	12	0	66.2

Codes 0, 1 are acceptable; Codes 2-6 are not acceptable.

Table 3. Number (percentage) of cervical restorations by restoration size and material performance at two years

Material	≤2 Surfaces		≥3 Surfaces		Total
	Intact	Failed	Intact	Failed	
Fuji IX GP	33 (26.4)	2 (1.6)	23 (18.4)	7 (5.6)	65 (52.0)
Ketac-Molar	31 (24.8)	4 (3.2)	9 (7.2)	16 (12.8)	60 (48.0)
Total	64 (51.2)	6 (4.8)	32 (25.6)	23 (18.4)	125 (100)
Fisher's exact test	P=0.67		P=0.003*		

*Statistically significant.

P=0.62). The ratings and cumulative survivals at each recall for the restorations placed using the two cavity preparation methods are shown in Table 2. Restoration losses (score=4) accounted for 82.8 per cent and marginal defects for 17.2 per cent of the failures. There were no instances of unsatisfactory restoration wear or active recurrent caries detected. After two years, cumulative restoration successes were 65.2 per cent for the conventional and 66.2 per cent for the ART method of cavity preparation. There were no statistically significant differences present between the two cavity preparation methods for restoration successes at any recall period (Fisher's exact test, P=0.62-1.00). Therefore, the null hypothesis was accepted.

Table 3 shows that there were significantly more cervical restoration failures after two years in teeth with three or more restored surfaces, principally for Ketac-Molar (P=0.003). The more extensive restorations accounted for 79.3 per cent of the total failures (P<0.0001). Similarly, Table 4 shows that there were significantly more restoration failures in anterior than in posterior teeth, again principally for Ketac-Molar (P=0.04). Examples of restoration deterioration and failure are shown in Fig 1, 2.

DISCUSSION

Although the number of patients was small, because of recruitment and mortality problems, the almost identical percentages of cervical restoration successes for both the conventional and ART preparations mirrored the almost identical, but higher, percentages of occlusal restoration successes for both conventional and ART preparations that were also restored with more-viscous GICs.[1,2] However, the cervical and occlusal studies are not comparable because the patient populations were quite different, as were characteristics of the different tooth sites.

Table 4. Number (percentage) of cervical restorations by tooth type and material performance at two years

Material	Anterior		Posterior		Total
	Intact	Failed	Intact	Failed	
Fuji IX GP	18 (14.4)	5 (4.0)	38 (30.4)†	4 (3.2)	65 (52.0)
Ketac-Molar	14 (11.2)	15 (12.0)	26 (20.8)‡	5 (4.0)	60 (48.0)
Total	32 (25.6)	20 (16.0)	64 (51.2)	9 (7.2)	125 (100)
Fisher's exact test	P=0.04*		P=0.48		

*Statistically significant.
†Includes five molars.
‡Includes four molars.

Fig 1. GIC cervical restorations one week after placement in the canine and first premolar.

Fig 2. The same GIC restorations at the two-year review. The surfaces of the GICs and teeth are stained. In the canine, the distal part of the restoration has fractured, but the base of the exposed cavity was hard.

The operative treatment of rampant root surface caries following cervicofacial radiation therapy can be very difficult. The margins of active lesions are poorly defined, and access for cavity preparation is often restricted and uncomfortable for the patient. In some situations, patients might be unable to attend a dental clinic for conventional operative treatment. However, the present study found that similar success rates with GIC restorations could be achieved when using either rotary or hand instrumentation alone for cavity preparation (Table 2).

Larger, more extensive restorations accounted for 79.3 per cent of all failures, usually from dislodgement (Table 3). These higher failures are attributed to increased difficulties with the operative procedures (with possible inadequate caries removal and restoration placement), reduced effective mechanical retention, and to the longer margins of the larger cervical restorations being at increased risk for deterioration and fracture. The higher failures reported

for Ketac-Molar might have been related to its high viscosity adversely affecting a close adaptation to dentine in some instances.[12]

Dislodgement (82.8 per cent) was the main reason for restoration failures, followed by marginal defects (17.2 per cent). Although there were no instances of recurrent caries observed following the dislodgements, there would have been many instances of residual infected dentine remaining at the time of placing the GIC restorations.[13] However, cariogenic micro-organisms sealed beneath GIC have been shown to decrease substantially in number and activity if the cavity remains sealed.[14-16] A reciprocal diffusion of various ions across the dentine/GIC interface has also been demonstrated,[17] as well as GIC augmentation of the physiological remineralization of carious dentine.[18]

Following the initial placement of GIC restorations over carious dentine, then hard dentine was reported clinically in 45 per cent of cases after seven months.[19] One ART study also found that following dislodgement of the GIC restorations over 6-30 months, 56-82 per cent of the cavities had hard dentine, frequently darkened, present in the floors and walls.[20] Similar observations of hard dentine following restoration dislodgement were made in the present study. Other clinical studies have observed that when topical fluoride gels were not used for xerostomic and irradiated patients, secondary caries was associated significantly less with GIC restorations than with either amalgam or resin composite restorations.[21,22]

Despite regular dental care after cervicofacial radiotherapy, the oral health of these patients is compromised when compared with that of healthy and newly diagnosed nasopharyngeal carcinoma patients.[4] Early active participation in developing preventive and therapeutic oral health strategies is important for addressing the often, poor quality of life of patients who have received cervicofacial radiotherapy.[23] Although further studies are required, newer radiotherapy treatment protocols might assist in limiting the frequently encountered adverse oral sequelae.[24]

CONCLUSIONS

This two-year study involved 15 patients with 146 radiation-induced root surface carious lesions restored with more-viscous GIC by one dentist, using two cavity preparation methods. The cumulative success for the restorations was 65.2 per cent for cavities prepared when using conventional rotary instrumentation, and 66.2 per cent when using ART hand instruments only, without statistical or clinical significance ($P>0.50$). Restoration dislodgement accounted for 82.8 per cent and marginal defects for 17.2 per cent of all failures. There were no instances of unsatisfactory restoration wear or recurrent caries observed. Teeth with three or more restored cervical surfaces accounted for 79.3 per cent of all failures ($P<0.0001$).

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