

Glass carbomer restorative material evaluation

Trevor Burke, Russell Crisp, and Ali James present a practice-based clinical evaluation of GCP Glass Fill.

Since the ability to bond to enamel was first described by Buonocore in 1955¹, bonding to tooth structure has become an integral part of restorative dentistry and has facilitated the development of resin composite materials. These materials have become increasingly used worldwide², principally because of patient concerns about the poor appearance of amalgam restorations and anxieties with respect to the use of a mercury-containing filling material. Resin composite materials are presently considered to be the gold standard in terms of aesthetics and physical properties.

Glass ionomer materials (GIC – glass ionomer cements) were developed in the 1970s, initially being derived from the FAS glass used in silicate materials, but with the phosphoric acid used in silicate being substituted by a polyacrylic acid. Initially, these materials had a number of benefits, such as fluoride release, but suffered from poor aesthetics and low flexural strength. Developments in Amsterdam in the early 2000s brought a prototype material which initiated the laying down of hydroxyapatite³, and this has now reached commercial fruition with the release of the material GCP Glass Fill⁴, manufactured by GCP Dental. This material contains a FAS glass formed in nanosized particles, but additionally contains liquid silica and fluor/hydroxyapatite crystals which are said to reduce solubility, improve flexural and compressive strengths and improve wear resistance. In addition, the fluoroapatite is said

to aid remineralisation. It bonds to dentine and enamel – without etching by phosphoric acid – indeed, this is positively contraindicated. The material requires the application of heat (such as may be obtained from the tip of many of today's light curing units) to aid its curing.

Indications for use include⁵:

- permanent class I restorations in primary and permanent teeth,
- small class II restorations in permanent teeth,
- core build ups,
- remineralising caries, and
- class V restorations.

Central to good performance of dental materials are their physical properties, but also their ease of use, since it could be suggested that a material which handles easily will be more likely to produce an optimally performing restoration than one which is difficult to use⁶. Given the novel nature of this new material – the first glass carbomer, GCP Glass Fill – it would seem appropriate that an assessment is carried out of the in-use handling of this material when used for placement of restorations by general dental practitioners. It is therefore the aim of this article to describe how a group of practice-based researchers considered the handling of GCP Glass Fill (GCP).

Methods

Selection of participants

All 33 members of the practice-based research group, the PREP Panel, were sent an email asking if they would be



Fig 1: Pre-operative class I restorations 36 and 37.



Fig 2: 36 and 37 class I GCP Glass Fill restorations immediately post-operative.

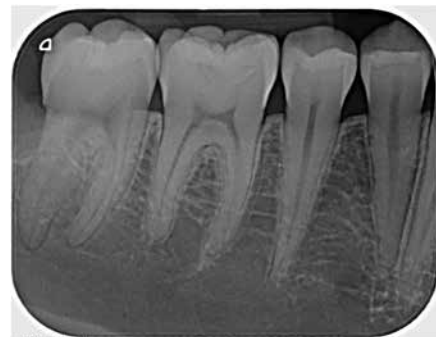


Fig 3: Follow up radiograph dated December 2016, of class 1 GCP Glass Fill restoration 46 placed over deep caries in February 2015.

prepared to be involved in the handling evaluation of a novel glass carbomer restorative material. Of those who agreed to participate, 12 were selected at random.

FJ Trevor Burke

is a professor at the University of Birmingham School of Dentistry and joint PREP Panel co-ordinator.

Russell J Crisp

is joint PREP Panel co-ordinator.

Ali James

is a PREP Panel member, GDP and a part-time clinical lecturer at the University of Birmingham.

Questionnaire design

A questionnaire was designed by the PREP Panel co-ordinators, and the manufacturers of the material under evaluation, in order to provide background information on the ease of use of composite and glass ionomer materials previously by the participating practitioners and to compare the ease of use of these with the material GCP Glass Fill. The majority of answers were made on visual analogue scales (VAS).

Instructions to evaluators

Explanatory letters, questionnaires and a pack of GCP Glass Fill, a GCP CarboLED CL-02 curing light, plus accessories (GCP Gloss, Sodium Hypochlorite solution, and barrier sleeves) were sent to the evaluators in July 2016, along with the instructions for use. The practitioners were asked to use the material, where indicated, for 10 weeks and return the questionnaire for analysis. The data from the returned questionnaires were collated as below.

Results

Of the 13 evaluators from the PREP Panel, one was female and the average time since graduation was 31 years, with a range of 20 to 43 years.

A variety of techniques was used by the evaluators for the placement of posterior composite restorations, with all but three of the evaluators placing more than five posterior composite restorations per week. The techniques which the evaluators used for the placement of these restorations were, principally, the use of a dentine bonding agent and/or a flowable composite base.

The ease of use of the previously used posterior composite restorative was stated to be (on a VAS where 5 equals easy to use and 1 equals difficult to use) as follows:



Other information gleaned from the questionnaire included:

- The evaluators also used a wide variety of Light Curing Units (LCUs).
- All the evaluators stated that a material with therapeutic/healing

properties would be an advantage.

Evaluation of GCP Glass Fill

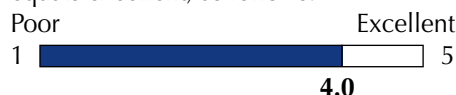
The technique guide for GCP Glass Fill was rated (on a VAS where 1 equals poor and 5 equals excellent) as follows:



Comments

- "A bit sketchy but fairly clear."
- "Confusing online video poor quality – camcorder handheld?"

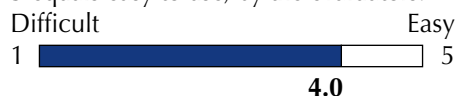
The overall presentation of the kit was (on a VAS where 1 equals poor and 5 equals excellent) as follows:



Comments

- "Not really a kit, but simple to store and use."
- "Make it more enticing."
- "Improve for nurses' use."
- "Capsules difficult to activate and place in gun."
- "Needs a neater box with separate compartments for each shade – we transferred it to an old composite kit box."

The ease of use of the CarboLED CL-02 thermocure light was rated as follows (on a VAS where 1 equals difficult to use and 5 equals easy to use) by the evaluators:



Comments

- "Got hot – patients commented."
- "Much better than the old one – you needed a degree to be able to use that one!"

The number of restorations placed in GCP Glass Fill during the evaluation was 580, comprised of 35 per cent class I, 41 per cent class II and MOD, 18 per cent in primary teeth, and others such as core build ups. Sixty-two per cent (n=8) of the evaluators stated they used GCP Glass Fill in deep cavities and all of them stated it had performed satisfactorily in the short term.

Comments

- "And in the long term – I have used

for two years and have photos of some cavities in which I left caries and sealed, with satisfactory performance."

- Had they not had GCP Glass Fill available for use, over half of the evaluators would have used a glass ionomer or GI derivative instead.

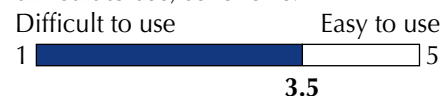
The evaluators rated their satisfaction with GCP Glass Fill (on a VAS where 1 equals unsatisfied and 5 equals very satisfied) as follows:



Comments

- "Application of hypochlorite not ideal as it is watery and some patients complained of taste and smell."
- "Set hard but colour very opaque."
- "Long cure time and too opaque."
- "All the evaluators stated they did not encounter any post-operative sensitivity."

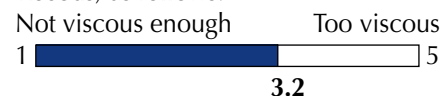
The evaluators rated the ease of use of GCP glass Fill (on a VAS where 5 equals easy to use and 1 equals difficult to use) as follows:



Comments

- "Difficult to fit capsules in gun and activate."
- Six (46 per cent) of the evaluators stated they experienced difficulty with the material sticking to instruments. This was overcome by dipping in gloss (2), silicone liquid (2) and Vaseline (1).

Eighty-three per cent of the evaluators (n=10) stated that the viscosity of GCP Glass Fill was satisfactory and rated the viscosity (on a VAS where 1 equals not viscous enough and 5 equals too viscous) as follows:



The working time of GCP Glass Fill was rated by the evaluators (on a VAS where 1 equals too short and 5 equals too long) as follows:



Comments

Comments on the use of the CarboLED thermocure and the level of hardness achieved included:

- “Working time fine but curing took too long.”
- “Easy to use and good hardness.”
- “Hardness OK but multiple cases took too long and hard to angulate light to get close proximity.”
- “Didn’t like CarboLED and went back to using Elipar.”
- “Still not optimal hardness at time of polish.”
- “Very hard – good for stability.”
- “If enough curing time then harder than RMGI.”

The evaluators stated the following curing times were used to obtain satisfactory hardness prior to polishing:

60s	1 evaluators
Between 60s and 90s	2 evaluators
90s	5 evaluators
120s	5 evaluators

Sensitivity was noted by two evaluators during thermocure. Comments included:

- “Heat caused mild discomfort & could be felt through gloves if holding a matrix strip.”

The rating (on a VAS where 1 = difficult to polish and 5 = Easy to polish) for ease of finishing and polishing using the evaluators usual system was as follows:



Regarding the aesthetics of GCP Glass Fill, the following comments were made:

- “Not bad but more opaque than shade guide.”
- “Not as good as composites.”
- “Aesthetics secondary for decision to use – then they were acceptable.”
- “Good for posterior teeth, long term temporary restorations and sealing root filled teeth.”
- “Better than GI or Amalgam. It’s great as a base plus composite. Patients did not object as they understood the therapeutic value.”

Also regarding aesthetics, 82 per cent (n=9) of the evaluators thought the number of shades to be adequate and

one evaluator suggested two additional shades, namely A4 and a dark brown/ yellow shade.

Eighty-two per cent (n=9) of the evaluators stated that the restorations of Glass Fill maintained their shape prior to curing.

Comments

- “Did not attempt to achieve ideal morphology.”

Regarding the PREP Panel’s overall approval of GCP Glass Fill, 62 per cent (n=8) of the evaluators also stated they would purchase the material, if available at an average price.

Comments

- “Only use glass ionomers on children so, if price the same as Fuji 9, then – yes.”
- “Have to be quite quick curing as it starts to set.”
- Sixty-two per cent of the evaluators (n=8) would recommend GCP Glass Fill to colleagues. (Plus one “maybe”!)
- “Very useful for difficult cases with poor retention, or for transitional restorations and elderly patients.”
- “Didn’t see the benefit – too many steps.”
- “A very satisfactory product.”

Further comments regarding the performance/handling and overall acceptability of GCP Glass Fill were:

- “Have used it for two years – excellent in deep cavities with minimal sensitivity and good results.”
- “Do not use where aesthetics essential.”
- “Great material for posterior teeth where I used RMGI in the past. Easy to use and shape although longer to cure; it is still better than self-cures.”
- “The material has its uses, so if a dentist is happy to accept its idiosyncrasies then I suggest they look at it. Light sheaths were too slippery and didn’t fit properly making the unit hard to use especially as having to get close to the material for curing.”
- “GCP Glass Fill II behaved like a glass ionomer. Thermocure set a real advantage. We had a few failures but perhaps we were asking too much of the material.”

Eighty-two per cent (n=9) of the

evaluators stated that it was an advantage to be able to use any adhesive system.

Representative illustrations of two restorations are presented in figures 1 and 2, while radiographs of a case in which caries was sealed into the cavity are presented in figure 3.

Discussion

As the population of patients who are treated by dentists gets older, the ability to call upon a material with some therapeutic properties in deep cavities may be considered to be a bonus. In addition, a non-mercury-containing material for the posterior dentition will become increasingly important as the phase down of amalgam suggested by the Minamata Agreement gathers momentum. The present study therefore evaluated the handling of Glass Carbomer Tech Fill, this being an innovative restorative carbomised glass cement which is monomer free and protected by three patents⁶, by a group of general dental practitioner members of the PREP Panel. Specially developed additives, including Nano-Fluoride-/Hydroxyapatite particles, provide for an extremely low solubility, superior flexural strength, compression strength and high durability⁶. GCP Glass Fill is 100 per cent biocompatible and safe for the dentist, the patient and the environment⁶. It is available in four VITA shades, A1, A2, A3, A3.5, and an additional shade, DG.

Of significance is the reported lack of post-operative sensitivity, given that this is a problem previously associated with placement of posterior composite restorations. The fact that 62 per cent (n=8) of the evaluators stated they had used GCP Glass Fill in deep cavities could be considered to indicate a principal benefit of the material under test, and, of those who used this indication, all stated it had performed satisfactorily in the short term. One member of the PREP Panel commented that he had used GCP Glass Fill for two years and had evidence of healing in some cavities in which caries had been left and sealed in a vital asymptomatic tooth.

The GCP Glass Fill restorative system has been subjected to an extensive evaluation in clinical practice, by

● members of the PREP Panel, in which 548 restorations were placed. Based on this the following conclusions may be made:

- The material scored above average in all the criteria scored.
- Suggestions were made to improve the presentation, mainly to make it more of a kit so all the components were to hand when using GCP Glass Fill.
- The illustrated technique guide/instruction scored highly (4.3 on a VAS where 5 equals excellent and 1 equals poor) but some comment was made regarding the quality of the online video guide.
- The score for ease of use was lower than the previously used posterior composite system (3.5 for GCP Glass Fill, compared with scores of 4.4 for the previous posterior composite material on a VAS where 5 equals easy to use and 1 equals difficult). However, this may be considered akin to comparing apples with pears, given that GCP Glass Fill is not a resin composite material, being a material with some glass ionomer characteristics.
- Though the score for aesthetic quality was lower than the previously used posterior composite material, from comments made it was more comparable with posterior glass ionomer materials than resin composite, so the comparison is probably not valid. In that regard, there are no claims from the manufacturer that GCP Glass Fill is intended to be an ultra-aesthetic material for use in anterior or posterior teeth.
- The scores achieved when rating the working time of GCP Glass Fill was slightly on the higher side of the ideal median score of 3.0 (both 3.5 on a VAS where 5 equals too long and 1 equals too short) and the long curing time was commented upon.
- The CarboLED Thermocure light scored well for ease of use (4.0 on a VAS where 5 equals easy to use and 1 equals difficult to use), though some comment was made that the patients did notice the heat. The recording of data for this study did not include whether LA was given during cavity preparation/restoration placement, so it may be that the small number of patients who commented on the heat had received their treatment without LA, and these patients experienced the heat via their gingival tissues.
- The heating of the material following placement is designed to improve its

physical properties, this being something which has been previously recognised with glass ionomer cements^{8,9}: the improved hardening appeared to have been recognised by some evaluators.

The potential for this new material is illustrated by the fact that the majority of evaluators (62 per cent) would both purchase the material and recommend it to colleagues.

Finally, the lack of post-operative sensitivity is a worthwhile feature of the material under test, as too was its perceived therapeutic properties by a number of the evaluators.

Conclusions

The satisfactory reception for this new type of posterior restorative material, requiring a different technique to posterior composite and RMGI materials, is indicated by the number of evaluators stating they would both buy and recommend the system to colleagues. Its indication as a suitable material for use in deep cavities in vital asymptomatic teeth appears to have been upheld. In addition, there were no reported cases of post-operative sensitivity. In some cases the GCP fill was placed directly on the pulp (direct pulp capping) generating no pain and/or sensitivity. This was due to the neutralising effect of the fluor/hydroxyapatite part of the glass fill.

Manufacturer's comments

GCP wish to thank the PREP Panel for their comments regarding our recently introduced GCP Glass Fill restorative material. We are pleased by their relatively positive responses, other than the opacity of the material. GCP Glass Fill was developed for its therapeutic properties, with ideal aesthetics being sacrificed as a result. (We hope to address that in years to come.) The lack of post-operative sensitivity, even in deep cavities, may be considered to be a manifestation of this.

Some of the dentists in the PREP Panel mentioned that patients experienced discomfort by heat from the Thermocure. The authors of the paper already remarked that they may have experienced discomfort because the gingival tissues were heated by the curing device. Our research and experience has shown that heat caused by Thermocure will be fully absorbed by the filling with the light (heat) being absorbed by the

bulkfill and the natural tooth material before it reaches the pulp and will not cause a rise of temperature of more than a few degrees in the pulp. Touching the gingiva during Thermocure may cause discomfort and should therefore be avoided.

Some dentists in the PREP Panel mentioned that patients did not like the taste of hypochlorite. This can be reduced by using a microbrush to apply the hypochlorite and rinsing well. GCP advises the use of hypochlorite to remove the smear layer and to promote exchange of ions for adhesion to the cavity and to enhance ion-exchange that will promote remineralisation. On the other hand, some patients complain about the smell of composite primers!

Some dentists commented on the instruction materials. GCP wish to inform you we are working on new, improved instruction materials for dentists and assistants based on animation techniques. These will be available on our website soon.

Acknowledgements

The authors thank the members of the PREP Panel for completing the feedback forms and thank GCP UK for providing the material and funding this evaluation.

Conflict of interest

The authors do not have any financial interest in the company whose material was included in this study.

References

1. Burke FJT, McCord JF. Research in dental practice – problems and solutions. *Br Dent J* 1993; 175: 396-398.
2. Burke FJT, Crisp RJ. Twenty years of handling evaluations and practice-based research by the PREP Panel. *Dent Update*. 2013; 40: 339-341.
3. Buonocore MG A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. *J Dent Res* 1955; 34: 849-853.
4. Burke FJT. Amalgam to tooth-coloured materials – implications for clinical practice and dental education: governmental restrictions and amalgam-usage survey results. *J Dent* 2004; 32: 343-350.
5. Van Duinen R, Davidson C, DeGee A, Feilzer A. *In situ* transformation of glass ionomer into an enamel-like material. *Am J Dent* 2004; 17: 223-227.
6. GCP Fill Product Profile.
7. Burke FJT, Liebler M, Eliades G, Randall RC. Ease of use versus clinical effectiveness of restorative materials. *Quintessence Int* 2001; 32: 239-242.
8. O'Brien T, Shoja-Assadi F, Lea SC, Burke FJT, Palin WM. Extrinsic energy sources affect harness through depth of a glass-ionomer cement. *J Dent* 2010; 38: 490-495.
9. Gavic L, Gorseta IC, Glavaina D, Czarnicka B, Nicholson JW. Heat transfer properties and thermal cure of glass ionomer dental materials. *J Mater Sci Mater Med* 2015; 26: 249-253.