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A Practice-based Clinical Evaluation of a Novel Two-bottle Dentine Adhesive system

Abstract: This study evaluated the handling of a recently introduced two bottle dentine adhesive system by a group of practice-based researchers. Twelve evaluators from the practice-based research group, the PREP Panel, were sent explanatory letters, a pack of the material under investigation, G2-Bond Universal, with a request to use it, where indicated, for 10 weeks and then to complete a questionnaire designed to elicit the evaluators' views on the handling of the materials. In total, 568 restorations were placed. The results from the questionnaire indicated good acceptance of the material, despite the fact that it required more clinical steps than the material previously used by the evaluators.

CPD/Clinical Relevance: Results from this evaluation indicate that there is a place in a majority of evaluators' practices for a two-bottle adhesive system.

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The value of practice-based research has been previously discussed,[1] with the arena of general dental practice having been considered the ideal environment in which to carry out evaluations of the handling of dental materials and their clinical effectiveness. In this regard, a wide variety of research projects may be considered to be appropriate to general dental practice,[1] including assessment of materials, devices and techniques, clinical trials of materials, assessment of treatment trends and, patient satisfaction with treatment.

A UK-based group of practice-based researchers is the PREP (Product Research and Evaluation by Practitioners) Panel. This group was established in 1993 with six general dental practitioners, and has grown to contain 25 dental practitioners located across the UK, with one in mainland Europe.[2] The group have completed over 70 projects – 'handling' evaluations of materials and techniques, and more recently, clinical evaluations (*n*=8) of restorations placed under general dental practice conditions, with the restorations being followed for periods of up to 5 years.[2]

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Dentine adhesive systems

While the work of Buonocore,[3] on the use of 85% phosphoric acid to alter enamel surfaces and make them suitable for mechanical adhesion, is most commonly cited as the genesis of 'adhesive dentistry', the publication of a lesser-known manuscript by Kramer and McLean in the UK in 1952,[4], in which they used a combination of 15 restorative materials on teeth extracted for orthodontic reasons, identified a 3-micron thick layer of dentine altered staining by the adhesive on sections, is now recognized as the first reference to what we now call the 'hybrid layer' 5.

Moving on, dentine bonding agents became classified into generations,[6] but this means of identifying different groups of bonding agents was considered to have fallen into disarray[7] because of confusion regarding which 'generation' each type of bonding agent fitted into. Until recently, the classification has therefore been to simply subdivide resin-based dentine adhesives into etch and rinse materials (also known as total etch materials) and self-etch materials, with some workers classifying these according to the number of steps involved in their placement (one or two), or by their

pH.[8,9] Since 2011, the classification has grown to include the universal adhesives (UAs),[7] which have become popular in restorative dentistry[10] and are indicated for a variety of clinical procedures. These contain the functional monomer 10-methacryloyloxydecyl dihydrogen phosphate (10-MDP) and are capable of being used in whichever etching mode the clinician considers appropriate, whereas the etch and rinse and self-etch materials are type specific.

Readers who wish to delve into the subject in depth are directed towards a number of recently-published comprehensive reviews on the subject of adhesion to dental tissues.[5,11–13] In one, by Van Meerbeck and colleagues,[13] the authors identified what they considered to be the characteristics of the ideal bonding agent as follows:

1. A separate primer has the following features:
   – It acts as the adhesion promoter and allows use of selective enamel etching;
   – chemical bonding based on 10-MDP;
   – photo-initiators, to ensure all areas, even in the deeper parts of the hybrid layer, will be covered
2. A separate bonding agent that can be light cured immediately has the following features:
   – Solvent-poor/free adhesive resin, hydrophobic to reduce the water uptake;
   – applied in a sufficiently thick layer, this provides stress-absorbing potentia;l
   – a good seal of the interface.

GC (Leuven, Belgium) appear to have taken this 'wish list' for an ideal dentine adhesive on board and have therefore modelled their recently introduced G2-Bond Universal on these ideal features. In this, a hydrophilic primer, containing 4META, MDP, MDTP, dimethacrylates, water, acetone, photo-initiator and filler, has been designed to wet and self-etch the tooth surface. The contents of a second bottle, containing dimethacrylates, Bis-GMA, fillers and photo-initiator, are then applied. Interestingly, this contains no solvent. In common with other UAs, clinicians may use whichever mode of etching that they wish.

It is therefore the aim of this article to evaluate the handling of this new dentine adhesive when used by a group of UK general dentists chosen from the PREP Panel.

The evaluation

A questionnaire was designed jointly by the PREP Panel co-ordinators and the sponsors of the project, with the objective to assess the respondents' views on the handling and ease of use of the material. Explanatory letters, questionnaires and packs of the GC G2-Bond Universal, were distributed in February 2021, with the evaluators being asked to use the material, where indicated, for 10 weeks and to complete and return the questionnaire. It has not been 'normal' practice for PREP Panel evaluations to send instructions other than those in the pack. However, given the novel nature of the system under evaluation, it was decided that a YouTube video might be helpful. Accordingly, the evaluators were asked to watch this. Some clinical cases were documented.

Evaluators

Twelve members were selected at random from the PREP Panel. Two were female, and the average time since graduation was 27 years, with a range of 9 to 41 years.

General baseline data before start of the evaluation

All the evaluators currently used a dentine/enamel bonding system.

Eight different bonding systems were used by evaluators prior to the evaluation: all had used a Universal system. Reasons for the choice of these materials were primarily ease of use, good results and good evidence base, while other reasons given were manufacturer's reputation, single bottle, familiarity, radiopacity, ideal viscosity (thin bond layer), no need to polymerize if used with compatible luting material, and practice standard purchase. Three evaluators used more than one system, but none used a 'two-bottle' system.

When the evaluators were asked to rate the ease of use of their current bonding system, the result was as follows:

Difficult to use — Easy to use

1  5

4.8

A majority of evaluators stated that they placed 10–15 dentine-bonded restorations per typical week, with three placing fewer than 10 and one placing more than 20. When asked how many solely enamel-bonded restorations they placed in a typical week, the average was 4 (range 0–10).

Regarding the explanatory video, the evaluators rated the helpfulness of the YouTube video in understanding how to use the material as follows:

Poor — Excellent

1  5

4.7

Comments:

'This was too long – 5 minutes is enough. Maybe split into 2 sections – the handling and the science'.

'Took me 2 weeks to find time to watch it all but content useful in understanding the material and therefore will enable me to use the material correctly'.

All (100%) of the evaluators stated that manufacturers should provide links to similar videos.

System ease of use

The evaluators rated the presentation of GC G2-Bond Universal as follows:

Poor — Excellent

1  5

4.8

When the evaluators were asked to rate the instructions, the result was as follows:

Poor — Excellent

1  5

5.0

Comment:

'Clear and concise – I have struggled with instructions for new systems before, but not in this case'

The bottle dispensers with the bottle covers were stated to be easy to use by all (100%) of the evaluators.

Comment:

'Great idea but pressure required was a little too much'

The cleanliness and ease of cleaning the bottle was rated as follows:

Poor — Excellent
1 — 5
4.9

In total, 568 restorations were placed using GC G2-Bond Universal, comprised as follows:

Class 1	88
Class II	223
Class III	57
Class IV	126
Class V	74
Total	**568**

When the evaluators were asked whether they used GC G2-Bond Universal for other applications, six evaluators reported using it for bonding indirect restorations, three for treatment of dentinal hypersensitivity, while one evaluator reported using it for repair of fractured porcelain and one evaluator for bonded amalgams and Nayyar cores.

All the evaluators (100%) stated that the bottles and nozzles worked satisfactorily, the resin liquid easily wet the tooth surface.

Comments:

'Bond quite viscous and hard to visualize on an already wet primed surface"
'Film thickness appeared quite thick'
'G2-Bond Universal did not have the yellow appearance of some other bonding systems, which I liked'
'Seemed to wet the surface easily'
'I actually liked the slightly 'gloopier' resin, however I am aware that on several restorations there was a very feint line around the margins (much as with 3M Filtek Silorane). Whether this stains in the future remains to be seen.'

When the evaluators were asked to rate their, and their dental nurses' assessment of the dispensing and handling of GC G2-Bond Universal, the result was as follows:

Inconvenient — Convenient
1 — 5
4.3

Comment:

'Easy to use and nurse happy with dispensing'

The viscosity of the bonding liquid was rated by the evaluators as follows:

Too thin — Too viscous
1 — 5
3.4

Six evaluators (50%) stated G2-Bond Universal was better to use, when compared with other bonding adhesives they have used. One stated it was the same (8%), and three evaluators (25%) stated that it was worse. Three evaluators (25%) stated it was less messy.

Comments:

'Harder to determine if applied evenly to proximal surface'
'More difficult to spread over cavity due to viscosity'
'One bottle system easier to use'

100% of the evaluators (*n*=12) stated that their dental nurses did not experience any difficulties using GC G2-Bond Universal.

Comments:

'No difficulties – just more time to set up/ clean up than a single bottle system'
'Just the pressure needed to dispense'

The evaluators did not report any instances of post-operative sensitivity.

Ninety-two per cent of evaluators (*n*=11) stated that GC G2-Bond Universal was more time consuming to use than other bonding systems. When asked by how much more, the average was 25% more (range 10–50%).

After having tried the GC G2-Bond Universal, 75% (*n*=9) of the evaluators stated they were happy to go to a two-bottle bonding system. One evaluator stated 'maybe' and two evaluators were not willing to go to a two-bottle system.

Comments:

'Yes, if evidence shows a significant superiority in bond strength and restoration performance'
'Easy system to use but I would not change'

Ninety-two per cent of evaluators (*n*=11) stated that they would purchase GC G2-Bond Universal if available at average price. However, if priced at a premium this figure dropped to 50% (*n*=6).

Comments:

'Quality beats price!'
'As a general purpose universal bonding agent, if combined with G-Cem LinkForce, there isn't much else needed'

The evaluators were asked where GC G2-Bond Universal would fit in their practice, comments were as follows:

'Direct restorations – I do see problems with indirect restorations' (2 similar)
'For all bonded restorations' (2 similar)
'Need to use it for longer to see how results went'
'Private work'
'I liked the material and would be happy to use for composite restorations'
'Sorry – still like a Universal'

Seventy-five per cent (*n*=9) of the evaluators saw the GC G2-Bond Universal system as an addition to their current bonding system.

When they were asked if there were any changes they considered essential to the acceptability of the material the following comments were made:

'Two bottles need two clearly identified wells – the liquids look much alike'
'Reduce bond viscosity and find a solution to make viewing the bond wetting better'
'Reduce bond viscosity – a thick layer is more likely to pool in line angles and crevices – weaken bond?'
'Kit needs more wells. Covers for the well to prevent evaporation and premature setting would be helpful'.
'The applicators were not flexible making access difficult to certain cavities.'

When the evaluators were asked to rate the ease of use of the GC G2-Bond Universal, the result was as follows:

Difficult to use — Easy to use
1 — 5
4.3

Final comments:

'Composite sticks to cured bond surface very well. No post-op sensitivity. Need to see data to show better than one bottle systems'
'Good material. It worked well and handled nicely. I just wouldn't change from the current single bottle system'
'Would remain with my Universal for ease of use of the one-bottle system'
'Great product and easy to use (for a two-bottle system)'
'I found that when we used our normal micro-brushes for thje bond it was less effective at wetting the tooth surface.

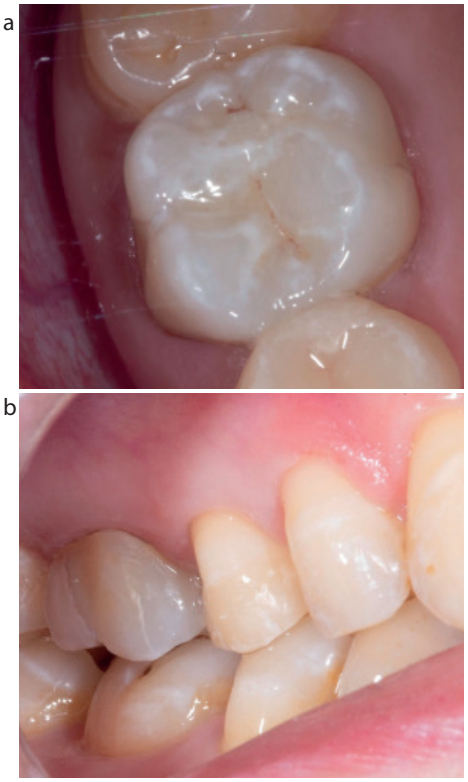

Figure 1. (a, b) Zirconia crown fitted on UR6.

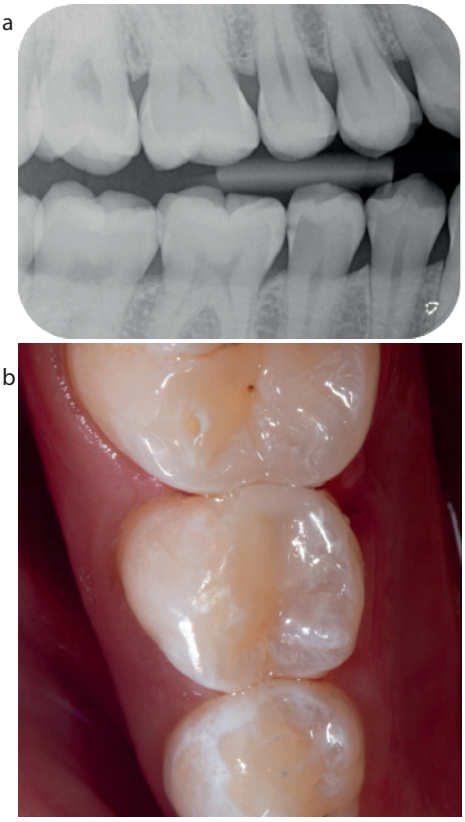

Figure 2. (a) Deep caries evident at LR5. **(b)** Direct resin composite restoration bonded with G2-Bond Universal.

Figure 3. (a) Defective restorations at LL6,7 to be replaced with resin composite and G2-Bond Universal. Caries is undermining the mesio-lingual cusp of LL6. **(b)** Defective restorations at LL6,7 replaced with resin composite and G2-Bond Universal. The restoration at LL6 includes the ML cusp.

The brush seemed to soak up the liquid much more than the pink micro-brushes in the kit. Will it always be sold as a kit or will refill bottles be sold separately? It maybe is worth labelling recommended size of microbrushes. Using plastic wells did help but more plastic waste – consider using recycled or biodegradable materials for packaging and disposing?'

Discussion

The GC G2-Bond Universal bonding system has been subjected to an extensive evaluation in clinical practice by members of the PREP panel, in which 568 restorations were placed.

The presentation of the material and the instructions scored very highly (5.0 and 4.8) on visual analogue scales (where 5 = excellent and 1 = poor). A near ideal score for viscosity (3.4 on a visual analogue scale where 5 = too viscous and 1 = too thin) was achieved.

When GC G2-Bond Universal was rated for ease of use it scored 4.3 on the visual analogue scale. The previously used adhesive system scored 4.8 on the same scale, but all the evaluators were previously using a one-bottle system so it may not be considered surprising that GC G2-Bond Universal did not score so highly for ease of use. On the other hand, 75% (*n*=9) of the evaluators stated they were happy to change to a two-bottle bonding system after using G2-Bond Universal, presumably because they recognized benefits in so doing. In that regard, 92% (*n*=11) of the evaluators would consider purchasing the material if available at an average price, but the number dropped to a still creditable 50% (*n*=6) if G2-Bond Universal was priced at a premium and 75% (*n*=9) stated that they would purchase the GC G2-Bond Universal system in addition to their current system.

This evaluation used a YouTube instructional video for the first time in the PREP Panel's history. Although some evaluators commended that it was too long, the overwhelming view was that is was valuable, perhaps something that manufacturers should consider in the future, given that such a video might improve clinicians' understanding of a material and thereby optimise its clinical use.

A two-bottle bonding system, Optibond FL (Kerr, Orange, USA) has been considered by Perdigao,[5] to be

a

b

Figure 4. (a) Worn lower anterior teeth in a 67-year-old patient. **(b)** Teeth in (a) restored with adhesive resin composite restorations using G2-Bond Universal.

the reference against which all etch and rinse adhesives are compared. However, in an era in which universal adhesives have become popular,[10] and potentially the standard against which all contemporary adhesives may be compared, the addition of 'universality' to a two-bottle bonding system would appear to hold benefits. In this regard, the 'wish list' for the ideal dentine adhesive system detailed by van Meerbeck and colleagues[13] came down strongly on a two-bottle bonding system. GC have designed such a system, but, in an era where dentists have adopted universal adhesives,[10] the manufacturers have incorporated 'universal' into the system, given that G-2 Bond Universal is universal insofar that it has a wide range of applications, contains the resin 10-MDP and is capable of being used in whichever mode of etching that the clinician considers appropriate.

Clinical uses

Figures 1 to 4 present a variety of clinical applications of G2 Bond Universal.

In Figure 1, a UR6 temporary crown was removed, and a zirconia crown tried in. Slightly tight contacts were adjusted and the surfaces polished. G2-Bond Universal was applied taking care to avoid any 'puddles' at internal line angles, polymerized and the crown cemented with GC Link Force. Good marginal fit.

Conclusion

The GC G2-Bond Universal system has achieved good scores in all criteria of this evaluation. Although all the evaluators used a one-bottle universal bonding system prior to this study, it is apparent from the results that this new two-bottle system has won over the majority of them, and who now would be happy to use this system.

Acknowledgement

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Manufacturer comments

GC welcomes the views of the PREP Panel on their new two-bottle bonding system, which we found reassuring, given the perceived benefits of a two-bottle system as gold-standard and the clinical benefits for operators looking for an optimum system to suit all etching, rinsing and adhesive protocols. We have taken on board the comments regarding the dispensing wells and applicators and are very pleased regarding the feedback on consistency and handling of the product.

Compliance with Ethical Standards

Conflict of Interest: The authors declare that they have no conflict of interest.

Informed Consent: Informed consent was obtained from all individual participants included in the article.

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CPD ANSWERS DECEMBER 2021

1. A	**6. B**
2. C	**7. B**
3. C	**8. D**
4. D	**9. C**
5. A	**10. C**