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A Practice-based Evaluation of a Novel Resin Luting Material and Dentine Bonding Agent

Abstract: This study evaluated the handling of a recently introduced resin luting material and its associated universal bonding agent by a group of practice-based researchers. Eleven evaluators from the practice-based research group, the PREP Panel, were sent explanatory letters and a pack of the materials under investigation, with a request to use them, 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, 217 restorations were placed: the results from the questionnaire indicated strong acceptance of the ease of use of the materials. The novel cement delivery system was found to reduce waste, the cement was of ideal viscosity, and the design of the mixing tips and easier clean up were particularly noteworthy. The investigators also appreciated that the same cement can cover adhesive and self-adhesive indications. Some clinical cases of different indications were documented and selected illustrations are presented.

CPD/Clinical Relevance: The luting system which was evaluated was found to be easy to use, with reduced waste of material.

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Practice-based research

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 and now comprises 30 dental practitioners located across the UK, with one in mainland Europe.² The group has 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

Resin luting materials

Resin luting materials have a comparatively short history when compared with 'traditional' luting materials such as zinc phosphate cement. Owing to the advent of the minimally invasive dentistry approach as well as the development of an increasing number of tooth-coloured restoration materials requiring a strong bond to the tooth, resin luting materials are taking an increasing share of the market, as demonstrated by the results of three questionnaire-based surveys of UK dentists in 2002, 2008 and 2015, in which resin luting materials were stated to be used by 6% and 14% of respondents in 2002 and 2015, respectively.³ Self-adhesive resin luting materials, which are less technique sensitive than other forms of resin luting material, were not available in 2002, but in 2008 they were used by 9% of respondents, rising to 13% in 2015. In that regard, the authors added that 'with

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Restorations cemented/ bonded with		Restorations/month	
		Average	Range
A	Conventional cements	3	0–35
B	Resin-modified glass-ionomer cements	6	0–20
C	Self-adhesive resin cements	3	0–15
D	Dual-cure resin cements	6	0–15
E	Light cure adhesive resin cements/composite	4	0–40

Table 1. Details of luting materials currently used by evaluators

such slow uptake, it takes manufacturers many years to recoup the research and development costs of new materials, possibly delaying further innovation and advances. In the future interests of patients and all stakeholders in the provision of oral healthcare, it is suggested that more rapid uptakes of materials representing a tangible advancement in the art and science of dentistry, would be a win-win situation for clinicians, manufacturers and patients alike!

These surveys indicated that the use of zinc phosphate cement was diminishing, with 32% of respondents using it to cement single crown units in 2002, dropping to 28% of respondents in 2008 and 15% in 2015. However, the authors expressed disappointment that a significant minority of general dental practitioners (GDPs) in the UK continued to use traditional zinc phosphate cement when alternative luting materials with superior properties and proven reliability are available. This may be seen to be a further example of a reluctance among certain GDPs to move with the times, apparently ignoring advances in dental biomaterials science.

Resin luting materials possess a wide range of excellent physical properties, for example:⁴

- Not soluble in the oral environment, particularly in the dilute organic acids found in plaque;
- Good physical properties;
- Tooth coloured;
- Enhanced marginal seal;
- Capability of being bonded to some restoration types;
- Capability of bonding to tooth structure via a bonding agent or

acidic phosphorylated groups.⁵

On the other hand, disadvantages include:

- May be technique sensitive if a separate bonding procedure to the tooth is required;
- Clean-up time is critical, and/or difficulties with removal of excess;
- Moisture and blood contamination control is critical;
- Need to finish restoration margins.

A resin luting material that could overcome some or all of these disadvantages could therefore be considered to hold clinical advantages. Simplification of the procedure and robustness of the workflow seem to be key for reliable, successful outcomes every day. In this regard, early resin luting systems used the resin cement in conjunction with a dentine bonding agent. Initially, these bonding systems may have had three (or, in some cases, more) bottles/stages, making the procedure of luting with a resin cement technique sensitive. While the self-adhesive resin cements helped simplify resin luting, contemporary one-bottle dentine bonding systems may also be considered to streamline the resin cementation process. This article examines the clinical handling of a novel resin luting material concept that can be used with or without its associated universal bonding agent.

The evaluation

Explanatory letters describing the study were sent to members of the PREP Panel in August 2019. Of those who expressed an interest in taking part in the evaluation, 11 members were selected at random. A questionnaire was designed jointly by the

PREP Panel co-ordinators and the project sponsors, with the objective of assessing the respondents' views on the handling and ease of use of the material. Questionnaires, instructions for use including a step-by-step card, and kits of RelyX Universal (3M) and the bonding agent, Scotchbond Universal Plus (3M) were distributed in mid-September 2019, with the evaluators being asked to use the materials for 10 weeks and then complete the questionnaire. The instructions indicated that RelyX Universal could be used with or without the bonding agent, Scotchbond Universal Plus, depending on the indication, as well as on personal preference. Some clinical cases were documented.

Results

Of the evaluators, one was female, and the average time since graduation was 29 years (range 18–40 years). One evaluator was unable to complete the questionnaire due to illness.

General baseline data before the start of the evaluation

On average the evaluators placed 31 fixed, permanent restorations in an average month (range 4–50). Table 1 lists the numbers of restorations placed with the each of the different classes of cement listed in Table 1.

The evaluators used a wide range of resin cements prior to the evaluation, the highest number being users of RelyX Unicem/Unicem 2 (3M ESPE).

When the evaluators were asked to rate the importance of a simplified workflow using resin cements, the result was as follows:



The evaluators were asked how satisfied they were with the brands of resin cements they were currently using, with the following result:



Regarding dual-cure cements, the evaluators were asked (after thinking broadly about all aspects including purchasing, storage, usage and clinical performance) to list the top three things they would like to see improved. The

results were:

1. Less waste (seven evaluators)
2. More colours and opacities (four evaluators)
3. Suitable for all types of restorations/ ease of use/ease of clean up (three evaluators each)

Other comments included: longer curing time, availability of try-in pastes, less moisture sensitivity, and less packaging. One further comment was: *'Improve nozzle direction – with a straight automix tip it is difficult to visualise the coverage of the fit surface without either the applicator or the operator's hand getting in the way.'*

The evaluators were asked about the ease of use of the resin luting system (the whole procedure) used prior to the present study, with the following result:
 Difficult to use Easy to use
 1  5
4.1

The evaluators were asked about the ease of use of the conventional luting system (the whole procedure) used prior to the present study, with the following result:
 Difficult to use Easy to use
 1  5
4.1

Results following use of the materials under evaluation

The evaluators rated the instructions for use and the booklet provided, as follows:
 Poor Excellent
 1  5
4.4

Comments

'Excellent diagrams throughout'
'A laminated card system would be easier to clean in the surgery setting'
 (See Discussion for a comment on this being implemented).

In total, 217 restorations were placed using 3M RelyX Universal for different indications, and following different treatment modes (Table 2): Also placed, were three metal wings (splints) and one titanium post.

The evaluators were asked to state which self mode (self-adhesive or adhesive) for each of the following restoration materials they used. The results are presented in Table 3.

Restoration	Self-adhesive	Adhesive
Crowns	62	73
Inlays		13
Onlays	3	21
Bridges	6	2
Fibre-posts	5	12
Veneers		5
Adhesive bridges		11

Table 2. Restorations with 3M RelyX Universal

Material	Self-adhesive	Adhesive
Zirconia	3	6
Hybrid ceramics	2	3
Glass ceramics	2	5
Composite	1	2
Metal/PFM	4	4

Table 3. Self mode for restoration materials

The four shades of RelyX Universal that were provided were stated by 90% (n=9) of the evaluators to be sufficient. A comment made by the remaining evaluator was: *'Please provide an A3 translucent shade'*

When the evaluators were asked to rate the overall satisfaction with the aesthetic results using RelyX Universal, the result was as follows:

Not satisfied Very satisfied
 1  5
4.5

System ease of use

When the evaluators were asked about the ease of use of the novel RelyX Universal delivery system, the result was as follows:

(a) For dispensing

Difficult to use Easy to use
 1  5
5.0

(b) For handling

Difficult to use Easy to use
 1  5
5.0

(c) For combined use of the Scotchbond Universal Plus with RelyX Universal

Difficult to use Easy to use
 1  5
4.9

The ease of mounting of the provided tips was rated as follows:

(a) Mixing tip

Difficult to use Easy to use
 1  5
4.9

(b) Elongation tip

Difficult to use Easy to use
 1  5
4.5

The viscosity of the RelyX Universal material was rated by the evaluators as follows:

Too thin Too viscous
 1  5
3.0

Regarding the ease of excess clean up, the evaluators rated the ease of removal of excess material after tack-curing as follows:

Hard Easy
 1  5
4.8

In this regard, 80% (n=8) of the evaluators stated that the excess was easier to remove than their previously used resin cement. One evaluator said it was equally easy.

Comments

- 'Great self-sealing TINY tips. Clean-up is a breeze'*
- 'This was a great advantage over other resin cements I have used before'*
- 'Nice flow to material, mixing tips excellent. Easy to fit and very little waste'*
- 'Did find the cement more difficult to clean up on composite based materials. I expect due to the self-adhesive nature of the cement'*
- 'More predictable tack cure time, therefore technique for margin clean up more reliable'*

The working time of RelyX Universal was rated by 100% of the evaluators (n=10) to be sufficient.

The evaluators were asked to name their currently used resin luting material and compare it with RelyX Universal. In terms of handling, eight evaluators found RelyX Universal better, and two the same; and in terms of working time, three found it better, and seven the same. None found it worse in terms of handling or working time than their currently used resin luting material.

None of the evaluators (n=10) reported any post-operative sensitivity.

The satisfaction of the material in both self-adhesive and adhesive modes was rated by the evaluators as follows:

(a) Self-adhesive



(b) Adhesive



All evaluators (100%; n=10) stated that they would purchase RelyX Universal if it were available at an average price, and all stated that they would recommend RelyX Universal to colleagues.

Comments

Final, unsolicited, comments included:

- 'One of, if not THE nicest luting materials & dispensing systems I have ever used. Well done 3M'
- 'I always thought that shorter syringes would make accuracy easier, especially for dentists with small hands (unlike me)! 'They did'
- 'Smart tips, less waste, mechanism very good – all things considered, I like the product!'
- 'Needs try-in pastes in translucent, opaque, yellow and white shades.'
- 'Excellent product, well thought through. Great packaging. Excellent properties and ease of use. One of the best cements I have used.'
- 'Great material – no improvements needed' (two similar)
- 'Loved the tips – much less volume of waste'
- 'The smaller mixing tip is welcomed & will result in less waste than the resin cement I currently use'
- 'Regarding Scotchbond Universal Plus, used the adhesive for 10 direct placement restorations – excellent material – seems just as good as Scotchbond Universal'

Discussion

The 3M RelyX Universal resin luting material was subjected to an extensive evaluation in which a total of 217 restorations were placed.

Based on this, the following conclusions may be made:

- The instructions and booklet scored very well, with just two suggestions made for improvement. In this regard, provision of a laminated card was suggested during the evaluation. This was implemented and the evaluators were provided with pre-production packaging and instructions for the evaluation.

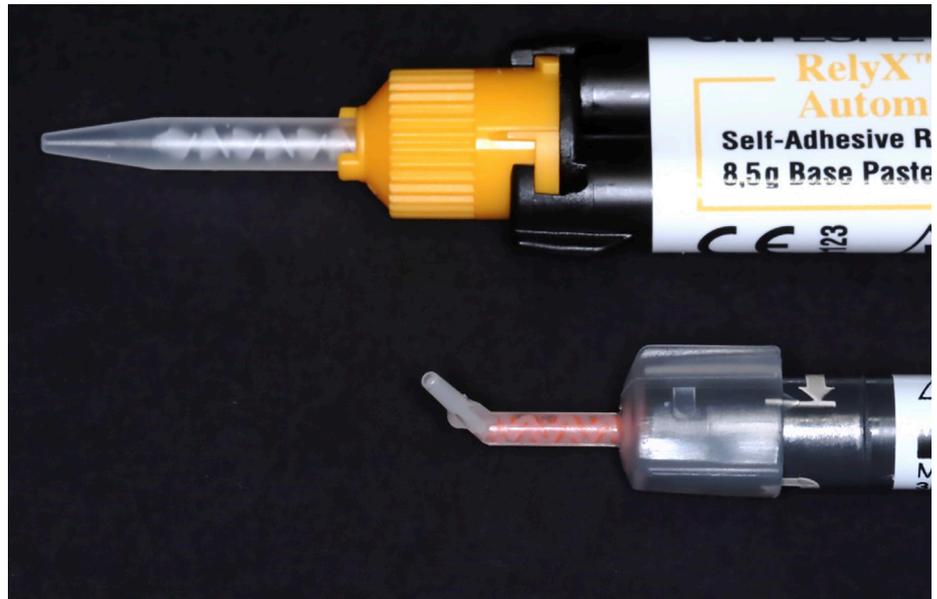


Figure 1. Real-size illustration of RelyX Unicem2 syringe tip (top) versus RelyX Universal syringe tip (bottom).

- Looking at the ease of use scores for dispensing and placement of the material, the material scored outstandingly for both (5.0 on a visual analogue scale (VAS) where 1 = difficult to use and 5 = easy to use), and also when used in combination with Scotchbond Universal Plus (4.9 on a similar VAS scale). It should be added that these scores are high for products of this type, in the authors' experience.
- The mixing tips were praised, especially the smaller tip, for dispensing and that less waste was produced. This is reflected in the high scores achieved (4.9 and 4.4 [elongation tip] on a VAS scale where 1 = difficult to use and 5 = easy to use).
- The viscosity of the material was rated as ideal, and the ease of clean up after tack curing scored very highly. The ease of clean up received positive comment from several evaluators.
- The fact that the material has scored highly in all of the aspects evaluated is reflected by all of the evaluators stating they would both purchase, and recommend,

RelyX Universal and Scotchbond Universal Plus to colleagues.

The potential difficulties with use of resin luting materials described in the introduction may have been a reason for the continued use of 'traditional' luting materials. However, when the results of the present study are examined, it may be considered that this novel resin luting material, with its newly designed self-sealing syringe and rotating tip, has overcome a majority of these potential difficulties. In this regard, the results indicated that a previously considered difficulty relating to difficult clean-up and removal of excess had largely been overcome (4.8 on a VAS scale where 1 = hard to remove and 5 = easy), while 'ease of use' and 'handling' produced maximum ease of use scores. Top of the wish list of 'things that evaluators would like to see improved' was 'less waste'. Figure 1 demonstrates that this has been achieved. In this regard, the manufacturer's data indicate that there is 50% less plastic waste and 80% less cement waste per application when compared to a previous cement system.

A further 'wish' that the material



Figure 2. (a) Adhesive cementation of an UL6 e.max (Ivoclar Vivadent, Liechtenstein) onlay using RelyX Universal (3M) and the dentine bonding agent Scotchbond Universal Plus (3M) to restore a root-filled tooth

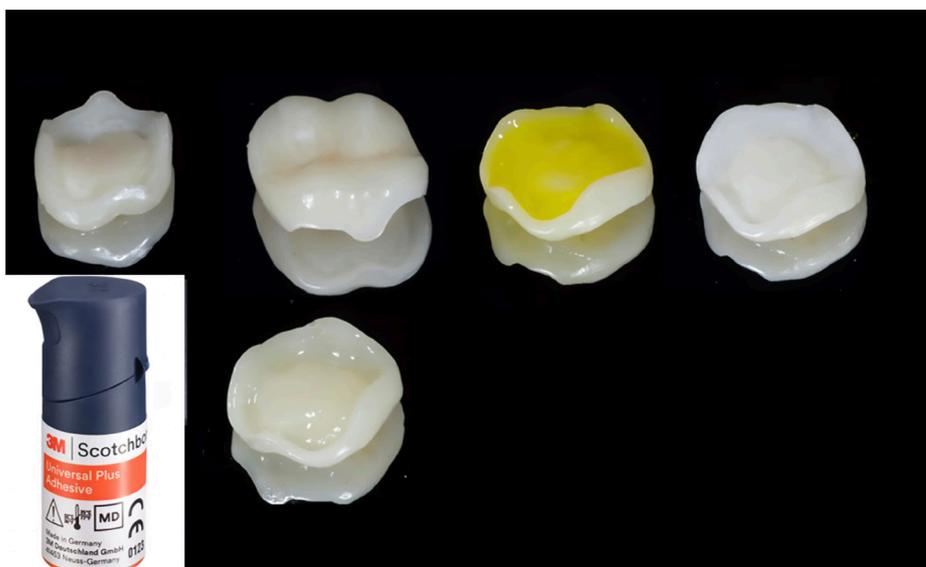


Figure 2. (b) Pretreatment of the fit surface of the UL6 e.max (Ivoclar Vivadent) onlay. HF etching is followed by application of Scotchbond Universal Plus (3M), which contains a silane.

should be available in 'more colours' appears to have been achieved since a majority of evaluators expressed satisfaction with the shade range available. The 'wish' 'suitable for all types of restorations' has been fulfilled, when looking at the wide range of restorations placed in the present study. A representative selection of these is presented in Figures 2 to 4, followed by a case report giving details of the use of RelyX Universal (3M) and Scotchbond Universal Plus (3M) in the placement of an all-ceramic resin-retained bridge.

Case study

A 71-year-old female patient (with no relevant medical history) indicated that she was unhappy with the colour of the pontic of the 8.5-year-old non-precious metal

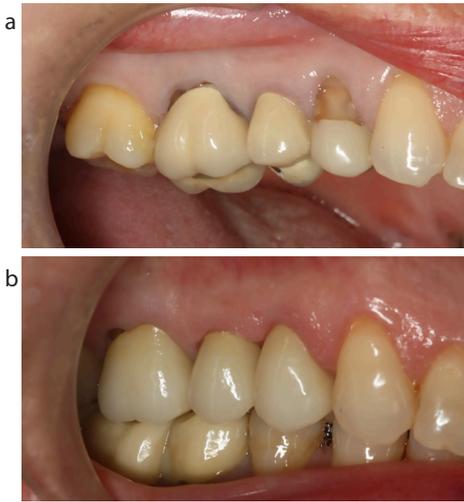


Figure 3. (a) Defective restorations at UR456, **(b)** Replacement with e.max (Ivoclar Vivadent) restorations at UR456, luted with RelyX Universal (3M).



Figure 4. (a) Surface treatment of e.max (Ivoclar Vivadent) onlay at UR4. Scotchbond Universal Plus (3M) was used as the dentine bonding agent (DBA).



Figure 4. (b) Cementation of e.max (Ivoclar Vivadent) onlay at UR4 with RelyX Universal (3M).

Maryland distal cantilever bridge at UR12, with UR1 also being discoloured due to the metal bridge backing: this tooth was also highly sclerosed. The patient stated that she wanted no tooth preparation.

Treatment plan

The plan was to remove the Maryland bridge, whiten the tooth at UR1 and place an Essix temporary partial while

the zirconia distal cantilever bridge was being constructed.

Tooth whitening improved the appearance of UR1, but not as much as hoped, as the patient chose to stop at this



Figure 5. (a, b) Pre-operative appearance.

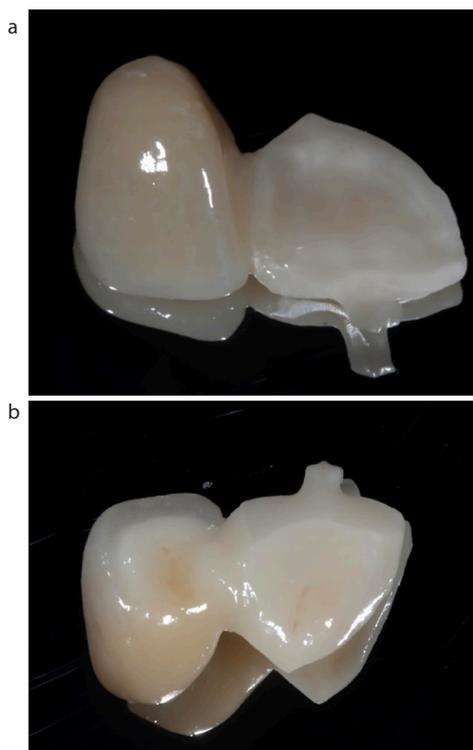


Figure 6. (a, b) Zirconia distal cantilever bridge replacing UR2 prior to cementation.

point. The zirconia resin-retained bridge was then constructed.

The fit surfaces of the zirconia restoration were sand blasted with 30-micron alumina, rinsed with water and cleaned with alcohol, air dried and treated with Scotchbond Universal Plus (3M) as a



Figure 7. Post-operative view of upper anterior teeth

zirconia primer in order to achieve additional bond strength. Following application of Scotchbond Universal Plus adhesive, this was carefully air dried, following the instructions for use, until no more ripples were observed, thereby ensuring that all the solvent had evaporated. Meanwhile, the tooth was etched with phosphoric acid, Scotchbond Universal Plus applied and gently air dried. RelyX Universal (3M) was then applied to the zirconia wing and the restoration was seated. Some excess cement was removed with a brush, while holding the restoration in place, and it was then tack cured. Further excess was then removed and floss used between the central incisors, followed by a final 15-second cure palatally and buccally with a curing light >1000mW/cm². This extra-long curing time was chosen in order to ensure sufficient light exposure for a fast and reliable cure of the cement. The location tag was then removed and the surface polished and final marginal finishing completed (Figures 5–7).

Discussion of case

The appearance of UR12 has been improved, but not to the degree hoped for by the clinician (P. Sands). The compromise was as a result of the patient’s request to limit the time spent on tooth whitening and to have no tooth preparation.

Conclusion

The good reception for this resin luting material is indicated by all the evaluators stating they would

both buy and recommend the system to colleagues.

Compliance with Ethical Standards

The authors do not have any financial interest in the company whose materials were included in this study. This evaluation has been partially funded by 3M Oral Care, Seefeld, Germany. Informed Consent: Informed consent was obtained from all individual participants included in the article.

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**CPD ANSWERS
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| 1. C | 6. C |
| 2. B | 7. C |
| 3. C | 8. A |
| 4. B | 9. B |
| 5. C | 10. A |