Is the best bond the one you don't need?

The current status of materials that don't need an adhesive to bond to the tooth

..a self-adhesive composite would be wonderful!

Even then I dreamed








Learning objectives

On completion of the presentation, listeners should:

- Know how Glass Ionomer (GIC) materials work
- Be aware of the current status of research into the performance of GIC in loadbearing situations
- Understand how self-adhesive composite luting materials work and how they can be developed as restorative materials
- Appreciate the challenges of developing a true self-adhesive material for posterior teeth and be aware of the current status of such

What I plan to talk about

- The current status of dentine adhesives, resin composite materials and Glass Ionomers (GICs)
- Current status of GICs and Glass Hybrids for restoration of posterior teeth
- Self-adhesive resin composite luting agents
- Their development into self-adhesive resin composites
- Are these good enough to change our philosophy today?
- Final thoughts

We thought that this was bonding!

1875

1875

The function of a traditional luting cement is to provide *retention* by interlocking the minor irregularities on the prepared tooth surface and the restoration surface

Smith, Wright and Brown, 1986

1875

1875

Baldwin 1897

“ I was struck by the readiness by which the oxyphosphate cement laid hold of the amalgam.

This composite filling is suitable for all which are considered suitable for amalgam alone.”

Trevor's classification for luting materials

ACTIVE LUTING

PASSIVE LUTING

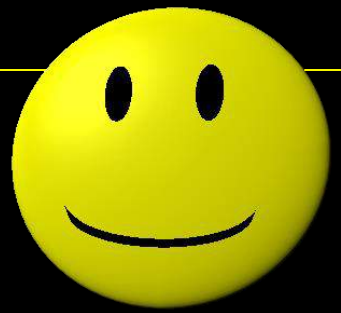
Zinc Phosphate

Advantages	Disadv
History of success	Post-op s
Adjustable working time	Long set time
High impact resistance	Mix technique
High rigidity	No measurable shear adhesion
	High solubility
	Low compressive strength
	Low diametral tensile strength
	Low fracture toughness

Lactic acid erosion test

Conventional resin cements

Advantages	Disadvantages
Not soluble in oral environment	Requires acid etch technique
High compressive & tensile strengths	Requires dentine bonding
Good fracture toughness	Technique sensitive
Capable of bonding to tooth structure via DBA	Moisture control is critical
	Clean –up time is critical



Additionally……

resin cements may be used as part of an adhesive approach where preparation geometry is suboptimal

Several papers confirm this

The retention of complete crowns prepared with three different tapers and luted with four different cements

Omar Zidan, BDS, HDD, MS, PhD,[a] and Gary C. Ferguson, DMD, MS[b]
School of Dentistry, University of Minnesota, Minneapolis, Minn

Statement of problem. The role of adhesive properties of cements on the retentive strength of crowns with different degrees of taper is not clear.
Purpose. This study evaluated the retention of full crowns prepared with 3 different tapers and cemented with 2 conventional and 2 adhesive resin cements.
Material and methods. One hundred twenty sound human molar teeth were assigned randomly to 1 of 12 groups, (n=10). The groups represented the 4 cements: zinc phosphate (Fleck's), a conventional glass ionomer (Ketac-Cem); 2 adhesive resin cements (C&B Metabond and Panavia); and 3 tapers of 6-degrees, 12-degrees, and 24-degrees within each cement. Crowns were cast with a high noble alloy. The 6-degree taper was considered the control within each cement group. Retention was measured (MPa) by separating the metal crowns from the prepared teeth under tension on a universal testing machine. Analysis of variance was used to test the main effects on the retentive strength of full crowns, namely cements, tapers, and failure modes. The Fisher's multiple comparison test was used to evaluate the source of the differences. The χ^2 analyses were used to examine the relationships between failure types, cements, and tapers. All statistical tests were conducted at $\alpha=.05$.
Results. There was a significant difference in the main effect cement ($P<.0001$) and taper ($P=.0002$). The mean retentive strength values of both Fleck's and Ketac-Cem were significantly lower than the mean retentive strength values of both C&B Metabond and Panavia ($P<.0001$). The retention of crowns prepared with 6-degree taper was not significant from the 12-degree taper ($P=.0666$). The difference in retention was significant between the 6-degree taper and the 24-degree taper ($P<.0001$) and between12-degree taper and 24-degree taper ($P=.0178$). The types of failure were adhesive in the cement (65%), cohesive in the tooth (31%), and assembly failure (fracture of embedding resin) (4%). The type of failure was dependent on the degree of taper ($P<.0001$) and on the type of cement ($P<.0042$).
Conclusion. Within the limitations of this study, the retentive values of the adhesive resins at 24-degree taper were 20% higher than the retentive values of the conventional cements at 6-degree taper. The use of resin luting agents yielded retention values that were double the values of zinc phosphate or conventional glass ionomer cement. (J Prosthet Dent 2003;89:565-71.)

CLINICAL IMPLICATIONS

The adhesive resin cements used in this in vitro study yielded retentive values at 24-degree taper higher than the values obtained from conventional cements at 6-degree taper and may be considered for luting restorations on teeth with less than ideal taper.

J.Prosthet.Dent.2003:89:565-571.

DENTAL MATERIALS 26 (2010) 193–206

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journal homepage: www.intl.elsevierhealth.com/journals/dema

Review

Crown pull-off test (crown retention test) to evaluate the bonding effectiveness of luting agents

S.D. Heintze*

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Luting agent

ABSTRACT

Objective. The purpose of this review was to assess the influencing factors which affect laboratory tests that evaluate the effectiveness of luting agents on the retention of crowns in prepared dentin and – based on the results of the review – to propose a reasonable experimental setup.
Materials and methods. The database MEDLINE was systematically searched for laboratory methods that evaluated the effectiveness of luting agents by pulling off crowns from prepared extracted teeth.
Results. Eighteen studies were included into the systematic review. The studies varied largely with regard to tooth type (molars, premolars), number of specimens (9–25), stump height (3–6 mm), convergence angle (4.8–33°), standardization and measurement of preparation surface, seating force (25–200 N), artificial ageing, crosshead speed for tensile force and statistical analysis. The coefficient of variation of the test results varied from 3% to 100%. The most important influencing factors for the crown dislodgement were stump height and convergence angle as well as the luting agent. Panavia and RelyX Unicem generally produced the highest values followed by glass ionomer and zinc phosphate cements. When pooling and normalizing the data, the mean difference between glass ionomer and resin-based materials as well as between glass ionomer and zinc phosphate cements was statistically significant (Wilcoxon, $p<0.05$). Seating force, roughness, type of cutting bur and use of a desensitizing agent had all a negligible effect on the test results. Artificial ageing like thermocycling had no influence with glass ionomer cements whereas for resin-based cements thermocycling and prolonged water storage generated similar a failures stress than thermocycling alone. The comparison with clinical results did not reveal conclusive evidence that the results of the laboratory methods completely reflect the results of prospective clinical trials in conjunction with single crowns and fixed dental prostheses. A reasonable experimental setup includes: at least 20 specimens per group, stump height 3 mm, convergence angle 20°, thermocycling of specimens (5000x), avoidance of shearing forces during dislodgement and failure probability statistics (Weibull).

Dent.Mater.2010:26:193-206.

Retentive properties and film thickness of 18 luting agents and systems

Development of new dental materials has resulted in significantly more luting agents over the past decade than in the previous 100 years. Some newer luting systems reach such high retentive values that one cannot help but wonder how much retention is needed to retain a casting. According to Shillingburg et al.[1] and Dryer-Jørgenson,[2] a direct relationship exists between retention and convergence angle, crown height, and total surface area of the preparation.

Enamel and dentin bonding and fluoride release are required attributes of newer generation cements. Adhesive forces like those generated through chelation by polycarboxylate and glass ionomer cements are weak compared to those systems for which dentin primers are recommended in conjunction with the luting component. Hypersensitivity following use of resin or hybrid cements appears to be of little concern, in contrast to experience with some glass ionomer cements.[3] There is no persuasive evidence for this hypersensitivity, although possibilities have been noted.[4] However, calcium hydroxide ($Ca[OH]_2$) used as a liner under crowns has been shown to reduce inflammation.[3] Resin and hybrid cements or ionomer resins are the newest additions to luting agents. One such cement (Biomer, L.D. Caulk & Co., Milford, DE), tested for pulp reactions in primates, caused little irritation after 5 days; after 26 and 60 days, the initial mild irritation had been resolved.[5] Since postoperative hypersensitivity is common, research has been directed at finding explanations

als, and developing new ones to improve patients' postcementation comfort, while increasing long-term success.

Retentive properties of 18 current luting materials/systems, out of more than 45 systems tested, are reported on here. In addition, film thickness was measured according to American Dental Association (ADA) Specification No. 8.

Methods and materials

Virgin, caries-free mandibular premolars, recently extracted for orthodontic reasons, were used for the crown preparations. Extracted teeth were stored in water until the experiment. The method used here, except for minor modifications, resembled that reported

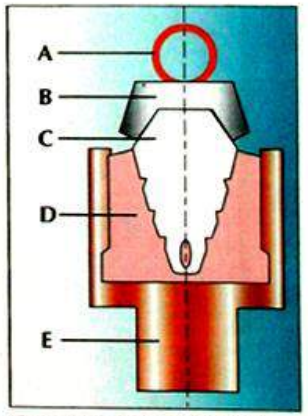

Fig. 1. Cross section of the experimental design. A = the ring to be attached to the Instron to apply a tensile force; B = the casting; C = the crown preparation; D = resin securing the

Pameijer CH, Jefferies SL, Gen.Dent.1996:44:524-530

Think adhesive cementation!

CONCLUSION: As the resin luting materials provided retention that was double the values of zinc phosphate or conventional cements, these results provide an ***overwhelming indication for the use of adhesive luting.***

The retention of complete crowns prepared with three different tapers and luted with four different cements

Omar Zidan, BDS, HDD, MS, PhD,[a] and Gary C. Ferguson, DMD, MS[b]
School of Dentistry, University of Minnesota, Minneapolis, Minn

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The adhesive resin cements used in this in vitro study yielded retentive values at 24-degree taper higher than the values obtained from conventional cements at 6-degree taper and may be considered for luting restorations on teeth with less than ideal taper.

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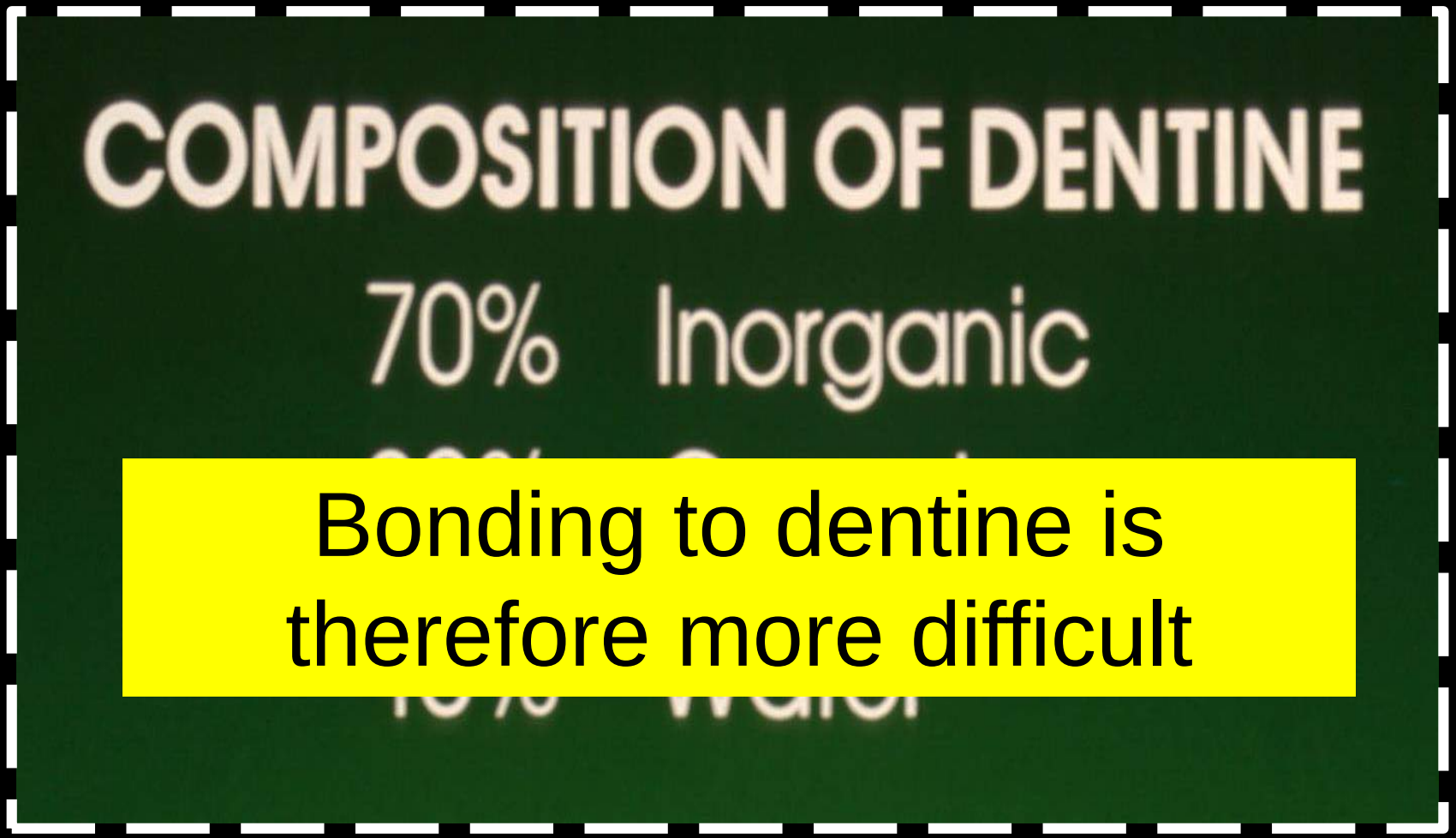
3M ESPE
RelyX™ Unicem
Aplicap™
CONTENTS
6280 mg
Ciment de scellement composit
et autoadhésif
Materiale di fiss
universale
Cemento de fijación de compo
autoadhesivo
New monomers, FAS glass filler, new initiator systems
More later!
3M ESPE
Unicem

The current status of dentine adhesives

Problems in bonding to dentine



Bonding to dentine is therefore more difficult

It is a vital substrate

Another problem: The smear Layer

- Thickness:
  0.5 - 5.0 microns
- Will not wash off
- Weak bond to tooth,
  2 – 3 MPa
- Very soluble in
  weak acid

Definition of a Universal Adhesive

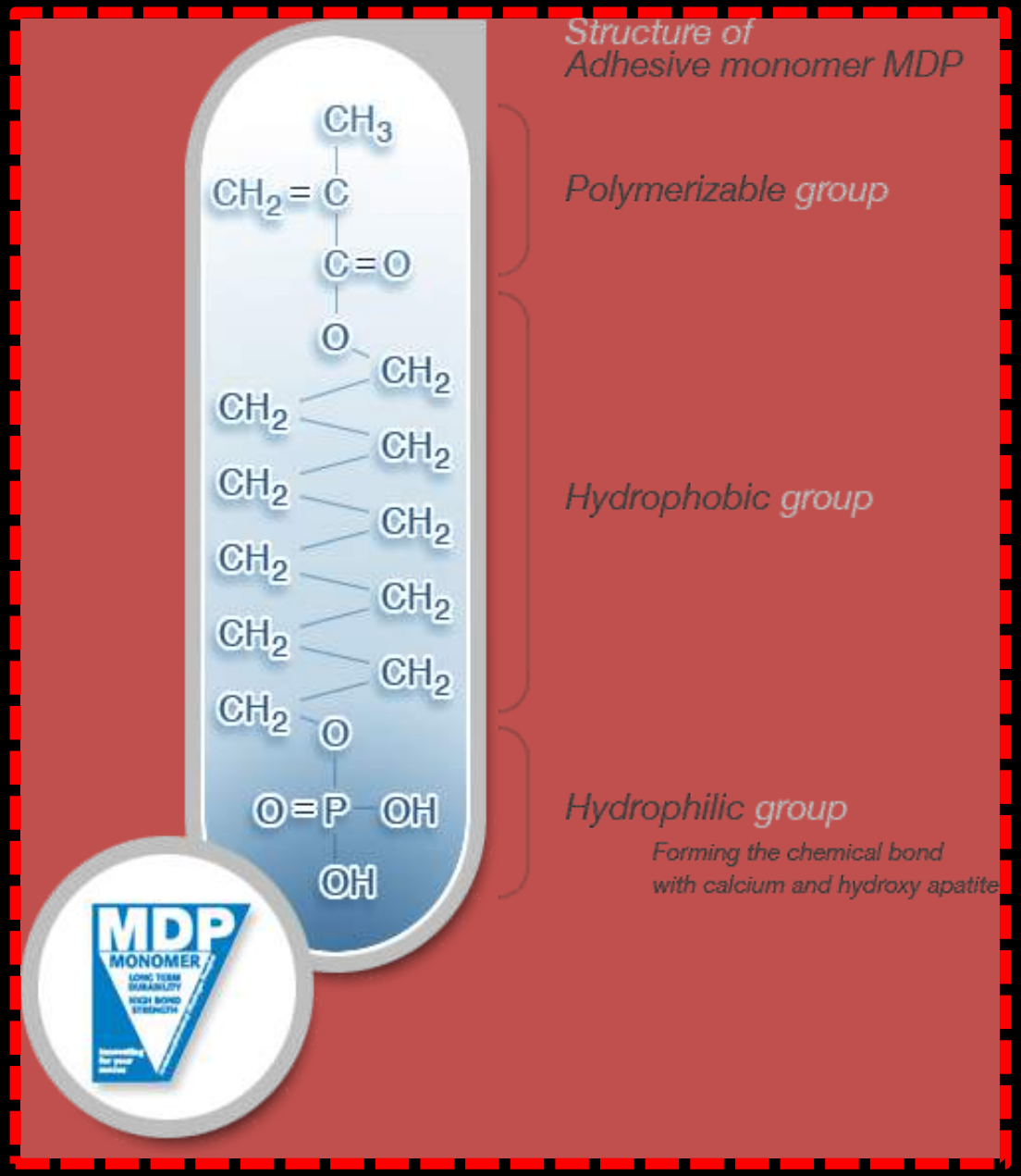
- capable of being used in whichever etching mode that the operator considers appropriate (total etch, self-etch or selective enamel etch):
- may be used for direct and indirect dentistry, the latter generally in conjunction with a resin-based luting system from the same manufacturer as the bonding agent, with the luting system incorporating a material-specific initiator (Burke et al)
- the addition of the monomer 10-MDP to provide chemical bonding to hard tissue & metals (Matos et al),
- a single-bottle, no-mix adhesive system that performs equally well with any adhesion strategy and bonds to tooth structure & to different direct/indirect restorative materials (Nagarkar and colleagues).
- suitable for clinical applications, e.g. direct/indirect restorations, core build-ups, zirconia primers and dentine densensitising (Perdigao et al)

Treatment of the smear layer

- REMOVE (Etch & Rinse/Total etch)
- LEAVE/PENETRATE (Self Etch)
- UNIVERSAL MATERIALS (Etch & Rinse, Selective enamel etch, Self etch) (use for direct and indirect)

Etch&Rinse and Self Etch were type specific

Why has 10-MDP become so popular?



10-MDP is important for the bond reaction with HAP

SUMMARY: Universal bonding agents:

- Can be used in total etch, self etch, selective enamel etch modes
- Are compatible with direct & indirect procedures
- Can be used with self & dual cure luting materials (with separate activator)
- Are suitable primers for silica & zirconia
- Can bond to different substrates (e.g.metal)

Scotchbond Universal Plus: What's different?

It bonds to caries affected dentine

Does everything that SBU did,
but better bond (manufacturer's data)

Improved silane

BPA free

Radio-opaque

Anyone prefer a 2-bottle (plus etch) system to a one-bottle bonding system?

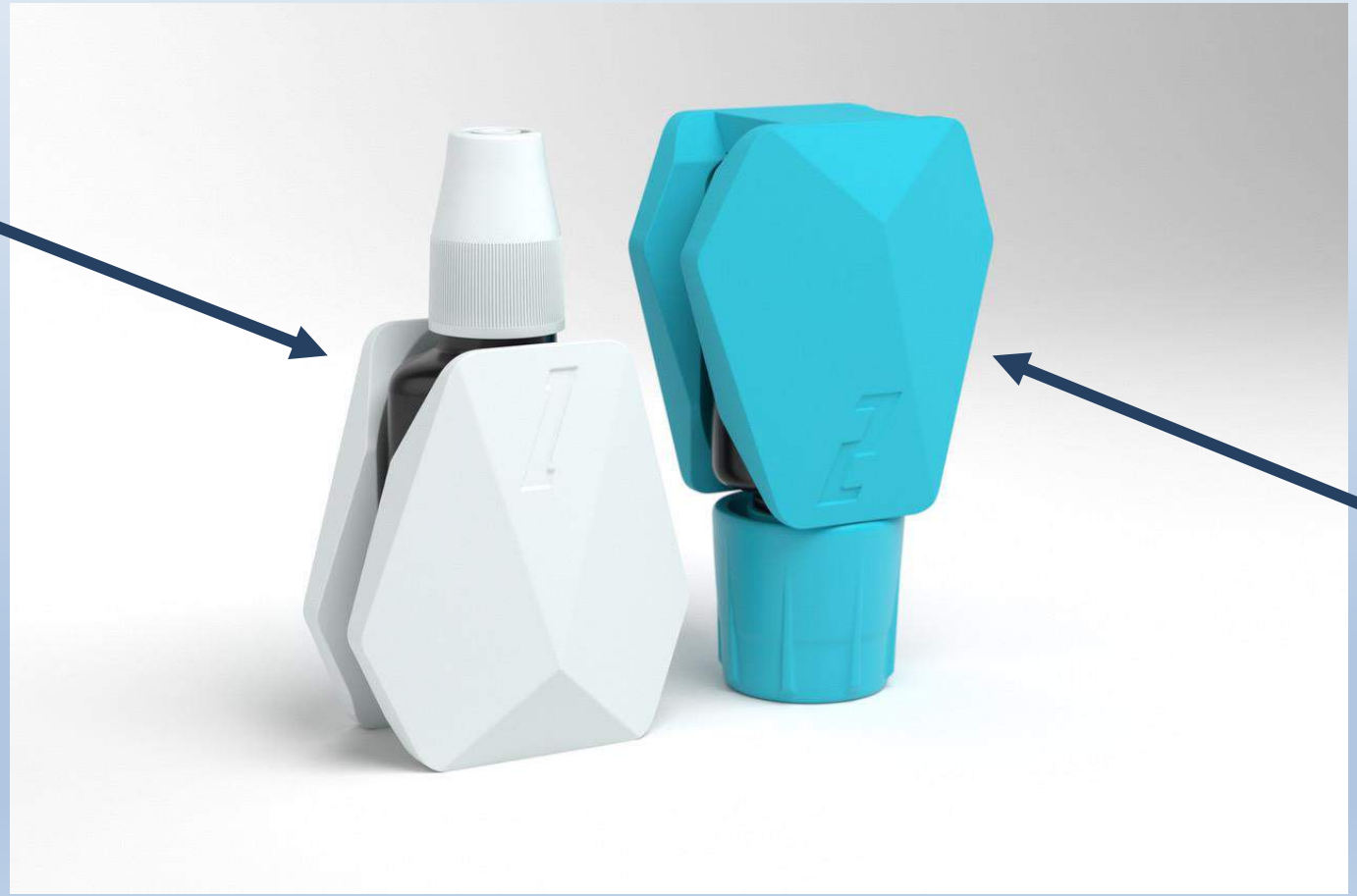
G2-BOND Universal

- All-round 2-bottle Universal Bonding system

G2-BOND Universal

1-PRIMER

- **Self-etching** process
- **Chemical BOND** to tooth structure with MDP
- **Photoinitiator:** cures in depth of hybrid layer
- **HEMA free** for long-term durability



G2-BOND Universal

2-BOND

- **Hydrophobic,** solvent **& HEMA free** for long term durability
- **Thick layer** that can absorb & relieve stress
- **High mechanical properties**
- Seal the interface

FJ Trevor Burke

Peter Sands and Russell J Crisp

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.

Dent.Update.2022:49:112-118

Trevor’s view:

Universal bonding agents generally represent improved ease of use compared with previous bonding agents

…this is good because….

An easy to use material may allow us to produce better results

Special Report

Ease of use versus clinical effectiveness of restorative materials

F. J. T. Burke, DDS, MSc, MDS[1]/ M. Liebler, DDS[2]/ G. Eliades, DDS, Dr Odont[3]/
R. C. Randall, M Phil, BChD[4]

"Ease of use," as applied to dental materials and techiques, means different things to different people. Factors that may contribute to ease of use include a minimum number of application stages, easy application and shaping ability, quickness of use, lack of stick, and moisture sensitivity. Ease of use may also imply that a material or technique does not cause stress for the dentist and patient, is cost effective, is easy to learn, and should provide the operators with a sense of satisfaction with their work. Similarly, "clinical effectiveness" of the treatments prescribed for patients is not always capable of being accurately defined. Suggested factors that may contribute to clinical effectiveness include a lack of patient complaints with respect to longevity and/or cost, no secondary caries, and preservation of the remaining tooth structure during functional loading. Ease of use and clinical effectiveness are not necessarily related, but they must be combined for a technique to be successful. The achievement of this demands a partnership between clinicians, manufacturers, and patients. *(Quintessence Int 2001;32:239–242)*

FJ Trevor Burke

Louis Mackenzie

Bonding to Dentine: An Update on Universal Adhesives

Abstract: The ability to successfully bond restorations to dentine is central to minimally invasive restorative dentistry. While dentine bonding agents have gone through a variety of 'generations', it is the purpose of this article to describe the latest clinical and laboratory research on universal adhesives. Results from the latest laboratory and clinical research indicates that universal adhesives are a step forward in the quest for the ultimate bond to tooth substance and ease of use of the adhesive. The wide variety of studies that indicates the effectiveness of universal adhesives are discussed, along with research that indicates that selective enamel etching is a beneficial procedure when using these materials.

CPD/Clinical Relevance: Universal adhesives appear to hold promise in the quest for a reliable bond to dentine.

Dent Update 2021; 48: 620–631

Dentine bonding agents play a central role in the sealing and retention (where necessary) of resin composite restorations, which are increasingly placed by dentists worldwide.[1] Bonding to dentine is also central to the practice of minimally invasive dentistry, given that restorations, which may be bonded to tooth substance, do not require the macro-mechanical retentive features such as locks and keys that are a feature of (non-adhesive) dental amalgam or gold cavity preparations.[2]

A dentine adhesive should perform the following functions:[3]

- Provide an immediate, strong and definitive bond to dentine;
- Seal the cavity and minimize leakage;
- Resist microbial or enzymatic degradation;
- Provide adhesion per se of the restoration in cases where this is necessary;
- Prevent post-operative sensitivity;
- Reduce the risk of recurrent caries;
- Prevent marginal staining;
- Be easy to use.

It is the intention of this article to trace the history of dentine adhesives since that is relevant to the performance of the latest group of adhesives, the universal adhesives (UAs), and thereby to update readers on the progress of UAs since a previous *Dental Update* paper in 2017,[4] and to compliment other *Dental Update* publications on the subject, which readers may wish to read as background, such as those by Green and Banerjee,[2] and, Green *et al*.[5]

A brief history of bonding to dentine

In the past, dentine bonding agents were bonding agents generally fell into disarray 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 bonding agents 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.[3,7]

The year 1955 heralded what we now realize to be a game-changing breakthrough in restorative dentistry, namely the genesis of adhesive (and, therefore, more minimally invasive) dentistry by enabling clinicians to bond to enamel, when this was first described by Buonocore.[8] This also has facilitated the development of resin composite materials, with these materials becoming increasingly used worldwide,[1] principally because of patient concerns regarding mercury in dental amalgam, the Minamata Agreement of 2013 that recommended reduction in the use of dental amalgam and increasing

FJ Trevor Burke, DDS, MSc, MDS, MGDS, FDS (RCS Edin), FDS RCS (Eng), FFGDP (UK), FADM, Emeritus Professor, University of Birmingham School of Dentistry, UK. **Louis Mackenzie**, BDS, FDS RCPS, Head Dental Officer, Denplan UK, Winchester and Clinical Lecturer, University of

Dent.Update.2021: 620-631

Hot off the press!

10 laboratory studies included

Finally, recent laboratory studies include the work by Lago and co-workers[39] who compared the shear bond strength of six UAs to dentine, using Clearfil SE Bond (Kuraray) as control. The results indicated highest bond strength values for Scotchbond Universal (3M) (33.9MPa), but this was not significantly different to Clearfil Universal (Kuraray) and Tetric N-Bond (Ivoclar-Vivadent). All six UAs provided superior bond strength values to the Clearfil SE control.

In summary, therefore, laboratory studies appear to confirm that the bond strengths obtained by UAs are generally an improvement over those previously attained, with a selective enamel etch strategy being preferred.

FJ Trevor Burke
Louis Mackenzie

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Abstract: The ability to successfully bond restorations to dentine is central to minimally invasive restorative dentistry. While dentine bonding agents have gone through a variety of 'generations', it is the purpose of this article to describe the latest clinical and laboratory research on universal adhesives. Results from the latest laboratory and clinical research indicates that universal adhesives are a step forward in the quest for the ultimate bond to tooth substance and ease of use of the adhesive. The wide variety of studies that indicates the effectiveness of universal adhesives are discussed, along with research that indicates that selective enamel etching is a beneficial procedure when using these materials.
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Hot off the press!

11 clinical studies included

In summary therefore, there is a strong body of evidence that indicates that recently developed UAs provide clinical effectiveness as good as, or better, than previous 'gold standard' adhesives, and that selective etching of the enamel is desirable, given that the results presented above indicate improved retention rates of class V restorations when the margins are etched, and reduced levels of discolouration around the margins of all restorations. The present authors therefore strongly recommend this procedure. Does that statement apply to all UAs? It is the authors' view that, in view of the similarities between many of the UAs (Table 1[21,22]), and the fact that their pH values tend to lie between 1.5 and 3, it is prudent to suggest that this is carried out if the clinician wishes to limit marginal staining over time.

Enhanced CPD DO C

F J Trevor Burke

Louis Mackenzie and Adrian CC Shorthall

Survival Rates of R Restorations in Loadbearing Situations in Posterior Teeth

The conclusion gleaned from the above systematic reviews is that resin composite restorations have acceptable survival rates when placed in loadbearing situations in posterior teeth, with AFRs generally within the range 2% to 3%. Risk factors for premature failure include patients at high risk of caries and the presence of a liner or base beneath the resin composite restoration.

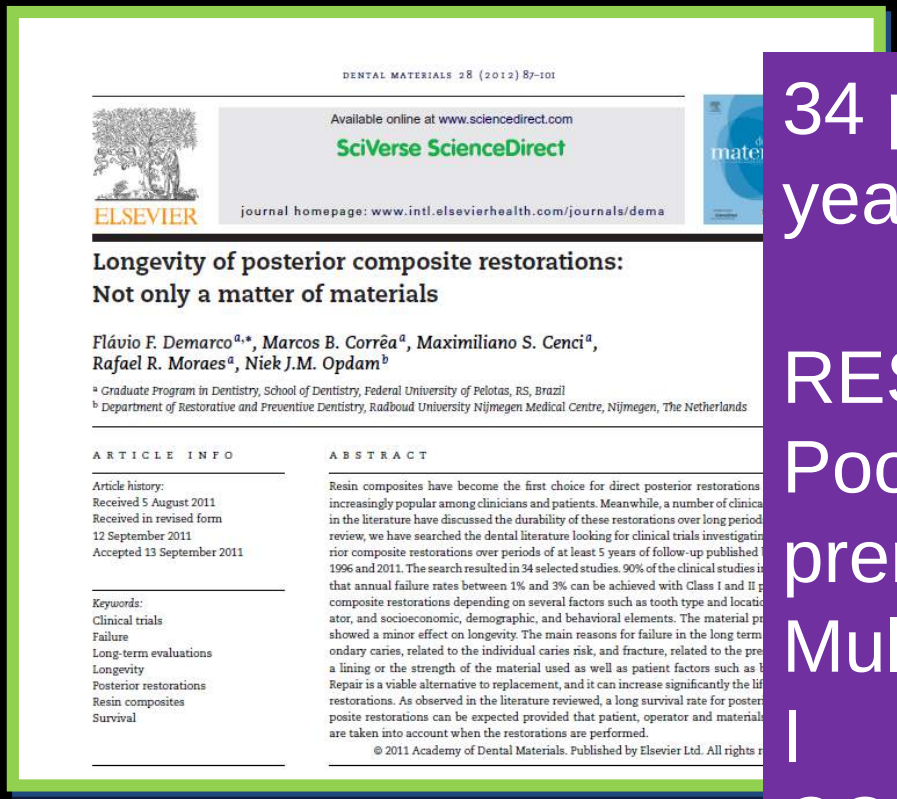
144 studies identified, 24 included

The conclusion gleaned from the above cohort studies is that resin composite restorations have acceptable survival rates when placed in loadbearing situations in posterior teeth, with AFRs generally within the range 2% to 3%, which the authors consider to

ommonplace, and will increase further following
eeth. It is therefore relevant to evaluate the
being reduced to 24 when inclusion criteria
dies, and six were systematic reviews. It
ith survival rates generally similar to those
may have a profound effect.
eth, it is relevant to note that these may

need for high-quality evidence from primary
dental care'. It has also been noted that RCCTs

Dent.Update. 2019:46: 523-535



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journal homepage: www.intl.elsevierhealth.com/journals/dema

ELSEVIER

Longevity of posterior composite restorations: Not only a matter of materials

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Survival

ABSTRACT

Resin composites have become the first choice for direct posterior restorations
increasingly popular among clinicians and patients. Meanwhile, a number of clinica
in the literature have discussed the durability of these restorations over long period
review, we have searched the dental literature looking for clinical trials investigatin
rior composite restorations over periods of at least 5 years of follow-up published
1996 and 2011. The search resulted in 34 selected studies. 90% of the clinical studies i
that annual failure rates between 1% and 3% can be achieved with Class I and II
composite restorations depending on several factors such as tooth type and locatio
ator, and socioeconomic, demographic, and behavioral elements. The material pr
showed a minor effect on longevity. The main reasons for failure in the long term
ondary caries, related to the individual caries risk, and fracture, related to the pre
a lining or the strength of the material used as well as patient factors such as
Repair is a viable alternative to replacement, and it can increase significantly the lif
restorations. As observed in the literature reviewed, a long survival rate for poster
posite restorations can be expected provided that patient, operator and materials
are taken into account when the restorations are performed.

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34 papers, each with evaluation periods of >5 years.

RESULTS:
Poorer survival rates in molar teeth than in premolars
Multiple surface fillings more likely to fail than class I
CONCLUSION:“composite restorations have been found to perform favourably in posterior teeth, with annual failure rates of 1-3%”.

“due to their aesthetic properties and good clinical service, composites have become the preferred standard for direct posterior restorations”.

Trevor's view:

Posterior composites perform as well as amalgams, but cannot be cost effective because they take longer to place *at present*. Perhaps bulk fills are the answer.

Is this non-retentive adhesive cavity design the cavity of choice for the COVID 19 era?

Use a Universal bonding agent

This can be cut without a turbine

Trevor's view:

Resin composites bonded with Universal adhesives are our current "gold standard" for loadbearing restorations in posterior teeth.

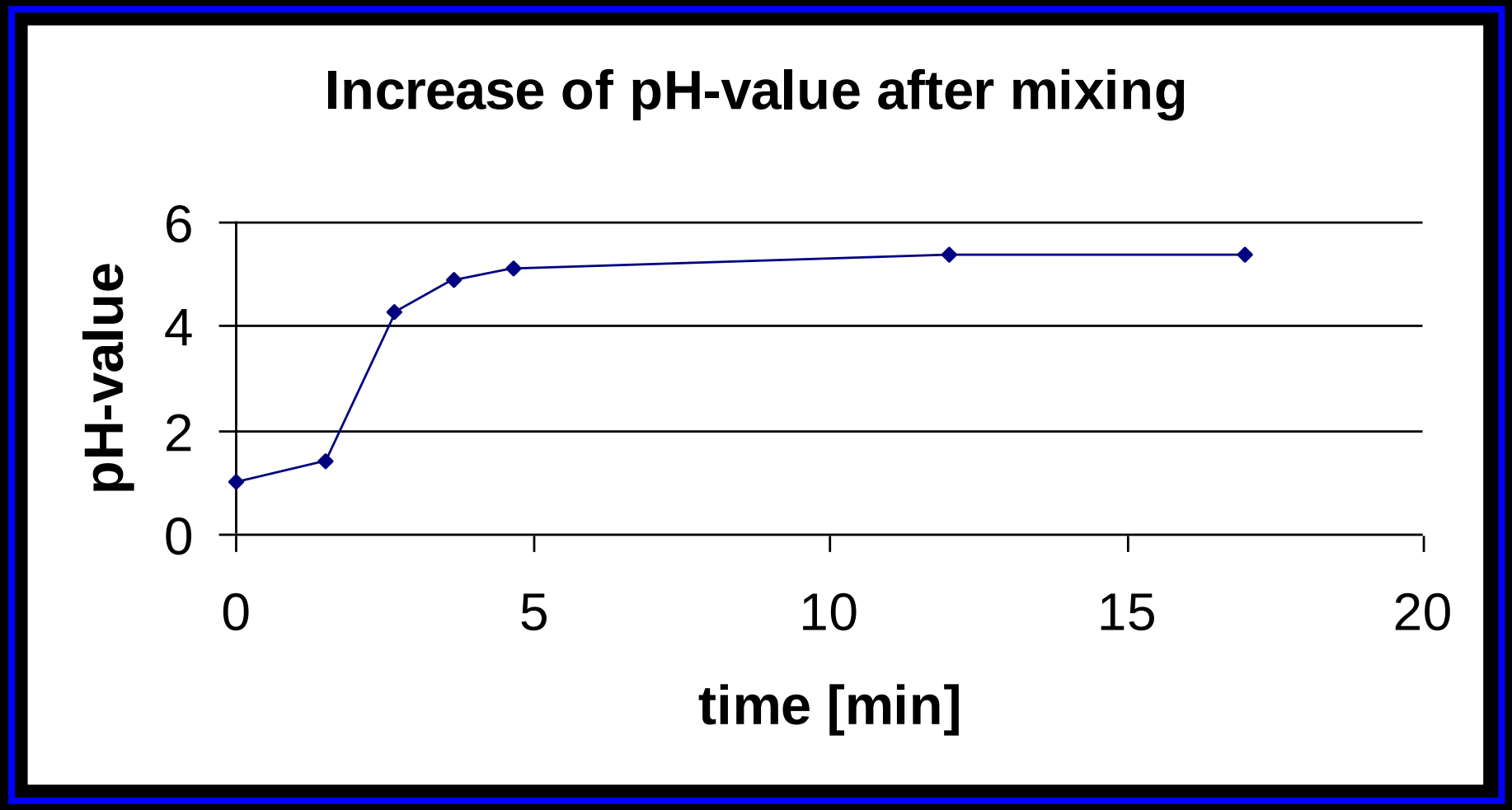
What I plan to talk about

- The current status of dentine adhesives, resin composite materials and Glass Ionomers (GICs)
- Current status of GICs and Glass Hybrids for restoration of posterior teeth
- Self-adhesive resin composite luting agents
- Their development into self-adhesive resin composites
- Are these good enough to change our philosophy today?
- Final thoughts

The first self-adhesive resin luting material, 2002

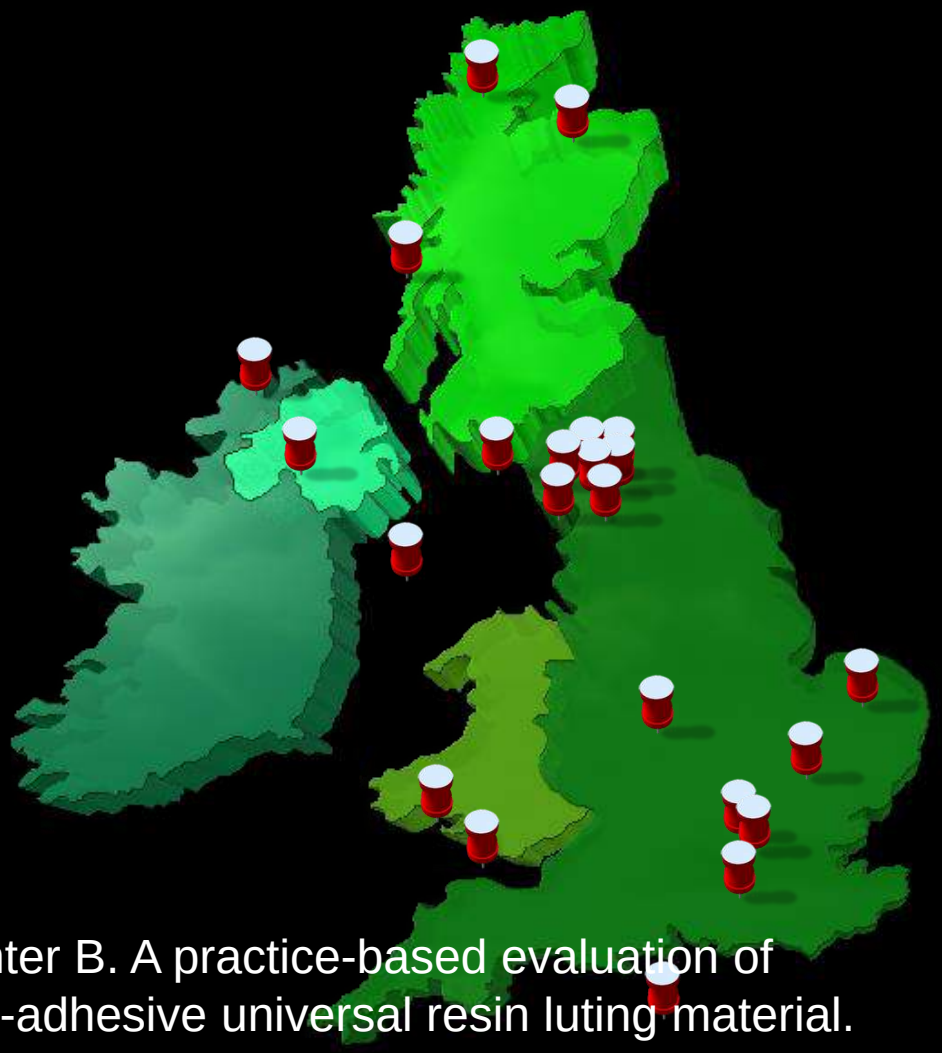
New monomers, FAS glass filler, new initiator systems

pH vs time: A neutralization reaction occurs within polymerization



Clinical evaluation by the PREP Panel

- 12 UK general dentists used Unicem for 6 weeks
- Variety of luting materials used pre-study
- 134 crowns cemented
- Rated material on analogue scales



Burke FJT, Crisp RJ, Richter B. A practice-based evaluation of the handling of a new self-adhesive universal resin luting material. Int.Dent.J.2006:56:142-146.

First clinical evaluation of RelyX Unicem by the PREP Panel

Ease of use of previous resin luting system

3.7

Ease of use of conventional luting system used prior to evaluation

4.2

Overall ease of use of RelyX Unicem

No reported incidence of post-op sensitivity

Evaluation of Unicem 2 by the PREP Panel, 2015

Flow of Unicem 2: Was flow satisfactory?

Ease of use of Unicem 2

Unicem 2 Automix

PREP Panel evaluation:

Conclusion:

Results indicate that 3M ESPE have managed to further improve a successful material.

Resin luting became much simpler after the introduction of self-adhesive luting materials

Use of resin cements by UK dental practitioners

Phosphate cement used by 32%, 28% and 19% in 2002, 2008, 2015

GI Luting cement used by 68%, 48%, 53% in 2002, 2008, 2015

Resin cement used by 6%, 11%, 14% in 2002, 2008,2015

Self adhesive resin cement used by 9% in 2008, and 13% in 2015 (not available in 2002)

RESEARCH

Dental practice in the UK in 2015/2016. Part 4: changes since 2002?

Br.Dent.J.2019:226:279-285

Do you want to read more?

Journal of Oral Rehabilitation

Journal of Oral Rehabilitation 2011 38; 295–314

Review Article

Self-adhesive resin cements – chemistry, properties and clinical considerations

J. L. FERRACANE*, J. W. STANSBURY† & F. J. T. BURKE‡ *Department of Restorative Dentistry, Division of Biomaterials and Biomechanics, Oregon Health & Science University, Portland, OR, †Department of Craniofacial Biology, School of Dental Medicine, University of Colorado Denver, Aurora, CO, USA and ‡Primary Dental Care, University of Birmingham School of Dentistry, Birmingham, UK

SUMMARY Self-adhesive resin cements were introduced to dentistry within the past decade but have gained rapidly in popularity with more than a dozen commercial brands now available. This review article explores their chemical composition and its effect on the setting reaction and adhesion to various substrates, their physical and biological properties that may help to predict their ultimate performance and their clinical performance to date and handling characteristics. The result of this review of self-adhesive resin cements would suggest that these materials may be expected to show similar clinical performance as other resin-based and non-resin based dental cements.

KEYWORDS: dental cement, self-adhesive, self-etch, properties, clinical performance

Accepted for publication 10 July 2010

Introduction

Self-adhesive resin cements, defined as cements based on filled polymers designed to adhere to tooth structure without the requirement of a separate adhesive or glass–ionomer and resin composite. However, dentists may still experience confusion over the specific composition and indications for other types of 'hybrid' cements, such as resin-modified glass–ionomer and polyacid-modified resin (compomers). Because of their

The logical next step?

Development into self-adhesive composites?

Previous Self adhesive restorative materials have had a bad name

ommended in non-retentive cavities. A recently published randomized clinical trial investigating this material for posterior restorations when applied according to manufacturer's instructions was discontinued already at one year due to an "unacceptable very high one-year failure frequency".[1] The authors concluded that further studies investigating this product should be conducted using a bonding agent, which obviously means that not only can the material no longer be considered self-adhesive, the alleged bioactive interaction with the surrounding tooth tissue is also highly questionable as the material no longer directly contacts the tooth tissue. Fortunately, the company adapted the

1. van Dijken JWV, Pallesen U, Benetti A. A randomized controlled evaluation of posterior resin restorations of an altered resin modified glass-ionomer cement with claimed bioactivity. Dent Mater 2019;35:335-343.

References for poor performance of self-adhesive flowables

- Mine A, De Munck J, Van Ende A et al (2017) Limited interaction of a self-adhesive flowable composite with dentin/enamel characterized by TEM. Dent Mater 33:209–217.
- Brueckner C, Schneider H, Haak R (2017) Shear bond strength and tooth-composite interaction with self-adhering flowable composites. Oper Dent 42:90–100. .
- Peterson J, Rizk M, Hoch M, Wiegand A (2018) Bonding performance of self-adhesive flowable composites to enamel, dentin and a nano-hybrid composite. Odontology 106:171–180.
- Celik EU, Aka B, Yilmaz F (2015) Six-month clinical evaluation of a self-adhesive flowable composite in noncarious cervical lesions. J Adhes Dent 17:361–368.

3M Self-adhesive bulk fill (SABF)

Table 1 Test materials

Component	FOBF	SABF
Neutral methacrylate monomers for network formation	Aromatic urethane dimethacrylate (AUDMA), addition-fragmentation monomer (AFM), diurethane dimethacrylate, 1,12-dodecane dimethacrylate	Crosslinking dimethacrylate, triethylene glycol dimethacrylate (TEGDMA)
Acidic methacrylate monomer for support of adhesive properties	none	Phosphoric acid functionalized methacrylate
Initiator system	Camphorquinone-based	Camphorquinone, oxidizing and reducing agents

This is obviously a resin-based material

SABF is a tooth-coloured, dual-curing, self-adhesive, resin-based bulk-fll restorative material, consisting of a powder and a liquid part in a capsule. The powder part contains acid-reactive glass fillers; the liquid part consists of acidic polymerizable components which promote self-adhesion. Dual-cure initiator system is distributed between the powder and the liquid. SABF has a CE mark.

One year data on 3M Self-adhesive bulk fill (SABF)

Clinical Oral Investigations (2022) 26:449–461
https://doi.org/10.1007/s00784-021-04019-y

ORIGINAL ARTICLE

One-year results of a novel self-adhesive bulk-fill restorative and a conventional bulk-fill composite in class II cavities—a randomized clinical split-mouth study

Fabian Cieplik[1] · Konstantin J. Scholz[1] · Julian C. Anthony[1] · Isabelle Tabenski[1] · Sarah Ettenberger[1] · Karl-Anton Hiller[1] · Wolfgang Buchalla[1] · Marianne Federlin[1]

Received: 9 December 2020 / Accepted: 31 May 2021 / Published online: 15 June 2021

Abstract

Objectives In the context of the phase-down of amalgam, development of easily applicable, permanent restorative materials is of high clinical interest. Aim of this study was to evaluate the clinical performance of a novel, tooth-colored, self-adhesive bulk-fill restorative (SABF, 3M Oral Care) and a conventional bulk-fill composite (Filtek One, 3M Oral Care; FOBF) for restoring class II cavities. The null-hypothesis tested was that both materials perform similar regarding clinical performance.

Materials and methods In this randomized split-mouth study, 30 patients received one SABF and one FOBF restoration each. Scotchbond Universal (3M Oral Care) was used as adhesive for FOBF (self-etch mode), while SABF was applied directly without adhesive. Restorations were evaluated by two blinded examiners at baseline, 6 months and 12 months employing FDI criteria. Non-parametric statistical analyses and χ^2-tests ($\alpha = 0.05$) were applied.

Results Thirty patients (60 restorations) were available for the 6- and 12-month recalls exhibiting 100% restoration survival. All restorations revealed clinically acceptable FDI scores at all time points and for all criteria. Only regarding esthetic properties, FOBF performed significantly better than SABF regarding *surface lustre* (A1) and *color match and translucency* (A3) at all time points and *marginal staining* (A2b) at 12 months.

Conclusions The null-hypothesis could not be rejected. Both materials performed similarly regarding clinical performance within the first year of clinical service. SABF exhibited slightly inferior, but clinically fully acceptable esthetic properties as compared to FOBF.

Clinical relevance Within the limitations of this study, the self-adhesive bulk-fill restorative showed promising results and may be recommended for clinical use.

Keywords Class II · Filtek one · Self-adhesive · RBC · Bulk-fill

For serving as a true alternative to amalgam, a restorative material should ideally combine bulk-fill and self-adhesive properties to avoid the additional use of an adhesive system or the necessity of a retentive and thus invasive cavity preparation [27, 28]. The novel self-adhesive bulk-fill restorative (SABF; 3M Oral Care, St. Paul, MN, USA) is a tooth-colored, dual-curing, self-adhesive, resin-based bulk-fill restorative material that does not require retentive cavity preparations, conditioning of dental hard tissues or separate application of an adhesive, and can be placed in one bulk with unlimited depth of cure, as specified by the manufacturer.

The aim of this randomized controlled clinical split-mouth study was to evaluate the clinical performance of class II restorations placed with SABF or a conventional bulk-fill composite (Filtek™ One Bulk Fill, FOBF; 3M Oral Care), whereby the latter was used in combination with a universal adhesive (Scotchbond™ Universal, SBU; 3M Oral

Clinical placement of 3M SABF

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PRESENTATION:

Powder/liquid in a capsule.

MIXING

Placed in capsule mixing device for 15 secs and placed in cavity in bulk.

The placement procedure for SABF was similar to that of known glass ionomer cements. The capsule tip was placed in the proximal box and while gradually moving the tip in a coronal direction the material was extruded, ensuring that the material adapted itself to the cavity bottom and the cavity walls. The solely light-curing FOBF allowed ample time to sculpt the material before light polymerization. Therefore, morphology of FOBF restoration was achieved by sculpting of the material in the unpolymerized condition. On the other hand, the dual-curing SABF allowed only little time for sculpting before auto-polymerization started, and thus needed to be overfilled to a certain extent and adapted to the cavity walls in an outward direction before the final restoration morphology could be achieved by subtractive measures. Finishing and polishing of the restorations from both materials was performed using fine (46 µm) and ultra-fine (25 µm) diamond burs (Hager & Meisinger, Neuss, Germany),

One year data on 3M Self-adhesive bulk fill (SABF)

Randomised controlled trial, split mouth design, 30 patients each received one SABF and one Filtek Bulk Fill/SBUniv.

Mainly 2-surface restorations, but some 3- and 4- surface

Reason for restoration placement was caries/failed restoration, predominantly. All teeth vital. Placed in Univ. Hosp, Regensburg

Examined by 2 blinded, trained examiners/failed restoration

One year data on 3M Self-adhesive bulk fill (SABF)

RESULTS

All restorations examined at one year

Surface lustre: SABF surfaces were more dull than Filtek One

Margin staining: Both showed an increase, but this was more in SABF

Margin adaptation: No differences

Occlusal contour and wear: No difference compared with enamel

One year data on 3M Self-adhesive bulk fill (SABF)

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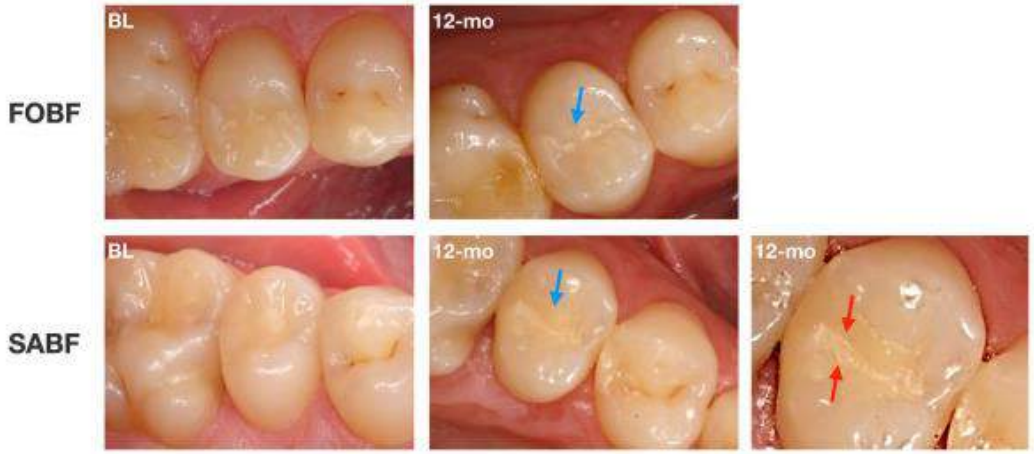

Fig. 2 Exemplary depiction of differences in *surface luster* between both materials over time. Top row: occlusal-distal FOBF restoration on tooth 25 at BL and 12-mo. Bottom row: Occlusal-distal SABF restoration on tooth 15 at BL and 12-mo. Note the differences in surface lustre (indicated by blue arrows) and the isolated pores in SABF (indicated by red arrows)

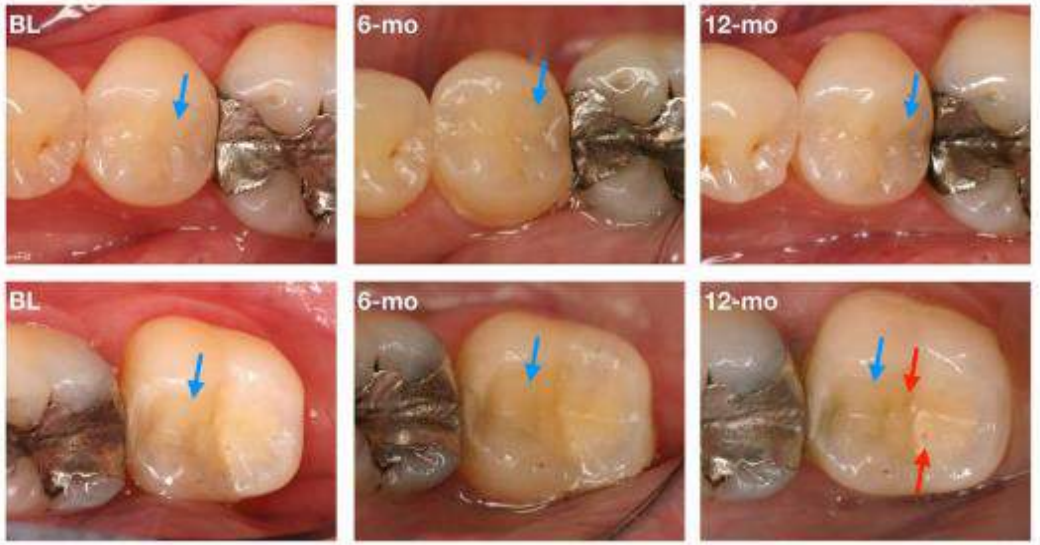

Fig. 4 Exemplary depiction of differences in *color match and translucency* between both materials over time. Top row: occlusal-distal FOBF restoration on tooth 35 at BL, 6-mo and 12-mo. Bottom row: Mesial-occlusal SABF restoration on tooth 37 at BL, 6-mo and 12-mo. Note the differences in color match and translucency between FOBF and SABF (indicated by blue arrows; SABF more yellowish and opaque) as well as the isolated pores in SABF (indicated by red arrows)

One year data on 3M Self-adhesive bulk fill (SABF)

Clinical Oral Investigations (2022) 26:419–431
https://doi.org/10.1007/s00784-021-04019-y

ORIGINAL ARTICLE

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Conclusions The null-hypothesis could not be rejected. Both materials performed similarly regarding clinical performance within the first year of clinical service. SABF exhibited slightly inferior, but clinically fully acceptable esthetic properties as compared to FOBF.

Clinical relevance Within the limitations of this study, the self-adhesive bulk-fill restorative showed promising results and may be recommended for clinical use.

Keywords Class II · Filtek one · Self-adhesive · RBC · Bulk-fill

CONCLUSIONS

In summary, the null-hypothesis of this study could not be rejected: both restorative materials exhibited only clinically acceptable scores in all examined FDI criteria. FOBF and SABF exhibited similar clinical performance in functional and biological properties, but FOBF showed significantly better performance with regard to esthetic properties *surface lustre* and *color match and translucency* at all examination time points and *marginal staining* at 12-mo than SABF. These differences in esthetic properties were already observed at BL and did not intensify over time up to 12-mo of clinical observation. Therefore, SABF seems to be a slightly less esthetic restorative material as compared to FOBF. Within

The novel self-adhesive bulk-fill restorative SABF showed promising results and may be recommended for clinical use.

New 3M self adhesive composite holds promise at 2 years

0102

Two-Year Clinical Performance of Novel Self-Adhesive-Composite Equivalent to Conventional Bulk-Fill-Composite

Konstantin J. Scholz[1], Karl-Anton Hiller[1], Julian C. Anthony[1, 2], Isabelle M. Tabenski[1, 3], Sarah Ettenberger[1], Fabian Cieplik[1], Marianne Federlin[1], Wolfgang Buchalla[1]

[1]Department of Conservative Dentistry and Periodontology, University Medical Center Regensburg, Regensburg, Bavaria, Germany, [2]Private Dental Practice, Potsdam, Germany, [3]Private Dental Practice, Regensburg, Germany

Objectives: Aim of this study was to evaluate the clinical performance of a novel, tooth-colored, self-adhesive bulk-fill restorative (SABF, 3M) compared to a bulk-fill composite (Filtek One, 3M; FOBF) for permanent restorations in class-II cavities. The null-hypothesis was that both materials perform similarly regarding clinical survival and performance.

Methods: In this randomized split-mouth study, 30 patients received one SABF and one FOBF restoration each. Scotchbond Universal (3M) in self-etch mode was used as adhesive for FOBF. SABF was applied without a separate adhesive. Restorations were evaluated by two blinded examiners at baseline (BL), 6-months, 12-months, and 24-months employing FDI criteria. Non-parametric statistical analyses, χ^2-tests (α=0.05), error-rates method and survival-analyses were performed.

Results: 29 out of the initial 30 patients (21-58 years; 21 females) with both restorations under risk were available at the 24-months recall. After 24-months, survival rate was 100% for SABF and 97% for FOBF (one restoration rated score 4 in criterion C12 due to secondary caries). All other restorations revealed clinically acceptable FDI scores (excellent-1; good-2; satisfactory-3) for all criteria at all timepoints. Error-rates method revealed a significant difference between materials in terms of *esthetic properties*, but not regarding *functional* and *biological properties*. Considering *esthetic properties*, both materials yielded clinically acceptable FDI scores (mainly excellent-1 and good-2), with FOBF performing significantly better than SABF in criteria *surface lustre* (A1, p=0) and *color match and translucency* (A3, p=0) at all time points. Over time, *marginal staining* (A2b) increased significantly for both materials ($p \leq 0.001$).

Conclusions: The null hypothesis could not be rejected. Both materials performed similarly regarding clinical survival and performance within 24-months of clinical service. SABF exhibited less favorable, but clinically fully acceptable *esthetic properties* compared to FOBF. The novel, self-adhesive bulk-fill restorative showed promising 2-year-results and may be recommended for clinical use.

What's in Surefill one?

Dentsply-Sirona

Component	General function
Modified polyacid (MOPOS)	Etchant, adhesion promoter, crosslinker between covalent and ionic network
Bifunctional acrylate (BADEP)	Crosslinker in the covalent network
Acrylic acid	Reactive diluent, Primer, crosslinker between covalent and ionic network
Water	Solvent for polyacid and resins, etching aid
Reactive glass filler	Filler supporting wear resistance and mechanical strength
Non-reactive glass filler	Radiopacifier, rheology modifier
Initiator	Photo- and redox initiator system
Stabilizer	Stabilize monomers upon storage

Composition of Surefil one, general function of components

MOPOS (MOdified POlyacrylic acid System

MOPOS is responsible both for the self-adhesion and the strength of the material

MOPOS bonds chemically to the tooth to create a strong and durable bond

The cross-linking groups of this molecule also bond to glass fillers, resins, acids, etc., making Surefil one as strong and durable as composite

Surefil one:Dual Curing

Surefil one can be light cured for 20 seconds with a conventional polymerization light

Areas that are not reached by the light will cure chemically within 6 minutes after activation of the capsule, ensuring a reliable cure of the restoration

TIP: If there is a matrix band, leave it in place until material has set. In cavities up to 4mm depth, the band can be removed directly after light curing.

Surefil one: the first clinical evaluation

www.nature.com/scientificreports

scientific reports

OPEN

One-year clinical results of restorations using a novel self-adhesive resin-based bulk-fill restorative

Andreas Rathke[1,2✉], Frank Pfefferkorn[1], Michael K. McGuire[3], Rick H. Heard[3] & Rainer Seemann[1,4]

This prospective study assessed the dual-curing self-adhesive bulk-fill restorative Surefil one. The restorations were placed and reviewed by dental practitioners who are members of a practice-based research network in the United States. Seven practitioners filled 60 cavities (20 class I, 19 class II and 21 class V) in 41 patients with Surefil one without adhesive, according to the manufacturer's instructions. The restorations were evaluated using modified USPHS criteria at baseline, 3 months, and 1 year. Patients were also contacted to report postoperative hypersensitivity one to four weeks after placement. The only patient that showed moderate hypersensitivity after 1 year had previously reported symptoms that were unlikely associated to the class I molar restoration. One class II restoration in a fractured maxillary molar was partially lost. The remaining restorations were found to be in clinically acceptable condition resulting in an annual failure rate of 2%. Color match showed the lowest number of acceptable scores (88%) revealing significant changes over time ($P = 0.0002$). No significant differences were found for the other criteria ($P > 0.05$). The novel self-adhesive bulk-fill restorative showed clinically acceptable results in stress-bearing class I and II as well as non-retentive class V cavities at 1-year recall.

Resin-based composites have become the standard filling material in dental practices for anterior and posterior restorations. Long-term clinical studies confirmed that the longevity of direct composite restorations in posterior teeth is comparable to that of amalgam restorations[1–4]. In addition, innovations in composite technology have simplified the application. Compared to conventional composite application in 2 mm thick layers, bulk-fill composites can be placed in 4–5 mm layer thickness due to their reduced polymerization shrinkage stress and high reactivity to light curing[5,6]. Clinical data of up to 10 years confirmed the safe applicability of these bulk-fill composites as alternative to conventional posterior composite restorations[6–8]. Further simplification involved the development of self-adhesive composites that eliminated the use of an adhesive, thus minimizing the time in which blood or saliva contamination could compromise the restoration. The most common approach was modifying the reactive diluents with acidic moieties to facilitate the bonding with enamel and dentin. This approach was commercialized as self-adhesive flowable composites, but many laboratory studies have questioned whether these materials are a valid alternative to composites where a separate adhesive is applied[9–11]. Particularly in load-bearing areas, the contradictory clinical performance of self-adhesive restorative materials has not led to a breakthrough[12–16].

Alternatively, the structural monomers can be modified with acidic groups to achieve sufficient adhesion. To its extreme this approach is realized in the polyacids used in glass ionomer cements[17]. However, polyacids cannot contribute to the radically polymerized network due to lack of polymerizable groups. Recently, a modified polyacid system of high molecular weight (MOPOS) has been formulated and patented to merge the self-adhesive properties of classical polyacids known from glass ionomer cements with the crosslinking ability of structural monomers known from composites[18]. The self-adhesive resin-based bulk-fill restorative (classified as self-adhesive composite hybrid by the manufacturer) has been launched under the brand name Surefil one (Dentsply Sirona, Konstanz, Germany). The manufacturer describes the initiator system as a combination of the

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Cohort study of 60 restorations (20 Class I, 20 Class II, 20 Class V) placed, without adhesive, in 41 patients by 7 general dentists in the US.

41 restorations were evaluated at one year

Results

41 (of 60 at baseline) restorations were evaluated at one year

One class II restoration in a fractured maxillary molar was partially lost resulting in an annual failure rate of 2%. No adverse events associated with the use of the restorative material were observed. he lowest number of acceptable scores after 1 year was found for colour match (88%).

Trevor’s view:

Two major manufacturers have produced self adhesive resin-based restoratives which appear to hold promise. More research needed.

Disclaimer:

There may be other self-adhesive composites out there!

A brief look at Glass Ionomer materials and how they work

Bonding to dentine

Chemical = Glass ionomer cement

Micromechanical = Dentine bonding systems

- A Glass Ionomer Cement (GIC) consists of a basic glass and an acidic polymer which sets by an acid-base reaction between these components

McLean et al., 1994

There is no evidence base for “own label” Glass Ionomer materials

DentalMaterials

Steffen Mickenautsch

How Well are GIC Product Labels Related to Current Systematic Review Evidence?

Abstract: Systematic reviews have been recommended as providing the best source of evidence to guide clinical decisions in dentistry. They appraise evidence from trials focused on investigating clinical effects of dental material categories, such as conventional glass-ionomer cements (GIC) or resin-modified GIC. In contrast, the general dental practitioner is introduced to these categories of materials in the form of branded or private product labels that are marketed during dental conventions or through advertisements. Difficulties may arise in recognizing material categories that have been subjected to systematic reviews, because of the multitude of product labels on the current market. Thus, the value and relevance of published systematic review evidence concerning the material categories represented by these labels may remain obscure. Based on a systematic literature search, this article identifies glass-ionomer cement product labels used during clinical trials which, in turn, were subsequently reviewed in systematic review articles (published between 15 April 2009 and 14 April 2011). This article further clarifies how these product labels relate to the systematic review conclusions. The results show that the conventional and resin-modified glass-ionomer cements that were used in most trials were marketed by GC and 3M ESPE, respectively. The conventional GICs used in most of the reviewed trials were Fuji III and Fuji IX, while Vitremer was the most commonly used resin-modified GIC. Evidence from the reviewed trials suggests that GIC provides beneficial effects for preventive and restorative dentistry. However, more trials of higher internal validity are needed in order to confirm (or disprove) these findings. Only GIC products of branded labels and none of private labels were identified, suggesting that private label GIC products have little or no research back-up.

Clinical Relevance: Dental products, such as glass-ionomers cements (GIC), can only be judged as effective when they are based on sufficient research back-up. Systematic reviews of clinical trials provide such back-up at the highest level. Thus clinicians must be able to identify GIC products for which reliable evidence from systematic reviews of clinical studies is available and know about what such evidence contains.

Dent Update 2011; 38: 634–644

Is it worth using low-cost glass ionomer cements for occlusal ART restorations in primary molars? 2-year survival and cost analysis of a Randomized clinical trial

Isabel Cristina Olegário[a,b], Nathalia de Miranda Ladewig[b], Daniela Hesse[c], Clarissa Calil Bonifácio[c], Mariana Minatel Braga[b], José Carlos Pettorossi Imparato[b], Fausto Medeiros Mendes[b], Daniela Prócida Raggio[b,*]

SHORT ANSWER!

NO! They don't last as long, and, despite the fact that Fuji IX is more expensive, they are not cost-effective.

The “evidence” for Own Label Brands

In the current situation, it might be tempting to save £s on materials, but the saving should be considered alongside the cost of one premature failure

Characteristics of Original GICs

- Release of fluoride
- Adhesion to enamel and dentine
- Reasonable biocompatibility
- Low thermal diffusivity
- Early types needed initial protection from moisture
- Aesthetics
- *Mechanical strength (poor in compressive)*
- *Erosion/abrasion/wear resistance (suboptimal)*

Silicate cement:
The ultimate in prevention?

The glass in Glass Ionomers is a Fluoro alumina silicate (FAS) glass, same as in silicate cements, but in those it is mixed with phosphoric acid

CONCISE REVIEW

Glass-ionomer Restoratives: A Systematic Review of a Secondary Caries Treatment Effect

R.C. Randall* and N.H.F. Wilson

Restorative Dentistry, Manchester University Turner Dental School, Higher Cambridge Street, Manchester, MI5 6FH, Un

28 papers included
No conclusive evidence for or against inhibition of secondary caries by glass ionomer restoratives

glass ionomers inhibit
rom *in vitro* studies
iew was a systematic
assessment, from the literature, of clinical evidence for the

Introduction

There is increasing interest in evidence-based dentistry (Antczak-Bouckoms *et al.*, 1994; I

Fluoride IS released by glass ionomers
F release by F-containing composites is negligible

No conclusive evidence for or against inhibition of secondary caries by the glass ionomer restoratives was obtained from the systematic review

ELSEVIER

dental materials

Dental Materials 18 (2002) 561–569

www.elsevier.com/locate/dental

In vivo vs in vitro anticariogenic behavior of glass-ionomer and resin composite restorative materials

Lisa Papagiannoulis*, Afrodite Kakaboura, George Eliades

Department of Pediatric Dentistry, School of Dentistry, University of Athens, 2 Thivon Street (Goudi), 115 27 Athens, Greece

Received 14 November 2000; revised 9 August 2001; accepted 14 August 2001

Abstract

Objective: To evaluate the in vivo vs the in vitro anticariogenic potential of glass-ionomer and resin composite restoratives, utilizing a standardized interfacial gap model.

depth between the restorative groups tested. Lesion length was increased in composite, and decreased in glass-ionomer, whereas lesion depth in both restorative groups was increased in comparison to gap-free regions ($p < 0.05$).

(b) In vivo study. No lesions were observed at gap-free regions. At gap regions, 75.5% of glass-ionomer and 62.5% of composite restorations developed lesions. The lesion dimensions were significantly greater in glass-ionomer ($p < 0.05$). A reduction in PO_4^{3-}, CO_3^{2-}, Ca and F was found in lesions compared to intact tissues. No F was detected and no CaF_2 lattice vibrations were found at the enamel margins facing the gap adjacent to glass-ionomers.

Significance: In the presence of a standardized interfacial gap, no preventive effect was exerted in vivo from the glass-ionomer to protect the adjacent enamel wall from secondary caries attack. The lack of any correlation between the in vivo and in vitro models tested implies that artificial caries experiments have a negligible clinical relevance in predicting the in vivo effect. © 2002 Academy of Dental Materials.

Another paper in agreement!

"No preventive effect was exerted ***in vivo*** from the GIC to protect the adjacent enamel from caries attack"

Characteristics of Original GICs

- Release of fluoride
- Adhesion to enamel and dentine
- Reasonable biocompatibility
- Low thermal diffusivity
- Early types needed initial protection from moisture
- Aesthetics
- *Mechanical strength (poor in compressive)*
- *Erosion/abrasion/wear resistance (suboptimal)*

Characteristics of Original GICs

- Release of fluoride
- Chemical adhesion to enamel and dentine
- Reasonable biocom
- Low thermal diffusi
- Early types needed m moisture
- Aesthetics
- *Mechanical strengt ion)*
- *Erosion/abrasion/w optimal)*

Chemfill, *circa* 1979:

Characteristics of Original GICs

- Release of fluoride
- Adhesion to enamel and dentine
- Reasonable biocompatibility
- Low thermal diffusivity
- Early types needed initial protection from moisture
- Aesthetics
- *Mechanical strength (good in compression: ?? In flexion)*
- *Erosion/abrasion/wear resistance (suboptimal)*

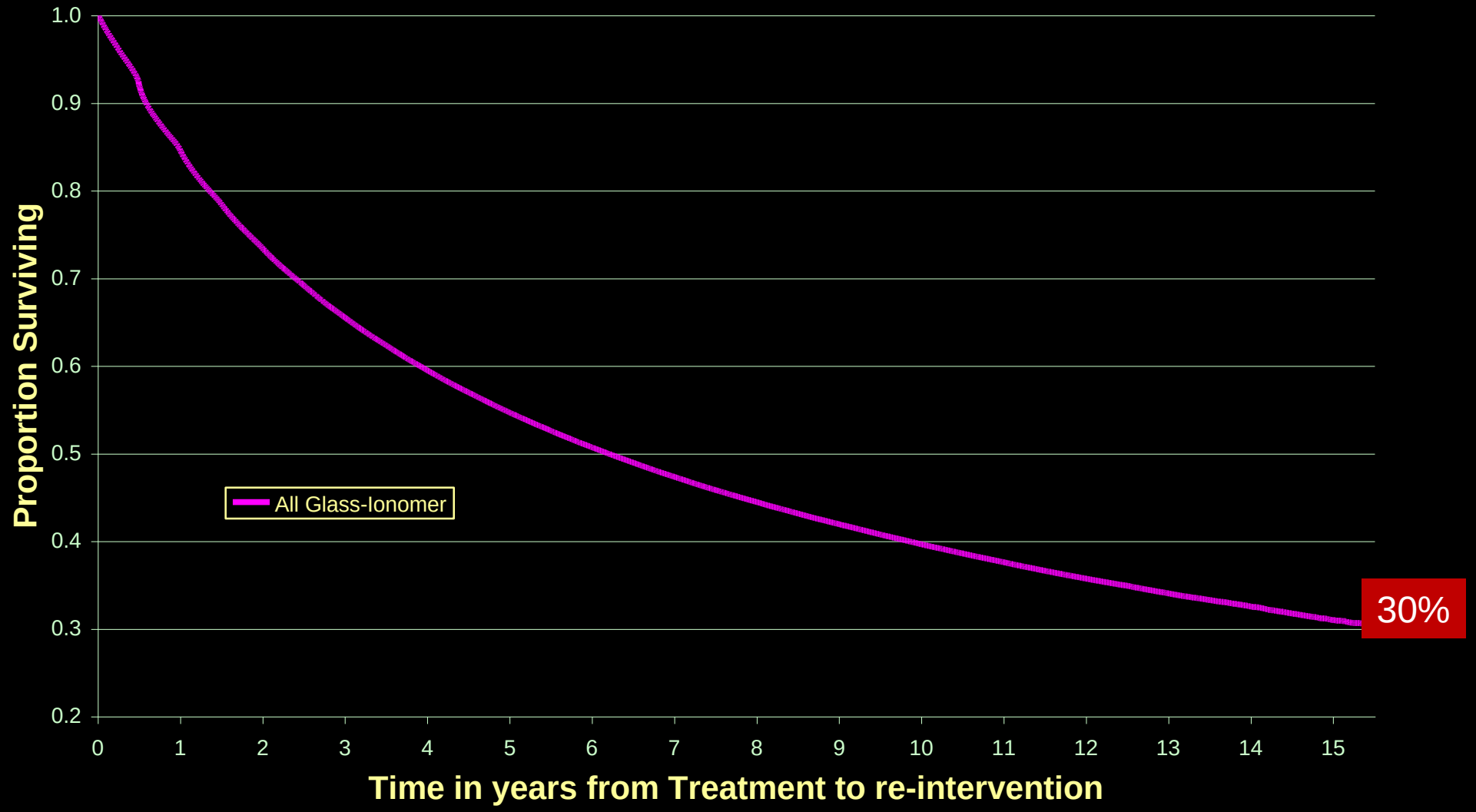
The database

- SN7024, available from UKDataService.ac.uk contains anonymized longitudinal data on patients attending the General Dental Services in England and Wales (UK)
- Over three million different patients
- Over 25 million courses of treatment, between 1990 & 2006
- Modified version of Kaplan-Meier methodology used to plot survival curves for different sub-groups

Because of the vast size of the dataset, we can now look at the effect of the restoration on *survival of the tooth*

Direct placement restorations: some examples: glass ionomer in class III and V

Glass-Ionomer Restoration Survival Overall



Summary:

Since dentists often replace composite and amalgam restorations with restorations of similar type, they appear to “believe” in these materials

Summary:

Glass ionomers seem to be used as transitional restorations in many cases: dentists often replace them with alternative materials

Conclusion

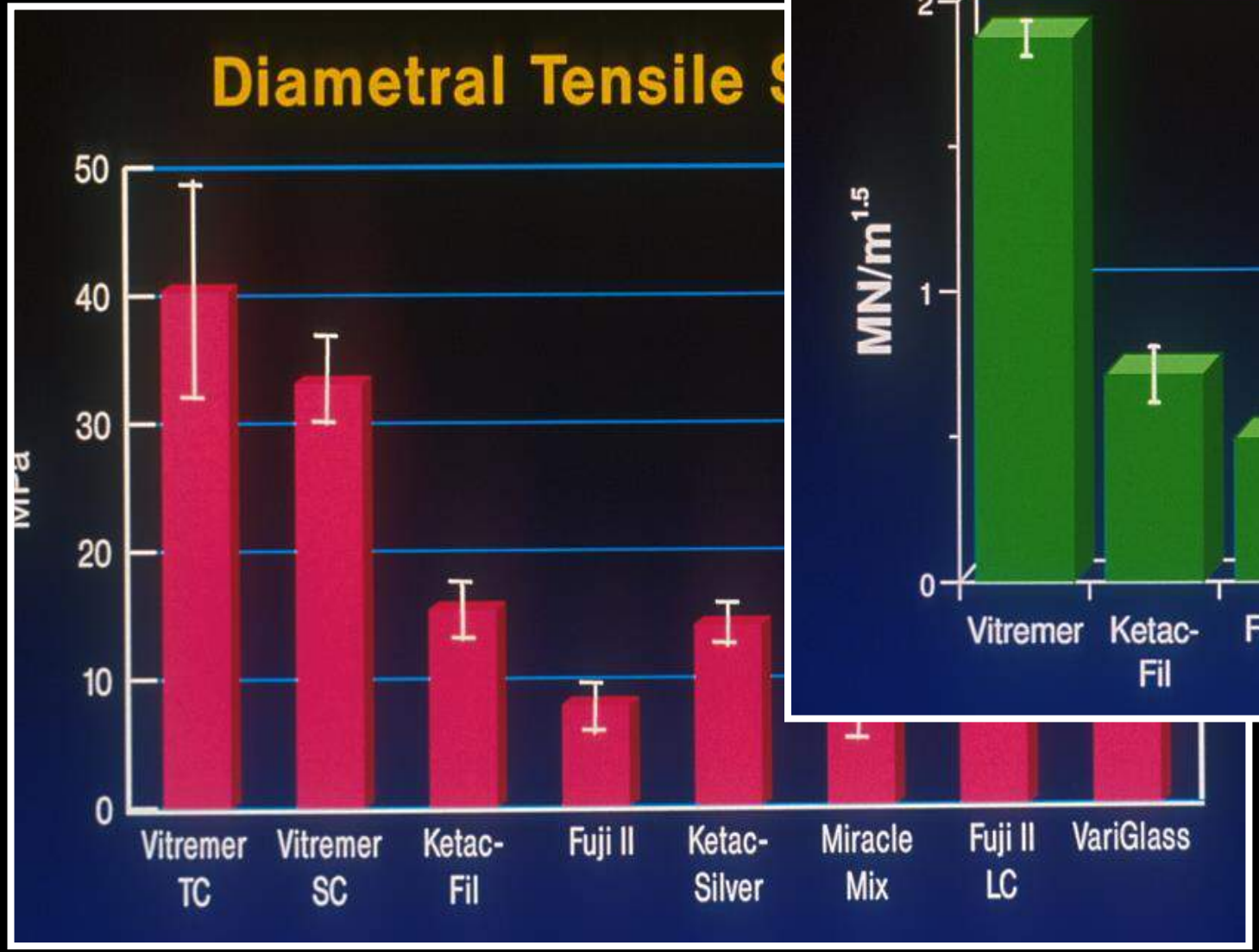
There was a need for an improved glass ionomer

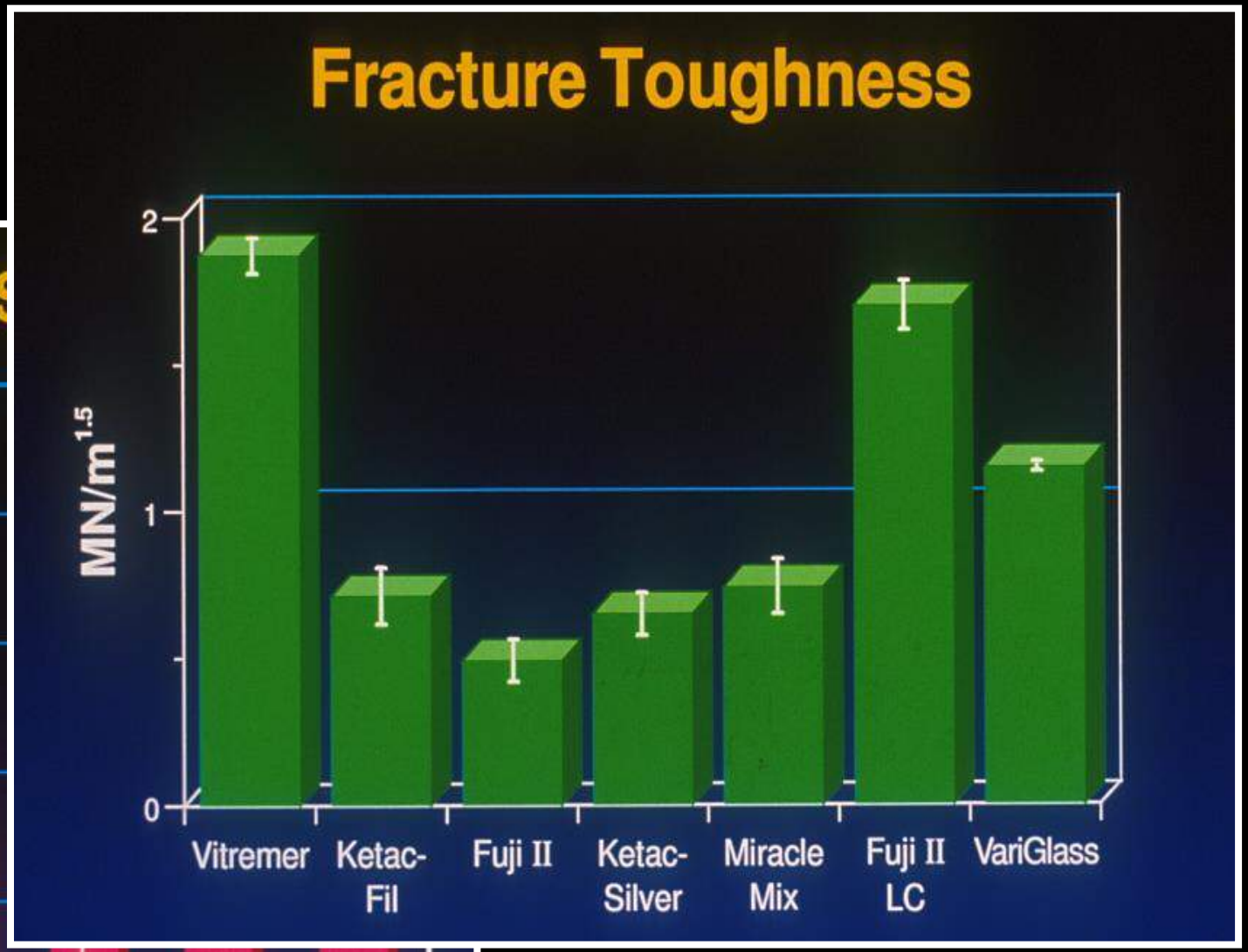
Hence, the development of Resin Modified Glass Ionomers (RMGI)

Hybrid materials that retain a significant acid/base reaction as part of their overall curing process.

McLean et al., 1994

Improved physical properties of RMGI





Advantages of RMGI

- ✓ Improved physical properties
- ✓ Command set
- ✓ Less susceptible to water loss or water contamination
- ✓ Immediate polishing possible
- ✓ May be repaired
- ✓ Better aesthetics
- ✓ Better adhesion
- ✓ Better fluoride release
- ✓ Higher initial pH

Trevor's view:

Traditional glass ionomers have poor physical properties and should be confined to history.

Reinforced and RMGI materials are superior.

More recently developed GICs

Reinforced GICs – smaller glass filler particles for faster reaction with the PAA liquid, plastic features, higher loading brings improved physical properties, but still a need for improved wear resistance

Glass hybrids - smaller, more reactive glass, improved PAA

Indications for reinforced GIs

- Class V
- Class I and II in primary teeth
- Lining/Base materials
- Core build-up
- Class I, II long-term provisional
- ART Technique

Reinforced Glass ionomer materials in loadbearing situations?

A crux question, because, if these work, they will be a cheaper replacement of amalgam than composite

IN BRIEF

- One hundred and sixty-nine reinforced glass ionomer restorations in posterior teeth were assessed in three UK dental practices.
- Ninety-eight percent of these restorations were performing satisfactory at two years.
- Further assessment by an independant observer is indicated.

Clinical performance of reinforced glass ionomer restorations placed in UK dental practices

F. J. T. Burke,[1] C. Siddons,[2] S. Phipps,[3] J. Bardha,[4] R. J. Crisp[5] and B. Dopheide[6]

Aim To retrospectively evaluate the performance of reinforced glass ionomer restorations placed in load-bearing surfaces of posterior teeth in three UK general dental practices.

Methods Inclusion criteria for the participating practitioners were that they would be able to find, in their regularly attending patients' mouths, a minimum of 30 Fuji IX restorations placed in load-bearing cavities in posterior teeth. The three practitioners who agreed to participate were given training in the methods of assessment of restorations. Presence/absence of the restoration, presence of secondary caries, anatomic form, margin adaptation, margin discolouration, surface roughness and colour match were recorded.

Results Three general dental practitioners and 169 restorations in 116 patients were included in the study. Seventy-eight percent of restorations were placed in molar teeth, the remainder in premolar teeth, with 67 being Class I and 102 Class II. The mean age of restorations at examination was 25 months, ranging from five months to 56 months. Of the restorations examined, 98% (n = 166) were found to be present and intact. No secondary caries was detected clinically. Three restorations were found to have fractured.

Conclusion Reinforced glass ionomer restorations placed in load-bearing situations in patients attending three dental practices in the UK were found to be performing satisfactorily at two years. Further investigations, of improved rigour, may now be indicated to more fully assess the performance of such restorations in the long term.

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Online article number E2
Refereed Paper – accepted 3 August 2006
DOI: 10.1038/bdj.2007.529

INTRODUCTION

Practice-based research

A majority of research into the effectiveness of dental materials is carried out in dental hospitals or other academic institutions, rather than in primary dental care/general dental practice where the majority of dental treatment, worldwide, is performed. Reasons for this include the potential cost of practice-based research, given that practices are geared to the efficient treatment of patients, and time is not budgeted for research.[1] Additionally, the training of general practitioners in research methods may be incomplete. However, there are many reasons why dental practice increasingly should become the prime location for clinical dental research. Dental practice is the real world. Accordingly, if a technique or material is to be successful, it must be appropriate to the dental practice situation.

A variety of types of research may be considered particularly appropriate to dental practice. These include clinical trials of materials and techniques, assessment of treatment trends, and assessment of dentists' behaviour and attitudes. For the practitioner, there is the benefit of being involved in something outside the daily routine of practice.[2] Patients have also been found to approve of practitioner involvement in research, with the practice and practitioner's professional image being enhanced.[2]

As a result, a number of practice-based evaluation groups have become established, such as the Clinical Research Associates, mainly in the USA, and BRIDGE (Birmingham Research in Dental General practicE) and the PREP (Product Research and Evaluation by Practitioners) Panel in the UK, both being administered from the University of Birmingham's School of Dentistry. The latter group, co-ordinated by Burke and Crisp, is well established, has 27 members representing the wide diversity of general dental practitioners, and has completed over 40 evaluations of dental restorative materials in the UK, plus a number of clinical trials.

Worldwide, there appears to be an increasing demand for

- Three participating practitioners able to find, in their regularly attending patients' mouths, a minimum of 30 Fuji IX restorations placed in load-bearing cavities in posterior teeth.

- 169 restorations in 116 patients were included in the study.
- 78% of restorations were placed in molar teeth, the remainder in premolar teeth
- 67 restorations were Class I & 102 Class II
- mean age of restorations at examination was 25 months, ranging from 5 months to 56 months.
- Of the restorations examined, 98% (n=166) were found to be present and intact.
- No secondary caries was detected clinically.
- Three restorations were found to have fractured.

Burke FJT, Siddons C, Phipps S, Bardha J, Crisp RJ, Dopheide B.

Clinical performance of reinforced glass ionomer restorations placed in UK dental practices. Br.Dent.J.2007:**203**:529:E2

- Reinforced glass ionomer restorations placed in load-bearing situations in patients attending three dental practices in the UK were found to be performing satisfactorily at two years
- Further long term investigations, of improved rigour, may now be indicated to more fully assess the performance of such restorations.

Burke FJT, Siddons C, Phipps S, Bardha J, Crisp RJ, Dopheide B.

Clinical performance of reinforced glass ionomer restorations placed in UK dental practices. Br.Dent.J.2007:**203**:529:E2

What is the current status for survival of restorations in back teeth using Glass Ionomer cements?

Burke FJT. Dent.Update: 2013:40(10):840-844.

Conclusions

In clinical situations where there are no adverse situations at work (such as high occlusal loading or an acidogenic plaque), certain restorations in reinforced GI materials (such as Fuji IX) may provide reasonable longevity.

However, the conditions for longevity are not readily identified.

Two of the studies (Scholtanus and Huysmans, 2007: Basso, 2013) demonstrate higher than desirable failure rates for GI restorations in posterior teeth, especially in the longer term.

Trevor's view

Until more high quality evidence becomes available, for practitioners using reinforced GI materials in loadbearing situations in posterior teeth, it is prudent to advise patients of the relative paucity of good quality evidence for the success of the restorations that they are placing.

Are reinforced glass ionomers an alternative to amalgam?

Not really, *at present,* because their wear resistance isn't good enough and they are soluble in dilute organic acids

Possibly OK in class I cavities?

Slide written in 2014

…there is now some new, more positive information on GIC in posterior teeth

Klinke *et al. Trials* (2016) 17:239
DOI 10.1186/s13063-016-1339-8

Trials

RESEARCH Open Access

Clinical performance during 48 months of two current glass ionomer restorative systems with coatings: a randomized clinical trial in the field

Thomas Klinke[1], Amro Daboul[1*], Anita Turek[1], Roland Frankenberger[2], Reinhard Hickel[3] and Reiner Biffar[1]

Abstract

Background: This study was carried out as a prospective clinical field study with the aim of evaluating the clinical performance of Equia Fil® with a nanofilled resin coating and the conventional Fuji IX GP® fast with an LC coating according to the World Dental Federation (FDI) restoration material evaluation criteria.

Methods: The clinical performance of Equia Fil® and Fuji IX GP® fast was evaluated on permanent posterior teeth of 643 adult patients aged between 20 to 80 years old in randomly selected clinics across Germany. Occlusal cavities in posterior permanent teeth were restored with Equia Fil® with a nanofilled, light-cured resin coating ($n = 515$) and Fuji IX GP® fast with an LC coating ($n = 486$). Direct clinical assessment as well as photographic assessment and assessment of stone casts of the restorations were made at 1 year, 2 years, 3 years, and 4 years.

Results: In 4 years, a total of 1001 fillings from both materials were placed by 111 dentists in 643 patients. Random slope models showed that the Equia filling system had overall lower odds of obtaining a delta event (material needs replacement) in comparison to Fuji IX GP® fast with an LC coating within all models. In both materials, filling size/surface was the most important component affecting the clinical performance of the materials. When measuring the odds of obtaining a delta event (material needs replacement), the odds ratios jumped to approximately 43 and 296 times for class II (two surfaces) and class II mesial-occlusal-distal (three surfaces) respectively in comparison to class I fillings.

Conclusion: Both materials showed similar good overall performance in class I cavities; however, when including numbers from both class I and II fillings, the Equia system with a nanofilled resin coating showed better overall performance with fewer failures in all the follow-up intervals. Nonetheless, the percentage of unsatisfactory to poor fillings according to the FDI criteria was relatively high in two-surface class II fillings and higher in three-surface class II fillings for both materials.

Trial registration: Deutsches Register Klinischer Studien (German Clinical Trials Register): DRKS00004220. (www.germanctr.de). Registration date: 6 Sept 2012.

Keywords: Practice-based network, Dental restoration, Permanent, Glass ionomer, Multi-center study

EQUIA Fil doing ok

1001 fillings placed by 111 general dentists in 643 patients

EQUIA fil and Fuji IX with resin coating

Prospective *randomised controlled trial*

Evaluation by three calibrated examiners

RESULTS

Conclusion

Within the limitations of the study, we can conclude that no significant difference in performance between both materials was found within 4 years. However, Equia Fil® with a nanofilled resin coating showed a slightly better overall performance than the conventional Fuji IX GP® fast with the LC coating and an overall lower odds to failure. Both materials performed well in class I cavities. In class II cavities, the dentist must pay attention to the cavity size. It was shown that higher odds of failure are associated with class II cavities, especially in large cavities and three-surface fillings (i.e., MOD class II), which indicate that the manufacturer's recommendations have to be followed.

servative class II cavities. Fillings in large cavities (isthmus width larger than half the intercuspal distance) and three-surface fillings showed more adverse observations. This observation was also confirmed when evaluating both materials only for fractures and loss of retention (B5 criterion) and for loss of anatomical form (B8 criterion, only class II and class II MOD); see Tables 2 and 3.

Note from authors: For class II cavities, the dentist must pay attention to the cavity size

GC Equia Fil doing well at 4 years

GC Equia Fil GIC *vs* Gradia Direct Composite in Class I and small class II cavities

100% success of GC Equia Fil at 4 years, 40 Class I, 30 Class II

©Operative Dentistry, 2015, 40-2, 134-143

Four-year Randomized Clinical Trial to Evaluate the Clinical Performance of a Glass Ionomer Restorative System

S Gurgan • ZB Kutuk • E Ergin
SS Oztas • FY Cakir

Clinical Relevance

The clinical effectiveness of Equia and Gradia Direct Posterior was acceptable in Class 1 and Class 2 cavities subsequent to four-year evaluation.

SUMMARY

Objective: The aim of this study was to evaluate the clinical performance of a glass ionomer restorative system compared with a microfilled hybrid posterior composite in a four-year randomized clinical trial.

Methods: A total of 140 (80 Class 1 and 60 Class 2) lesions in 59 patients were either restored with a glass ionomer restorative system (Equia, GC, Tokyo, Japan), which was a combination of a packable glass ionomer (Equia Fil, GC) and a self-adhesive nanofilled coating (Equia Coat, GC), or with a microfilled hybrid composite (Gradia Direct Posterior, GC) in combination with a self-etch adhesive (G-Bond, GC) by two experienced operators according to the manufacturer's instructions. Two independent examiners evaluated the restorations at baseline and at one, two, three, and four years postrestoration according to

Sevil Gurgan, DDS, PhD, professor, Hacettepe University

The same study at 10 years

Journal of Dentistry 94 (2020) 103175

Contents lists available at ScienceDirect

Journal of Dentistry

journal homepage: www.elsevier.com/locate/jdent

A randomized controlled 10 years follow up of a glass ionomer restorative material in class I and class II cavities

Sevil Gurgan, Zeynep Bilge Kutuk*, Filiz Yalcin Cakir, Esra Ergin

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ARTICLE INFO

Keywords:
Clinical longevity
Glass ionomer
Composite resin
Posterior restorations

ABSTRACT

Objective: To evaluate the durability of a glass ionomer restorative material in Class I and Class II cavities during 10 years compared with a micro filled composite resin.
Methods: Fifty-nine participants (mean age 24 years) received 140 (80 Class I and 60 Class II) glass ionomer (GI) or composite resin (CR) restorations. Evaluation was performed with slightly modified USPHS criteria at baseline, and yearly during the 10 years. Data were analyzed with Cohran's Q and McNemar's tests.
Results: Fifty-one patients and 124 restorations (61 GI / 38 Class I - 23 Class II, 63 CR / 38 Class I, 25 Class II) were evaluated after 10 years. The recall rate was 86.4%. The overall clinical recall rate of restorations was 88.6%. The success rate of Class I and II restorations were calculated as 100% for both materials. The cumulative failure rate (CRF) of all Cl I and Cl II GI restorations was 3.17% in total, but CFR was 8 % for Cl II GI restorations. A significant difference was observed between the marginal discoloration scores of restorations at 10 years ($p = 0.022$). No significant difference was seen between two restorative materials in terms of marginal adaptation ($p > 0.05$). A significant change was seen in color match of GI restorations at 10 years ($p < 0.05$). No significant change was found for the anatomical form, secondary caries, postoperative sensitivity, surface texture, and retention for either restorative material ($p > 0.05$).
Conclusions: Both tested restorative materials showed an acceptable success rate in the restoration of Class I and Class II cavities during the 10-year follow up.

1. Int

Re
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rejection of amalgam in many countries due to esthetic and potential toxic concerns. A number of countries have banned amalgam in response to the treaty agreed by the United Nations Environmental

due to their biocompatibility, bioactivity, long-term fluoride release, ability to adhere to moist enamel and dentin without necessitating an intermediate agent and the ability to use them in bulk [21]. The ability

tation ($p > 0.05$). A significant change was seen in color match of GI restorations at 10 years ($p < 0.05$). No significant change was found for the anatomical form, secondary caries, postoperative sensitivity, surface texture, and retention for either restorative material ($p > 0.05$).
Conclusions: Both tested restorative materials showed an acceptable success rate in the restoration of Class I and Class II cavities during the 10-year follow up.

51 patients and 124 restorations available for examination

No differences in marginal discolouration scores or anatomical form. No secondary caries

Colour match of the GIC restorations worse

The same study at 10 years
The maths don't add up!

Journal of Dentistry 94 (2020) 103175

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Conclusions: Both tested restorative materials showed an acceptable success rate in the restoration of Class I and Class II cavities during the 10-year follow up.

1. Introduction

Remarkable changes have taken place in the era of restorative dentistry, over the last 30 years. The concept has mostly been concentrated on minimally invasive tooth tissue removal and the use of adhesive restorative materials, which have the potential to procure therapeutic actions on demineralized dentin [1]. Eventually, marked innovations have been witnessed in restorative materials and biomi-

Programme (UNEP) [7]. Both the World Dental Association (FDI) and the World Health Organization (WHO) have called for alternatives to amalgam [8,9]. The long term clinically and micro morphologically examined performance of CR restorations in posterior teeth revealed the advantages and disadvantages of these tooth-colored restorative materials [10–13].

Glass ionomers (GIs) have also become considered as permanent restorative material for the restoration of posterior teeth in daily dental

3. Results

Fifty-one patients and 124 restorations (61 GI/38 Class I-23 Class II, 63 CR / 38 Class I, 25 Class II) were evaluated after 10 years. The patients recall rate was 86.4% (Fig. 1). Although the recall rate was 79.6% at the six-year recall, four patients who could not be reached at the six-year recall were available at the 10-year recall. The overall recall rate of restorations at the 10-year recall was 88.6%.

Class I GI restorations showed no failures during the 10-year period. One Class II GI restoration was missing due to a marginal fracture at three years and another one restoration at four 4 years. In contravention of a 96% success rate of Class II GI restorations at four-year recall, the success rate of Class II GI restorations was calculated as 100% at the 10-year recall, because of the absence of two patients with failed restorations at the 10-year evaluation. No failures were monitored, either in the Class I or Class II CR restorations during the 10-year follow-up. The cumulative failure rate (CRF) of all Cl I and Cl II GI restorations was 3.17% in total, but CFR was 8 % for Cl II GI restorations.

No failures in Class I GICs, 8% failures in Class II GICS @10years

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A randomized controlled 10 years follow up of a glass ionomer restorative material in class I and class II cavities

Sevil Gurgan, Zeynep Bilge Kutuk*, Filiz Yalcin Cakir, Esra Ergin

Hacettepe University, Faculty of Dentistry, Department of Restorative Dentistry, Sihhiye, Ankara Turkey

ARTICLE INFO

Keywords:
Clinical longevity
Glass ionomer
Composite resin
Posterior restorations

ABSTRACT

Objective: To evaluate the durability of a glass ionomer restorative material in Class I and Class II cavities during 10 years compared with a micro filled composite resin.
Methods: Fifty-nine participants (mean age 24 years) received 140 (80 Class I and 60 Class II) glass ionomer (GI) or composite resin (CR) restorations. Evaluation was performed with slightly modified USPHS criteria at baseline, and yearly during the 10 years. Data were analyzed with Cohran's Q and McNemar's tests.
Results: Fifty-one patients and 124 restorations (61 GI / 38 Class I - 23 Class II, 63 CR / 38 Class I, 25 Class II) were evaluated after 10 years. The recall rate was 86.4%. The overall clinical recall rate of restorations was 88.6%. The success rate of Class I and II restorations were calculated as 100% for both materials. The cumulative failure rate (CRF) of all Cl I and Cl II GI restorations was 3.17% in total, but CFR was 8 % for Cl II GI restorations. A significant difference was observed between the marginal discoloration scores of restorations at 10 years ($p = 0.022$). No significant difference was seen between two restorative materials in terms of marginal adaptation ($p > 0.05$). A significant change was seen in color match of GI restorations at 10 years ($p < 0.05$). No significant change was found for the anatomical form, secondary caries, postoperative sensitivity, surface texture, and retention for either restorative material ($p > 0.05$).
Conclusions: Both tested restorative materials showed an acceptable success rate in the restoration of Class I and Class II cavities during the 10-year follow up.

1. Introduction

Remarkable changes have taken place in the era of restorative dentistry, over the last 30 years. The concept has mostly been concentrated on minimally invasive tooth tissue removal and the use of adhesive restorative materials, which have the potential to procure therapeutic actions on demineralized dentin [1]. Eventually, marked innovations have been witnessed in restorative materials and biomimetic materials designed for treatment of carious lesions have been introduced into clinical use [2–5].

During the recent years, direct restorations have been mostly favored in posterior teeth over indirect restorations, as they require less hard tissue removal, shorter treatment time and offer the benefit of low cost, in addition to their acceptable clinical performance [6]. Today, composite resins (CRs) are regarded as the first choice for restorative materials for the resto
rejection of amalgam i
toxic concerns. A num
sponse to the treaty Programme (UNEP) [7]. Both the World Dental Association (FDI) and the World Health Organization (WHO) have called for alternatives to amalgam [8,9]. The long term clinically and micro morphologically examined performance of CR restorations in posterior teeth revealed the advantages and disadvantages of these tooth-colored restorative materials [10–13].

Glass ionomers (GIs) have also become considered as permanent restorative material for the restoration of posterior teeth in daily dental practice [14]. Since their introduction by Kent and Wilson in 1970s [15], many modifications of these materials have been done to improve their mechanical and handling properties [16]. With these improvements, today, they are considered esthetically more attractive than metallic restorations and less expensive than CRs [5,14,17–19]. Current GIs are more translucent and provide more color options compared to conventional predecessors enabling a broader range of esthetic re-

HOWEVER:

Study carried out in a dental hospital
Two experienced dentists
Motivated patients
All the restorations were small in size
High proportion of premolar teeth
Conservative cavity designs, no cusp replacements
More marginal discolouration found in GI restorations
Power calculation not met
BUT
No restorations required replacement

This study is efficacy (ideal situation) not effectiveness (practice-based, real world situation) but the authors, in fairness, discuss this

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A randomized controlled 10 years follow up of a glass ionomer restorative material in class I and class II cavities

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Methods: Fifty-nine participants (mean age 24 years) received 140 (80 Class I and 60 Class II) glass ionomer (GI) or composite resin (CR) restorations. Evaluation was performed with slightly modified USPHS criteria at baseline, and yearly during the 10 years. Data were analyzed with Cohran's Q and McNemar's tests.
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1. Introduction

Remarkable changes have taken place in the era of restorative dentistry, over the last 30 years. The concept has mostly been concentrated on minimally invasive tooth tissue removal and the use of adhesive restorative materials, which have the potential to procure therapeutic actions on demineralized dentin [1]. Eventually, marked innovations have been witnessed in restorative materials and biomimetic materials designed for treatment of carious lesions have been introduced into clinical use [2–5].

During the recent years, direct restorations have been mostly favored in posterior teeth over indirect restorations, as they require less hard tissue removal, shorter treatment time and offer the benefit of low cost, in addition to their acceptable clinical performance [6]. Today, composite resins (CRs) are regarded as the first choice for restorative materials for the restoration of posterior teeth as a consequence of the rejection of amalgam in many countries due to esthetic and potential toxic concerns. A number of countries have banned amalgam in response to the treaty agreed by the United Nations Environmental Programme (UNEP) [7]. Both the World Dental Association (FDI) and the World Health Organization (WHO) have called for alternatives to amalgam [8,9]. The long term clinically and micro morphologically examined performance of CR restorations in posterior teeth revealed the advantages and disadvantages of these tooth-colored restorative materials [10–13].

Glass ionomers (GIs) have also become considered as permanent restorative material for the restoration of posterior teeth in daily dental practice [14]. Since their introduction by Kent and Wilson in 1970s [15], many modifications of these materials have been done to improve their mechanical and handling properties [16]. With these improvements, today, they are considered esthetically more attractive than metallic restorations and less expensive than CRs [5,14,17–19]. Current GIs are more translucent and provide more color options compared to conventional predecessors enabling a broader range of esthetic restorations [20]. GI have been used for decades in restorative dentistry due to their biocompatibility, bioactivity, long-term fluoride release, ability to adhere to moist enamel and dentin without necessitating an intermediate agent and the ability to use them in bulk [21]. The ability

COMMENTARY from Evidence Based Dentistry
Hutchison C, Cave V.Evid.Based Dent.2019:20:113-114

The strength of evidence from this study is likely to be very low. However, it provides prospective data on a topical subject and offers conflicting ideas to conventional knowledge.

Recent clinical research on GIC

Operative Dentistry, 2016, 41-6, 587-598

A Prospective Six-Year Clinical Study Evaluating Reinforced Glass Ionomer Cements with Resin Coating on Posterior Teeth: Quo Vadis?

LS Türkün • Ö Kanik

Clinical Relevance

Despite minor reparable defects, the overall clinical performance of EquiaFil was found to be excellent even in large posterior class II restorations after a period of six years compared to Riva SC.

SUMMARY

Objective: The aim of this study was to evaluate the long-term clinical performance of two encapsulated glass ionomer cements (GICs) (EquiaFil and Riva SC) covered with two different coatings (Equia Coat and Fuji Varnish) over six years using modified US Public Health Service (USPHS) criteria.

Methods: Fifty-four patients having class I and II restorations/caries were included in the study. A total of 256 restorations were made with EquiaFil and Riva SC. Equia Coat or Fuji Varnish was used randomly on the surface of the restorations. After cavity preparations, the teeth were randomly restored with one GIC and coated with Equia Coat or Fuji Varnish. The restorations were evaluated at baseline; six, 12, and 18 months; and six years after placement using modified USPHS criteria. Two evaluators checked color match, marginal discoloration, marginal adaptation, caries formation, anatomical form, postoperative sensitivity, and retention rate, and photographs were taken at each recall. The results were evaluated with Pearson chi-square and Mann-Whitney U-test ($p<0.05$).

Results: Thirty-seven patients were evaluated. There was a significant difference between EquiaFil and Riva SC regarding retention rate and color match after six years ($p=0.033$ and 0.046). When comparing baseline to six years, the overall success of EquiaFil was better than Riva SC, having significant problems regarding retention rate and anatomical form ($p=0.016$ and 0.031). Class II cavities were

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DOI: 10.2341/15-331-C

256 fillings placed (124 Class I, 132 Class II

Equia Fil (+ coating)
Riva SC (+ coating)

176 fillings (69% recall) at 6 years

"It was anticipated that some class II restorations might show chipping, so scored differently"

CONCLUSIONS

In the present study, the EquiaFil system in both cavity types exhibited significantly better clinical outcomes over the observation period of six years than Riva SC. Therefore, the null hypothesis formulated at the beginning of the study was rejected.

Reinforced GICs may be considered as the material of the future in restorative dentistry and minimally invasive dentistry. Their long-term clinical success is making them promising as a permanent restorative material, even in moderate-size class II restorations. Further developments are needed to improve their mechanical properties and extend their indications.

CONCLUSION

The highly viscous reinforced GIC restorative system EquiaFil showed acceptable clinical performance according to modified USPHS criteria in class I and moderate-size to large class II restorations over a period of six years.

6 years of Glass Ionomer in Class II cavities

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Six-year results of a randomized controlled clinical trial of two glass ionomer cements in class II cavities

Katrin Heck*, Iris Frasheri, Christian Diegritz, Juergen Manhart, Reinhard Hickel, Christina Fotiadou

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ARTICLE INFO

Keywords:
glass ionomer cement
clinical study
longevity
class II restorations
FDI criteria

ABSTRACT

Objectives: Long-term survival of two highly viscous glass ionomer cements (Fuji IX GP Fast and Equia Fil) over a period of 6 years in vivo.

Methods: A total of 85 two- or three-surface class II restorations, comprising 43 Equia Fil / Equia Coat and 42 Fuji IX GP Fast / Fuji Coat LC, were placed in 34 patients. The restorations were re-evaluated after 6 years using the FDI criteria. The statistical analysis was performed with Fisher's exact test, the Wilcoxon signed-rank test, the Mann-Whitney U test and the Kaplan-Meier method.

Results: Forty-four restorations (22 Equia Fil and 22 Fuji IX GP Fast) could be assessed at the 6-year follow-up. During the whole study period, eight failures, four for each material, were observed. The main reasons for failure were material fractures and retention loss, which were partly combined with poor marginal adaptation or poor proximal anatomical form. Two failures may be attributed to insufficient application of the materials, as suspected according to the radiographs. The Kaplan-Meier survival proportion for Equia Fil restorations at 6 years was 86.5% and that for Fuji IX GP Fast at 6 years was 86.8% (log-rank p = 0.907). During the period from 3 to 6 years, only one filling in each group failed.

Conclusion: Both materials showed acceptable and comparable survival rates after 6 years.

RESULTS

- 8 failures (4 in each group) of the 44 restorations examined at 6 years – 81.8% survival, Annual Failure Rate of 3%
- 7 failures because of restoration fracture, 1 due to secondary caries

- 6 year follow up of Fuji IX GP Fast and Equia Fil in Class II cavities
- 85 restorations placed in 34 patients
- BUT, only 44 restorations assessed at 6 years, because of “patient relocation, restorations replaced by other dentist, or unwillingness to attend for follow up”

Of relevance today, there is positive evidence from the world of *ART*

Clin Oral Invest (2012) 16:429–441
DOI 10.1007/s00784-011-0513-3

ORIGINAL ARTICLE

Survival of atraumatic restorative treatment (ART) sealants and restorations: a meta-analysis

29 publications included on high-viscosity GIs: Survival of single-surface ART restorations in permanent teeth was 85% at 5 years

Abstract The purpose of this study is to perform a systematic investigation plus meta-analysis into survival of atraumatic restorative treatment (ART) sealants and restorations using high-viscosity glass ionomers and to compare the results with those from the 2005 ART meta-analysis. Until February 2010, four databases were searched. Two hundred four publications were found, and 66 reported on ART restorations or sealant survival. Based on five exclusion criteria, two independent

86% (CI, 59–98%). The mean annual dentine lesion incidence rate, in pits and fissures previously sealed using ART, over the first 3 years was 1%. No location effect and no differences between the 2005 and 2010 survival rates of ART restorations and sealants were observed. The short-term survival rates of single-surface ART restorations in primary and permanent teeth, and the caries-preventive effect of ART sealants were high. Clinical relevance: ART can safely be used in single-

Trevor's view:

Recently introduced reinforced GICs (e.g. EQUIA Fil) perform well in class I restorations and in small/medium class II restorations.

More recently developed GICs

Reinforced GICs – smaller glass filler particles, for faster reaction with the PAA liquid

Glass hybrids – glasses of different sizes, more reactive glass, therefore improved crosslinking with the PAA, therefore improved physical properties

Higher molecular weight PAA, more chemically stable, improves physical properties of the matrix,

+ better handling

Improved resin coating = smoother restoration surface and may improve wear resistance

What is a Glass Hybrid?

The glass filler matrix combines fillers, Fluor-alumino-silicate (FAS) glasses of different sizes. This inclusion of filler particles of different sizes is similar to the evolution of the matrix of the Composites (from macro-filled to hybrid composites).

Glass Hybrid Technology from GC

Recent laboratory research on EQUIA Forte (GC)

ORIGINAL ARTICLE

Year : 2019 | **Volume** : 37 | **Issue** : 3 | **Page** : 265-270

Comparative evaluation of compressive strength and surface microhardness of EQUIA Forte, resin-modified glass-ionomer cement with conventional glass-ionomer cement

P Poornima, Paromita Koley, Mallikarjuna Kenchappa, NB Nagaveni, Kashetty Panchakshari Bharath, Indavara Eregowda Neena

Department of Pedodontics and Preventive Dentistry, College of Dental Sciences, Davangere, Karnataka, India

54 cylindrical 6X4mm specimens, 3 groups

Compressive strength and surface microhardness measured

CONCLUSION: "EQUIA Forte shows comparatively better mechanical properties than the other groups".

Recent laboratory research on EQUIA Forte (GC)

Original Article

Water Sorption and Solubility of a High-viscous Glass-Ionomer Cement after the Application of Different Surface-Coating Agents

Merve Nur Yilmaz, Pinar Gul, Ahmet Kiziltunc[1]

Department of Restorative Dentistry, Faculty of Dentistry, Atatürk University, [1]Department of Biochemistry, Faculty of Medicine, Atatürk University, Erzurum, Turkey

Abstract

Aim: The aim of this study was to compare the effect of different surface coating agents on water sorption and solubility of a high-viscous glass ionomer cement (GIC). **Materials and Methods:** A high-viscous GIC (EQUIA Forte, GC, Tokyo, Japan) was used for this study. Sixty disc-shaped specimens (8 mm × 2 mm) were prepared from material. Specimens were divided six subgroups and five different coating systems were applied on specimen surfaces. Other groups were used as the control group (n = 10) (Group 1: Control, Group 2: Scotchbond Universal Adhesive (3M ESPE, St. Paul, MN, USA), Group 3: Petroleum jelly (Vaseline, India, Lever Ltd.), Group 4: BisCover LV (Bisco, Schaumburg, IL, USA), Group 5: EQUIA Forte Coat (GC, Tokyo, Japan), Group 6: Final Varnish LC (VOCO, Cuxhaven, Germany). All specimens were prepared according to the manufacturer's instructions and subjected to water sorption and solubility tests based on the ISO 4049 requirements. Data were analyzed by paired samples t-test, one way analysis of variance, *post hoc* Tukey HSD, and Tamhane's T2 tests (α

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GIC, which carry the optical and fluoride release properties of silicates with chemical adhesion to enamel and dentin and biocompatibility properties of polyacrylic acid matrix, are also widely used because of their ability to exhibit thermal expansion coefficient similar to dentin. However, glass ionomers have disadvantages such as low wear resistance, long-hardening times, poor esthetic properties, and early moisture sensitivity. These disadvantages also reduce the clinical success of GIC restorations.[1,3,4]

aluminum ions from the surface of the restoration in case of early contact with moisture and decreases the translucency of restoration.[5,6]

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GIC is sensitive to hydration & dehydration during setting, therefore protection from moisture needed when the physical properties are weak

CONCLUSION: "EQUIA Forte Coat and Final Varnish LC showed least water sorption while the Final Varnish LC (VOCO) group was least soluble"

Recent laboratory research on EQUIA Forte (GC)

Official publications of the Medical and Dental Consultants' association of Nigeria

Nigerian Journal of Clinical Practice

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ORIGINAL ARTICLE

Year : 2019 | **Volume** : 22 | **Issue** : 6 | **Page** : 833-841

Mechanical performance of a newly developed glass hybrid restorative in the restoration of large MO Class 2 cavities

RESULTS: Compressive strength of G-Aenial (278MPa) statistically greater than EQUIA Forte (165 Mpa)

RESULTS: Fracture resistance of G-Aenial restored teeth not statistically different from EQUIA Forte restored teeth

Recent laboratory research on EQUIA Forte (GC)

al List Acta Stomatol Croat v.53(2); 2019 Jun PMC6604565

ACTA STOMATOLOGICA CROATICA

Acta Stomatol Croat. 2019 Jun; 53(2): 125–131. PMCID: PMC6604565
doi: 10.15644/asc53/2/4 PMID: 31341320

Mechanical Properties of High Viscosity Glass Ionomer and Glass Hybrid Restorative Materials

Ivan Šalinović,[1] Matea Stunja,[1] Zdravko Schauperl,[2] Željko Verzak,[3] Ana Ivanišević Malčić,[4] and Valentina Brzović Rajić[4]

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This article has been cited by other articles in PMC.

Abstract

Go to: Go to:

Objectives

to determine the
Compressive stre
Universal Aplica
performed.

6X4mm samples for compressive strength & hardness of 3 GICs:

Ketac Universal (3M). EQUIA Forte & EQUIA Fil

CONCLUSIONS:

No differences in compressive strength and fracture modes, but Ketac Universal had higher hardness values than EQUIA Fil or EQUIA Forte

Recent laboratory research on EQUIA Forte (GC)

Journal of Dentistry

In vitro wear of (resin-coated) high-viscosity glass ionomer cements and glass hybrid restorative systems

Andrej M. Kielbassa, Eric Paul Oehme, Natalia Shakavets, Michael Wolgin

EQUIA Fil and EQUIA Forte performed similarly, conventional GIC had highest wear rate:
No influence of resin coating on surface wear

Conclusions: Resinous coating of hvGIC or ghRS does not appear to exert an effective long-term protection against advanced abrasive wear. Compared to the conventional GIC showing a considerable substance loss, both hvGIC and ghRS materials revealed an improved abrasion resistance, but clearly failed to meet the excellent values of the CR.

Clinical Significance: Occlusal loading should be carefully considered when using hvGIC or ghRS as amalgam (or composite resin) alternatives for the restoration of posterior teeth.

Differences from Fuji IX

New ultrafine highly reactive glass particles added

Higher molecular weight polyacrylic acid

20% improved flexural strength, 21% improvement in acid resistance, 40% wear resistance

Improved fluoride release

Independent testing partially confirms these claims

Clinical studies on EQUIA Forte are now starting to appear

(I am not including ART studies, or studies on primary teeth)

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The Journal of Adhesive Dentistry

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J Adhes Dent 22 (2020), No. 3 29. May 2020

J Adhes Dent 22 (2020), No. 3 (29.05.2020)

Page 235-247, doi:10.3290/j.jad.a44547, PubMed:32435764

Positive
short term findings!

Long-term, split-mouth, randomized, prospective, multicentre clinical study enrolled 180 patients (mean age 34.6 years) identified as in need of two Class II, two-surface restorations in the molar region of the same jaw.

The estimated survival rates at the 2-year recall were 93.6% (EQUIA Forte) and 94.5% (Tetric EvoCeram), showing no significant differences between the two materials.

A recent 4-year research abstract from the same study

IADR
International Association for Dental Research

48-Month Clinical Performance of a Glass-Hybrid in Extended-Size Class-II Cavities

Objectives: To evaluate the clinical performance of a glass hybrid restorative compared to a resin composite in the restoration of large and deep Class II cavities after 48 months

Methods: A total of 108 extended size (the proximal box in occlusion and width of the proximal box not interfering with the peak of the cusps) Class II lesions in 37 patients were either restored with a glass hybrid restorative or with a micro-hybrid composite resin in combination with selective etching by two experienced operators according to the manufacturer's instructions. Two independent examiners evaluated the restorations at baseline and at 12-, 24- 36- and 48-month recalls according to the modified USPHS Criteria. Negative replicas at each recall were examined under SEM to evaluate surface characteristics. The Cochran Q-test was used to compare the changes across different time points within each restorative material. The changes in each category within the restorative groups were compared using the Fisher Exact test (α=0.05)

KEY POINTS:

- 90 restorations evaluated in 32 patients
- 4 restorations failed, 3 due to bulk fractures (after 12 months), 1 due to interproximal fracture (i.e. 4.5% failure rate overall, or 1.2% AFR)
- 6 exhibited colour changes

AUTHORS' CONCLUSION

Although glass hybrid restorations showed a mismatch in colour, these restorations could be considered permanent restorative material for the restoration of large class II cavities after 48 months.

3-year Class V evidence from Germany

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Glass hybrid versus composite for non-carious cervical lesions: Survival, restoration quality and costs in randomized controlled trial after 3 years

Falk Schwendicke [a,*], Anne Müller [a], Tilmann Seifert [b], Linda-Maria Jeggle-Engbert [c], Sebastian Paris [d], Gerd Göstemeyer [d]

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[b] Department of Periodontology, Oral Medicine and Oral Surgery, Charité – Universitätsmedizin Berlin, Germany
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ARTICLE INFO

Keywords:
Composite
Glass ionomer
Non-carious cervical lesions
Randomized controlled trial
Restoration
Sclerotic dentin

ABSTRACT

Objective: This study compared survival, restoration quality and costs of glass hybrid (GH; EQUIA Forte Fil/EQUIA Forte Coat) and resin composite restorations (RC; OptiBond FL/Filtek Supreme XTE) of sclerotic non-carious cervical lesions.

Methods: This is a cluster-randomized trial (ClinicalTrials.gov: NCT02631161). 88 patients (50–70 years) with 175 sNCCLs were randomized to receive GH or RC. Restorations were placed without mechanical cavity preparation and followed for a mean 36 (min/max: 31/55) months (variable follow-up due to COVID-19 lockdown). Restoration quality was re-evaluated at 1-, 18- and 36-months using FDI-criteria. Survival was assessed using multi-level Cox-regression analysis. Costs were estimated from a payer's perspective in Germany. Initial costs were determined based on micro-costing using time recordings and hourly costs, and follow-up costs based on statutory insurance fee-item-catalogues.

Results: 88 patients (175 restorations) were treated; 43 received GH (83 restorations), 45 RC (92 restorations). 17 GH and 19 RC showed total retention loss, 5 GH were partially lost ($p = 0.396$/Cox). FDI ratings were not sufficiently different for any domain except surface luster, where RC showed higher score ($p < 0.001$). Costs were initially lower for GH (32.57; SD 16.36 €) than RC (44.25; SD 21.40 €), while re-treatment costs were similar (GH: 9.15; SD 15.70 €; RC: 7.35; SD 14.51 €), resulting in significantly lower costs for GH (GH: 41.72; SD 25.08 €) than RC (51.60; 26.17 €) ($p < 0.001$/GLM).

Conclusions: While survival was not significantly different, GH was significantly less costly both initially and long-

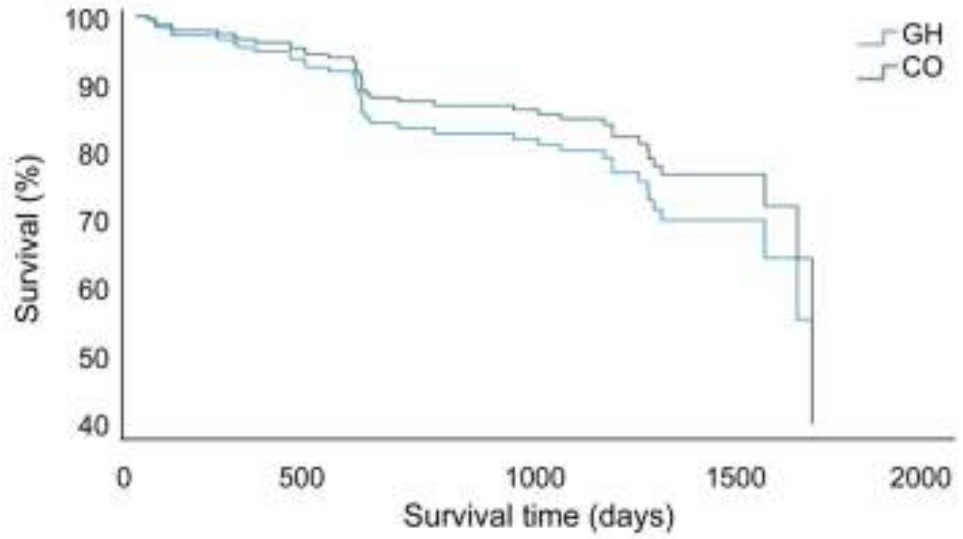


Fig. 2. Survival of Glass Hybrid (GH) and Resin Composite (RC) restorations.

Conclusions: While survival was not significantly different, GH was significantly less costly both initially and long-term than RC for restoring non-carious cervical lesions.

Clinical significance: Within this trial, survival was not significantly different between GH and RC to restore sclerotic NCCLs. As GH was significantly less costly both initially and long-term than RC, using RC was only cost-effective for payers willing to invest high additional expenses per minimal survival gains.

Evidence on Class II from Croatia, Serbia, Italy & Turkey

Journal of Dentistry

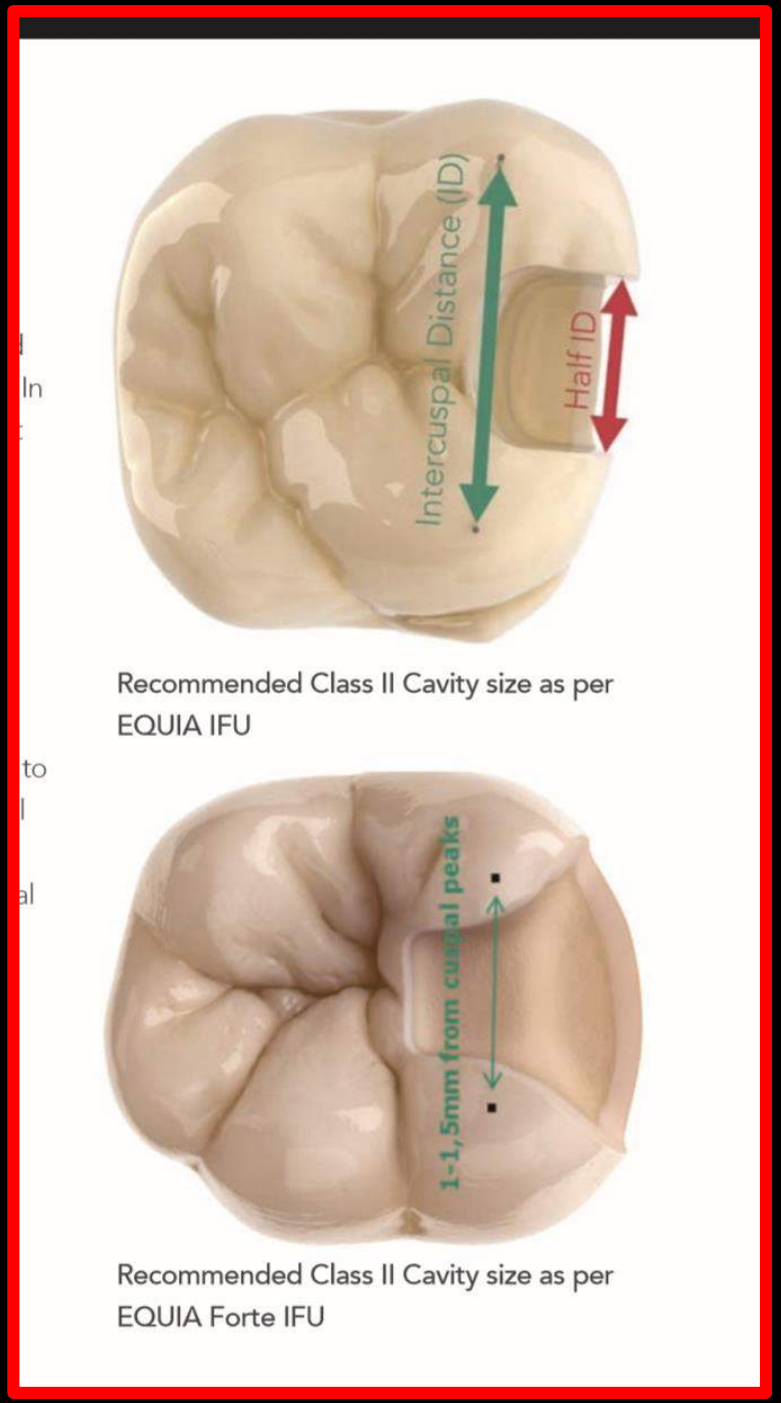
Cost-effectiveness of glass hybrid versus composite in a multi-country randomized trial

Falk Schwendicke, Jesus Gomez Rossi, Joachim Krois, Matteo Basso, Tamara Peric, Lezize Sebnem Turkun, Ivana Miletić

Results: Overall costs were lower for GH than CO in Croatia, Turkey and Serbia, while this difference was minimal in Italy. GH tended to survive longer than CO in Croatia and Italy, and shorter in Serbia and Turkey; overall survival time was not significantly different (p = 0.67/log-rank). The cost-effectiveness differences indicated CO to be more expensive at limited (ICER: 268.5 USD/month without any complications) or no benefit at all (-186.2 USD/month without major complications).

Conclusions: GH was less costly than CO both initially and over 3 years. Efficacy differences were extremely limited.

Clinical significance: Given their low initial costs and as efficacy between GH and CO did not differ significantly, GH had a high chance of being more cost-effective within this specific trial.



Manufacturer's (GC) suggestion

Perhaps! But, clinical trials on this cavity design are needed.

Do you want to read more?

Trevor's view:

EQUIA Forte seems to hold promise. Results good for class I restorations. Use a cautious approach in class II until more research appears.

Am I flying a kite?

Placement tips for Glass Ionomer in posterior teeth

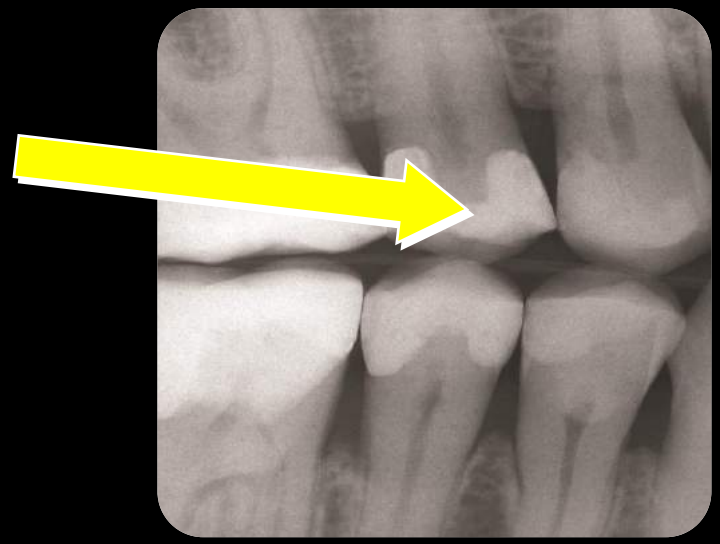
- Glass Ionomer adheres chemically to metal, therefore can bond/stick to metal matrices: as the matrix is (forcefully) pulled off with the GIC not fully matured, microcracks can form in the proximal surface or result in partial debonding of the material at the bottom:
- Therefore use a coated matrix, or coat matrix with Vaseline
- DO NOT pull the matrix off in an occlusal direction

Placement tips for Glass Ionomer in posterior teeth

- Use rounded internal cavity line angles
- Use an anatomically contoured matrix such as a sectional
- Or burnish out matrices with flatter interproximal contour

Straight matrix system

- Fails to restore proximal anatomy
- Thin contact at marginal ridge
- Certain food trap
- Eventual periodontal disease



Placement tips for Glass Ionomer in posterior teeth

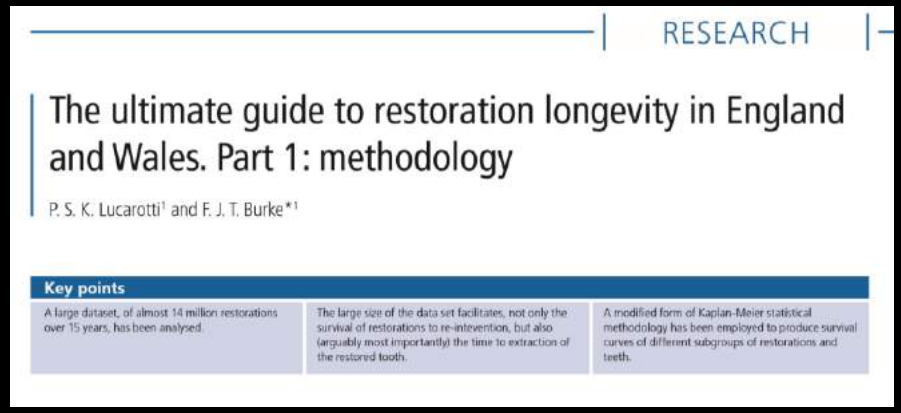
- GI is soluble in dilute organic acids, therefore can dissolve interproximally in high caries cases
- For materials which comprise a coating, therefore, pass the coating down the interproximal surface using floss
- Another reason for interproximal coating - GIs may react to apple juice and orange juice due to chelating carboxylic acids in the juices. Conversely, the phosphoric acid in cola drinks has no effect!

Placement tips for Glass Ionomer in posterior teeth

- Presence of an occlusal contact on the interproximal box area of a GI restoration leads to increased risk of bulk fracture of the restoration (Frankenberger et al, Int.Dent.J., 2009)
- Therefore, for GIs, AVOID OCCLUSAL CONTACTS ON CLASS II BOXES!

- If your curing light gets hot at the tip, light cure the GI for 30 seconds maximum

Why direct-placement restorations are king/queen!



RESEARCH

The ultimate guide to restoration longevity in England and Wales. Part 1: methodology

P. S. K. Lucarotti[1] and F. J. T. Burke*[1]

Key points

A large dataset, of almost 14 million restorations over 15 years, has been analysed.

The large size of the data set facilitates, not only the survival of restorations to re-intervention, but also (arguably most importantly) the time to extraction of the restored tooth.

A modified form of Kaplan-Meier statistical methodology has been employed to produce survival curves of different subgroups of restorations and teeth.

Dataset of 10 million restorations followed for 16 years

It’s only in older patients that crowning a molar tooth is a good idea!

Therefore, direct placement restorations should be employed where there is sufficient tooth substance

Trevor’s view:

Resin composite bonded with a Universal adhesive remains the gold standard, but new self-adhesive materials have arrived.

The ideal restorative material

That's Is the best bond the one you don't need??

Hope these lecture notes were helpful