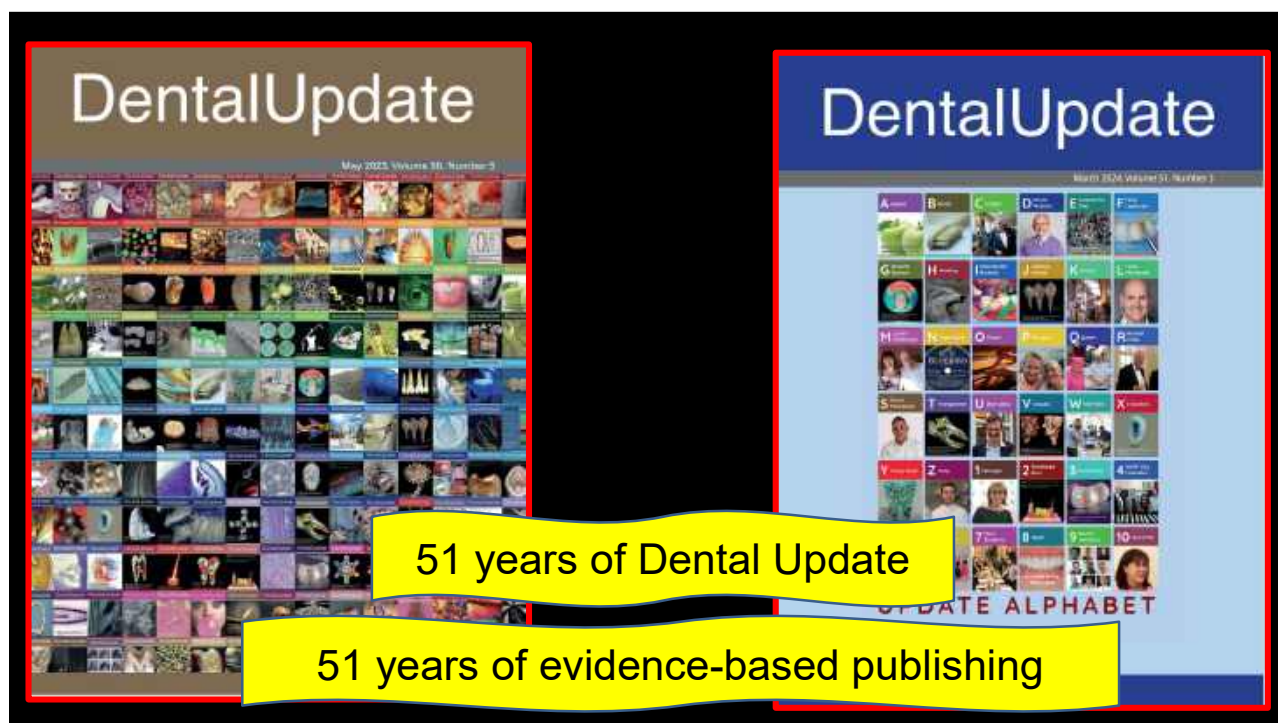






www.dental-update.co.uk





"I am not anti-amalgam"

"But, I am in favour of minimally invasive dentistry"

Disclosures



I have not placed an amalgam restoration since 2000

I am also one of the heavy metal brigade, so have plenty of experience of amalgam restorations!

Disclosures



Disclosures

"I am not paid by any company to promote their products"

"I will discuss materials, devices and techniques that I have used, but there may be others that are better"

Some manufacturers fund my research"

"I will try to be evidence-based rather than anecdotal"



Learning objectives

On completion of the presentation, listeners should:

- Be aware of why dental amalgam's days are numbered.
- Know the most recent developments in bulk fill resin composite materials, including self-adhesive variants, for loadbearing situations in posterior teeth
- Be aware of the clinical performance of new GIC materials in loadbearing situations in posterior teeth



What I plan to talk about

- Amalgam, briefly
- Bulk fill resin composites – a true alternative?
- Latest on self-adhesive composite materials
- Current status of Glass Ionomers and Glass Hybrids for restoration of posterior teeth – a true alternative?
- Final thoughts



What I plan to talk about (not necessarily in this order!)

- Amalgam, briefly
- Resin composites – a true alternative?
- Latest on self-adhesive composite materials
- Current status of GICs and Glass Hybrids for restoration of posterior teeth
- How to place these
- Are these good enough to change our philosophy today?
- Final thoughts



In the beginning

We had amalgam!

Dental amalgam has had a turbulent history



A short history of silver amalgam

- 💀 1819 English chemist Charles Bell invents Silver Amalgam
- 💀 1826 Auguste Onesime Taveau "Pate d'Argent" (France)
- 💀 1833 – 1841 Crawcour brothers "Royal Mineral Succedaneum" to the USA
- 💀 1840 American Society of Dental surgeons (ASDS) founded
- 💀 1843 ASDS declared the use of amalgam to be malpractice
- 💀 1848 ASDS suspended 11 members

A short history of silver amalgam

“I hereby certify it to be my opinion and firm conviction that any **amalgam whatever is unfit for the plugging of teeth or fangs** and I pledge myself never under any circumstances to make use of it in my practice as a dental surgeon, and furthermore, as a member of the American Society of Dental Surgeons, I do subscribe and write with them in this protest against the use of the same.”

The Amalgam debate...continued

- 💡 2 US members of congress want to abolish amalgam
- 💡 They demand full disclosure re the alleged dangers
- 💡 2002 (April) US Congress Rep. members Dan Burton (Ind) & Diane Watson (D) co-sponsor modified legislation “Mercury in Dental Filling Disclosure & Prohibition Act”

Rep. Congresswoman
Diane Watson (D.-Calif)



Serving the dental profession for 50 years

March 2009 Vol. 31, No. 3
ISSN 1750-2688

THE PROBE

Mercury rising on Tonight exposure

By Margaret Smith

Mercury use in dental amalgam rises in public consciousness as new programme looks at both visitors and patient complaints, raising the potential cause of one author's Alzheimer's...

What's in this month?

NEWS

DENTSPY

COMPETITION

FEATURE

BUSINESS

FINANCIAL FEATURE

100th Britain's first full-length motorway, the M1, is opened to public traffic

1000: The Probe forges the way in news coverage for the dental profession

A Health Information Book
To Answer Questions You May Have
On Countering The Effects of
Dental Mercury Exposure

DENTAL MERCURY DETOX

BY
Sam Ziff
Michael F. Ziff, D.D.
Mats Hanson, Ph.D.

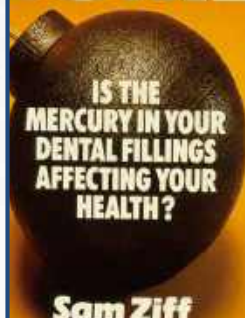
REVISED & EXPANDED
1995 EDITION

FTFD SYMPTOM ANALYSIS OF 1569 PATIENTS

% of Total	SYMPTOM	Total No.	No. Improved or Cured	% of Cases or Improvement
14%	ALLERGY	221	196	89%
5%	ANXIETY	86	80	93%
5%	BAD TEMPER	81	68	84%
6%	BLOATING	88	79	89%
6%	BLOOD PRESSURE PROBLEMS	99	53	54%
5%	CHEST PAINS	79	69	87%
22%	DEPRESSION	347	315	91%
22%	DIZZINESS	343	301	88%
45%	FATIGUE	795	603	76%
15%	GASTROINTESTINAL PROBLEMS	231	191	83%
8%	GUM PROBLEMS	129	121	94%
34%	HEADACHES	531	460	87%
3%	MIGRAINE HEADACHES	45	39	87%
12%	INSOMNIA	187	146	78%
10%	IRREGULAR HEARTBEAT	159	139	87%
8%	IRRITABILITY	132	119	90%
17%	LACK OF CONCENTRATION	270	216	80%
6%	LACK OF ENERGY	91	88	97%
17%	MEMORY LOSS	265	193	73%
17%	METALLIC TASTE	260	247	95%
7%	MULTIPLE SCLEROSIS	113	86	76%
8%	MUSCLE TREMOR	126	104	83%
10%	NERVOUSNESS	158	131	83%
8%	NUMBNESS ANYWHERE	118	97	82%
20%	SKIN DISTURBANCES	310	251	81%
5%	SORE THROAT	149	128	86%
6%	TACHYCARDIA	97	68	70%
4%	THYROID PROBLEMS	56	44	79%
12%	ULCERS & SORES (ORAL CAVITY)	189	162	86%
7%	URINARY TRACT PROBLEMS	115	87	76%
29%	VISION PROBLEMS	462	289	63%

MERCURY/AMALGAM DENTAL FILLINGS

THE TOXIC TIME BOMB

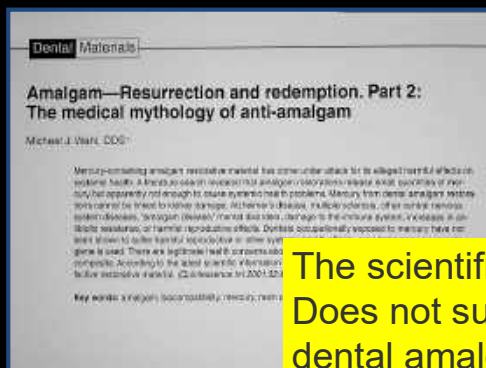


**IS THE
MERCURY IN YOUR
DENTAL FILLINGS
AFFECTING YOUR
HEALTH?**

Sam Ziff

Foreword by J.C. Levenson
Member of the British Dental Society for Clinical Nutrition

None of these
publications has
ever been backed
by scientific fact



The scientific evidence (170 references):
Does not support the myth that mercury from
dental amalgam causes kidney damage
Does not support the myth that dental amalgam is
associated with MS, Alzheimer's Disease, mental
disease or "amalgam illness"
Does not support the myth that mercury from dental
amalgam damages the immune system or causes
harmful reproductive effects

A must read paper, Dent. Update Sept 2021



Perhaps the best paper ever written on amalgam?



What does the future hold for amalgam?



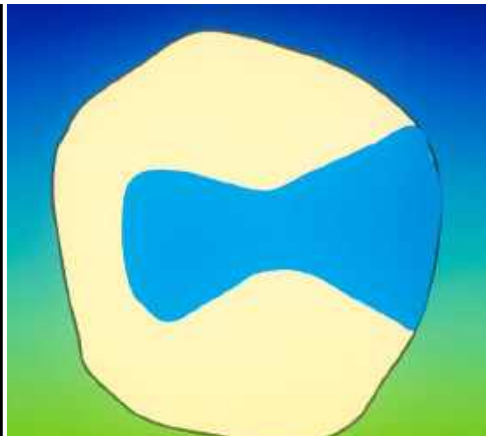
The Minamata Convention

Final agreement, 10th & 11th October
2013, 147 countries signed up



July 2018
Amalgam banned in children 15 years
and younger, and in pregnant/nursing women

Amalgam is not adhesive, so
mechanical retention is needed



i.e. not minimally invasive

AMALGAM

Environmental concerns.....YES

Toxicity issues..... NO

Slide made in 1996

RESEARCH

IN BRIEF

- One hundred and eighty dental surgeries were tested for environmental mercury.
- Sixty eight per cent had environmental mercury readings over the occupational exposure standard.
- Greater emphasis is needed in the safe handling of mercury.
- Dentists were more likely to have suffered a kidney disorder than the control group.

Mercury vapour levels in dental practices and body mercury levels of dentists and controls

K. A. Ritchie,¹ F. J. T. Burke,² W. H. Gilmour,³ E. B. Macdonald,⁴ I. M. Dale,⁵ R. M. Hamilton,⁶ D. A. McGowan,⁷ V. Binnie,⁸ D. Collington⁹ and R. Hammersley¹⁰

Aim A study of 180 dentists in the West of Scotland was conducted to determine their exposure to mercury during the course of their work and the effects on their health and cognitive function.

Design Data were obtained from questionnaires distributed to dentists and by visiting their surgeries to take measurements of environmental mercury.

Methods Dentists were asked to complete a questionnaire including items on handling of amalgam, symptoms experienced, diet and possible influences on psychomotor function such as levels of stress.

Results Sixty eight per cent of the 180 dentists had environmental mercury readings over the occupational exposure standard. In the majority of these surgeries high levels of mercury were found at the skirting and around the of the dental chair. In 45 surgeries (25%) the personal dosimetry measurement (ie in the breathing zone of dental staff) was above OES.

Conclusions The study found that dentists had higher levels of mercury in their bodies, compared with a control group of academics. This also found that dentists were significantly more likely to report kidney disorders and memory disturbances than the academic staff.

Keywords Mercury, dental, health, environment, mercury, dentists, kidney, memory, stress, amalgam, occupational exposure standard, OES, personal dosimetry, skirting, dental chair, breathing zone, academic staff, control group.

BBC NEWS

Teeth fillings 'make dentists ill'

Dentists may be at risk of developing kidney and memory problems because of their exposure to mercury, a study suggests.

Mercury is used safely in tooth fillings but long term exposure can cause health problems.

The study, by researchers at the University of Glasgow, suggests that dentists may be at particular risk.

Dr Susan Macdonald, lead researcher, found that dentists had higher levels of mercury in their bodies, compared with a control group of academics.

She also found that dentists were significantly more likely to report kidney disorders and memory disturbances than the academic staff.

Dr Susan Macdonald, University of Glasgow.

Healthlink

The authors stressed that of making a dent. But, writing in the journal Occupational and Environmental Medicine, they said: 'The mercury exposure at higher levels is known to

RESEARCH

IN BRIEF

- One hundred and eighty dental surgeries were monitored.
- Sixty eight per cent had environmental mercury readings over the occupational exposure standard.
- Greater exposure was found in dentists who performed surgery.
- Dentists v

CONCLUSIONS

- Dentists short-term memory worse than controls
- Periodic health surveillance of DHCWs indicated
- Kidney disorders not correlated with surgery Hg vapour levels
- Safer handling of amalgam needed
- Further studies indicated on all members of the dental team

Mercury in the body

K. A. Ritchie,
V. Binnie,⁸

Aim A study to determine the level of mercury in the work and the home environment of dentists and dental staff.

Design Data were collected from dentists and dental staff who performed surgery. The study included 11,906 dentists who attended for American Dental Association's annual meeting over 24 years (1986-2007 and 2011-2012). The

high levels of mercury were found at the skirting and around the base of the dental chair. In 45 surgeries (25%) the personal dosimetry measurement (ie in the breathing zone of dental staff) was above the OES.

COVER STORY

Occupational mercury exposure in association with prevalence of multiple sclerosis and tremor among US dentists

Julia Anglen, MS; Stephen E. Gruninger, MS; Hwai-Nan Chou, MD; Jennifer Wilson, PhD; Mary Ellen Turyk, PhD; Sally Fries, PhD; Leslie Thomas Stayner, PhD

Investigators in many studies using the general population have reported no association between exposure to elemental mercury (Hg⁰) from dental amalgam and neurologic diseases.¹⁻⁶ Workers occupationally exposed to higher concentrations of Hg⁰ (> 100 micrograms per liter urinary Hg⁰), however, have been reported to experience tremors, memory deficits, blurred vision, paresthesia, nerve conduction deficits, and other neurotoxic effects.⁷⁻¹¹ The US Environmental Protection Agency has set the lowest observed adverse effect level for ambient Hg⁰ exposure at 0.05 mg per cubic meter, approximately equivalent to 25 µg/L urinary Hg⁰ concentration.¹² Investigations in studies of low-level Hg⁰ exposure examining this threshold for neurologic deficits have found both null¹³⁻¹⁵ and positive findings.¹⁶⁻¹⁸

Dentists' occupational exposure to Hg⁰ has decreased over the past decades because of the development of encapsulated amalgam technology, the increasing use of composite resin restorations, and an overall heightened awareness of occupational Hg⁰ hygiene. In 1986, dentists' urinary Hg⁰ concentrations averaged 4 µg/L, in contrast to more recent averages of 1.0 µg/L urinary Hg⁰ (Hwai-Nan Chou, MD, American Dental Association).

This article has an accompanying online continuing education activity available at: <http://jama.ada.org/ce/home>. Copyright © 2015 American Dental Association. All rights reserved.

ABSTRACT

Background. The effects of chronic occupational exposure to elemental mercury (Hg⁰) are largely unknown. The objective was to evaluate the association of occupational Hg⁰ exposure with multiple sclerosis (MS) and tremor.

Methods. The study included 11,906 dentists who attended for American Dental Association's annual meeting over 24 years (1986-2007 and 2011-2012). The

Results. Among participants, 0.10% reported MS and 1.24% reported tremor. Hg⁰ exposure was not associated with MS (odds ratio [OR] per 101 micrograms per liter in cumulative Hg⁰ exposure: 0.85; 95% confidence interval [CI], 0.39-1.85). Increased point-dose risk of tremor was found with exposure to both urinary Hg⁰ exposure (OR, 1.10 [95% CI, 1.06-1.22]) and cumulative Hg⁰ exposure among younger dentists (< 51 years: OR, 1.23 [95% CI, 1.05-1.22]).

Conclusions. Occupational Hg⁰ exposure in US dentists decreased over time and now is approaching that of the general population. Our results suggest a positive association between Hg⁰ exposure and tremor.

Practical implications. Studies with more sophisticated outcome and exposure measures, and including more critical dentists, would provide critical information toward understanding the relative risk of Hg⁰ exposure in MS and tremor risk.

Key words. elemental mercury; dentists; occupational health; multiple sclerosis; tremor; epidemiology. JADA 2015;146(10):659-668.

<http://dx.doi.org/10.1016/j.jada.2015.09.016>

More recently...

13,906 US dentists surveyed at ADA's annual meetings over 24 years

25,382 urinary Hg measurements

COVER STORY
Occupational mercury exposure in association with prevalence of multiple sclerosis and tremor among US dentists

Abstract The effect of chronic occupational exposure to elemental mercury (Hg⁰) on the prevalence of multiple sclerosis (MS) and tremor among US dentists was assessed. The study included 1,000 dentists who were exposed to Hg⁰ in the workplace from 1960 to 1980. The prevalence of MS and tremor was assessed by a standardized questionnaire. The results showed that the prevalence of MS and tremor was significantly higher among dentists who were exposed to Hg⁰ in the workplace compared to those who were not exposed. The results also showed that the prevalence of MS and tremor was significantly higher among dentists who were exposed to Hg⁰ in the workplace for a longer duration compared to those who were not exposed. The results suggest a positive association between Hg⁰ exposure and the prevalence of MS and tremor among US dentists.

Keywords: Occupational mercury exposure, multiple sclerosis, tremor, US dentists.

Conclusions. Occupational Hg⁰ exposure in US dentists decreased over time and now is approaching that of the general population. Our results suggest a positive association between Hg⁰ exposure and tremor.

Practical Implications. Studies with more sophisticated outcome and exposure measures, and including more retired dentists, would provide critical information toward understanding the relation of Hg⁰ exposures to MS and tremor risk.

The situation today....

Eastbourne, The Dental Practice Board,
now, The Dental Services Division of the
Business Services Authority (Newcastle)

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 restored tooth*

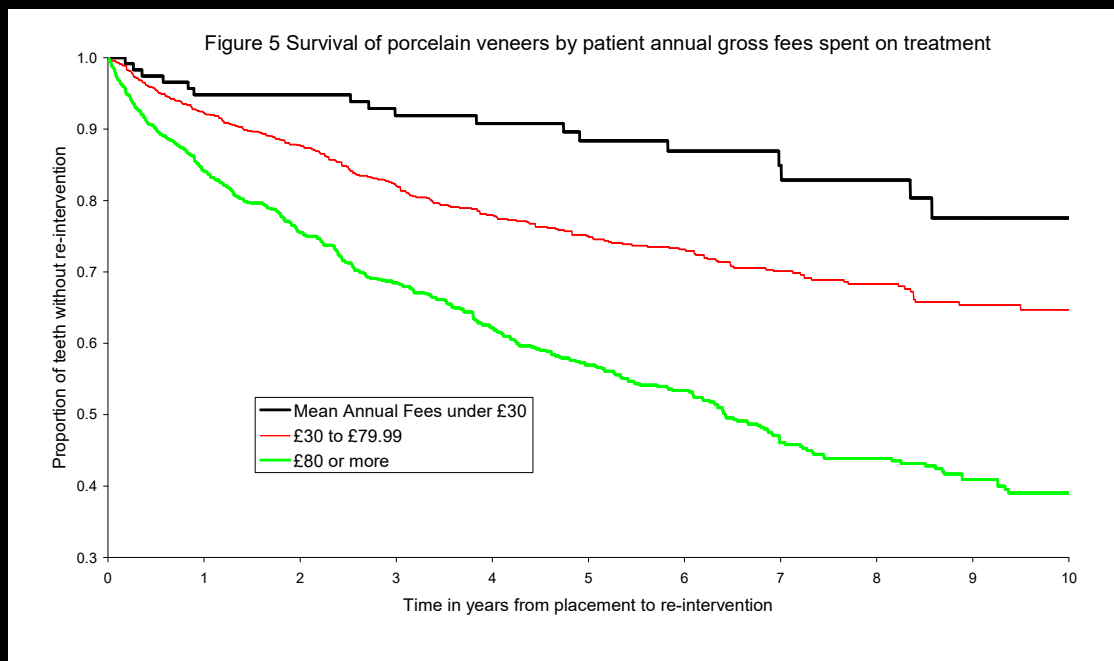
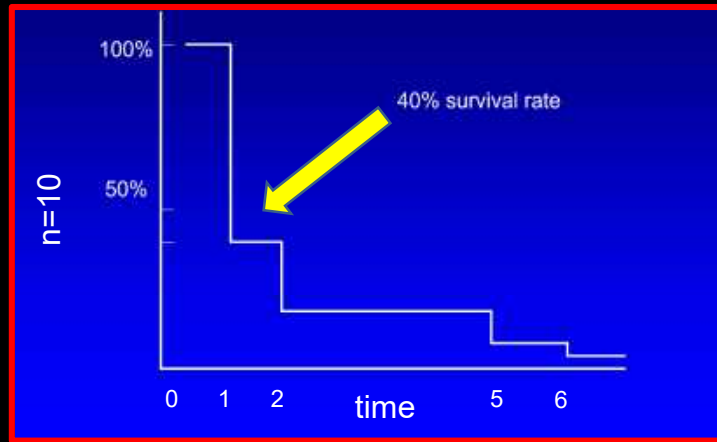
First, a brief lesson in Kaplan Meier

The goal is to estimate a population survival curve from a sample.

If every patient is followed until death, the curve may be estimated simply by computing the fraction surviving at each time.

However, in most studies patients tend to drop out, become lost to follow up, move away, etc.

A Kaplan-Meier analysis allows estimation of survival over time, even when patients drop out or are studied for different periods of time.



The effect of cavity design on amalgam restoration survival

RESEARCH

The ultimate guide to restoration longevity in England and Wales. Part 2: Amalgam restorations – time to next intervention and to extraction of the restored tooth

F. J. T. Burke*¹ and P. S. K. Lucarotti¹

Key points

Circa 7.5 million amalgam restorations were included, of which 2.5 million had a re-intervention at 15 years. Kaplan-Meier Analysis revealed that, overall, 41% of amalgam restorations had not required a re-intervention at 15 years.

Upper restorations survived less well to re-intervention than small restorations, with similar findings for time to extraction of the restored tooth. The placement of onlay/crown type restorations resulted in poorer performance of restorations.

Amalgam restorations in younger patients performed better than those in older patients, both in terms of time to re-intervention and time to extraction of the restored tooth.

Aim It is the aim of this paper to present data on the survival of amalgam restorations by analysis of the time to re-intervention on the restorations and time to extraction of the restored tooth, and to discuss the factors which may influence this.

Methods A data set was established, consisting of General Dental Services' patients, this being obtained from all records for adults (aged 18 or over at date of acceptance) in the GDS of England and Wales between 1990 and 2006. The data consist of items obtained from the payment claims submitted by GDS dentists to the Dental Practice Board (DPB) in Eastbourne, Sussex, UK. This study examined the recorded intervals between placing an amalgam restoration and re-intervention on the tooth.

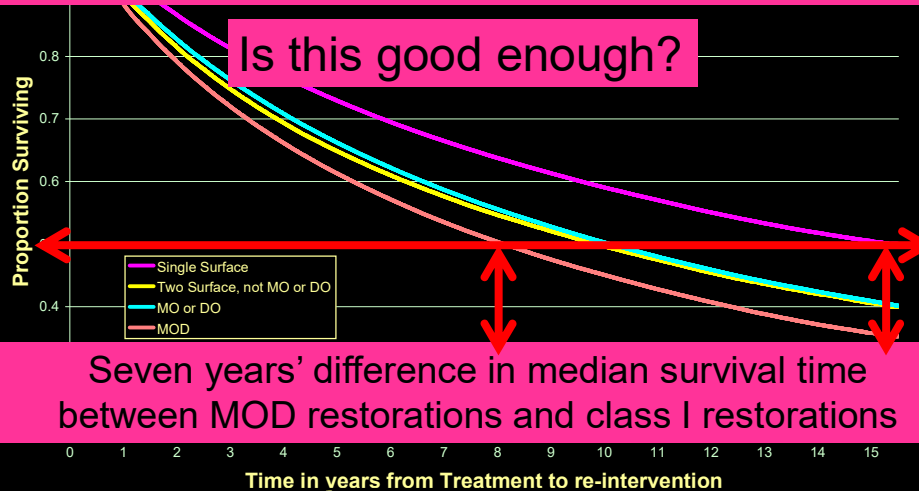
Direct placement restorations: amalgam

7,425,049 amalgam cases included, of which 2,537,331, of which had a re-intervention

21

Amalgam Restoration Survival by Type of Cavity

Annual failure rate (AFR) for class II amalgam=4%



Take home message

Keeping restorations as small as possible is therefore important

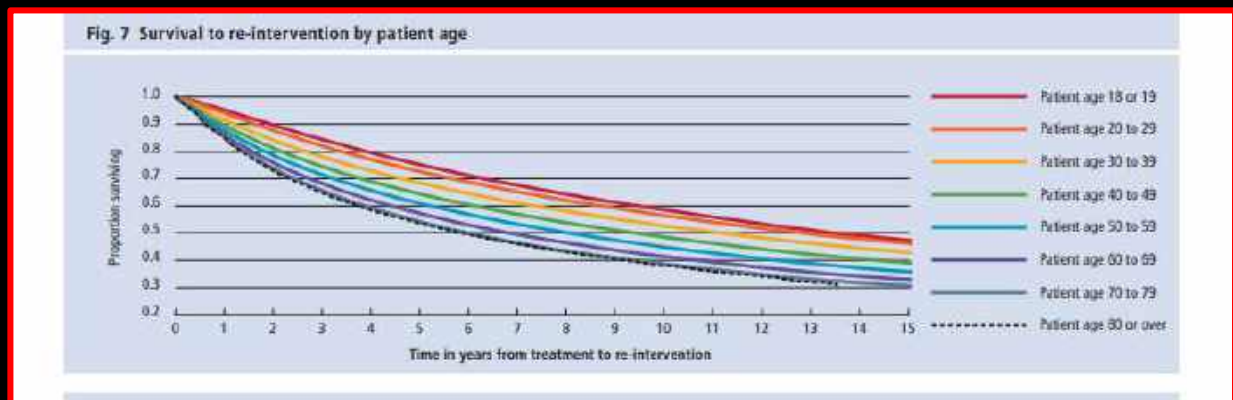
We can only do this with adhesive dentistry



The effect of patient age: Older patients have a higher % of amalgam restorations than younger patients



Amalgam Restoration Survival (to next intervention), by Patient Age





Was amalgam an ideal material?

- ⦿ No toxicity issues to patients: To dentists?? To the environment? **XX**
- ⦿ Physical properties good ✓
- ⦿ Relatively easy placement, said to be “forgiving” ✓
- ⦿ Comparatively cost effective (reduced surgery time) ✓
- ⦿ High thermal conductivity **X**
- ⦿ Did not need an intermediate bonding agent ✓
- ⦿ But, required retentive cavity features = tooth destruction **XX**
- ⦿ Plenty of research “evidence” on longevity ✓
- ⦿ Aesthetics poor (although colour contrast facilitates removal) **X**
- ⦿ Waste is highly regulated **X**

5+/7-

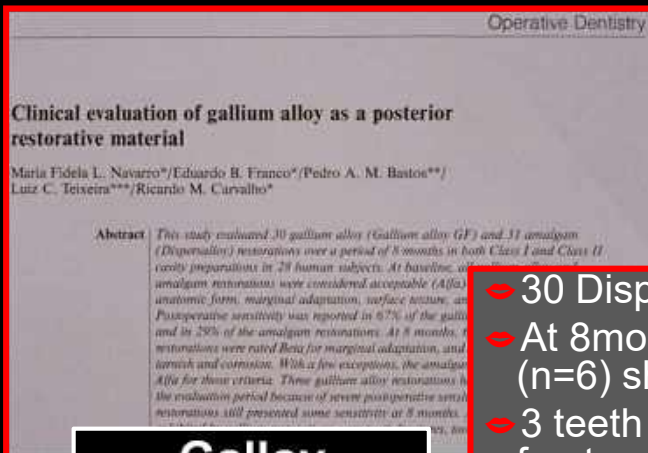
**The first attempt
at an amalgam
replacement.**



Gallium



- ❑ Grey-white rare metal
- ❑ Atomic number 31, discovered in 1875
- ❑ Liquid at near room temperature, boils at 1983°C
- ❑ Gallium expands by 3.1% in volume when it solidifies and for this reason should not be stored in glass or metal containers.



Galloy	
ALLOY	LIQUID
Ag 60%	Ga 62%
Sn 28%	In 25%
Cu 12%	Sn 13%
(Similar to Tytin alloy)	

- 30 Dispersalloy, 30 Gallium Alloy (GA)
- At 8 months, 21% of GA restorations (n=6) showed marginal defects
- 3 teeth with GA restorations had fractured
- Severe tarnish and corrosion observed
- 9 GA restorations were associated with post-op sensitivity

Clinical evaluation of gallium alloy as a posterior restorative material

Maria Fidela L. Navarro^{*}/Eduardo B. Franco^{*}/Pedro A. M. Baston^{**}/
Lutz C. Teixeira^{***}/Ricardo M. Curvalho^{*}

Abstract This study evaluated 30 gallium alloy (Gallium alloy GF) and 31 amalgam (Dispersalloy) restorations over a period of 8 months in both Class I and Class II cavity preparations in 28 human subjects. At baseline, all gallium alloy and amalgam restorations were considered acceptable (A/a) in terms of caries, anatomic form, marginal adaptation, surface texture, and bulk fracture. Postoperative sensitivity was reported in 67% of the gallium alloy restorations and in 29% of the amalgam restorations. At 8 months, 61% of the gallium alloy restorations were rated Beta for marginal adaptation, and all restorations exhibited tarnish and corrosion. With a few exceptions, the amalgam restorations were rated A/a for these criteria. Three gallium alloy restorations had to be replaced during the evaluation period because of severe postoperative sensitivity and 19% of gallium restorations still presented some sensitivity at 8 months. Additional problems exhibited by gallium restorations were nail fractures, tooth cracks, and marginal softening. (Quintessence Int. 1996;27:315-320.)

Because of the high degree of post-op sensitivity, tooth fracture, and intense tarnish and corrosion, the authors terminated the study after 8 months.

Clinical performance of Gallium-based silver alloy Smith et al., J.Dent.Res.1998

Galloy

ALLOY	LIQUID
Ag 60%	Ga 62%
Sn 28%	In 25%
Cu 12%	Sn 13%
(Similar to Tytin alloy)	

- 48 restorations in Galloy/PAAMA and Tytin/Amalgambond
- 60% failure of Galloy restorations at 15 months
- 52% failed due to fracture (44% tooth, 8% restoration)
- 6% failure of Tytin
- Trial abandoned at 15 months

2-year clinical evaluation of a gallium restorative alloy

JOHN W. OSBORNE, DDS, MSD, & JAMES B. SUMMITT, DDS, MS

ABSTRACT:
and include
body of the
Nine patients
ble under a
moisture. The
posed surface
tions were e
tions were e
hibited tarnish and 50% had a rough surface. The fracture at the margins of these restorations was minimal, and no
significant difference could be found between those using Amalgam
medical problems were reported by the patients, and postoperative
(194).

CLINICAL SIGNIFICANCE: The Galloy gallium restorative alloy may be used as a substitute for amalgam in certain
situations. This class of material is very sensitive to moisture, and restorations must be protected from saliva and/or
pulpal fluid during insertion and in the early postoperative hours.

CORRESPONDENCE: Dr. J.W. Osborne, Box C284, 4200 E. 9th Ave.

The only “success”

Sensitivity to moisture not a
great property for a dental material!

- 9 patients received 30 Gallium Alloy class I restorations
- Pulpal floor lined/sealed with resin, restorations placed under rubber dam
- Exposed surfaces of restorations sealed with BisGMA resin
- At 2 years, all restorations intact, but one tooth had a fractured cusp

CLINICAL SIGNIFICANCE: The Galloy gallium restorative alloy may be used as a substitute for amalgam in certain situations. This class of material is very sensitive to moisture, and restorations must be protected from saliva and/or pulpal fluid during insertion and in the early postoperative hours.

Why did amalgam survive so long?

Easy and fast

(Because it was) Bulk fill

“Self adhesive”

Reasonable success rates

Therefore, a true amalgam replacement must
have these properties

The alternatives therefore are:

Bulk fill resin composites

Self adhesive bulk fill composites

Glass Ionomers and its latest derivatives



What I plan to talk about

- Amalgam, briefly
- Bulk fill resin composites – a true alternative?
- Latest on self-adhesive composite materials
- Current status of Glass Ionomers and Glass Hybrids for restoration of posterior teeth – a true alternative?
- Final thoughts



A problem with resin
composite materials:
they don't bond to
the tooth!

Problems in bonding to dentine

COMPOSITION OF DENTINE

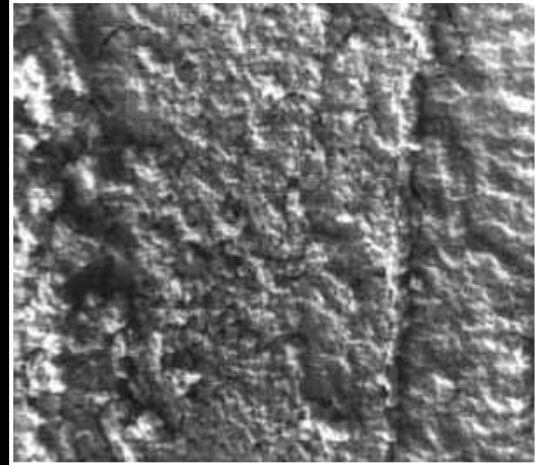
70% Inorganic

Bonding to dentine is
therefore more difficult

It is a vital substrate

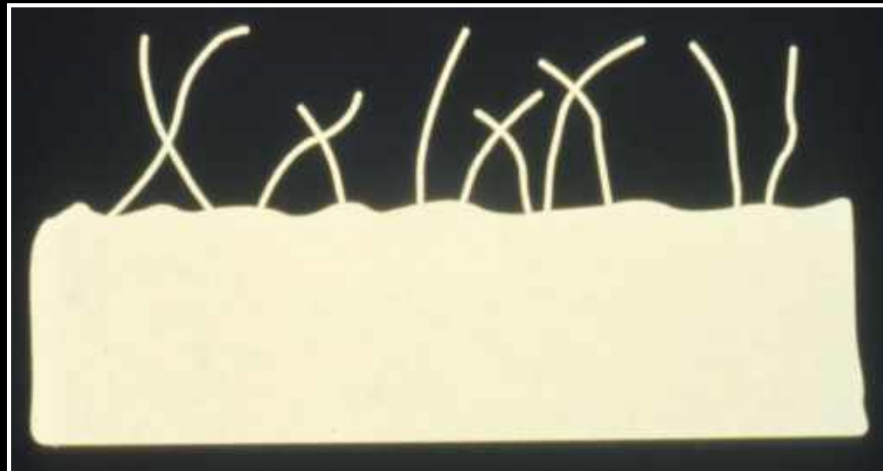
Another problem: The smear Layer

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



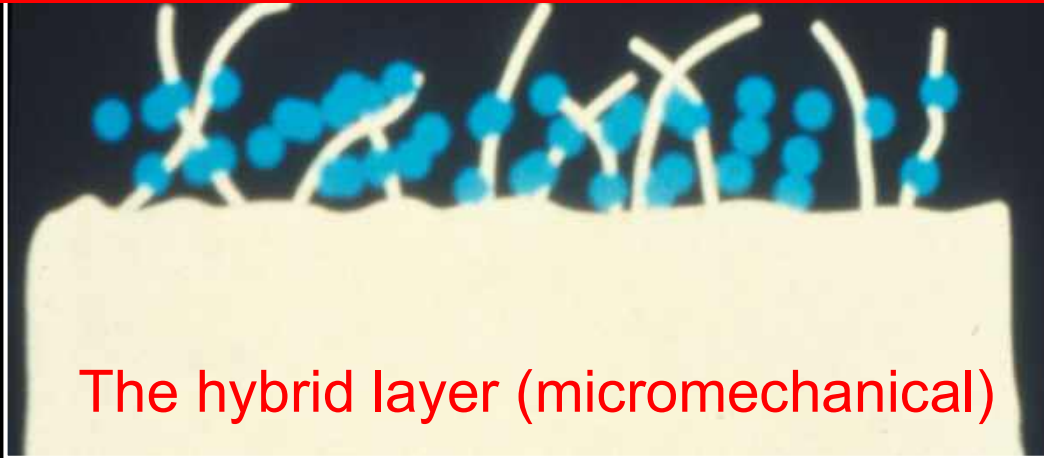
B. Van Meerbeek in: Summitt Fund. Oper. Dent. 2001,
Enamel and Dentin Adhesives, Col Kraig S. Vandewalle, USAF Dental
Investigation Service.

Published 1982, but not into mainstream dentistry for *circa* 10 years



Nakabayashi N, Kojima K, Masuhara E. The promotion of adhesion by infiltration of monomers into tooth substance.
J. Biomed.Mater.Res.1982;16:265-273

Overdrying causes the collagen to collapse



Nakabayashi N, Kojima K, Masuhara E. The promotion of adhesion by the infiltration of monomers into tooth substrates. J Biomed Mater Res 1982; 16: 265–273.

....NOW

The Universal Adhesives

A collage of various universal adhesive products. The top left shows a box of 3M ZIPBOND Universal Adhesive. The top right shows a hand applying a drop of adhesive from a syringe to a tooth. The bottom left shows a box and bottle of 3M ESPE AC Adhesive. The bottom center shows a blue bottle of 3M ESPE AC Adhesive. The bottom right shows a box of Voco Adhesive. The text '....NOW' is written in white on a red background in the center, and 'The Universal Adhesives' is written in white on a red background at the bottom.

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

Universal bonding agents:

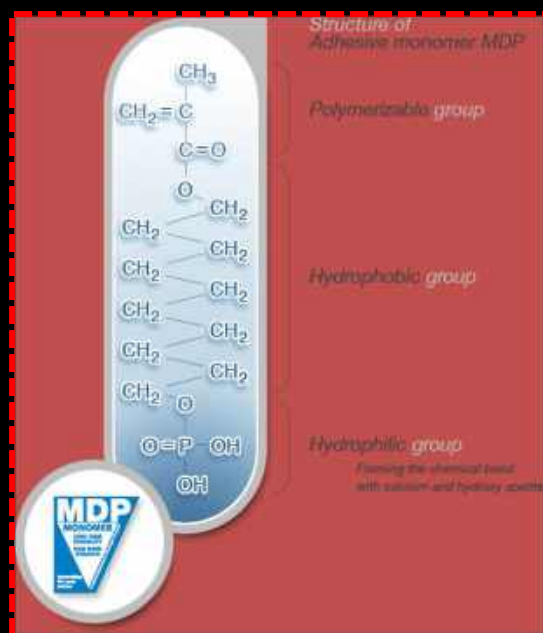


The first Universal Adhesive:
Scotchbond Universal (3M)

Universal bonding agents:

New additions are here!

All contain the resin 10-MDP



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

The gamechanger



Some recent PREP Panel evaluations

The PREP Panel evaluation of G-Premio Bond

2 evaluators, 719 restorations placed

When the evaluators were asked to rate the ease of use of the bonding system which they currently used, the result was as follows:



When the evaluators were asked to rate the ease of use of the G-Premio Bond, the result was as follows:





Food Hygiene 2019; 48: 1212–1249

Research and Evaluation by Practitioners: Forest. This group was established in 1980 with the general dental practitioners (GDPs), and has grown to contain 21 dental practitioners located across the UK, with a view to maintain Europe's first group has completed over 70 projects – funding evaluations of materials and techniques, and, more recently, clinical evaluations, as a result of members placed under general dental practice conditions, with the most data being followed up to the present.

as patients increasingly come away from prosthetic interventions in their own hands,⁴ with the added impetus of the Harmonization Agreement by which the use of amalgam has been banned since 1st July 2005, incidentally 15 years after amalgam was in pregnant and nursing women, dental practitioners have had to use an alternative material. The most appropriate of which is resin composites. In this regard, particle-based clinical evaluations of this material have indicated positive results. However, in order to obtain such results, along with the resin composite material, a variety of materials and devices need to be employed. For example, a denture-bonding agent, a suitable matrix system

have been redefined as a single system, the Dentally Strong Chain of Solutions system. It is therefore the aim of this study to evaluate the opinions of a group of practice-based researchers, the WEF Panel, of the components of the system, and the system as a whole.

and the system as a whole.

For Dentsply Sirona products, similar marketing therefore involves identifying leading system owners. For example, leading system owners include Active™, the Palodent V2 Structural Matrix System, i200® Flow composite Curation Universal composite and the Enhance® Finishing and Polishing System (all manufactured by Dentsply Sirona, Building 3, The Heights, Brockton, Westridge, Surrey, KT3 9PP) at www.dentsplysirona.com/en-gb.

Evaluation of participants

All 21 members of the practice-based research group, the PRP Panel, were sent an email communication asking if they would be prepared to be involved in this leading evaluation of a recently introduced Class II laser composite system. Of those who agreed to participate, 12 were selected at random.

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Difficult Easy to use
1 5
4.8

Final comments



The PREP Panel evaluation of Zipbond

A good result!

100% would purchase if available at “average” price

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

“None”

“Make single dose compule easier to use- may have been just my inexperience using them”

“Packaging of single dose compules a little bulky”

When the evaluators were asked to rate the ease of use of SDI Zipbond, the result was as follows:



593
restorations
placed



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, MDS¹/ M. Liebler, DDS²/ G. Eliades, DDS, Dr Odont³/
R. C. Randall, M Phil, BChD⁴

"Ease of use," as applied to dental materials and techniques, 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)



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 indicate that universal adhesives are a step forward in the quest for the ultimate bond to both substrate and dentine of the adhesive. This review of the literature addresses the effectiveness of universal adhesives as discussed, along with research that indicates that selective universal 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. (See updates 2021: 48: 635-643)

Dentine bonding agents play a central role in the sealing and retention (when 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 loaded to tooth substance, do not require the macro-mechanical retentive features such as locks and keys that are a feature of non-adhesive dental analogues.

- Provide an immediate, strong and definitive bond to dentine

Dr Trevor Barker, DSc, MSc, MEd, MPhil, FDS (RCR) Edin, FDS (RCR) (Eng), FRCR, FRCR, FRCR, Emeritus Professor, University of Birmingham School of Dentistry, UK.
Leslie Mackenzie, BDS, FDS (RCR), Head Dental Officer, Deplair UK, Winchester and Clinical Lecturer, University of

- Seal the cavity and minimise leakage.
- Result in minimal or asymptomatic degradation.
- Provide adhesion per cent 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 denture adhesives since that is relevant to the performance of the latest group of adhesives, the universal adhesives (UAs), and thereby to update matters on the progress of UAs since a previous Dental Update paper in 2012,¹ and to complement other Dental Update publications on the subject, which readers may wish to read as background, such as those by Green and Stevenson,² and Green et al.³

A brief history of bonding

In the next, double-headed arrows were

bonding agents, generally fall into three categories 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 dental bonding agents into etch and three materials (also known as total etch materials) and self etch materials, with some authors classifying these according to the number of steps involved in their placement (one or two), or by their pH.²⁷

The year 1935 heralded what we now believe to be a game-changing breakthrough in restorative dentistry, namely the genesis of adhesive luting, therefore, more specifically, indirect dentistry by creating clinicians to bond to enamel, when this was first described by Buonocore.¹ This also has facilitated the development of resin composite materials, with these materials becoming increasingly used worldwide,² principally because of patient desires to request mercury in dental amalgams, the Minamata Agreement of 2013 that recommended reduction in the use of dental amalgams, and increasing

10 laboratory studies included

Finally, recent laboratory studies include the work by Lago and co-workers³⁹ 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.

Dent.Update.2021: 620-631



Abstract: The ability to successfully bond restorations to denture is central to minimally invasive restorative dentistry. While denture bonding options have grown through a variety of generations, it is the purpose of this article to describe the latest clinical and laboratory options for universal adhesives. Results from the latest laboratory and clinical research indicate that universal adhesives are a step forward in the quest for the ultimate bond to denture substrate and ease of use of the adhesive. The wide variety of options that can adapt the effectiveness of universal adhesives are discussed, along with research that indicates that selective universal bonding is a beneficial procedure when used when suitable.

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

Dentine bonding agents play a central role in the sealing and retention (when necessary) of resin composite restorations, which are increasingly placed by dentists worldwide. '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 slots and keys that are a feature of non-adhesive dental prostheses'.

- Provide an immediate, strong and definite bond to dentine

Dr Trevor Burke, DDS, MSc, MEd, MSc, PhD, FDS RCS Edin, FDS RCS (Eng), FRCR (D), FRCR, Emeritus Professor, University of Birmingham School of Dentistry, UK, **Leeds Mackenzie**, BDS, FDS RCSEd, Head Dental Officer, Dimpler UK, Winchester Clinical School, University of

- 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

It is the intention of this article to trace the history of dentine adhesives (what 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 *Gene Dent* paper in 2017,¹ and to complement other *Dental Update* publications on the subject, which readers may wish to read in background, such as those by Green and Brannstrom,² and Green et al.³

A brief history of banding

to denture

bonding agents generally fall into three categories because of confusion regarding which generation each type of bonding agent fitted into. Until recently, the classification has therefore been too simply subdivided: resin-based dentine bonding agents into etch and three materials (also known as etch materials) and self-etch materials, versus water cements, classifying these according to the number of steps involved in their placement (one or two), and their ability to

The year 1950 heralded what we now believe to be a game-changing breakthrough in restorative dentistry, namely the genesis of adhesive joint, therefore, more minimally invasive dentistry by utilizing cements to bond enamel, when this was first described by Buonocore.¹ This also has facilitated the development of resin composite materials with these materials becoming increasingly used worldwide, principally because of patient interests regarding mercury in dental amalgams. The Minamata Agreement of 2003 that recommended reduction in

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.

Dental Materials 41 (2017) 141–158

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The evolution of adhesive dentistry: From etch-and-rinse to universal bonding systems

Lorenzo Breschi^{a,*}, Tatjana Maravic^a, Claudia Mazzitelli^a, Uros Josic^a, Edoardo Mancuso^a, Milena Cadenaro^{b,c}, Carmem S. Pfeifer^d, Annalisa Mazzoni^a

^a Department of Biomedical and Neuroscience Sciences, University of Bologna - Aldo Moro Stadium, Via San Vitale 59, Bologna 40125, Italy
^b Department of Medical Sciences, University of Trieste, Strada di Fiume 447, Trieste 34149, Italy
^c Institute for Material and Oral Health - IRCCS "Galea Galea", Via dell'Industria 60/1, Trieste 34137, Italy
^d School of Dentistry, Division of Biomaterial and Biomedical Sciences, Oregon Health & Science University, 2700 S. Moody Ave., Portland, OR 97201, USA

Latest
thoughts
on
Universal
bonding
agents

ARTICLE INFO

Keywords:
Hybrid layer degradation
Universal adhesive systems
Matrix metalloproteinases
Dentin collagen
Dentin remineralization

ABSTRACT

Objective: This review aimed at presenting the mechanisms and pitfalls of adhesion to enamel and dentin, advances in the materials science and in the development of strategies to improve hybrid layer (HL) longevity. **Methods:** Search of the literature was performed on PubMed, Scopus and Web of Science with keywords related to the structure of the dental substrate, HL degradation mechanisms and strategies to contrast them. **Results:** After the advances in the dental materials' properties, HL degradation is still a relevant and current issue in adhesive dentistry. However, adhesive materials have become more resistant and less operator sensitive, and good adhesion is currently in the hands of every practitioner. Numerous novel strategies are being developed, able to improve the resistance of adhesive resins to degradation, their ability to infiltrate and chemically bond to dentin, to remove the unbound/unfilled water within the HL, reinforce the dentin collagen matrix, and inhibit endogenous metalloproteinases. Many of the strategies have turned to nature to search for powerful bio-modifying compounds, and for the inspiration to mimic naturally occurring regenerative processes. **Significance:** Extensive knowledge on the structure of the dental substrate and the complexity of adhesion to dentin has led to the development of improved formulations of dental adhesives and numerous valid strategies to improve the strength and longevity of the HL. Nevertheless, for many of them the road from bench to bedside still seems long. We encourage practitioners to know their materials well and use the strategies readily available to them.

Benefits	Drawbacks
Excellent clinical performance for follow-up period of up to 5 years and can be comparable to a more complex 3-step EAR. No need to apply an additional layer of bonding resin to achieve optimal clinical behavior in non-carious cervical lesions. [43] 2-step HEMA-free UAs have favorable bonding properties in the challenging high C-factor class-I cavity model and are comparable to that of the gold-standard 3-step EAR and 2-step SE adhesives. [44]	The lack of data from randomized clinical trials regarding behavior of UAs in longer term period (>10 years). The necessity to etch enamel as to provide predictable clinical outcome questions UAs' claimed versatility. [34,42]

good adhesion is currently in the hands of every practitioner.

Cavities like this are only possible with composite!



Use a Universal bonding agent



Fig. 1. The twelve LCDs used in the study from left to right: Elmer A Fil, Curesa CV 215-07 Red, Curesa Super V-05 Yellow, Curing Light, Vario Cordless, Vario X, Quasar, Woodpecker O Star, Radix Cal CX, Radix Xpert, Bluephase PowerCure, Monor.



Fig. 2. Photocopy, also used to provide a light representation of the different spectra and light intensity of the three LCDs. (A) Elmer A Fil (B) Curesa CV 215-07 (C) Vario Cordless. The two devices (A and B) are used to provide the position of the light.



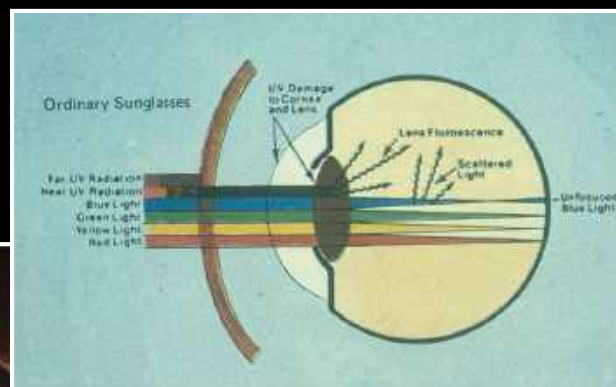
Fig. 7. Mouth opening required to position the LCU tip directly over a mandibular second molar on a semi-adjustable articulator.

J.A.G. Guarneri et al.

- 1) There were substantial and significant differences among the LCUs tested, particularly in terms of total power values (ranging from 380 mW to 2472 mW), irradiance (ranging from 731 to 3091 mW/cm²), emission spectra, effect of distance, and beam profiles.
- 2) Distance had a significant impact on the irradiance from all the LCUs. Not all LCUs could deliver 10 J/cm² in 10-s to a 6 mm diameter area at the 5- or 10-mm distances.
- 3) The Monet laser was the least affected by distance and could deliver 10 J/cm² in 2.1 s to a 6 mm diameter area at the 10-mm distance.
- 4) Not all LCUs could provide direct access to the second molar.

Alternative conclusion: if placing posterior composites at the back of the mouth, choice of Light Curing Unit is important

DANGER!



Avoid retina burns

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.

The current status of bulk fill resin composite materials

BULK FILL IS IN!

My classification for **BULK FILL** materials:

BULK FILL BASE MATERIALS

(which need a capping because their wear resistance isn't good enough)

BULK FILL RESTORATIVE MATERIALS

(satisfactory wear resistance)

Burke FJT, Crisp RJ et al. Eur J.Prosthodont. Rest.Dent.2016:24:152-157

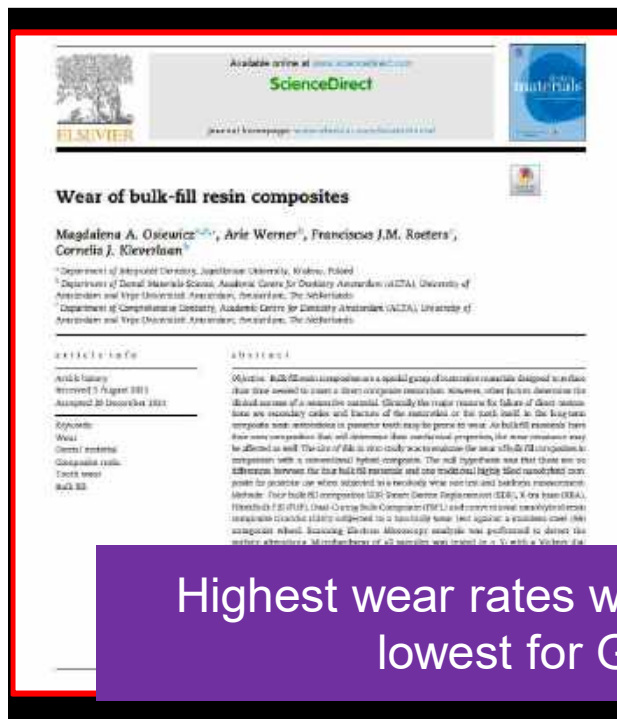
BULK FILL IS IN!

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BULK FILL BASE MATERIALS

(which need a capping because their wear resistance isn't good enough)

Burke FJT, Crisp RJ et al. Eur J.Prosthodont. Rest.Dent.2016:24:152-157



Wear of 4 bulk fill composites compared in a two-body wear test:

Wear rate (µm / 200.000 cycles):

GDO (composite) 31.4
 SDR 118.4
 Xtra Base (VOCO) 60.5
 Fill Up (Coltene) 59.3
 Filtek Bulk Fill 69.7

Highest wear rates were recorded for SDR, the lowest for Gradio composite

NOW!



Now, bulk fills that don't need a topping!

BULK FILL RESTORATIVE MATERIALS (satisfactory wear resistance)

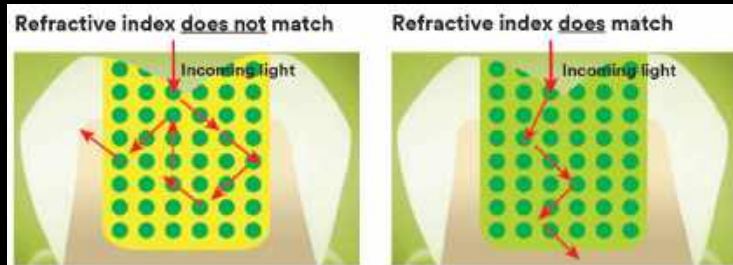




How do manufacturers do it?

All have a translucent filler, with matching filler and resin refractive indices

Curing light transmission and depth of cure are influenced by matrix reactivity and a relative refractive index mismatch.
Shortall et al., 2008



Refractive index match

Refractive index mismatch

- = Potential Scattering
- = Potential Scattering site
- = Light Ray



interaction. Composites became more opaque or translucent on curing. Optimizing filler/resin refractive index mismatch provides increased curing depth and assists shade-matching.



Tetric EvoCeram Bulk Fill



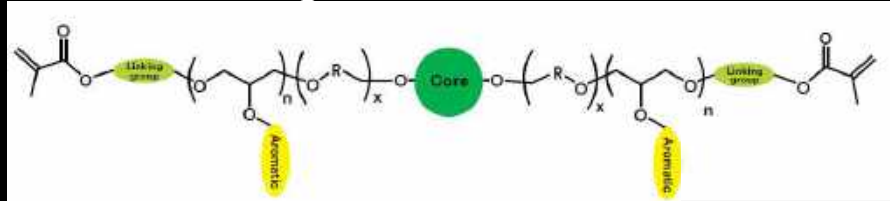
3 shades
"Enamel-like translucency"



Ivocerin initiator provides greater curing depth

vivadent
passion vision innovation

3M Filtek One: Monomer systems for Lower Shrinkage and Stress Relief



AUDMA: Aromatic urethane dimethacrylate

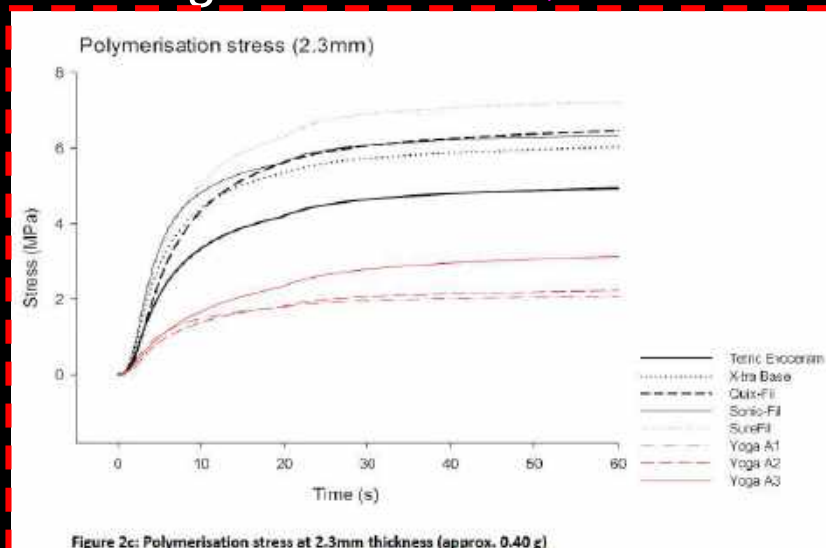
AFM: Addition-fragmentation (AF) monomer



...plus three types of nanofiller for ease of polishing & absence of voids



3M Filtek Bulk Fill/Filtek One show low shrinkage stress Palin W, Watts D 2014



How do manufacturers do it?

SUMMARY

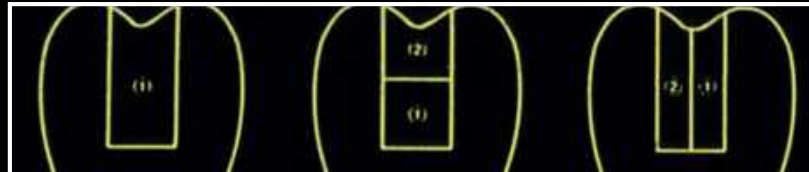
More potent/efficient initiator systems
Increasing the translucency of the filler
For some, improved resin systems

Advantages of Bulk Fill *Restorative* materials

- Time saving, no need for complex layering technique
- Easier handling/one step placement, due to 5mm depth of cure
- Fewer increments, fewer voids
- Simpler shade selection, due to fewer shades

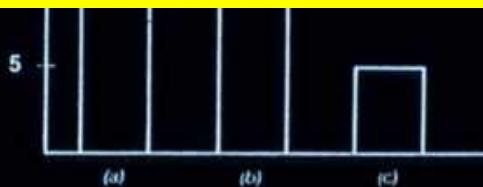
...but.. because of the translucent filler, there may be aesthetic compromises if the cavity floor is stained

Some bulk fill worries!



Bulk fill might lead to high stress!

It is therefore important that the material that we use has demonstrable low shrinkage stress



shrinkage **STRESS** is the problem

Stress is a function of materials
factors such as:
Polymerisation shrinkage
Modulus of elasticity

Cusp deflection in Dublin

Available online at www.elsevier.com/locate/jdent
ScienceDirect
Journal homepage: www.elsevier.com/locate/jdent

Bulk fill restoratives: To cap or not to cap – That is the question?

Iwona M. Tomaszewska^a, Jennifer O. Kearns^b, Nicoleta Ilic^a,
Garry J.P. Fleming^{b,*}

^aDepartment of Medical Education, Jagiellonian University Medical College, Krakow, Poland
^bMaterials Science Unit, Dublin Dental University Hospital, School of Dental Science, Trinity College Dublin

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Keywords:
Bulk fill composite
Cuspal deflection measurement
Cuspal microleakage score
Bulk fill flowable base material
Bulk fill resin restoration

ABSTRACT

Objective: To assess the cuspal deflection and cuspal microleakage scores of standardized large mesio-distal-distal (DSD) cusps filled with different restoration protocols: (1) conventional resin restoration, (2) bulk fill flowable base material in 'inlay' form, (3) conventional resin restoration material inlay. **Methods:** Standardized MOD cavities were prepared in step-down second mandibular premolar teeth and randomly allocated to eight groups. Restorations were placed in conjunction with a universal bonding system and resin restoration materials were finished with a quartz-tungsten-boron (QTB) curing unit. Restoration protocol eight (dipping increments of conventional resin restoration, bulk fill flowable base and two occlusal topping BDC increments) (dipping increments in total) on bulk fill resin restoration (one increment) was the dependent variable. A resin thermal deflection measuring gauge measured the buccal and palatal cuspal deflections. Teeth were thermally fatigued, immersed in a 0.2% basic fuchsin dye for 24 h, sectioned and examined for cuspal microleakage score.

Bulk fills without a cap seem to stress cusps less



Are bulk fill composites quicker to place?

Title: 1407 - Clinical-time and Postoperative-sensitivity When Using Bulk-Fill Composites With Universal Adhesives

Authors:

Chane Tardem Pereira (Presenter)
Fluminense Federal University

Elisa Albuquerque, Federal Fluminense University
Sthefanie Barbosa, Fluminense Federal University
Letícia Lopes, Fluminense Federal University
Fernanda Calazans, Fluminense Federal University
Stella Martins, Fluminense Federal University
Luiz Augusto Poubel, Fluminense Federal University
Roberta Barcelos, Fluminense Federal University
Marcos Barcelino, Fluminense Federal University

Abstract:

Objectives: The first objective of this double-blind randomized clinical trial was to compare the different clinical-time using Scotchbond Universal adhesive (3M ESPE), in self-etch or selective enamel-etching strategy, associated with incremental or bulk-fill composite in posterior restorations. The second objective was to compare the postoperative sensitivity, 24h and 48h after the restorations.

Methods: A total of 196 restorations were placed in 43 patients according to the following groups: SETB- Self-etch/bulk fill; SETI- Self-etch/incremental; SEEB- Selective enamel-etching/bulk-fill and; SEEI- Selective enamel-etching/incremental. Filtek Z350XT composite (3M ESPE) was incrementally placed and Filtek Bulk Fill (3M ESPE) was placed using Bulk-fill technique. The adhesive system was used according to manufacturer's instructions. Postoperative-sensitivity was evaluated using two scales (NRS and VAS).

196 restorations
in 43 patients

Filtek Z350 vs
Filtek Bulk Fill, both
placed with SB
Universal

"Less time consuming"

Conclusions: The simultaneous use of the tested Universal adhesive using the self-etching strategy with the tested Bulk-fill composite is less time consuming and does not increase the postoperative risk or intensity when compared with traditional incremental technique.

Keywords

Esthetic
Compositional Resin
Quality
Restoring Properties

Authors

Dr. Tardem Pereira*
ORCID: 0000-0001-7331-0331 (link)

Assoc. Prof. Dr. Jorge*
ORCID: 0000-0001-7331-0331

Assoc. Prof. Dr. Jorge*
ORCID: 0000-0001-7331-0331

Assoc. Prof. Dr. Jorge*
ORCID: 0000-0001-7331-0331

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ORCID: 0000-0001-7331-0331

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ORCID: 0000-0001-7331-0331

European Journal of Prosthodontics and Restorative Dentistry 2019; 36, 150-157

A Practice-Based Clinical Evaluation of a Bulk Fill Restorative Material

ABSTRACT

Objective: To evaluate the handling, by a group of practice-based researchers, of a newly introduced bulk fill resin-based composite restorative material, Filtek Bulk Fill Restorative Composite (3M ESPE). **Methods:** The twelve select of evaluation were self-explanatory letters, a pack of the material with rinsing/etching by color, 6 weeks, and a questionnaire. Results: The evaluation was the same of the bulk fill restorative material as the previously used restorative composite material. The procedure of the study for evaluation may have compromised the results for a realistic quality. No post-operative sensitivity was reported. Conclusion: The bulk fill restorative material was well accepted by the group of researchers who evaluated the material and considered it to be a high quality. Clinical relevance: A new bulk fill restorative material without a curing time waiting with a similar of the restorative procedure used with composite. Although there were some concerns regarding the time of curing of the material.

INTRODUCTION

PRACTICE-BASED RESEARCH

The value of practice-based research has been previously discussed¹ with the focus of evidence-based practice having been considered the ideal environment in which to carry out evaluations of the handling of dental materials and their clinical effectiveness. In this regard, a wide variety of research projects may be considered to be appropriate to general dental practice, including assessment of materials, devices and techniques, clinical trials of materials, assessment of treatment trends and patient satisfaction with treatment.

A UK-based group of practice-based researchers in the FRCR² (FRCR is the

Filtek™ Bulk Fill
Posterior Restorative

The PREP Panel evaluation

12 dentists, use FBFR (shade A3)
for 8 weeks
Respond to questionnaire

183 restorations placed:
23 Class I, 37% Class II, 27% MOD,
plus cusp replacements, restorations
in primary teeth and cores



© 2014 3M. All Rights Reserved.

Filtek™ Bulk Fill
Posterior Restorative

The PREP Panel evaluation

FBFR assessment Ease of use



None of the evaluators had difficulty with FBFR sticking
to instruments



© 2014 3M. All Rights Reserved.

An amalgam substitute should:

Be self adhesive

Have 5mm depth of cure

Have low shrinkage stress

Have good physical properties
and good wear resistance

Be quick & easy to place

Be non toxic

In addition, today, adequate aesthetics for back teeth

The future of composite

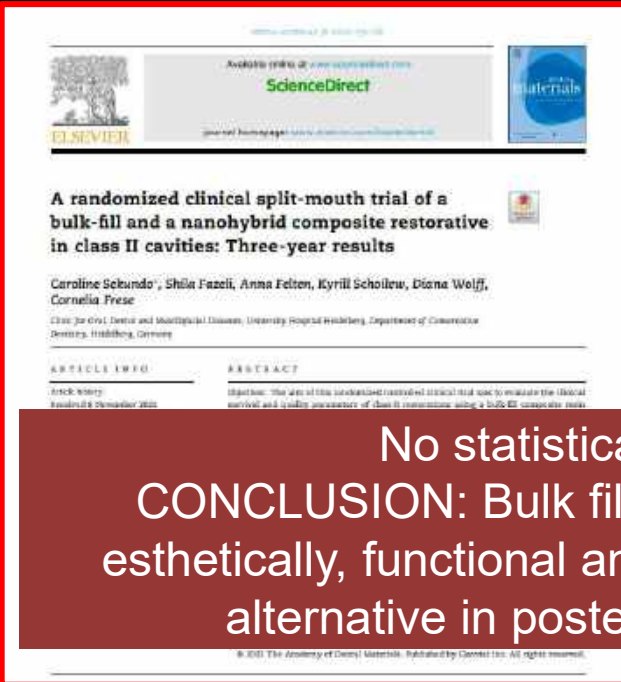
Might bulk fills be the answer?
Latest research:



120 Class II restorations,
split mouth:
60 Filtek Bulk Fill,
60 control (Fil Supreme)
52 restorations in each
group at 3 years

4 BF failures due to tooth
fracture, chipping (n=2),
caries (n=1)

AFR Bulk Fill 2.4%
Conv comp 1.8%



120 Class II restorations,
split mouth:
60 Filtek Bulk Fill,
60 control (Fil Supreme)
52 restorations in each
group at 3 years

4 BF failures due to tooth
fracture, chipping (n=2),
caries (n=1)

No statistical difference:
CONCLUSION: Bulk fill composite provided an
esthetically, functional and biologically satisfactory
alternative in posterior teeth at 3 years

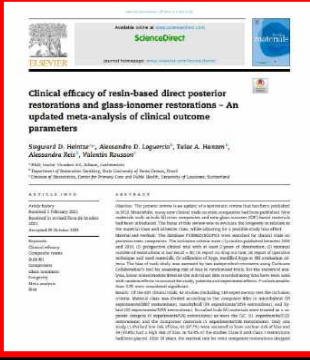
The final word from a massive piece of work



428 clinical trials
assessed, 62 included

Categorised into composites, bulk fill composites and GIC

Clinical implications drawn from the meta-analysis (published 2022)



Here, Bulk fill RBCs identified as a group. Results similar to other composites in terms of marginal caries.

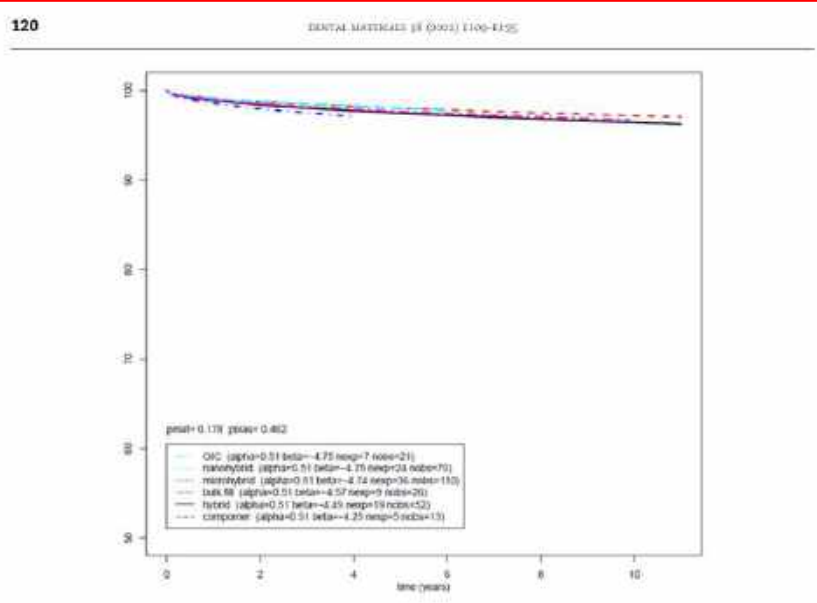


Fig. 6 - Estimated median survival curves of restorations that were not lost due to caries at the restorative margins in relation to the restorative material and observation time - adjusted for study bias, number of restorations and duration.



Bulk fill performance similar to other composites, better than compomer or RMGIC

1. Material: There was no difference of restorations made of nanohybrid, microhybrid, or hybrid composites with regard to colour stability, surface texture, fracture incidence and overall longevity. However, longevity of compomers and GICs was significantly inferior compared to resin composites, mainly due to higher frequency of fractures and excessive wear.
2. Adhesive system: To achieve best results the dentist should prefer an adhesive system which includes enamel conditioning with 34-37% phosphoric acid (etch&rinse adhesives or self-etch adhesives with the selective enamel etching technique). This reduces the occurrence of marginal discoloration, which in turn may reduce the temptation to prematurely replace restorations due to the confusion between stained margin and caries at the margin.
3. Operative procedure: Beveling of the enamel or the application of rubber dam does not lead to better and long-lasting restorations. The additional beveling of the enamel did not result in reduced marginal discoloration. Absolute isolation with a rubber dam did not have an influence on color stability, surface texture, fracture incidence, as well as on the overall longevity of restorations.

RMGIC	3	+	+	-	-	+
++ = very good, += good, +/- acceptable, - = bad, -- = very bad						

The future of composite

SUMMARY

Recent research on bulk fill composites is positive

Trevor's view in 2021



Bulk fill restorative materials
will be our amalgam alternative
in the short to medium term

Is bulk fill composite better or worse than amalgam?



BULK FILL COMPOSITE

Is bulk fill composite an ideal material?

- No toxicity issues to patients: To dentists?? To the environment? ✓
- Physical properties good ✓
- Relatively easy placement X
- Comparatively cost effective (quick to use) ✓ X
- Low thermal conductivity ✓
- Needs an intermediate bonding agent X
- No retentive cavity features needed ✓
- Research “evidence” on longevity building ✓
- Aesthetics reasonable ✓
- Waste not highly regulated ✓

8+/3-



What I plan to talk about

- ❖ Amalgam, briefly
- ❖ Bulk fill resin composites – a true alternative?
- ❖ Latest on self-adhesive bulk-fill composite materials
- ❖ Current status of Glass Ionomers and Glass Hybrids for restoration of posterior teeth – a true alternative?
- ❖ Final thoughts



The first self-adhesive resin luting material, 2002



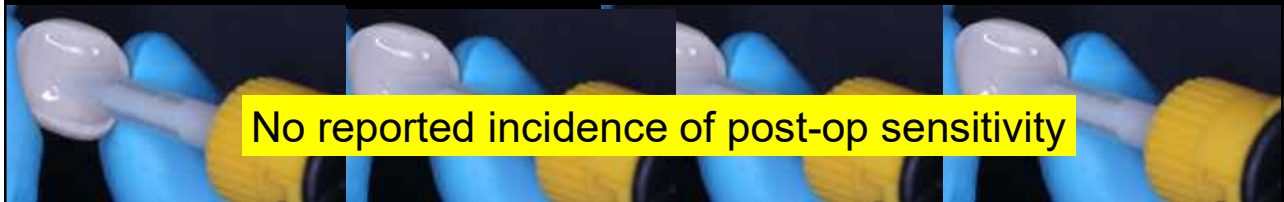
Acidic monomers, FAS glass filler,
new initiator systems

Evaluation of Unicem 2 by the PREP Panel, 2015

Flow of Unicem 2: Was flow satisfactory?



Ease of use of Unicem 2

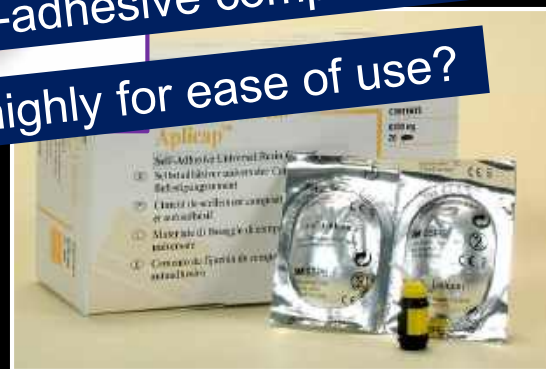


The logical next step?

Their development into self-adhesive composites?

Which might also score highly for ease of use?

Materials which scored highly for ease of use



Recently introduced (self adhesive) composites for posterior teeth

What's in Surefil 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	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

This appears to be a hybrid ionomer/resin material

Scientific Manual

Surefil one™
Self-Adhesive Composite Hybrid



Do you want to read more?

Large volume of scientific data, some independent testing, some Dentsply in-house testing

However, this material was withdrawn from the market a year ago

3M Self-adhesive bulk fill (SABF)

Component

Neutral methacrylate monomers for network formation

Acidic methacrylate monomer for support of adhesive properties

Initiator system

Filler system

SABF

Crosslinking dimethacrylate, triethylene glycol dimethacrylate (TEGDMA)

Phosphoric acid functionalized methacrylate

Camphorquinone, oxidizing and reducing agents

74% (w/w) strontium-fluoro-alumino-silicate filler, zirconia-silica filler

“SABF is a tooth-coloured, dual-curing, self-adhesive, resin-based bulk-fill restorative material, consisting of a powder and a liquid part in a capsule. The powder = acid-reactive glass fillers; the liquid = acidic polymerizable components which promote self-adhesion. It does not need retentive cavity preparation. 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/s00785-021-00019-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 Cieplik¹ · Konstantin J. Scholz¹ · Julian C. Anthony¹ · Isabelle Tabenski¹ · Sarah Ettenberger¹ · Karl-Anton Hiller¹ · Wolfgang Buchalla¹ · Marianne Federlin¹

Received: 9 December 2020 / Accepted: 11 May 2021 / Published online: 15 June 2021
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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

Randomised controlled trial, split mouth design, 30 patients each received one SABF and one Filtek One 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

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

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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 4 yrs



Scholz KJ, Cieplik F, Ettenberger S, Hiller K-A, Buchalla W, Federlin M. Prospective randomized split-mouth study investigating class-II-Restorations with novel self-adhesive-bulk-fill and conventional bulk-fill composites: 4-year results. Abstract No 25: ORCA (Organisation for Caries Research) and European Federation for Conservative Dentistry Joint Meeting, July 2023.

25. Prospective randomised split-mouth study investigating class-II restorations with novel self-adhesive-bulk-fill and conventional bulk-fill composites: 4-year results

Scholz, Kerstin-Johanne* (Hiller, Karl-Josef (Ettenberger, Sarah (Cieplik, Fabian (Buchalla, Wolfgang (Federlin, Marianne (Department of Conservative Dentistry and Periodontology, University Hospital Regensburg, Regensburg, Germany (Department of Conservative Dentistry and Periodontology, University Hospital Regensburg, Regensburg, Germany (Department of Conservative Dentistry and Periodontology, University Hospital Regensburg, Regensburg, Germany (Department of Conservative Dentistry and Periodontology, University Hospital Regensburg, Regensburg, Germany (Department of Conservative Dentistry and Periodontology, University Hospital Regensburg, Regensburg, Germany (Department of Conservative Dentistry and Periodontology, University Hospital Regensburg, Regensburg, Germany

Aim: Clinical performance evaluation of a novel, tooth-coloured, self-adhesive bulk-fill material (SABF; 3M) in comparison with a conventional bulk-fill composite (F0BF; 3M; F0BF) for class-II restorations. The null-hypothesis was that both materials perform equally in terms of survival and FDI-criteria. **METHODS:** In this prospective, randomised split-mouth study, 30 patients received one SABF and one F0BF posterior restoration. Before F0BF-application, a universal adhesive (Scotchbond Universal, 3M) was applied [self-etch-mode]. SABF was applied without adhesive. The restorations were evaluated by two calibrated, blinded examiners using FDI-criteria at baseline (BL) and 48 months. Nonparametric statistical analyses (Mann-Whitney U-test, $p < 0.05$), error rates method, and survival-analysis were performed. **RESULTS:** Twenty-six from initially 30 patients were available with at least one restoration under risk at 48-months. Survival was 96% for SABF (one restoration: secondary caries) and 92% for F0BF (one restoration: secondary caries, one restoration: fracture). All other restorations showed clinically acceptable (1-excellent, 2-good, 3-satisfactory) FDI-ratings for all criteria and time points. Error rates method revealed significantly better aesthetic properties for F0BF compared to SABF, but no significant differences in functional and biological properties. F0BF performed significantly better regarding surface lustre (AL, $p < 0.001$), surface staining (A2s, $p < 0.01$), and colour match/translucency (A3, $p < 0.001$). Over time, surface lustre (A1, $p < 0.01$), surface staining (A2s, $p < 0.05$), marginal discoloration (A2s, $p < 0.001$), and marginal adaptation (M0, $p < 0.001$) deteriorated significantly for both materials. **CONCLUSION:** The null-hypothesis could not be rejected. Both materials performed similarly regarding survival-rate and FDI-criteria within 48 months of clinical use. SABF exhibited significantly less favourable but clinically acceptable aesthetic properties compared with F0BF. After 4 years, the new self-adhesive bulk-fill restorative material showed clinically satisfactory results and can be recommended for clinical use.

The study was supported by 3M Oral Care.

New **3M** self adhesive composite holds promise at 4 yrs

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But, still not commercially available

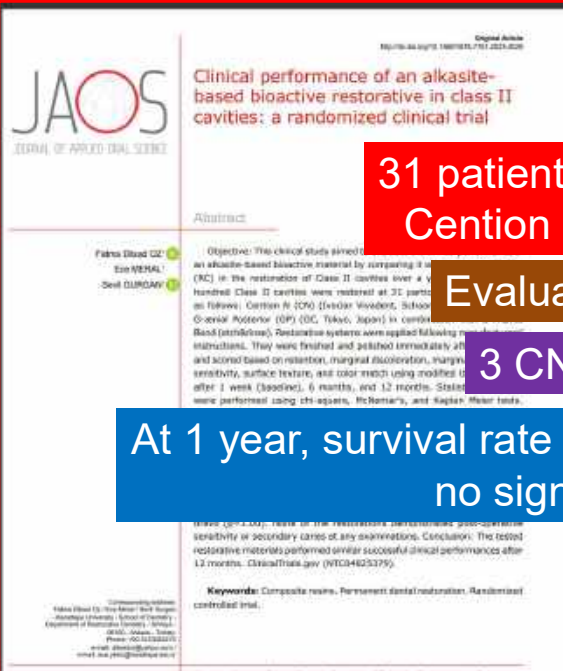


Product profile

- Amalgam alternative
- *No primer* or curing light, therefore quick, and bulk fill possible
- *Non-adhesive (undercut) cavity*
- Indicated Class I & II
- F, Ca, OH release
- 4 instead of 11 steps
- More aesthetic than GI or amalgam



Manufacturers have now changed instructions to state that an adhesive can be used for non-retentive cavities



BUT...most recently

31 patients, 100 class II restorations, 50 in Cention N (CN), 50 in GC G-aenial (RC)

Evaluated at one year by 2 researchers

3 CN restorations lost retention, 1 RC

At 1 year, survival rate of CN was 92.5%, 97.7% for RC, no significant difference

Cention-N at 2 years

Two-year clinical performance of an alkasite direct restorative material in Class I and II cavities without using an adhesive resin: A prospective single-arm clinical trial

FUNDA ÖZTÜRK-BOZKURT, DDS, PhD, TUĞBA TOZ-AKALIN, DDS, PhD, ALEV ÖZSOY-KANER, DDS, PhD, MAHMET KUŞDEMİR, DDS, PhD & MUTLU ÖZCAN, DDS, DMD, PhD

ABSTRACT: Purpose: To evaluate the clinical performance of an alkasite material for Class I and Class II cavities. **Methods:** 50 subjects (30 females, 20 males; mean age: 28.7) referred to the Department of Restorative Dentistry, Istanbul Medipol University, Dental School, Istanbul, Turkey, received 89 Class I and II restorations (Cention N) by 1 operator. All restorations were made in bulk application without an adhesive resin and without photo-polymerization. **Results:** 65 restorations were followed in 37 subjects at a 2-year recall. The mean observation period was 27.6 months. 24 restorations (13 subjects) were not followed up at 2-year recall and were considered as drop out. The restorations were made either due to primary caries (n= 73) or restoration replacement (n= 16). 89 restorations were placed in 51 in the maxilla and 38 in the mandible. In deep cavities, a cavity liner was applied (with n= 53; with Hypersensitivity was observed in nine cases that disappeared at the latest after 1 month. No debonding, no fracture, no endodontic complications were observed at 6-month and 1-year recalls whereas four partial retention losses and one pulpal complication occurred at the 2-year recall. The overall survival rate was 88.9% with a mean observation time of 27.6 months (Kaplan-Meier, Log Rank; Mantel-Cox) (95%CI=31.07-32.25). (*Am J Dent* 2024;37:317-324).

CLINICAL SIGNIFICANCE: This study provided promising evidence for application of alkasite material applied in bulk without retentive features, etching or an adhesive system.

✉: Prof. Dr. Funda Öztürk-Bozkurt, Department of Restorative Dentistry, School of Dentistry, Istanbul Medipol University, Unkapanı, Atatürk Bulvarı 34083, Fatih, Istanbul, Turkey. E-mail: fbozkurt@medipol.edu.tr



Cention-N at 2 years

50 patients received 89 Class I/II restorations

65 assessed at 2 years (13 patients dropped out)

Bulk fill, no adhesive and no light curing

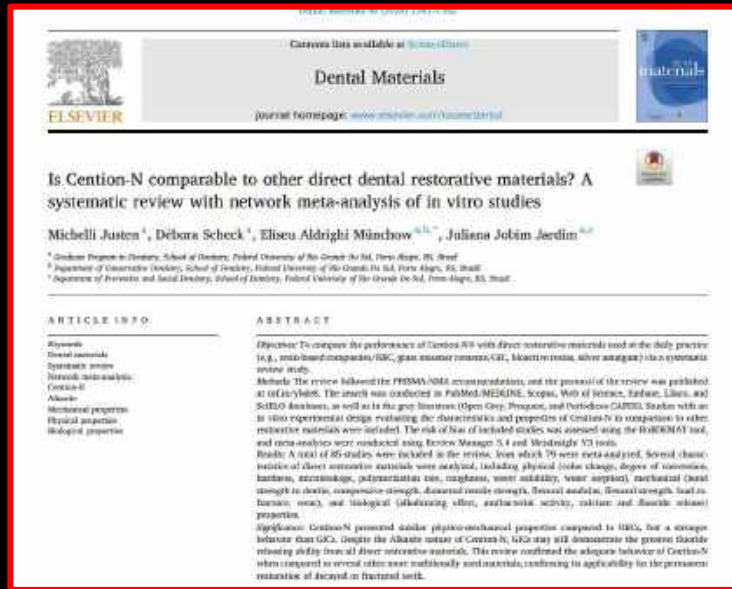
RESULTS: Hypersensitivity in 9 restorations, gone within one month

4 restorations lost retention, one needed endo:
Survival rate = 89% at 27.6 months

Cention-N at 2 years

In summary, the study provided evidence on the clinical performance of an auto-polymerized alkasite restorative material used in the absence of etching and adhesive resin application. After 2 years in function, except for esthetic deviations, functional and biological parameters remained unchanged compared to baseline indicating that ion release properties of the tested material may serve as an alternative for restoring posterior dentition.

Cention-N systematic review



75 studies included

Compared *in vitro* properties of Cention-N with other materials

However, not a direct comparison.



Cention-N systematic review



5. Conclusion

Cention-N demonstrated comparable properties to conventional resin composites, and an overall greater performance than glass ionomer cements. Despite the increased solubility of Cention-N, this material showed a tendency towards a greater ion releasing ability, which was similar compared to the ionomeric materials. This review confirmed the adequate behavior of Cention-N when compared to several other more traditionally used materials, confirming its applicability for the permanent restoration of decayed or fractured teeth.

However, in the absence of clinical data, is the conclusion justified?

Trevor's view

At least one major manufacturer has produced a self-adhesive resin-containing restorative which appears to hold promise. This is the nearest we can get to a true amalgam replacement.

Hot off the press!

SDI Stela

Introduced to the dental market, August 2024

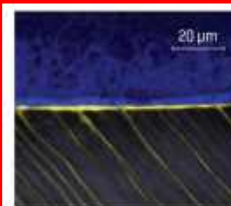
Choice of automix or capsule



Apply MDP primer: After 5 secs, dry (3 secs), place Stela in single increment. It is self-curing & flowable. Universal shade, A2/A3.



Manufacturer's data:



HIGH BOND STRENGTH

PRIMARY BOND: Stela Primer chemically bonds to Stela composite

SECONDARY BOND: tags of Stela Primer into the dentinal tubules form micromechanical retentions

CONCLUSION:

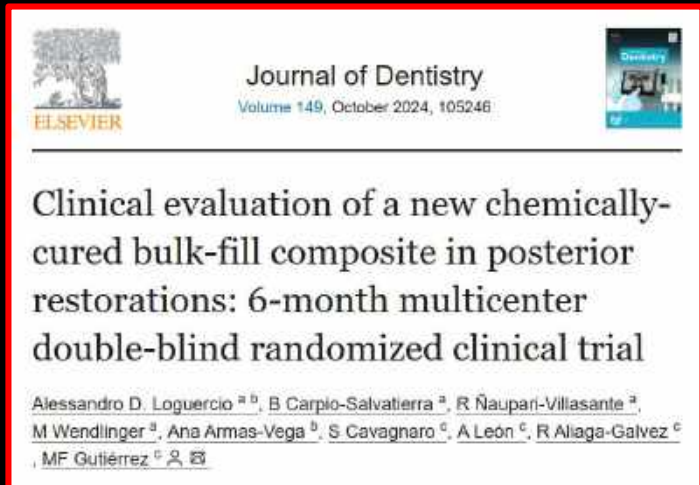
Looks promising, clinical trial results needed.

Six months of Stela

55 participants with three Class I or II cavities

50% restorations in Stela, 50% controls in Filtek One

Restorations assessed for post-op sensitivity and used updated FDI criteria



Six months of Stela



Conclusion

Chemically-cured composites exhibit lower postoperative sensitivity and less color mismatch compared to a light-cured bulk-fill composite after 6 months of clinical service.

Disclaimer:
**There may be other self-
adhesive composites out
there!**



What I plan to talk about

- Amalgam, briefly
- Bulk fill resin composites – a true alternative?
- Latest on self-adhesive composite materials
- Current status of Glass Ionomers and Glass Hybrids for restoration of posterior teeth – a true alternative?
- Final thoughts



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

Bond strength improved by treating dentine with 20% Polyacrylic Acid (PAA)



Other brands are available

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
- Adhesion to enamel and dentine
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Characteristics of Original GICs

- Release of fluoride
- Chemical 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 GLCs

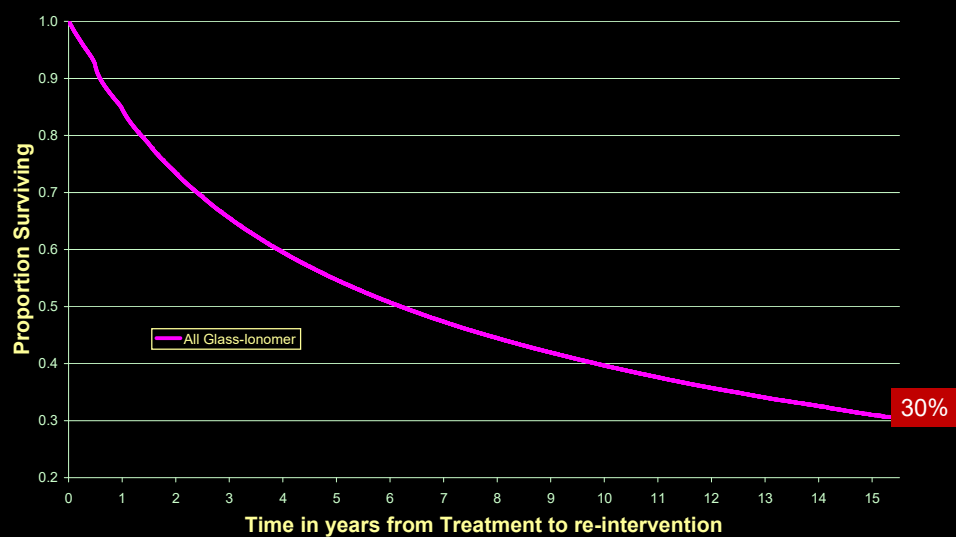
- Release of fluoride
- Adhesion to enamel and dentine
- Reasonable biocompatibility
- Low thermal diffusivity
- Early types needed initial protection from moisture
- Can be placed in bulk*
- Mechanical strength (good in compression: ?? in flexion)
- Erosion/abrasion/wear resistance (suboptimal)



Direct placement
restorations:
some examples:

Glass Ionomer in class
III and V

Glass-Ionomer Restoration Survival Overall



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

Examples of Resin Modified Glass Ionomer (RMGI) filling materials



However, minimal data on their use in loadbearing situations in posterior teeth

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



F.J. Trevor Burke

Dental Materials- What Goes Where? The Current Status of Glass Ionomer as a Material for Loadbearing Restorations in Posterior Teeth

Abstract: Glass ionomer materials have been available for 40 years, but have not been indicated for loadbearing restorations, other than when used in the ART concept. However, there is anecdotal evidence that dentists are using the reinforced versions of this material in posterior teeth, possibly as a result of demands from patients to provide them with tooth-coloured restorations in posterior teeth at a lower cost than resin composite. This paper reviews the existing literature on reinforced glass ionomer restorations in posterior teeth, concluding that, under certain circumstances (which are not fully elucidated) these materials may provide reasonable service. However, the patient receiving such restorations and the potential need for the

8 papers on GI in posterior teeth included

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

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 GIC restorations in posterior teeth, especially in the longer term.

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

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 Klinka¹, Anas Dabab², Anita Turak³, Roland Frankenberg³, Reinhard Nickel³ and Rainer Bittl⁴

Abstract

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

Methods: The clinical performance of Equia F[®] and Fuji X GP[®] fast was evaluated on permanent posterior teeth of 147 adult patients aged between 20 to 60 years old in randomly selected clinics across Germany. Clinical cavities in posterior permanent teeth were restored with Equia F[®] with a nanofilled, light-cured resin coating (Fuji LC) and Fuji X GP[®] fast with an LC coating (n = 486). Direct clinical assessment as well as photographic assessment and assessment of some tests of the restorations were made at 1 year, 2 years, 3 years, and 4 years.

Results: In 4 years, a total of 1931 fillings from both materials were placed by 111 dentists in 66 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 X GP[®] fast with an LC coating within all models. In both materials, filling sealant 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 ratio jumped to approximately 4.1 and 3.86 times for Class I, two surface, and class II mesial-cuspal-distal three surface class II fillings to both materials.

Conclusion: Both materials showed similar good overall performance in class I cavities; however, when including numbers from both class I and 4 fillings, the Equia system with a nanofilled resin coating showed better overall performance with lower failure rate at the follow-up intervals. Nevertheless, the percentage of unsatisfactory post-filling according to the FDO criteria was relatively high in non-surface class I fillings and higher in three-surface class II fillings to both materials.

Trial registration: Deutsches Register Klinischer Studien (German Clinical Trials Register) DRKS00009223. [www.germanclinicaltrials.de] Registration date: 4 Sept 2012.

Keywords: Proctor-based network, Dental restorations, Permanent Glass ionomer, Multi-center study

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

S. Gurgan¹, ZB Kutuk², E. Ergin³,
SS Oztas⁴, FY Cakir⁵

Clinical Relevance

The clinical effectiveness of Equia and Gradia Direct Posterior were acceptable in Class I and Class II 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 micro-filled hybrid posterior composite in a four-year randomized clinical trial.

Methods: A total of 140 (60 Class I and 80 Class II 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 F[®], 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 post-restoration. An overall



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

Sentil Gurgan, Zeynep Bide Kutuk¹, Elita Yalcin Cakir, Erta Ergin

Restorative University, Faculty of Dentistry, Department of Restorative Dentistry, 06100, Ankara, Turkey

ARTICLE INFO

Keywords:
Clinical longevity
Three material
Posterior teeth
Randomized controlled

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 patients (female age 24 years) received 140 (60 Class I and 80 Class II) glass ionomer (GI) or microfilled resin (MF) restorations. Evaluation was performed with digital-matrix (DM) criterion at baseline, and yearly during the 10 years. Data were analyzed with SPSS (SPSS Inc., Cary, NC, USA). GI and MF restorations were compared for Class I and Class II cavities. The overall clinical performance of restorations was 88.9%. The success rate of Class I and II restorations was 94.4% and 88.8% for both materials. The restorative material cost (PPI) of GI and MF restorations was 1.1% and 1.4% for GI and MF restorations, respectively. A significant difference was observed between the marginal distribution scores of restorations at 10 years (p = 0.002). The significant difference was also between the restorative materials in terms of marginal color index (p = 0.002). A significant change was seen in color index of GI restorations at 10 years (p = 0.002). The significant change was found for the marginal form, marginal color, postoperative sensitivity, surface wear, and retention for both restorative materials (p < 0.0001).

Conclusion: Both 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

Restorative changes have taken place in the use of restorative dentistry over the last 20 years. The concept has mostly been concerned with esthetically pleasing tooth-like restorations and the use of adhesive restorative materials, which have the potential to provide permanent restorations on demineralized dentin [1]. Eventually, restorative dentistry has been influenced by esthetic, functional, and biocompatible materials designed for treatment of various dental issues have been introduced into clinical use [2–5].

During the recent years, a number of posterior teeth have been restored with glass ionomer cements (GICs). In addition to their aesthetic appearance, GICs are also recommended due to the minimal risk of rejection of amalgam in sensitive restorations. A number of studies have shown that GICs are better than amalgam in the long-term survival of restorations [6–10].

Procedures (ISMP) [11]. The World Dental Federation (WDF) and the World Health Organization (WHO) have called for attention to this subject [12]. The long-term clinical and micro-morphologically evaluated performance of GI restorations in posterior teeth revealed the advantages and disadvantages of these non-metallic restorative materials [13–15].

Glass ionomer cements (GICs) have been considered as permanent restorations in response to the restoration of posterior teeth in daily dental practice [16]. Since their introduction by East and Wilson in 1970s [17], many modifications of these materials have been made to improve

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

LS Turkan¹, Ö. Korkut

Clinical Relevance

Despite minor reparative defects, the overall clinical performance of EquiaF[®] was found to be excellent even in large posterior class II restorations after a period of six years compared to Resin.

SUMMARY

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

Methods: Fifty-five patients having class I and II restorations were included in the study. A total of 286 restorations were made

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 (inter-observer) and one evaluator (intra-observer) evaluated the restorations. The results were analyzed with SPSS (SPSS Inc., Cary, NC, USA).

Overall, the clinical performance of EquiaF[®] was found to be excellent even in large posterior class II restorations after a period of six years compared to Resin. The results were analyzed with SPSS (SPSS Inc., Cary, NC, USA).

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

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 Klein¹, Arno Daboul^{1*}, Anita Turk², Roland Frankenberg³, Renshaw Hinkel⁴ and Rainer Bittl⁵

Abstract

Background: This study was carried out as a prospective performance of Equia Fil® with a nanofilled resin coating according to the World Dental Federation (FDI) test.

Methods: The clinical performance of Equia Fil® and Fuji IX GP® fast with an LC coating (Vitremer®) in posterior permanent teeth were compared with the FDI test. In total, 1001 fillings were placed in 643 patients aged between 20 to 80 years old.

Results: In 4 years, a total of 1001 fillings from both random slope models showed that the Equia Fil® (material needs replacement) in comparison to Fuji IX GP® fast with an LC coating (Vitremer®) was the most important material. When measuring the odds of obtaining a survival to approximately 41 and 296 times for the surface respectively in comparison to class I fillings.

Conclusion: Both materials showed similar good numbers from both class I and II fillings, the Equia Fil® performed with lower failures in all the follow-up poor fillings according to the FDI criteria was seen surface class II fillings for both materials.

Trial registration: Deutsches Register Klinischer Studien (ClinicalTrials.gov), Registration date: 4 Sept 2013.

Keywords: Practice based research, Dental restorative

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.

A closer look!

Practice-based research
Large numbers (1001) fillings,
placed by 111 dentists in 643
patients

Trevor's view:



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

More recently developed GICs

Why are they called glass hybrids when they really are glass ionomers?

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

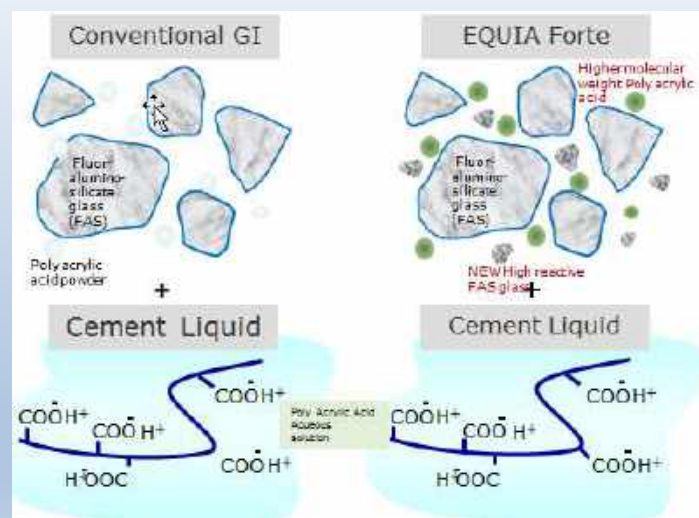
Higher molecular weight PAA, more chemically stable, improves physical properties of the matrix, + better handling

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

Differences from Fuji IX

New ultrafine highly reactive glass particles added

Higher molecular weight polyacrylic acid

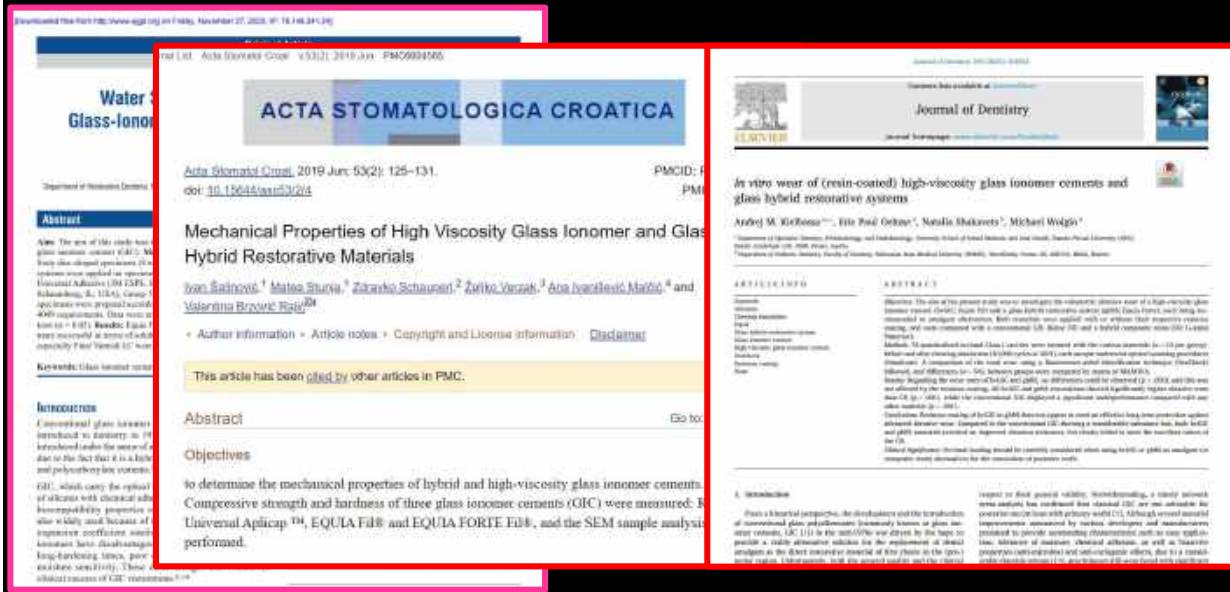
20% improved flexural strength, 21% improvement in acid resistance, 40% wear resistance

Improved fluoride release

Is there independent work to confirm these data?

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GC data
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Recent laboratory research on EQUIA Forte (GC)



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



What does this show?

Well designed clinical studies on EQUIA Forte are now starting to appear.
 (I have not included ART studies, or studies on primary teeth)

Clinical Performance of a Glass-Hybrid System Compared with a Resin Composite in the Posterior Region: Results of a 2-year Multicenter Study

Ivana Miletić, Anja Baraba, Matteo Basso, Maria Giulia Pulcini, Dejan Marković, Tamara Perić, Cigdem Atalay Ozkaya, Lezize Sebnem Turkus

PMID: 32435764 DOI: 10.3290/jad.a44547

Positive short term findings!

Abstract

Purpose: To compare the clinical performance of a glass-hybrid restorative system, EQUIA Forte, with that of a nanohybrid resin composite, Tetric EvoCeram, in two-surface class II cavities.

Materials and methods: This multicenter, randomized controlled clinical study was conducted at four different dental schools. In total, 360 restorations were placed in patients in need of two class-II, two-surface restorations in the molar region of the same jaw. Each patient received one glass hybrid restoration (EQUIA Forte, GC) and one resin composite restoration (Tetric EvoCeram, Ivoclar Vivadent). Two independent evaluators performed a clinical evaluation of each site after 1 week (baseline), 1 year, and 2 years using the criteria of the FDI World Dental Federation (FDI-2).

Results: The estimated survival rates at the 2-year recall were 93.6% and 94.5% for EQUIA Forte and Tetric EvoCeram, respectively. There were no significant differences in the survival rates or in any of the evaluated esthetic, functional or biological properties between EQUIA Forte and Tetric EvoCeram restorations ($p > 0.05$).

Conclusion: Both the glass-hybrid restorative system and nanohybrid resin composite showed good clinical performance in moderate to large two-surface class II restorations in a 2-year follow-up.

Split-mouth, randomized, prospective, multicentre clinical study.

180 patients (mean age 34.6 years) who needed two Class II two-surface restorations in the molar region

Restorations examined by two independent examiners. Survival rates at the 2-year recall were 93.6% (EQUIA Forte) and 94.5% (Tetric EvoCeram), no significant differences between the two materials.

CONCLUSION: "both the glass hybrid and resin composite system showed good performance in moderate to large two-surface class II restorations in a 2-year follow up".

Evidence from previous work re-used for cost effectiveness



360 restorations (2 per patient)

Randomised controlled split mouth trial, 4 dental schools
Equia Forte v Tetric Evo Ceram

Placed by 2 operators of 3 years' experience in each dental school

Two examiners per school

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



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 ($p = 0.67/\log\text{-rank}$). 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.

Oper Dent. 2020 May/Jun;45(3):243-254. doi: 10.2341/18-282-C. Epub 2019 Oct 29.

Clinical Performance of a Glass Hybrid Restorative in Extended Size Class II Cavities

S Gurgan, Z B Kutuk, C Ozturk, R Spilwieser, F Y Cakir

PMID: 31661352 DOI: 10.2341/18-282-C

Abstract

Objective: To evaluate the clinical performance of a glass hybrid restorative compared with a resin composite in the restoration of large and deep Class II cavities after 24 months.

Methods and materials: A total of 108 extended size, with the width of the proximal box not interfering with the peak of the cusps and the proximal box in occlusion, 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 the six-, 12-, 18-, and 24-month recalls according to the modified US Public Health Service criteria. Negative replicas at each recall were observed under scanning electron microscopy (SEM) to examine surface characteristics. Data were analyzed statistically.

Results: After 24 months, 90 restorations were evaluated in 32 patients (recall rate: 86.5%). Four glass hybrid restorations were missing; three were due to bulk and one was due to proximal fracture at 12 months. Only six restorations were scored as bravo at baseline and at the six-, 12-, 18-, and 24-month recalls for color ($p < 0.05$). No significant differences were observed between the two restorative materials for the other criteria evaluated ($p > 0.05$). SEM observations exhibited acceptable surface and marginal adaptation characteristics for both restorative materials at 24 months.

Conclusions: Although glass hybrid restorations showed significant mismatch in color, both restorative materials exhibited successful performance for the restoration of large Class II cavities after 24 months.

Two-year evaluation of 108 extended-size class II restorations (width of the proximal box not interfering with the peak of the cusps and the proximal box in occlusion) in 37 patients.

Half of the restorations were restored with EQUIA Forte, the others with composite.

Two independent examiners

Clinical Performance of a Glass Hybrid Restorative in Extended Size Class II Cavities

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- At 2 years, 90 restorations in 32 patients examined (recall 86.5%). Four glass hybrid restorations were “missing”, three due to bulk fractures and one due to proximal fracture, but no significant differences were noted between the two materials.
- CONCLUSION “although the glass hybrid materials showed a significant mismatch in colour, both materials exhibited successful performance for the restoration of large class II cavities at 24 months”.

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Despite this conclusion, four of the restorations, of 90, had fractured. WARNING! large interproximal box widths employed in this study may be best avoided and the manufacturer's indications for use should be followed. The other message might be – use a resin composite for such wide boxes.

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Five-year randomized clinical trial to evaluate the clinical performance of high-viscosity glass ionomer restorative systems in small class II restorations

Ramy Ahmed Wafale BDS, MDS, PhD¹ | Ashraf Ibrahim Ali BDS, MDS, PhD² |
Salwa Abd El-Raof El-Negoly BDS, MDS, PhD³ | Salah Hasab Maheroud BDS, MDS, PhD³

¹Oral and Maxillofacial Department, Faculty of Dentistry, Mansoura University, Mansoura, Egypt
²Oral and Maxillofacial Department, Faculty of Dentistry, Mansoura University, Mansoura, Egypt
³Oral and Maxillofacial Department, Faculty of Dentistry, Mansoura University, Mansoura, Egypt

Correspondence:
Ramy Ahmed Wafale, Faculty of Dentistry, Mansoura University, Mansoura, Egypt.
Email: ramy.wafale@mansoura.edu.eg

Abstract

Objective: Evaluate and compare the 5-year clinical performance of three high-viscosity glass ionomer restorative materials in small class II restorations.

Materials and Methods: Forty patients, each with four class II restorations, were enrolled in this trial. A total of 160 restorations were placed, 25% for each material, as follows: three high-viscosity conventional glass ionomer restorative systems (Ketac Universal Adhesive, EQUIA Forte and Riva Self Cure HV) and a microhybrid resin composite system (Filtek Z250). Clinical evaluation was performed at baseline and after 5, 3, and 5 years by two independent examiners using FDI criteria. Space resin regions were observed under scanning electron microscope (SEM) to examine surface characteristics. Data were analyzed with Kruskal-Wallis, Mann-Whitney U, Friedman, and Wilcoxon signed-rank tests ($p < 0.05$).

Results: The success rates were 100% for resin composite, 97.4% for Ketac Universal, and 94.1% for both EQUIA Forte and Riva HV restorations. Statistically significant differences were observed between all groups in terms of surface lustre and color-match criteria ($p < 0.05$). Statistically significant changes were found over time for all criteria except the fracture of material, postoperative hypersensitivity, recurrence of caries, tooth integrity, periodontal response, adjacent tissues, and oral health criteria ($p < 0.05$). SEM evaluations were in accordance with the clinical findings.

Conclusions: Although drawbacks in surface lustre and color match appeared over the 5-year evaluation period, the three high-viscosity glass ionomer restorative materials provided successful clinical performance in small to medium sized class II cavities compared to microhybrid resin composite.

Clinical Significance: Glass ionomer restorations exhibited clinical performance similar to that of microhybrid resin composite restorations in small class II cavities subjected to 5-year evaluation.

KEYWORDS

class II restorations, clinical performance, direct fill glass ionomer, resin composite

- Well-constructed, independent randomised trial in Egypt.
- Three high-viscosity glass ionomer materials in small class II cavities after five years. Ketac Universal Applicap (3M), EQUIA Forte (GC) and Riva self-cure (SDI), vs a hybrid resin composite system, Filtek Z250 (3M), as control.
- Patients were between 20 and 40 years of age, with each needing *four or more* restorations.
- 160 restorations in 40 patients. Isthmus width of the cavities was not more than 1/3 of the intercusp distance
- Isolation by cotton rolls & high-volume saliva ejector. Restorations examined by two independent examiners, epoxy resin replicas of the restorations observed.

Five-year randomized clinical trial to evaluate the clinical performance of high-viscosity glass ionomer restorative systems in small class II restorations

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Conclusions: Although drawbacks in surface lustre and color match appeared over the 5-year evaluation period, the three high-viscosity glass ionomer restorative materials provided successful clinical performance in small to medium sized class II cavities compared to microhybrid resin composite.

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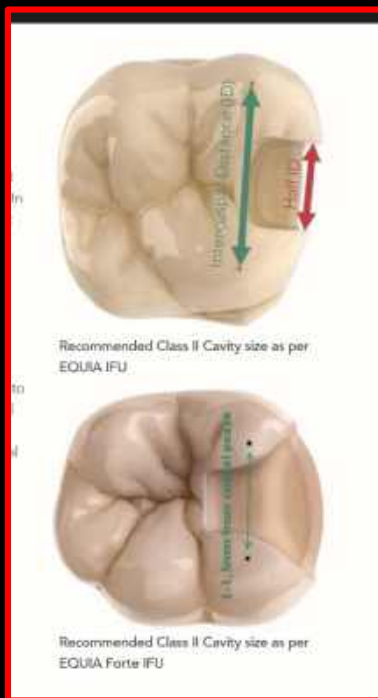
KEYWORDS

class II restorations, clinical performance, direct fill glass ionomer, resin composite

- 39 patients examined at five years
- 100% success for the resin composite restorations,
- 5 failed class II glass ionomer restorations (one Ketac Universal (2.6% failure), two EQUIA Forte (5.1%), and two Riva HV (5.1%).
- AFR of 0.5% for Ketac Universal and 1% for both EQUIA Forte and Riva HV groups.
- Reason for failure - fracture of class II glass ionomer restorations, while one Riva HV restoration failed because of "partial looseness *in situ*".
- CONCLUSION:** Although differences in surface lustre and colour match at 5 years, the three high-viscosity glass ionomer materials provided successful clinical performance in small to medium class II cavities.

Manufacturer's (GC) suggestion

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



Easy solutions even in difficult situations

CASE 1: EQUIA, Class V, Dr. José Zubizarreta, private practitioner, Spain



CASE 2: EQUIA Forte, Class II, Professor Irena Mikic, Zagreb University, Croatia



CASE 3: EQUIA, Class I, Professor Matteo Rocca, Milan University, Italy



Do you want
to read more?

Introducing the
restorative innovation of
glass hybrid technology

A COMPREHENSIVE GUIDE TO EQUIA FORTE

EQUIA
FORTE

GC

Hot off the press!

Two very recent studies which include EQUIA Forte



128 restorations in 30 patients, mean age 21 years

EQUIA Forte, GCP Carbomer, Zircomer [reinforced GIC], Tetric Bulk Fill, placed with manufacturer's instructions

At 4 years, 97 restorations evaluated



....but... relatively small numbers (23-25) per group!

B=Glass Carbomer (GC) failure, others satisfactory

Conclusions: GC restorations showed statistically lower anatomical form values, indicating lower wear resistance than the other materials. However, no significant difference was observed in the retention rates (as primary outcome) as well as the other secondary outcomes of the four different restorative materials after 48 months. **Clinical Significance:** GI-based restorative materials and BF composite resin restorations in Class I cavities yielded satisfactory clinical performance after 48 months.



High viscosity GIC vs Composite

159 studies read, 16 included

HV GICs = Fuji IX, EQUIA Fil, EQUIA Forte



the subject. The authors acknowledge the difficulties in conducting clinical trials. However, HV-GIC seems to be a versatile material with promising clinical performance. Therefore, it is important to highlight that not only new well-designed clinical trials are required, but it is desirable that ongoing trials further publish results for longer follow-ups.

5. Conclusion

Within the limitations of the present work, it can be concluded that both HV-GIC associated with a resin-based coating and composite resin displayed comparable results in class I and II posterior restorations in permanent teeth followed for up to 3 years. The only weakness observed for the HV-GIC was regarded to its wear, which was poorer than composite resin for class I restorations after 2 years in service.

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.

Trevor's view:

The study by Wafaie *et al* also indicated good results at 5 years for Ketac Universal (3M), which doesn't need a coating or a cavity conditioner.

Restoration Dentistry

Interview CPD 6012

Dr. Trevor Bates

Lectur, Materials and Resto Dent

Fifty Years of Glass Ionomers. Are the Latest GICs Suitable for Restoring Back Teeth?

Abstract Glass ionomer cements (GICs) have been available for use by clinicians for almost 50 years. Their beneficial properties, such as adhesion to tooth substrate, have long been recognised, but early versions suffered from brittleness, lack of translucency, poor wear resistance and a difficulty to seal fluids. Hence, over the years, new versions have been developed with a view to overcoming these drawbacks. It is widely acknowledged that GICs are usually a suitable loadbearing material in posterior teeth. They could hold advantages because of their lower placement than resin composite materials and possibly be more cost-effective. It is therefore the purpose of this article to review recent research into the performance of the latest versions of the glass ionomer cements (GICs) and the so-called glass hybrid cements, but to leave development from the composite material side to CPD Clinical Database. Such cements, materials, which, unlike resin composite restorations do not need a separate bonding agent, may hold promise as a long-term alternative to resin composite placement.

Keywords: GICs, GICs, GICs, GICs

In the last 50 years, the history of glass ionomer cements (GICs) has been a story of continuous development. Over the 50 years of their existence, and it is nearly half a century since the first GICs were introduced, a great deal of research has been carried out to improve their properties. This article reviews the history of GICs, from their first introduction to the current state of the art, and discusses the challenges that remain for the future.

Early history of glass ionomer materials

Glass ionomer cements were first described by Bowen in 1958, with the

first publication being in 1957 by Bowen and Frost.¹ They were originally considered to be a development of silicate cements, which contained a basic silicate filler (PbO, glass, mixed with a silicate filler) and a silicate cement (PbO, glass, mixed with a silicate filler). The mixed material suffered from many deficiencies, especially solubility in water, and so the first glass ionomer cements (GICs) were developed as a separate material, and were based on a silicate cement (PbO, glass, mixed with a silicate filler) and a silicate cement (PbO, glass, mixed with a silicate filler).

One of the main reasons for the development of GICs was the need for a material that could be used in the treatment of children. The first GICs were based on a silicate cement (PbO, glass, mixed with a silicate filler) and a silicate cement (PbO, glass, mixed with a silicate filler). The mixed material suffered from many deficiencies, especially solubility in water, and so the first glass ionomer cements (GICs) were developed as a separate material, and were based on a silicate cement (PbO, glass, mixed with a silicate filler) and a silicate cement (PbO, glass, mixed with a silicate filler).

Dr Trevor Bates (Dent, Mat, Resto, Endo, Paed, Ortho, Prost, Radiol, Surg, JAGD, UK), Lectur, Materials and Resto Dent, School of Dentistry, University of Birmingham, UK. Dr Bates is also a Lectur, Materials and Resto Dent, School of Dentistry, University of Birmingham, UK. Dr Bates is also a Lectur, Materials and Resto Dent, School of Dentistry, University of Birmingham, UK. Dr Bates is also a Lectur, Materials and Resto Dent, School of Dentistry, University of Birmingham, UK.

Conclusion

Amalgam and resin composite restorations, placed in loadbearing situations in posterior teeth, have stood the test of time and may be considered to have extensive research to back up their clinical effectiveness. The present review has indicated that contemporary GICs and their variants, such

as glass hybrids, feature in an increasing number of publications, which suggests that their clinical effectiveness in Class I and small-to-medium sized loadbearing Class II cavities holds promise. Accordingly, we conclude that composites, glass hybrids and GICs all have their merits and, when faced with a patient, restoration and clinical scenario, the clinician has to weigh up the options and decide what material to use.

J Dent 2010

May 2011

Are the new glass hybrids better or worse than amalgam?



GLASS HYBRID

Are glass hybrids an ideal material?

- No toxicity issues to patients: To dentists?? To the environment? ✓
- Physical properties good ✓ ✗
- Relatively easy placement ✓
- Comparatively cost effective (reduced surgery time) ✓
- High thermal conductivity ✓
- Do not need an intermediate bonding agent ✓
- Does not require retentive cavity features ✓
- Plenty of research “evidence” on longevity ✓ ✗
- Aesthetics reasonable ✓
- Waste not highly regulated ✓

10+/-



What I plan to talk about

- Amalgam, briefly
- Bulk fill resin composites – a true alternative?
- Latest on self-adhesive composite materials
- Current status of Glass Ionomers and Glass Hybrids for restoration of posterior teeth – a true alternative?
- Final thoughts



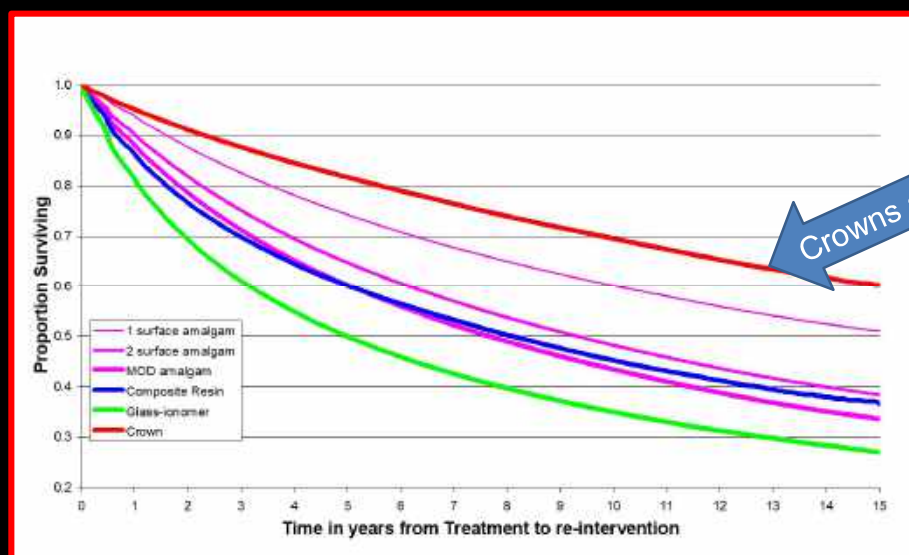
Why direct-placement restorations are important!

Molar teeth: 6,311,720 restorations

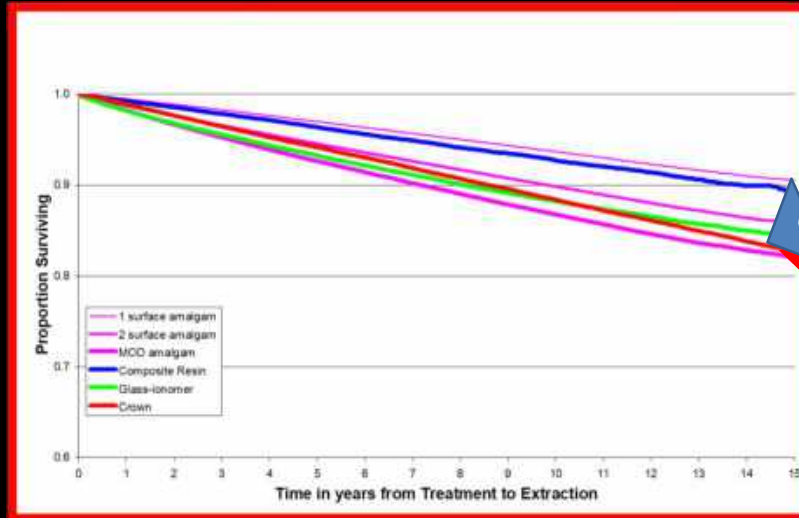


The effect of crowns

Molar teeth: restoration survival to next intervention

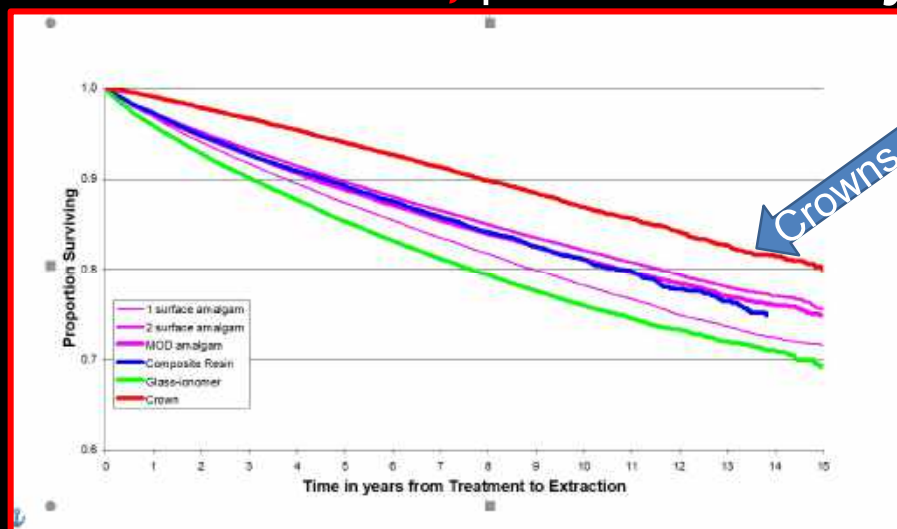


Crowns in molar teeth: **survival of the restored tooth to extraction**, patients **under 40 years**



Crowns are worst!

Crowns in molar teeth: **survival of the restored tooth to extraction**, patients **over 60 years**



Crowns are best!



Thoughts on survival of restorations & teeth

Therefore, *direct placement* restorations should be employed where possible

Trevor's view in 2021 – has it changed?



Bulk fill restorative materials will be our amalgam alternative in the short to medium term

Trevor's view:

Bulk fill resin composite bonded with a Universal adhesive remains the gold standard “amalgam replacement”. However, new glass hybrid materials hold promise and are quick & simple to use.

Some final thoughts

Concise Review

Alternative Direct Restorative Materials for Dental Amalgam: A Concise Review Based on an FDI Policy Statement

Gottfried Schmalz^{a,b}, Falk Schwendicke^c, Reinhard Hinkel^d, Jeffrey A. Platt^{e*}^a Department of Conservative Dentistry and Periodontology, University Hospital Regensburg, Regensburg, Germany^b Department of Periodontology, University of Bern, Bern, Switzerland^c Department of Conservative Dentistry and Periodontology, University Hospital LMU Munich, Germany^d Department of Biomedical Sciences and Comprehensive Care, Division of Dental Biomaterials, Indiana University School of Dentistry, Indianapolis, Indiana

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ABSTRACT

Dental restorative procedures remain a cornerstone of dental practice, and for many decades, dental amalgam was the most frequently employed material. However, its use is declining, mainly driven by its poor aesthetics and by the development of tooth-coloured adhesive materials. Furthermore, the Minamata Convention agreed on a phase-down on the use of dental amalgam. This concise review is based on a FDI Policy Statement which provides guidance on the selection of direct restorative materials as alternatives to amalgam. The Policy Statement was informed by current literature, identified mainly from PubMed and the internet. Ultimately, dental, oral, and patient factors should be considered when choosing the best material for each individual case. Dental factors include the dentition, tooth type, and cavity class and extension; oral aspects comprise caries risk profile and related risk factors; and patient-related aspects include systemic risks/medical conditions such as allergies towards certain materials as well as compliance. Special protective measures (e.g. a no-touch technique, blue light protection) are required when handling resin-based materials, and copious water spray is recommended when adjusting or removing restorative materials. Cost and reimbursement policies may need to be considered when amalgam alternatives are used, and the material recommendation requires the informed consent of the patient. There is no single material which can replace amalgam in all applications; different materials are needed for different situations. The policy statement recommends using a patient-centred rather than purely a material-centred approach. Further research is needed to improve overall material properties, the clinical performance, the impact on the environment, and cost-effectiveness of all alternative materials.

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Reviewed resin-based materials, GICs (inc.glass hybrids), resin/GIC materials, Reviewed tooth type, size & location of restoration, pulp reaction, caries risk, allergies, endocrine disruptors, special risk groups, environment, reimbursement systems

Conclusions

It has become apparent that, currently, there is no single material which can replace amalgam in all applications. Therefore, a range of materials are needed, with different materials being indicated for different situations. In their Policy Statement, FDI recommends:

- Using a patient-centred approach instead of a purely material-centred approach when selecting a restorative material, taking individual and material factors into consideration, including:
 - o Location and size of the planned restoration, as these impact the required physical and biological properties of the material;
 - o Caries risk of the individual as ion-/fluoride-releasing materials may be preferred in high-risk individuals;
 - o Systemic risk and medical conditions including allergies as alternative materials (specifically resin-containing ones) may induce allergic reactions;

- o Protection of the provider by use of a no-touch technique when handling resin-based materials, as well as relevant physical, chemical, and biological personal protective measures including protection against blue light emitted from curing devices;
- o Use of copious water spray when adjusting or removing restorative materials for sufficient cooling and to mitigate the presence of nanoparticles;
- o Cost and reimbursement policies for placing different materials in different countries;
- o Patients' expectations and demands as the material of choice should be the result of shared decision-making;
- o Informed consent for using a specific material should be sought.
- Further research is needed to improve overall material properties and, eventually, their clinical performance and cost-effectiveness.
- Oral health professionals are encouraged to remain up-to-date as research continues.

