Life after Minamata
Disclosures

“I am not paid by any company to promote their products”

“Some manufacturers fund research that I carry out”
“I am not anti-amalgam (really!)”

“I am in favour of minimally invasive dentistry”

I am also one of the heavy metal brigade, so am interested in longevity of amalgam restorations!
Take home message

Nothing lasts forever:
Size matters – big fillings last less well than small
Take home message

Keeping cavities as small as possible is therefore important.

It is not possible to do that with amalgam!
AMALGAM

Environmental concerns........YES
Toxicity issues..................NO

Slide made in 1996
Diplomatic Conference for the Minamata Convention on Mercury

Chemical company started in 1908 (Chisso Co.)
In 1932 they started making acetaldehyde, used with other chemicals to make plastics, Hg used as catalyst
Organic Hg dumped into the ocean
Locals ate the fish and shellfish
Cats started going crazy: humans had difficulty walking, talking, eating, had convulsions and died
Resultant mercury poisoning affected 60,000 people, first reported in 1956
One of the world’s worst environmental disasters
Diplomatic Conference for the Minamata Convention on Mercury

- Ministry of Trade & Industry blocked researchers from getting access to company waste
- Eventually made the company install a cyclator (sedimentation system)
- 1959, agreement with patients of Minamata disease to give sympathy money in return for promising not to sue
- 1968, the Government officially announced the cause
- 1973, Chisso Co. lost a lawsuit, largest settlement in Japan at that time
Diplomatic Conference for the Minamata Convention on Mercury

Annex A, Part II; Measures to be taken to phase down the use of dental amalgam

- Set national objectives for caries prevention
- Set national objectives aimed at minimising amalgam use
- Promote use of cost-effective and clinically effective mercury-free alternatives
- Promote R&D into quality mercury-free materials
Diplomatic Conference for the Minamata Convention on Mercury

Annex A, Part II; Measures to be taken to phase down the use of dental amalgam

- Encourage professional organisations and dental schools to train dental professionals and students in the use of mercury-free alternatives
- Discourage insurance programmes that favour dental amalgam use, and encourage insurance programmes that favour use of alternatives
- Restrict use of amalgam to capsulated form
- Promote best environmental practices in dental facilities to reduce releases of mercury
The Minamata Convention
Final agreement, 10th & 11th October 2013, 147 countries signed up

Treaty is “expected to come into force in 2 to 3 years”

“Worldwide reduction and ultimate ban on mercury containing products”
Minamata four years on

Readers will be aware that the Minamata Convention on Mercury is a global treaty signed by the UK and over one hundred countries from all over the world in October 2013, with the intention of protecting human health and the environment from the adverse effects of mercury, for example, by limiting the use of mercury from all sources, including LED light bulbs, fluorescent tubes, thermometers and, of course, dental amalgams. The agreement indicated that the mercury limitation would commence within four years, and Annex A Part II dealt specifically with dentistry. Four years on, it might be considered useful to reflect how far along that road we have gone, given that we agreed to ‘promote use of cost-effective and clinically effective mercury-free alternatives’.

At the time of writing, the Convention has been signed by 128 countries and ratified by 71, with Jamaica being the most recent country to ‘deposit the instrument of ratification’. The arrangements sealed within the Convention were that it would enter into force on 15 August 2017 in the ratifying countries, that being 90 days after the fiftieth ratification was received.1 Regulation (EU) 2017/852 of the European Parliament was agreed on 17 May this year, the implication of this being that, from 1 July 2018, dental amalgam ‘shall not be used for dental treatment of deciduous teeth, of children under the age of 15 years and for pregnant or nursing women, except when deemed strictly necessary by the dental practitioner, based on the specific medical needs of the patient’. I cannot think of anything falling into that category, with the exception of allergy to a constituent of an alternative...
Norway did it!
How?
1991, Directorate to reduce amalgam use
2003, National clinical guidelines - encouragement to reduce amalgam use. Amalgam no longer the material of choice for posterior teeth, informed consent needed from the patient if amalgam used
2007, Restrictions on mercury vapour emissions from crematoria
2008, Partial ban on amalgam use
2011, Complete ban, although dentists can apply for exemptions

Amalgam has had a turbulent history.
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


If it’s OK in children........
Take home message:
There is no evidence of mercury toxicity for patients.
Evidence of mercury toxicity for dentists
What was I about to say?

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


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 and alcohol intake. They also completed the 12-item General Health Questionnaire. Dentists were asked to complete a dental chart of their own mouths and to give samples of urine, hair and nails for mercury analysis. The dentists were visited at their surgeries where environmental measurements were made in eight areas of the surgery and they undertook a computerised package of psychomotor tests. One hundred and eighty control subjects underwent a similar procedure, completing a questionnaire, having their amalgam surfaces counted, giving urine, hair and nail samples and undergoing the psychomotor test procedure.

Conclusion On the basis of these findings, it is recommended that greater emphasis should be made relating to safe handling of amalgam in the training and continuing professional development of dentists, that further studies are carried out on levels of mercury exposure of dental team members during the course of their working day, and that periodic health surveillance, including urinary mercury monitoring, of dental personnel should be conducted to identify possible effects of practising dentistry.
- 122 surgeries had mercury levels higher than the Occupational Exposure Standard
- In 45 surgeries the personal dosimeter measurement was above the OES
- Dentists were 4 times more likely to have kidney disease
- Urinary mercury levels of dentists were 4 times greater than controls
- Dentists’ reported short-term memory worse than controls
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

CONCLUSION: From the responses received, it would appear that there are few restrictions worldwide to the placement of dental amalgam

AND, Composite use is increasing worldwide
Why amalgam?

- Cheap, easy to use
- Technique tolerant
- Familiarity
- Relatively good service life

...and, it is said to tolerate a breadth of clinical situations!!!
Amalgam: disadvantages

- Not adhesive
- Aesthetically poor
- Mechanical retention required
Do amalgam substitutes exist?

Indirect Cast alloys Ceramics Resin-based materials

All of these are more than X4 as expensive as amalgam
Do amalgam substitutes exist?

Direct – small cavities
- Resin composite
- Glass ionomer

Does GI require more development for this indication?
Reinforced Glass ionomer materials

- Smaller particle size leads to faster reaction
- Higher loading brings improved physical properties
- Exhibits plastic features – can be condensed and packed
- Still a need for improved wear resistance

Typical glass ionomer features
Conclusions

In clinical situations where there are no adverse situations at work (such as high occlusal loading or an acidogenic plaque), certain restorations in reinforced GI materials (such as Fuji IX) may provide reasonable longevity. However, the conditions for longevity are not readily identified.

Two of the studies (Scholtanus and Huysmans, 2007: Basso, 2013) demonstrate higher than desirable failure rates for GI restorations in posterior teeth, especially in the longer term.
Until more high quality evidence becomes available, for practitioners using reinforced GI materials in loadbearing situations in posterior teeth, it is prudent to advise patients of the relative paucity of good quality evidence for the success of the restorations that they are placing.
Do amalgam substitutes exist?

Are reinforced glass ionomers an alternative?

Not really, at present, because their wear resistance isn’t good enough and they are soluble in dilute organic acids.
Gls in posterior teeth – a medicolegal perspective

👉 Tell the patient that it is a glass ionomer that the evidence base is variable and limited

👉 Definitive restoration or long term provisional?

👉 The restorations may need re-surfacing with composite

👉 Alternatives are more expensive

👉 May not do harm

Semi-definitive dentistry?
Do amalgam substitutes exist?

Direct

- Compacted gold
- Gallium alloys
- Resin-based composite

The current status of posterior composite restorations
Filler particle size is associated with polishability.

Filler loading is associated with physical properties.

Bonding of filler to resin, and filler characteristics, are associated with wear resistance.
Amalgam restorations occupied 25% of the occlusal surface.
Composite restorations occupied 5% of the occlusal surface.

Welbury et al., Br. Dent. J. 1990:165:361
CONCLUSION: It is concluded that the saucer-shaped resin composite restoration represents a viable treatment modality for small cavities. The time may have come to include it in dental curricula as a routine operative treatment for small class II lesions.
Dentists undertook a course on posterior composite placement.

Exclusion criteria were deep subgingival margins and inability to isolate.

Cavity outline determined by caries lesion.

Isolation with cotton rolls and suction.

Etch & rinse bonding agent, 2mm oblique increments of composite.
8 year evidence from dental practice

- 2881 children, mean age 13.7 years
- 4335 restorations placed by 115 dentists
- 49% of cavities were class I
- 3507 in molars
- Spectrum APH used for 88%, bonding agent Prime & Bond used for 94%
8 year evidence from dental practice

Overall failure rate: 2% failure per annum
22 year retrospective evaluation of posterior composites

- Retrospective, practice-based design
- 80 adult patients selected (from 980) – continuous attenders for 22 years, invited to attend for examination: 19 declined
- The remaining patients had 362 restorations
- Full dentition and normal occlusion
- Examined by 2 examiners (not the dentist who placed the restorations!) using USPHS

22 year retrospective evaluation of posterior composites

Overall failure was *circa* 2% per annum
34 papers, each with evaluation periods of >5 years.

RESULTS:
Poorer survival rates in molar teeth than in premolars
Multiple surface fillings more likely to fail than class I

CONCLUSION: “Composite restorations have been found to perform favourably in posterior teeth, with annual failure rates of 1-3%.”
Laske M et al. Longevity of Class II restorations placed in Dutch general dental practices. IADR Boston, Abstract 1937

Electronic patient files from 24 dental practices

358,548 restorations in 75,556 patients, 67 gdfs

AFR varied between 2.3% and 7.9%, mean 4.6% @10 years

Restorations in molars had higher AFR

AFR of composites was 4.4%, amalgam 5.1%, and GI 11.1%
Are success rates for posterior composite as good as for amalgam?

YES – and we aren’t even comparing composite in its best situation
8 steps to ensure better light curing
(after Price R., 2010)

1. Wear orange safety classes so that you can see what you are doing

2. Re-position the patient so that you can see the restoration and access it with the light

3. Position yourself so that you can stabilise the light directly over the preparation

4. Stabilise the light so that the beam is perpendicular to the surface of the resin
8 steps to ensure better light curing
(after Price R., 2010)

5. Begin curing no closer than 1mm from the resin, then move as close as possible after 1 sec

6. Adjust the light guide so that you can operate the light comfortably

7. Ensure that the tip is free of damage and debris

8. Air cool or wait between curing cycles, depending on the heat proximity to sensitive tissues. (Test the temperature from the light on the back of your hand)
Stress is a function of materials factors such as:
Polymerisation shrinkage
Modulus of elasticity/filler load
Degree of conversion

shrinkage STRESS is the problem
REDUCING POLYMERISATION
CONTRACTION STRESS

Five ways:
1. Increase the filler loading
2. Reduce resin shrinkage
3. Reduce % resin conversion
4. Bulk fill low stress material
5. Use a high molecular wt. resin
Class I & II restorations in a low shrinkage stress

Work by the Practice-based research group, The PREP Panel
Methods

Ethical approval obtained

Five UK dental practitioners

Each practice recruited sufficient patients to provide a minimum of 20 class I or II restorations per centre.

Restorations assessed using modified USPHS criteria by an independent examiner along with the practitioner who placed the restorations
3M ESPE Filtek Silorane Criteria for restoration evaluation (*=unacceptable)

**Anatomic form**
A: Restoration is continuous with existing anatomic form, not under contoured.
B: Restoration is under contoured but no dentine or base exposed.
C*: Sufficient restorative material is missing so that dentine or base is exposed.

**Margin integrity**
A: No visible evidence of a crevice along the margin into which a probe will catch.
B: Probe catches in a crevice along the margin, no exposure of dentine or base.
C*: Visible evidence of a crevice with exposure of dentine or base along the margin

**Margin discolouration**
A: No discolouration evident at margin.
B: Slight staining at margin
C*: Obvious staining, cannot be polished away.

**Colour match**
A: Restoration matches adjacent tooth structure in colour and translucency
B: Mismatch in colour and translucency but within an acceptable range.
C*: Mismatch in colour and translucency outside acceptable range.

**Surface roughness**
A: Smooth surface with no irritation of adjacent tissues.
B: Dull, matte surface, can be refinished.
C*: Shallow surface pitting is present. Rough, cannot be polished
Results

- 127 restorations placed in 72 patients
- 8 restorations lost to the trial, 70 restorations (recall rate 59%) of mean age 62 months (range 54 – 68 months) in 45 patients (28 female and 17 male) of mean age 53 years examined.
- The 70 restorations composed of 17 Class I and 53 Class II restorations
  - 34% (n= 24) of the restorations involved the replacement of one or more cusps
  - 74% (n=53) were placed under rubber dam
Why no post-op sensitivity?

Reported post-op sensitivity in evaluations of “conventional” posterior composite:

- Burrow and colleagues\(^2\) - 4% of restorations exhibited sensitivity in daily function
- Zero post-operative sensitivity reported by Opdam and co-workers\(^3\), although 19% of the teeth were sensitive to loading.
- Other studies reported 10% to 20% incidence of post-operative sensitivity at one week and one month recalls\(^4,5\)
- Auschill and colleagues reported 6% overall post-operative sensitivity in a study of 600 teeth restored with resin composite with cavity depth being significantly associated with the occurrence of post-operative sensitivity\(^6\).

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Take home message

Indications at 5 years are that a low shrink composite, Filtek Silorane, is a viable alternative for restoration of posterior teeth.

No post-operative sensitivity because of its low shrinkage stress.
Perceived difficulties with Silorane

and, some dentists didn’t realise the benefits of low shrinkage stress!

Needed its own dedicated 2-stage adhesive

Only 2.5mm depth of cure

Large filler particles

Aesthetics suboptimal, other than A2

Difficult manufacturing process
Novel Stress Relieving Monomer System

**AUDMA**
High molecular weight dimethacrylate—acts to lower volumetric shrinkage

**AFM**
Addition-fragmentation (AF) monomer
– Reacts into developing polymer network through terminal methacrylate bonds like other dimethacrylate monomers
– **Central AF group can fragment and release stress**
– Fragment may then polymerize into network in a lower stress orientation compared to its pre-fragmented state.
Filtek Bulk Fill/Filtek One Posterior Restorative: Advantages over Silorane

- One-step placement
- 5 mm depth of cure
- Can use dentine bonding agent of choice
- Therefore, faster than Silorane Bond
- Easier polishing due to nanofiller
- Potentially better aesthetics

**BUT**

- Still excellent stress relief
- Still excellent handling and sculptability
Bulk Fill Flowables provide:

- Potentially faster restorations in back teeth
  Fewer steps than incrementally placed composites

- Potentially easier restorations in back teeth
  Flowable viscosity provides easy adaptation
  Potentially fewer voids
My new 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)
Early materials needed a “capping” because their wear resistance wasn’t good enough!

However, the bulk fill base materials are now history!
BULK FILL IS IN!

The new classification for BULK FILL materials:

BULK FILL RESTORATIVE MATERIALS
(satisfactory wear resistance)
Sonicfill: Potential benefits

- Single step filling of cavities of 5mm depth
- No need for packing instruments
- Low set-up and handling time
- Reduced potential for voids
- Satisfactory aesthetics

...but need to purchase the handpiece

...and you cannot shape fissures with a hand instrument
PREP Panel evaluation of Filtek Bulk Fill/Filtek One

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
PREP Panel evaluation of Filtek Bulk Fill/Filtek One

“Excellent handling & viscosity. Doesn’t slump, good depth of cure and no post-operative sensitivity”

“Initially I didn’t think there was a need for a Bulk Fill material but the longer I used it the better I felt about complete curing. Less shrinkage than Filtek Supreme – I have found an alternative!”

“Great material, looks great. Very convenient to place in 4mm increments – a good time saver. I would definitely buy!”

“Aesthetics good but heavily stained dentine shows through – problem to leave remove more dentine or leave and opaque out”

Conclusions: 75% of evaluators would purchase
92% (n=11) would recommend to colleagues
3M Nanofiller Technology
(Filtek One Bulk Fill Restorative)

Nanofiller technology enables …

- Good polish retention
- Management of opacity and translucency
- No voids
- High strength
- Good wear resistance
Another bulk fill with no capping

Contains a “shrinkage stress reliever”
HOT OFF THE PRESS

Shofu Bulk Fill Beautiful

Aura Bulk Fill (SDI)

VOCO Admira Fusion x-tra
Bulk fill might lead to high stress!

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

In addition, polymerisation shrinkage stress increases in a thicker composite bulk.

.. also, with Bulk Fills you only get one chance at light curing!
Advantages of Bulk Fill Restorative materials

- Time saving, no need for complex layering technique
- Easier handling
- Fewer increments, fewer interface imperfections
- Simpler shade selection, due to fewer shades

BULK FILL IS IN!
How do manufacturers do it?

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

“Retentive undercuts similar to that needed for amalgam is necessary” (Product profile)

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

- Amalgam alternative?
- Quick application
- Bulk fill possible
- Non-adhesive cavity preparation
- Indicated Class I & II
- F, Ca, OH release
- White shade

Slide made in 2000
Research published after 12 months


METHOD:
50 fillings placed in Ariston, 49 in Solitaire 1
Two examiners assessed the restorations at 9-12 months using USPHS criteria

6% failure at one year
“The material failed clinically within the 18 month control period....16% due to marginal caries. Hypersensitivity also a reason for restoration replacement”

Merte J, Schneider H, Merte K.
Schweiz Zahnmed
2004:114:1124-1131
Disadvantages of posterior composite

- More technique sensitive
- More time consuming, more costly
- Need to learn new technique

But, patients like them!
Advantages of posterior composite

- Good aesthetics
- Conservation of tooth substance
- Low thermal conductivity
- Polishable at placement visit
- May be repaired easily
- No potential for galvanism
- Avoids the use of mercury
Posterior composites take 2.5 times longer to place than amalgam

Is bulk fill the answer?
Self Etch + Low shrink + 5mm depth of cure = Amalgam substitute??
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

Adequate aesthetics for back teeth
Trevor’s view

Bulk fill restorative materials will be our amalgam alternative in the short to medium term
Some own label materials performed as well in testing as those from manufacturers in the field.

However, greater batch to batch variation in several mechanical & physical properties of the own-label materials was noted.
Avoiding post-op sensitivity with posterior composites

Use a so-called self etch or Universal Material, AND do not etch the dentine
Use a low shrinkage stress composite
Ensure good adaptation at the gingival margin
Ensure adequate light luring
Use a reliable manufacturer’s material
University of Birmingham
Masters in Advanced General Dental Practice

Has been running for 14 years
Distance version commenced February 2013
University of Birmingham Masters in Advanced General Dental Practice

**Six modules**

- Informed & informing clinician (20 credits)
- Contemporary dental practice (20)
- Medical and surgical management of oral disease (20)
- Oper. Dent.1: Aesthetic dentistry and endodontics (20)
- Oper. Dent.2: Fixed and Removable Prosthodontics (20)
- Running a clinical business (20)

Case study 30 credits, Audit project 30 credits:
When completed, a total of 180 PG credits = MSc
Reasons to adopt minimal intervention

- Patients like it (if you advise them of your philosophy)
- Teeth like it (fewer die!)
- It’s easier for dentists (fewer die: better for their blood pressure!)
- Lawyers hate it (fewer dentists get sued!)
- We now have the materials to make this work

But, others are still adopting an invasive approach (and being sued!)
Thank you for listening
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