Evidence summary: which dental liners under amalgam restorations are more effective in reducing postoperative sensitivity?

KEY TERMS

- **Microleakage:** penetration of oral fluids, bacteria and their toxic products at the interface between dental tissue and restorative material.
- **Postoperative sensitivity:** an outcome measure in a number of studies for which the definition and measurement methods varies, but which includes pain and thermal sensitivity (sensitivity to cold or hot stimulus).

Developed from an original question by Rav Jaks: 'What evidence-based research is present which details the most effective lining to be used under amalgam restorations?'

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Since August 2009, members of the Primary Care Dentistry Research Forum (www.dentistryresearch.org) have taken part in an online vote to identify questions in day-to-day practice that they felt most needed to be answered with conclusive research. The question that receives the most votes each month forms the subject of a critical appraisal of the relevant literature. Each month a new round of voting takes place to decide which further questions will be reviewed. Dental practitioners and dental care professionals are encouraged to take part in the voting and submit their own questions to be included in the vote by joining the website.

The paper below details a summary of the findings of the ninth critical appraisal. In order to address the question raised by dentistry research forum, first a search was conducted for systematic reviews on the topic. There was one systematic review retrieved comparing bonded amalgam restorations versus non-bonded amalgam restorations. However, there was no other systematic review identified assessing the effectiveness of dental liners under amalgam restorations in general. Therefore, a search was conducted for any randomised controlled trial (RCT) comparing use of a lining under amalgam restorations versus no lining or RCTs comparing differing lining materials under amalgam against each other. There were eight relevant RCTs identified. Due to the low quality, small sample sizes or lack of adequate reporting of the outcome data, the evidence is inadequate to claim or refute a difference in postoperative sensitivity between different dental liners. Further well-conducted RCTs are needed to answer this question. These RCTs would be preferably included and synthesised in a systematic review.

BACKGROUND

One of the most widely used dental materials is dental amalgam, made up of mercury and alloy particles. A recognised limitation of dental amalgams compared to other dental materials such as composites,is that they cannot bond to the dental tissue. The gap between dental tissue and amalgam restoration risks attracting a buildup of the waste products of the dental amalgam.[1] The microleakage from the tooth and restoration interface has been reported as a potential contributing factor towards some of the problematic symptoms experienced by patients following placement of amalgam restorations, for example postoperative sensitivity.[2,3] Therefore, some dentists recommend using liners between the amalgam and dental tissue. In this review, we intend to evaluate the available evidence for the effectiveness of different dental liners placed under amalgam restorations.

METHODS

First, a search for systematic reviews was conducted in PubMed and the Cochrane Library (Cochrane Database of Systematic Reviews (CDSR) and Database of Reviews of Effects (DARE)). The details of the search strategy for systematic reviews are available in Appendix 1. We did not find any systematic review that was directly relevant to the question of this rapid assessment. There was one review that was partially relevant and examined the question of whether bonded amalgams are better than non-bonded ones in restoring permanent teeth.[1] The authors found one trial with 31 patients (113 restorations) that compared adhesively bonded amalgam restorations (Dycal (LD Caulk) liner; ED primer (Kuraray); Panavia 21TC (Kuraray); Oxyguard II gel (Kuraray); Dispersalloy amalgam (Dentsply)) *versus* non-bonded amalgam restorations (Dycal (LD Caulk) liner.

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A search was then conducted in Medline (OVID) and the Cochrane Central Register of Controlled Trials (CENTRAL) to identify any randomised controlled trial (RCT) comparing use of a lining under amalgam restorations *versus* no lining or RCTs comparing differing lining materials under amalgam against each other. We excluded studies that were done on extracted teeth or done on primary teeth. Details of the search strategy are provided in Appendix 2.

FINDINGS

In the one identified systematic review, bonded amalgam restorations (amalgam restorations with dental adhesive) compared to non-bonded amalgam (amalgam restorations without dental adhesive) showed no significant differences in postoperative sensitivity. The authors concluded that the evidence is inadequate to conclusively judge whether bonded amalgam is better than non-bonded.

The searches for primary studies identified 94 results in Medline and 52 results in PubMed. After screening the title and abstracts, there were 20 potentially relevant studies. We excluded one study by Baratieri *et al.*,[4] one study by Gordan *et al.*[5] and those by Gupta *et al.*,[6] Miller *et al.*[7] and Wright *et al.*[8] as it was not clear whether they were RCTs. We also excluded studies by Fanian *et al.*,[9] Lim and McCabe,[10] Sandoval *et al.*[11] and Qvist *et al.*[12] as they were conducted on extracted teeth. Finally, we also excluded studies by Shaddy *et al.*[13] and Hucke *et al.*[14] as they were conference abstracts and full access to data and study details was not possible. Eight studies were included. Characteristics of these studies are provided in Table 1.

The studies compared a range of liners against each other or against a control group or bonded amalgam. The outcome measurements were very diverse. The studies were categorised based on the comparison group in Table 1. A summary of the results of the included studies are provided below.

Comparing amalgam restorations with liners and bases *versus* amalgam restorations with no liners

There were three studies that had relevant comparison groups.[15–17] It seems that amalgam restoration with copal varnish have less postoperative sensitivity compared to amalgam restorations with no liners. The other comparisons were:

1. Amalgam restoration with calcium hydroxide *versus* amalgam restoration with no liner
2. Amalgam restoration with modified glass ionomer liner *versus* amalgam restoration with no liner
3. Amalgam restoration with fluoridated desensitising agent *versus* no liner.

The other comparisons did not find consistent significant differences. The current data are inadequate to reach a definite conclusion.

Comparing amalgam restorations with different liners and bases against each other

There were six studies with relevant comparison groups.[3,17–19] Data for the following comparisons were available:

- Amalgam with glass ionomer liner *versus* amalgam with copal varnish (three studies)
- Amalgam with copal varnish *versus* amalgam with a fluoridated desensitising agent (two studies)
- Amalgam with glass ionomer and calcium hydroxide (Dycal) *versus* amalgam with zinc phosphate and calcium hydroxide (Dycal) – Dycal was only used if the cavity was deep (one study)
- Amalgam with copal varnish *versus* amalgam restoration with calcium hydroxide (one study)
- Amalgam with glass ionomer *versus* amalgam with calcium hydroxide (one study).

The data were limited or inconclusive and the studies are therefore not adequate to detect consistent significant differences.

Comparing amalgam restorations with liners and bases *versus* bonded amalgam (amalgam with adhesives)

There were five studies that included relevant comparisons.[15–17,20,21] Data for the following comparisons were available:

- Amalgam with copal varnish, glass ionomer and calcium hydroxide (Dycal) – Dycal was only used if the cavity was deep – *versus* bonded amalgam (amalgam with dental adhesive liner) (one study)
- Amalgam with copal varnish, zinc phosphate cement and calcium hydroxide (Dycal) – Dycal was only used if the cavity was deep – *versus* bonded smalgam (amalgam with dental adhesive liner) and calcium hydroxide (Dycal) – Dycal was only used if the cavity was deep (one study)
- Amalgam with copal varnish *versus* bonded amalgam (amalgam with dental adhesive liner) (three studies)
- Amalgam with a fluoridated desensitising agent *versus* bonded amalgam (amalgam with dental adhesive liner) (one study)
- Amalgam with glass ionomer liner *versus* bonded amalgam (amalgam with dental adhesive liner) (two studies)
- Amalgam restoration with calcium hydroxide *versus* bonded amalgam (one study).

The data were limited or inconclusive and the studies were of low quality or were of small sample sizes, making it difficult to detect consistent significant differences. The current evidence can not demonstrate whether one of the dental liners is better than bonded amalgam in reducing postoperative sensitivity.

SUMMARY

In conclusion, the current studies are inadequate to claim or refute a difference in postoperative sensitivity between different dental liners. The reasons are the low quality of studies, small sample sizes, and inadequate reporting of the outcome data. Further well-conducted RCTs are needed to answer this question. These RCTs would be preferably included and synthesised in a systematic review.

1. Fedorowicz Z, Nasser M, Wilson N. Adhesively bonded versus non-bonded amalgam restorations for dental caries. *Cochrane Database Syst Rev* 2009; **(4):** CD007517.
2. Schedle A, Ortengren U, Eidler N, Gabauer M, Hensten A. Do adverse effects of dental materials exist? What are the consequences, and how can they be diagnosed and treated? *Clin Oral Implants Res* 2007; **18(Suppl 3):** 232–256. Erratum in *Clin Oral Implants Res* 2008; **19:** 326–328.
3. Schwartz R S, Conn L J Jr, Haveman C W. Clinical evaluation of two fluoridated desensitizing agents for use under class 5 silver amalgam restorations. *J Prosthet Dent* 1998; **80:** 269–273.
4. Baratieri L N, Machado A, Van Noort R, Ritter A V, Baratieri N M. Effect of pulp protection technique on the clinical performance of amalgam restorations: three-year results. *Oper Dent* 2002; **27:** 319–324.

Table 1 Characteristics of the included studies

Reference number	Year	Study aim and design	Population	Country	Experimental and control groups	Outcome measurement
21	1997	Double blind randomised controlled trial to compare the sensitivity to cold in two groups of patients: one that received dentinal adhesive liner and one that received conventional bases and liners.	60 patients (18-55 yrs old) with moderate class I or class II carious lesion on molars or premolars. Two were lost to follow up in the control group.	USA	Group A: Etching enamel and dentine and then OptiBond prime and Optibon Dual cure. If the lesion is deep (within 1 mm of the pulp on either the axial or pulpal walls) then Dycal would be also used Group B: If within 1 mm of ideal depth pulpally and axially then only copal varnish; if more than 1 mm past ideal depth axially and/or pulpally then copal varnish and flecks cement (zinc phosphate); finally, if within 1 mm of the pulp or either the axial or pulpal walls, Dycal on the area nearest to pulp and then copal varnish and flecks cement.	Cold response measures (injecting water at a constant temperature of 8°C through a stent at a rate of 0.5 cm^2 per second and recorded the moment the patient felt coldness coming from teeth with a stop watch) Pain (visual analogue scale for pain (scale 1-5))
22	1997	Double blind randomised clinical trial to compare sensitivity to cold between two groups of patients one week after placing the restoration	60 patients (18-55 yrs old) with moderate class I or class II carious lesion on molars or premolars. Six were excluded due to errors in collecting baseline data: two from the group that received Copalite and four from the group who received amalgam bond plus	USA	Group A: Etching enamel and dentine and then amalgam bond plus (Parkel) dentinal adhesive and finally amalgam restoration (26 subjects) Group B: Depending on the depth of the restoration, a preparation within 1 mm of ideal preparation received two coats of Copalite (Harry J Bosworth Co.) copal varnish. If it was deeper but not within 1 mm of the pulp on either side, it received three coats of Vitrebond (3M) glass ionomer liner with two thin coats of Copalite if it was deeper, Dycal VLC (Denstply) was put on the area where the blushing of dentine was apparent and then three coats of Vitrebond and two thin coats of Copalite (28 subjects).	Cold response measures (injecting water at a constant temperature of 8°C through a stent at a rate of 0.5 cm^2 per second and recorded the moment the patient felt coldness coming from teeth with a stop watch) Pain (visual analogue scale)
17	1999	Randomised trial to assess the postoperative sensitivity following restoring primary carious lesions class I or II with amalgam restoration and different treatments of dentine	66 primary carious lesions with class I or class II amalgam restoration	USA	Group A (19 patients): no liner group (control) Group B (19 patients): two coats of Copalite under amalgam restoration Group C (19 patients): dentine adhesive resin liner, Scotchbond Multipurpose (SBMP, 3M Dental) Group D (19 patients): resin modified glass ionomer liner, Fuji bond LC (GC)	On days 2, 14, 90 postoperatively: Sensitivity (asking the patient) Duration of sensitivity Degree of pain Causes of initial sensitivity
18	2008	Randomised split-mouth design trial comparing three lining materials and unlined restorations on postoperative cold sensitivity of class I amalgam restorations.	22 adult subjects (15-25 yrs old), each of the subjects had four class I carious lesions on vital molar or premolar teeth that were included in the study.	Iran	Amalgam restorations with: Group A: Copalite, Colley & Colley Ltd, USA Group B: Adper Prompt L-pop, 3M ESPE, USA (Bonded Amalgam) Group C: VivaSens, Ivoclar Vivadent, Lechtenstein (fluoridated desensitising varnish) Group D: unlined	Cold response measure (CRM) (or standardised cold stimulus) at baseline, 24 hours, 1 week, and 1 month. Self-reported questionnaire at 24 hours, 1 week and 1 month recording cold sensitivity and eight common postoperative complaints with four different ratings of pain (these were not adequately reported to be included in this rapid assessment).
19	1998	Randomised split-mouth trial to compare the postoperative sensitivity of teeth restored with adhesive resin-lined amalgam with teeth that are restored with copal varnish-lined amalgams.	20 Patients with paired class I or class II restorations that at least have one unrestored surface in each restoration.	USA	Each set of paired restorations were done by one operator at the same time and with the same technique. The only difference was the cavity liner. After cavity preparations, the two cavities were assigned randomly to the following groups: Group A: Plastodent copal varnish and air-dried in two layers Group B: Scotchbond Multipurpose Plus for bonded amalgam restorations. The restorations were then completed with hand-condensed Tytin spherical alloy employing a pre-carve and post-carve burnishing technique.	Visual analogue scale for pain at baseline, and 1, 3, 7, 14, 30 days postoperatively

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Table 1 Characteristics of the included studies

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3	1998	Randomised trial aiming to compare the postoperative sensitivity after amalgam restoration with Copalite varnish with amalgam restoration in DentinBloc	16 patients with 70 restorations, class V carious lesions and there were at least two carious lesions in each patient.	USA	Group A: Two coats of Copalite varnish (Copalite, HJ Bosworth, Skokie, Ill.) were applied to the preparation and air-dried for 5 seconds (standard dentine treatment) Group B: A single application of a fluoridated desensitising agent DentinBloc solution (DentinBloc, Colgate Oral Pharmaceuticals, Canton, Pa.) was painted into the preparation with the foam applicator for 1 minute The preparations were all filled with precapsulated Tytin amalgam	Cold sensitivity using ice sticks and recording sensitivity after 20 seconds at 24 hours, 1, 2, 4 and 16 weeks after placement
20	1990	Randomised split-mouth trial comparing postoperative sensitivity after using two different base materials for amalgam restorations: an admix, silver-reinforced glass-ionomer cement material with zinc-phosphate cement.	57 patients with a minimum of two carious class I or II lesions located in different quadrants. Two were excluded from the analysis as they had carious exposures.	USA	Group A: Glass ionomer was conditioned (G-C Dentin conditioner, G-C international corp) for 15 seconds. If there were deep aspects in the cavity preparation, calcium hydroxide (L G Caulk, Milford, DE 19,963) was used. Group B: Zinc phosphate cement with cavity varnish (copalite H Bosworth Co, Shokie, IL 60076). If there were deep aspects in the cavity preparation, calcium hydroxide (L G Caulk, Milford, DE 19,963) was used.	The patients were given a card with three Yes/No questions asking whether they have any discomfort in biting, any discomfort to cold stimuli and of any discomfort to hot stimuli
16	2006	Randomised controlled trial which aimed to compare patients with amalgam restorations using a disinfected solution to clear the cavity before the restoration with restorations placed after various cavity treatments and liners and a control group with no liners.	120 Patients (mean age 28, range 16-65) with a primary carious lesion that required a class I or II restoration. Carious lesions limited to the one third outer level of the dentine were excluded. 60 patients had middle third lesions and 60 had inner third lesions (they were equally divided in the six subgroups)	Kuwait	Group A: Amalgam restoration with prior chlorhexidine (Consepsis, Ultradent Products Inc, UT, USA) disinfection (20 patients) Group B: Amalgam restoration with single bond (3M ESPE, St Paul, MN, USA) (10 patients) Group C: Amalgam restoration with Vitrebond (3M ESPE, St Paul, MN, USA) (20 patients) Group D: Amalgam restoration with Copalite varnish (Cooley & Cooley Ltd, Houston, TX, USA) (20 patients) Group E: Amalgam restoration with calcium hydroxide (Life regular set, Karr, Salerno, Italy) (20 patients) Group F: Amalgam restoration without any dental liner. (20 patients)	Postoperative sensitivity to cold on days 2 and 7 (ordinal scale 0, 1, 2, 3). If patient had sensitivity on day 7, they were contacted again at days 30 and 90.

5. Gordan V V, Mjör I A, Moorhead J E. Amalgam restorations: postoperative sensitivity as a function of liner treatment and cavity depth. *Oper Dent* 1999; **24:** 377–383.
6. Gupta M, Pandit I K, Srivastava N, Gugnani N. Comparative evaluation of 2% sodium fluoride iontophoresis and other cavity liners beneath silver amalgam restorations. *J Indian Soc Pedod Prev Dent* 2010; **28:** 68–72.
7. Miller B C, Charbeneau G T. Sensitivity of teeth with and without cement bases under amalgam restorations: a clinical study. *Oper Dent* 1984; **9:** 130–135.
8. Wright W, Mazer R B, Teixeira L C, Leinfelder K F. Clinical microleakage evaluation of a cavity varnish. *Am J Dent* 1992; **5:** 263–265.
9. Fanian F, Hadavi F, Asgar K. Marginal leakage of dental amalgams: effect of cavity varnish and burnishing. *J Can Dent Assoc* 1984; **50:** 484–487.
10. Lim M Y, McCabe J F. Lining materials for amalgam restorations. *Br Dent J* 1982; **152:** 313–315.
11. Sandoval V A, Cooley R L, Barnwell S E. Evaluation of potassium oxalate as a cavity liner. *J Prosthet Dent* 1989; **62:** 283–287.
12. Qvist J, Qvist V, Lambjerg-Hansen H. Bacteria in cavities beneath intermediary base materials. *Scand J Dent Res* 1977; **85:** 313–319.
13. Shaddy R S, Murdoch C M, Tamisiea P E, Cavel W T, Latta M A. Clinical evaluation of liners vs. no liner under silver amalgams. (AADR Abstract Annual Meeting March 7–10 2001). *J Dent Res* 2001; **80(1 Spec Iss)**.
14. Hucke R D, Mjor I A, Martini C, Smith G E. Effect of resin liners on post-operative sensitivity of amalgam restorations. (IADR Abstract 1996). *J Dent Res* 1996; **75(Spec Iss)**.
15. Al-Omari W M, Al-Omari Q D, Omar R. Effect of cavity disinfection on postoperative sensitivity associated with amalgam restorations. *Oper Dent* 2006; **31:** 165–170.
16. Gordan V V, Mjör I A, Hucke R D, Smith G E. Effect of different liner treatments on postoperative sensitivity of amalgam restorations. *Quintessence Int* 1999; **30:** 55–59.
17. Hajizadeh H, Akbari M, Ghavamnasiri M, Abedini S. Clinical evaluation of a resin-based fluoridated desensitizing agent and a self-etching adhesive on the reduction of postoperative sensitivity of amalgam restorations. *J Contemp Dent Pract* 2008; **9:** 9–16.
18. Kennington L B, Davis R D, Murchison D F, Langenderfer W R. Short-term clinical evaluation of post-operative sensitivity with bonded amalgams. *Am J Dent* 1998; **11:** 177–180.
19. Scherer W, Cooper H, Kaim J, Hittleman E, Staffa J. Sensitivity study *in vivo*: glass-ionomer versus zinc-phosphate bases beneath amalgam restorations. *Oper Dent* 1990; **15:** 193–196.
20. Browning W D, Johnson W W, Gregory P N. Postoperative pain following bonded amalgam restorations. *Oper Dent* 1997; **22:** 66–71.
21. Browning W D, Johnson W W, Gregory P N. Reduction of postoperative pain: a double-blind, randomized clinical trial. *J Am Dent Assoc* 1997; **128:** 1661–1667.

Appendix 1 Search strategy for identifying systematic reviews.	
PubMed, date of search 10.02.2011	
#1	"Dental Amalgam"[Mesh]
#2	"Dental cavity lining"[Mesh]
#3	#1 AND #2
#4	amalgam AND (liner* OR lining*)
#5	#4 OR #3
#6	systematic[sb] AND (#5)
The Cochrane library (Cochrane Database of systematic reviews (CDSR) and Database of Reviews of effects (DARE), date of search 10.02.2011	
#1	MeSH descriptor Dental Cavity Lining explode all trees
#2	MeSH descriptor Dental Amalgam explode all trees
#3	(#1 AND #2)
#4	amalgam AND (liner* OR lining*)
#5	(#4 OR #3)

Appendix 2 Search strategy for identifying randomised controlled trials	
Search strategy Medline (OVID) <1948 to January Week 1 2011> Date of search 13 Jan 2011	
The first search:	
1	exp *Dental Cavity Lining/ (844)
2	exp Dental Amalgam/ (7,567)
3	1 and 2 (185)
4	exp Treatment Outcome/ (460,190)
5	Comparative Study/ (1481,132)
6	exp Longitudinal Studies/ (694,308)
7	(effectiv$ or effic$ or success$ or fail$ or comparative$ or evaluat$).ti. (734,544)
8	3 and (4 or 5 or 6 or 7) (102)
9	limit 3 to "review articles" (4)
10	(amalgam and (liner$ or lining$)).ti. and (4 or 5 or 6 or 7) (21)
11	(amalgam and (liner$ or lining$)).ti. (36)
12	limit 11 to "review articles" (0)
13	8 or 9 or 10 or 12 (108)
14	limit 13 to english language (94)
The second search:	
1	exp *Dental Cavity Lining/ (844)
2	exp Dental Amalgam/ (7,568)
3	1 and 2 (185)
4	(amalgam and (liner$ or lining$)).ti. (36)
5	3 or 4 (189)
6	limit 5 to english language (156)
7	limit 6 to (clinical trial, all or controlled clinical trial or randomized controlled trial) (18)
Cochrane Central Register of Controlled Trials (CENTRAL), Date of search: 10.02.2011	
#1	MeSH descriptor Dental Cavity Lining explode all trees
#2	MeSH descriptor Dental Amalgam explode all trees
#3	(#1 AND #2)
#4	amalgam AND (liner* OR lining*)
#5	(#4 OR #3)