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Title:

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Part 4: clinical factor

Date:

2017-09-01

Citation:

Alexander, G., Hopcraft, M. S., Tyas, M. J. & Wong, R. H. K. (2017). Dentists' restorative decision-making and implications for an 'amalgamless' profession. Part 4: clinical factor. Australian Dental Journal, 62 (3), pp.363-371. <https://doi.org/10.1111/adj.12519>.

Persistent Link:

<https://hdl.handle.net/11343/293114>

Dentists' restorative decision-making and implications for an 'amalgamless' profession. Part 4: clinical factors.

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This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the [Version of Record](#). Please cite this article as [doi: 10.1111/adj.12519](https://doi.org/10.1111/adj.12519)

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ABSTRACT

Background

The Minamata Convention embodies a world-wide reduction in the production and use of mercury and mercury-containing products and processes, including a phase-down of dental amalgam. This will change the approach to the use of direct restorative materials in the near future. There is little research as to the influence of clinical factors on dentists' decision-making which may be of use when determining the impact of any change.

Methods

An online survey relating to aspects of and attitudes to the use of direct restorative materials was distributed to all dentists who were members of the Australian Dental Association and/or Members or Fellows of the Royal Australasian College of Dental Surgeons. Data were statistically analysed.

Results

There were 408 respondents to the survey. Eighty-seven per cent of respondents (strongly) disagreed that amalgam was a technically more difficult material to place compared to resin composite, 82 per cent (strongly) disagreed that placement time for amalgam was longer than that for resin composite and 69 per cent (strongly) disagreed that amalgam was more difficult to finish than resin composite. Eighty-three per cent of respondents stated they were confident in their ability to place amalgam restorations. Where physical properties were of importance indirect restorations were preferred e.g., parafunction, 54 per cent. The factors considered most important when choosing a direct restorative material included moisture control and aesthetics; least important factors were cost and time to place.

Conclusions

There is consensus that amalgam is not more technically difficult to use, place or finish than resin composite and vice versa. There is recognition that both amalgam and resin composite have limitations in terms of physical properties. When choosing a direct restorative material, clinical factors considered to be of greatest importance are moisture control, aesthetics and the need to apply minimally invasive approaches. There is little difference in the opinions of users and non-users of amalgam with respect to these findings.

Key Words

Amalgam, Decision-making, Dentist, Direct restoration, Resin composite

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Article type : Scientific Article

INTRODUCTION

This article is Part 4 of a research series investigating the implications a phase-down of amalgam^a as a direct restorative material may have for dentists in Australia. A proposed approach by way of a 'phase-down' by the United Nations Environment Programme (UNEP), supported by the World Health Organisation (WHO)^b recognises that cessation of amalgam as a restorative material requires further research as to the implications, especially the appropriateness, of the available alternatives. More recently the Minamata Convention proposed a world-wide reduction in the production and use of mercury and mercury-containing products and processes.^c

There is an emerging consensus that a shift away from amalgam is warranted,¹ however attention should be paid to the knowledge and training of dentists who graduated 'earlier'.² In Australia the use of amalgam has declined over many years and hence discussion has focussed on the potential minimal impact that a phase-down would have.³ It is established that an increasing number of dentists does not use amalgam⁴ and that the material of choice in many clinical situations, including restoration of posterior teeth, is resin composite.⁵⁻¹¹ There are many factors involved that have influenced this change; these have been summarised¹⁰ and reviewed by the present authors.¹²

^a 'amalgam' is intended to include the various terms found in the literature including 'dental amalgam' and 'silver amalgam'.

^b www.unep.org/hazardoussubstances. Accessed February 2014.

^c www.unep.org/newscentre/default.aspx?DocumentID=2702&ArticleID=9373. Accessed September 2013.

There is little research examining why dentists choose a particular restorative material. Factors taken into consideration have been identified but focus on non-clinical matters, rarely including factors such as caries experience and risk¹³⁻¹⁵ and tooth type and size.^{13, 16} Operator 'skill' and technique sensitivity have also been analysed.¹⁷⁻²⁰

A review of the literature¹² and a qualitative study by the present authors²¹ identified and classified 'clinical factors', many of which are the focus of this part of a broader research series analysing dentists' decision-making processes. The clinical themes are reproduced at Table 1. It was surmised that variation exists as to dentists' views of the properties and capabilities of resin composite, resulting in differing opinions as to the management of various clinical situations, and was symptomatic of the complex nature of the evidence-base. There was the impression that many dentists viewed a shift to an 'amalgamless' profession to be premature. This variation of opinion on clinical matters is attempted to be quantified by this study.

METHODS

The methods including creation, administration and analysis of the survey and data have been described previously.²² Essentially, the final survey consisted of eight sections and 29 subsections totalling 71 questions related to demographics and seven key themes. This paper relates to the theme of 'clinical' factors. The questions were presented in a Likert format and examined use of amalgam and other direct restorative materials from various clinical perspectives. The nature of these questions was derived from previous research.^{12, 21}

The survey was distributed to all members of the Australian Dental Association state and territory branches (ADA) and Members and Fellows of the Royal Australasian College of Dental Surgeons (RACDS). The survey was web-based utilising 'SurveyMonkey'^d. It is estimated this constituted 12,557 invitations including dentists, dental specialists, specialists in training and non-practising dentists.

Responses were required to statements relating to comparisons between amalgam and resin composite, including technical difficulty, placement, finishing and confidence in one's clinical ability. Various clinical situations were presented and the material of choice in these situations requested, including ascribing the relative importance of factors influencing decision-making. The specific questions and statements are identified in the Results.

^d SurveyMonkey Inc. Main website: www.surveymonkey.com: Palo Alto, CA, USA

The study received approval from the Human Research Ethics Committee, The University of Melbourne; reference number 1239020.

RESULTS

There were 408 respondents to the survey. Responses were not complete for all questions and statements. Responses of 'strongly agree' and 'agree' and 'strongly disagree' and 'disagree' are occasionally presented as combined data, worded as (strongly) agree and (strongly) disagree. The percentages expressed in the results exclude any missing values and are rounded to whole numbers.

Responses in terms of demographics and amalgam use have been described previously.²² In summary, respondents comprised of 62 per cent males and 38 per cent females, 73 per cent of respondents obtained their primary dental qualification in Australia, 79 per cent of respondents were in private general practice and 71 per cent named a metropolitan city as their principal work location. Responses were received from dentists in all Australian states and territories.

Thirty per cent of respondents indicated they do not use amalgam as a direct restorative material. Of those using amalgam, the mean use for all direct restorative procedures was 18 per cent. Cross tabulation showed no appreciable difference by gender and place of primary dental qualification. Those respondents falling below the mean non-use of 30 per cent included those obtaining their primary dental qualification between 1960 and 1979, practising in a regional, rural or remote location, in public or 'other' practices, 'other' being hospital, postgraduate study and university/teaching/research. There is a pattern of decreasing use of amalgam relative to year of primary dental qualification; the later the year of graduation being associated with less amalgam use.

Operator technique

Tables 2 to 5 relate to aspects of operator technique. Table 2 shows results of responses to the statement, 'Amalgam is technically more difficult to place than resin composite'. Eighty-seven per cent of respondents (strongly) disagreed with the statement. Five per cent (strongly) agreed with the statement. Cross-tabulation showed that those respondents mostly (strongly) disagreeing were those dentists obtaining their primary dental qualification between 1960 and 1979 (90 per cent) and in Australia (91 per cent). Amalgam users (strongly) disagreed more than non-users (91 and 81 per cent respectively). There was no statistical difference when comparisons were made by gender or practice location. The group mostly (strongly) agreeing

with the statement were those identifying practice type as 'other' (hospital, postgraduate study, and university/teaching/research; 12 per cent).

Table 3 shows responses to the statement, 'Amalgam takes longer to place than resin composite'. Eighty-two per cent of respondents (strongly) disagreed with the statement. Eight per cent (strongly) agreed. Cross-tabulation showed that those respondents mostly (strongly) disagreeing were those dentists obtaining their primary dental qualification between 1960 and 1979 (94 per cent) and those mostly (strongly) agreeing being those obtaining their primary dental qualification between 1980 and 2000 and identifying practice type as 'other' (15 and 16 per cent respectively). The data revealed no statistically significant difference ($P < 0.001$) when cross-tabulated. Amalgam users and non-users gave similar overall responses, those (strongly) disagreeing being 84 and 80 per cent respectively.

Table 4 shows responses to the statement, 'Finishing amalgam is more difficult than finishing resin composite e.g., recreating functional morphology'. Sixty-nine per cent of respondents (strongly) disagreed and 20 per cent (strongly) agreed with the statement. Cross-tabulation showed that those respondents mostly (strongly) disagreeing were those obtaining their primary dental qualification after 2000 (77 per cent) and those mostly (strongly) agreeing being females (27 per cent). The data revealed no statistically significant difference ($P < 0.001$) when cross-tabulated. Amalgam users and non-users gave an identical overall response for (strongly) disagree, being 71 per cent.

Table 5 shows responses to the statement, 'I am confident in placing amalgam restorations'. Eighty-three per cent of respondents (strongly) agreed with the statement and cross-tabulation showed that respondents mostly (strongly) agreeing to be those obtaining their primary dental qualification overseas and those mostly (strongly) disagreeing being 'other' (47 per cent). A statistically significant difference was obtained when comparing the (strongly) agree and (strongly) disagree responses of 'other' (53 and 47 per cent) to the overall response (83 and 12 per cent; $P < 0.001$). There was no statistically significant difference between amalgam users and non-users.

Physical properties

Table 6 shows responses to the question, 'Which direct restorative material are you most likely to use in different clinical situations?' Where a parafunctional habit was assumed, most respondents were most likely to use an indirect restorative material (54 per cent). Responses naming amalgam and resin composite were similar, being 21 and 24 per cent respectively.

Where the opposing restoration consisted of an indirect material the material mostly chosen was also indirect in nature. Where resin composite was the opposing material, most respondents were more likely to use resin composite (79 per cent) and resin composite remained the preferred material to amalgam when the opposing restorative material was amalgam. Patterns of response were similar where the adjacent, compared with opposing, restoration was in question, and where the question related to a tooth requiring cusp coverage, although the preference was for an indirect restoration in these situations. When responses (ranks) were cross-tabulated by amalgam use or non-use there was no statistically significant difference, this being consistent for all variables (data not tabled).

General clinical considerations

Table 7 shows responses to the question, 'The following are factors I consider when making a choice between an amalgam or resin composite restoration' ('1' = 'not important'; '5' = 'very important'), the responses achieving the highest rank being moisture control (rank = 1), aesthetics (rank = 2) and minimally invasive approaches (rank = 3). Those achieving the lowest rank were cost of material (rank = 31), time to place (rank = 30) and potential systemic toxicity to clinician/assistant or patient (rank = 29 and 28 respectively). There was no statistically significant difference between any of the variables when ranks were compared for amalgam users or non-users (data not tabled).

DISCUSSION

The higher use of resin composite as a direct restorative material in preference to amalgam is becoming increasingly supported by an evolving evidence-base.^{17, 23-27} A review of the literature¹² and a qualitative study by the current authors²¹ identified and classified 'clinical factors', reproduced at Table 1, and suggested that variation exists as to dentists' views of the properties and capabilities of resin composite. This current study included lines of questioning relating to clinical factors and focussed on specific aspects, namely operator technique, physical properties and general clinical considerations.

It is suggested that the use of resin composite may limit the problems that surgical intervention potentially causes, especially the risk of further restorative intervention.⁵ This, along with the advantages of amalgam, has been reviewed by the current authors.¹² The principles of minimal intervention dentistry have been comprehensively reviewed by Walsh & Brostek.²⁸ The implications for decision-making regarding repair or replacement of defective restorations is important, as it has been established that a significant amount of a dentist's restorative treatment

involves restoration of previously restored teeth.^{29, 30} Decision-making for repairs is dictated by various criteria which have been summarised,¹² and include clinical considerations such as: caries risk/activity, caries depth³¹ and previous restorative history; material-to-material bonding and/or adhesion i.e., repair ‘strength’; interdisciplinary considerations (periodontal, prosthetic status/requirements); and the dentist’s technical capabilities.

Mackert and Wahl³² identified problems of clinical technique that resin composite has, including: recreation of approximal contacts;^{32, 33} use of alternative (usually sectional) matrices;^{34 35} and post-operative sensitivity due to operator error, given problems associated with the bonding stage.¹⁷⁻¹⁹ A key concern of dentists is operator technique, including the technical difficulties, placement, finishing and general confidence in the use of direct restorative materials.²¹ This line of investigation in the current study is also founded on the premise that the ‘operator’ is a main factor influencing restoration longevity, as opposed to material properties.¹³ With respect to the question relating to the technical difficulty of placement of amalgam compared to resin composite, responses suggested that the majority of all dentists disagreed that amalgam use was more difficult, suggestive of an appreciation that the material is equivalent to or less difficult to place than resin composite. Greatest correlation with this finding came from those dentists who graduated ‘earlier’ (primarily prior to 1980) and may be explained by the increased use of amalgam as a restorative material by these respondents. A high level of agreement with the premise of the question also came from those identifying their practice type as hospital, postgraduate study and university/teaching/research, suggestive that those involved in an academic environment have a different perspective on the technical difficulties associated with the use of amalgam. These findings aligned with responses to the question relating to confidence in the use of amalgam. This is a theme reproduced in other areas of this study and indicates a difference of opinion between those in academic and teaching environments to those in general practice. The idea that this may be associated with differing understandings of the evidence-base associated with amalgam, or any direct restorative material, is to be explored later in this research series. It may also be surmised that those in academic and teaching environments may be less practised in the use of amalgam than their general practice colleagues and hence less confident with its use.

As to aspects of placement, finishing and confidence in the use of amalgam, the difficulty of finishing amalgam achieved the lowest disagreement, suggesting that placement is not as much of an issue as finishing and by implication a recognition that resin composite is technically more difficult to finish than amalgam. The finding that respondents mostly (strongly) disagreeing that the finishing of amalgam was more difficult than resin composite were those obtaining their

primary dental qualification after 2000 (77 per cent) may be counter to that expected. More recent graduates would be expected to be less experienced in the use of amalgam so the finding may suggest either a lack of appreciation of that required for adequate finishing of an amalgam restoration or an appreciation of the difficulty in finishing resin composite, a material this group uses more often than those graduating earlier.

Of note for each of the aspects of placement, finishing and confidence in the use of amalgam was the lack of a statistically significant difference between users and non-users of amalgam, suggesting that irrespective of reasons for use or non-use, both groups have an equivalent appreciation of the difficulties of use of each material. In this respect the most important factors are year of primary dental qualification and practice type.

Questions relating to the physical properties of various restorative materials aimed to ascertain if dentists had differences in approach to restorations in clinical scenarios where physical properties of the material were paramount, including parafunction, opposing/adjacent pre-existing restorations and cusp coverage indications. Of interest was whether the responses would suggest that dentists held concerns as to the physical properties of resin composite compared to amalgam. The literature relating to issues of longevity, and the primary reasons for failure being secondary caries and fracture,³⁶ are problematic as many factors must be considered,³² but there is an emerging consensus that amalgam's superior properties, including increased fracture resistance, compressive strength and wear resistance,³⁷ and longevity^{3, 42, 32, 53-55} is now matched by resin composite.^{17, 20, 24, 25, 27}

Where a parafunctional habit, an opposing indirect restoration or a cusp coverage requirement was assumed, the option of an indirect restoration was made available to respondents as an attempt to ascertain the 'trust' of dentists in either of the direct restorative materials in question. Most respondents were most likely to choose an indirect restorative material, indicating that concerns existed as to the physical properties of each direct material in these situations. Responses relating to opposing or adjacent restorations of resin composite or amalgam, or situations where cusp coverage was required, produced similar outcomes, with the majority of respondents choosing resin composite over amalgam. There was no statistically significant difference in this result when data were cross-tabulated for use or non-use of amalgam. This suggests that the majority of dentists consider resin composite to possess the required physical properties to achieve a desirable result, assuming longevity is considered of importance. In this respect the data obtained from questions relating to general clinical considerations are of interest.

In 2004, reference was made to clinical implications of choice of restorative material,³⁸ but no specific clinical factors were identified. Of note were United Kingdom and Australian surveys from 2001 and 2002 respectively that identified ‘clinical indications’ and ‘aesthetics’ as key factors.^{39, 40} The factors offered as options to respondents included all those identified by the current authors^{12, 21} and included aesthetics and a range of specific options relating to ‘clinical indications’, identified in Table 7. The factors achieving the highest rank were moisture control, aesthetics and minimally invasive approaches. Longevity, which interrelates with many other factors listed, ranked fourth. This suggests that while dentists have an understanding of the importance of technique sensitivity and aspects of microleakage or ‘seal’ (rank = 5), the importance may be countered by the desire to achieve an aesthetic result. Therefore, respondents may still choose resin composite as a direct restorative material in clinical situations where concerns may be had as to its suitability. This finding of the relative importance of aesthetics correlates with that of other studies.^{14, 41} The high ranking and relative importance of minimally invasive approaches is suggestive of an appreciation and acceptance of the importance of conservation of tooth substance in modern operative approaches.

Those factors achieving the lowest rank were cost of material and time to place, indicating that respondents placed greater importance on the quality of outcome rather than considerations of convenience. The next lowest rank was for potential systemic toxicity to clinician/assistant or patient, indicating a broad acceptance from respondents of the evidence-base pertaining to this issue,⁴² and that while no direct restorative material is free of potential biological side-effects, the risk should not be overstated. Specific attitudes of dentists on this matter will be explored in a later part of this research series.

LIMITATIONS

The limitations and potential sources of error have been described previously.²² Essentially they include: generalisability and sampling error, given the survey was made available to members of the ADA and Members and Fellows of the RACDS and not to all registered dentists in Australia; survey design and measurement error, given the predominantly ‘closed’ question and self-administration nature of the survey; self-selection bias due to participation in the survey being voluntary; and non-response error.

CONCLUSIONS

There is consensus that amalgam is not more technically difficult to use, place or finish than resin composite. This belief was most held by respondents who graduated ‘earlier’, and was

influenced by year of obtaining their primary dental qualification. Those mostly believing amalgam to be a more difficult material to use and feeling less confident in its use were identified as practicing in teaching and academic environments. There is little difference in the opinions of users and non-users of amalgam with respect to the difficulty of the use of amalgam.

There is recognition that both amalgam and resin composite have limitations in terms of physical properties, and where clinical scenarios present issues of greater physical demands, indirect restorations are preferred. A majority of respondents considered resin composite to possess the required physical properties to achieve acceptable outcomes when compared to amalgam, but factors other than physical properties are of greater importance.

When choosing a direct restorative material, clinical factors considered to be of greatest importance are moisture control, aesthetics and minimally invasive approaches. Of least importance are the cost of materials, time to place and potential systemic toxicity to clinician, assistant or patient. The lack of a statistically significant difference between any of the variables when responses (ranks) are compared for amalgam users or non-users suggests recognition by all respondents of the relative importance of these factors.

A key issue requiring further consideration is a need for compilation and targeted dissemination of clinical guidelines on the appropriate use of direct restorative material.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the support of the Australian Dental Association's state and territory branches, and the Royal Australasian College of Dental Surgeons for allowing distribution of the survey to its Members and Fellows.

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