Removal, Replacement and Placement of Amalgam Restorations by Ontario Dentists in 2002

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ABSTRACT

Aim: To determine the patterns of removal, replacement and placement of amalgam restorations by Ontario dentists.

Methods: A structured self-administered postal survey was sent to dentists randomly selected from the list of all dentists licensed to practise dentistry in Ontario. The questionnaire sought information on the numbers of 1-, 2-, 3- and ≥ 4-surfaced amalgam restorations and core amalgam buildups that each dentist removed, replaced and placed during a 7-day period.

Results: A total of 878 (44%) of 1,994 dentists responded to the survey. Most dentists (82%) who returned completed questionnaires (n = 837) had removed, replaced or placed at least one amalgam restoration during the 7-day period. Most respondents (90%) were general practitioners; respondents practised for a mean of 45.7 weeks each year and had practised for a mean of 20.1 years. On average, each dentist removed 8.91 (standard deviation [SD] 17.32) amalgam restorations during the 7-day period. However, the mean number of new amalgam restorations placed was just 6.64 (SD 18.88): 2.99 (SD 8.74) new restorations in previously unrestored teeth and 3.65 (SD 11.40) replacements of amalgam restorations removed from previously restored teeth. For the year 2002, it was estimated that the 6,915 dentists registered to practise in Ontario had removed 2,855,178 (95% confidence interval [CI] 2,484,566–3,225,790) amalgam restorations. Overall, the dentists placed 2,112,800 (95% CI 1,682,307–2,543,292) amalgam restorations; 1,163,665 (95% CI 919,204–1,408,126) to replace amalgams in previously restored teeth and 949,135 (95% CI 763,103–1,135,166) as new amalgam restorations.

Conclusions: Removal of old amalgam restorations by Ontario dentists exceeds current levels of placement and replacement of amalgam restorations.

MeSH Key Words: Canada; dental amalgam; dental restoration, permanent/statistics & numerical data; questionnaires

This article has been peer reviewed.

Only limited information exists on the patterns of removal, replacement and placement of amalgam restorations in Ontario. One survey of Ontario dentists[1] showed significant individual variation in the choice between composite resin and amalgam, as well as in the design of cavity preparations. A survey of treatment provided to military personnel reported that dentists placed similar numbers of composite and amalgam restorations.[2] Modern tooth-coloured direct restorative materials can be used as an alternative to dental amalgam in certain circumstances.[3–8] However, these materials tend to be more technique-sensitive than amalgam and do not last as long in the oral cavity.[9–14]

An increase in the use of alternatives to amalgam, including in stress-bearing locations

of the posterior teeth, has been reported in many countries.[15–23] In addition, some patients now request tooth-coloured materials.[15,16] Forss and others[17] found that dentists who sought the opinion of their patients on the choice of materials used alternatives to amalgam more frequently than dentists who did not seek patients' input.

The aim of this study was to determine patterns of removal, replacement and placement of amalgam by Ontario dentists.

Materials and Methods

Selection of Participants

The Epitable Calculator in Epi-info version 6.04b (U.S. Centers for Disease Control and Prevention, Atlanta, Ga.) was used to randomly select 2,000 names from a list of 6,915 dentists licensed to practise in Ontario. (A total of 7,150 dentists were licensed at the time of the study, but the names of 235 dentists with an address outside Ontario were purged from the list.)

Data Collection

A structured self-administered questionnaire and a self-addressed envelope were sent by mail to the selected dentists during the first week of March 2002. After the deadline of May 31, 2002, a second copy of the questionnaire was sent to dentists who had not responded. A reminder urging dentists who had not returned their questionnaires to do so promptly was published in the July/August 2002 issue (Volume 16, Number 3) of *Dispatch*, the publication of the Royal College of Dental Surgeons of Ontario (RCDSO).

The questionnaire asked the dentist to report the following information for the 7-day period immediately following the day the questionnaire was received: the numbers of 1-, 2-, 3- and ≥ 4-surfaced amalgam restorations and core amalgam buildups that he or she had removed from previously restored teeth; and the numbers of 1-, 2-, 3- and ≥ 4-surfaced amalgam restorations and core amalgam buildups that he or she had placed in previously restored teeth and previously unrestored teeth. Each dentist was also asked whether he or she was a specialist, the number of weeks usually worked in a year and the number of years he or she had been in practice.

Data Analysis

The numbers of 1-, 2-, 3- and ≥ 4-surfaced amalgams and core amalgam buildups that each dentist removed or placed during the 7-day period were computed. For each type of amalgam restoration, computer algorithms were developed that multiplied the number of amalgams removed or placed by the number of weeks the dentist reported working yearly to obtain the number of restorations removed or placed annually. For dentists who did not respond to the question about the number of weeks worked annually, the mode of the number of weeks worked by dentists who did provide this information was

Table 1. Mean number (and standard deviation [SD]) of amalgam restorations removed during the 7-day period by the 878 responding dentists, according to type of restoration and type of tooth

	Type of amalgam restoration					All types of restorations
Type of tooth	**1-surfaced**	**2-surfaced**	**3-surfaced**	**≥ 4-surfaced**	**Core buildup**	
Cuspids						
Mean (SD)	0.06 (0.34)	0.12 (0.50)	0.02 (0.21)	0.01 (0.18)	0.0 (0.00)	0.21 (0.78)
Total no.	53	107	21	9	0	190
Premolars						
Mean (SD)	0.29 (1.21)	1.16 (2.43)	0.71 (1.56)	0.19 (0.73)	0.01 (0.15)	2.36 (4.55)
Total no.	251	1,021	625	169	9	2,075
Lower molars						
Mean (SD)	0.69 (1.78)	1.08 (2.74)	0.90 (2.05)	0.42 (1.14)	0.02 (0.20)	3.12 (6.34)
Total no.	603	952	791	373	23	2,742
Upper molars						
Mean (SD)	0.59 (1.66)	1.06 (2.63)	0.82 (1.90)	0.43 (1.18)	0.03 (0.28)	2.92 (6.07)
Total no.	517	932	716	374	25	2,564
Deciduous molars						
Mean (SD)	0.05 (0.43)	0.18 (0.83)	0.05 (0.38)	0.01 (1.10)	0.00 (0.00)	0.29 (1.47)
Total no.	47	160	42	5	0	254
All types of teeth						
Mean (SD)	1.68 (4.25)	3.61 (7.88)	2.50 (5.12)	1.06 (2.58)	0.06 (0.53)	8.91 (17.32)
Total no.	1,471	3,172	2,195	930	57	7,825

used. Zero values were used for dentists who responded but did not complete the questionnaire and for those (including specialists) who had neither removed nor placed any amalgam during the 7-day period. The χ^2 test or analysis of variance (ANOVA) was used to examine differences between groups. The data were analyzed with SAS version 8.02 software (SAS Institute Inc, Cary, N.C.).

Results

Response Rate

Nearly half of the randomly selected Ontario dentists responded (878/1,994 or 44%); 6 of the questionnaires were returned as undeliverable. The respondents were representative of the 2,000 dentists randomly selected from the list of Ontario practitioners; they were mostly general practitioners ($p = 0.26$ by χ^2 test) and had a metro Toronto postal address ($p = 0.22$ by χ^2 test). Among the dentists who did not complete the questionnaire, 18 were retired or no longer in clinical practice; 6 were temporarily out of practice because of maternity leave or relocating; 11 were either specialists or graduate students; 3 reported that they no longer used amalgam; 1 respondent practised on a part-time basis; and 1 worked only in emergency care.

Dentists who responded to the second mailing had practised for significantly fewer years than those who responded to the first mailing ($p < 0.001$ by ANOVA). Otherwise, dentists in the 2 groups were comparable with respect to having a metro Toronto postal address ($p = 0.35$ by χ^2 test), completing the questionnaire ($p = 0.83$ by χ^2 test), being general practitioners ($p = 0.39$ by χ^2 test) and the number of weeks worked annually ($p = 0.73$ by ANOVA). A detailed description of the characteristics of early and late respondents have been reported previously.[24]

The average respondent who removed or placed amalgam during the 7-day period worked for 45.7 (standard deviation [SD] 6.0) weeks per year. Ten dentists did not indicate the number of weeks worked in a year. The average time that respondents reported being in practice was 20.1 (SD 11.0) years. The majority of respondents (90%) were general practitioners; 82% of those who completed the questionnaire (690/837) or 78% of overall respondents had removed or placed amalgam restorations during the 7-day period.

Removal and Placement of Amalgams

Table 1 presents the means, standard deviations and total numbers of various types of amalgam restorations removed during a 7-day period by the 878 responding Ontario dentists. On average, each dentist removed 8.91 (SD 17.32) amalgam restorations during a 7-day period; 26.6% of the respondents did not remove any amalgam restoration during the period (data not included in the table). Overall, the mean number of amalgams placed during that period was 6.64 (SD 18.88): 2.99 (SD 8.74) new restorations in previously unrestored teeth

Table 2. Mean number (and standard deviation [SD]) of amalgam restorations placed in previously unrestored teeth during the 7-day period by the 878 responding dentists, according to type of restoration and type of tooth

	Type of amalgam restoration					All types of restorations
Type of tooth	**1-surfaced**	**2-surfaced**	**3-surfaced**	**≥ 4-surfaced**	**Core buildup**	
Cuspids						
Mean (SD)	0.02 (0.16)	0.03 (0.23)	0.00 (0.07)	0.00 (0.03)	0.00 (0.00)	0.05 (0.34)
Total no.	17	25	4	1	0	47
Premolars						
Mean (SD)	0.06 (0.59)	0.29 (1.26)	0.11 (0.61)	0.03 (0.35)	0.00 (0.06)	0.49 (2.02)
Total no.	53	257	93	23	3	429
Lower molars						
Mean (SD)	0.26 (0.92)	0.34 (1.33)	0.17 (0.93)	0.06 (0.54)	0.01 (0.15)	0.84 (2.85)
Total no.	224	298	153	56	11	742
Upper molars						
Mean (SD)	0.23 (0.76)	0.34 (1.14)	0.16 (0.74)	0.07 (0.46)	0.02 (0.17)	0.82 (2.23)
Total no.	205	303	141	58	13	720
Deciduous molars						
Mean (SD)	0.13 (0.86)	0.54 (2.18)	0.09 (0.79)	0.01 (0.22)	0.00 (0.07)	0.78 (3.25)
Total no.	117	472	82	11	2	684
All types of teeth						
Mean (SD)	0.70 (2.37)	1.54 (4.86)	0.54 (2.28)	0.17 (1.10)	0.03 (0.35)	2.99 (8.74)
Total no.	616	1,355	473	149	29	2,622

Table 3. Mean number (and standard deviation [SD]) of amalgam restorations placed in previously restored teeth during the 7-day period by the 878 responding dentists, according to type of restoration and type of tooth

	Type of amalgam restoration					All types of restorations
Type of tooth	**1-surfaced**	**2-surfaced**	**3-surfaced**	**≥ 4-surfaced**	**Core buildup**	
Cuspid						
Mean (SD)	0.01 (0.10)	0.03 (0.22)	0.00 (0.06)	0.00 (0.07)	0.00 (0.07)	0.05 (0.29)
Total no.	9	23	3	4	2	41
Premolar						
Mean (SD)	0.06 (0.42)	0.34 (1.31)	0.18 (0.79)	0.09 (0.65)	0.00 (0.07)	0.68 (2.35)
Total no.	54	298	160	79	4	595
Lower molar						
Mean (SD)	0.20 (0.74)	0.52 (2.02)	0.41 (1.40)	0.27 (1.01)	0.02 (0.18)	1.42 (4.24)
Total no.	173	461	361	234	18	1,247
Upper molar						
Mean (SD)	0.18 (0.77)	0.51 (1.98)	0.37 (1.41)	0.25 (1.16)	0.02 (0.18)	1.33 (4.23)
Total no.	157	446	328	220	14	1,165
Deciduous molar						
Mean (SD)	0.02 (0.26)	0.12 (0.87)	0.04 (0.34)	0.00 (0.08)	0.00 (0.00)	0.18 (1.24)
Total no.	18	105	31	4	0	158
All types of teeth						
Mean (SD)	0.47 (1.75)	1.52 (5.58)	1.00 (3.51)	0.62 (2.60)	0.04 (0.32)	3.65 (11.40)
Total no.	411	1,333	883	541	38	3,206

(**Table 2**) and 3.65 (SD 11.40) replacements of amalgam removed from previously restored teeth (**Table 3**); however, 44.2% of dentists did not place new amalgams nor replaced old amalgams with new ones (data not shown in the table) during the 7-day period. There was no statistical difference between late and early responders to the questionnaire in terms of numbers of amalgam restorations placed ($p = 0.63$ by ANOVA), replaced ($p = 0.98$ by ANOVA) or removed ($p = 0.31$ by ANOVA).

Participants reported replacing only some of the amalgams that were removed with new ones. For the 7-day period, 1,471 one-surfaced amalgams were removed, but only 411 (28%) were replaced with amalgam. A higher proportion of other types of restorations were replaced with amalgam: 42%, 40%, 58% and 67% for 2-, 3- and ≥ 4-surfaced amalgams and core buildups, respectively. Similarly, 22%, 29%, 45%, and 62% of amalgam restorations removed from cuspids, premolars, mandibular and maxillary molars, and deciduous molars were replaced with amalgam.

Figure 1 compares total placements (replacements of old amalgam restorations and placement of new amalgam restorations in previously unrestored teeth) with amalgam restorations removed. In contrast to core amalgam buildups, there were net losses in the numbers of 1-, 2-, 3- and ≥ 4-surfaced amalgam restorations; the net gain for core buildups was 10 restorations. There was also a net gain in the number of deciduous molars with amalgam restorations, but there were net losses for all other tooth types (**Fig. 1**).

Overall, amalgam restorations placed in previously restored and unrestored teeth balanced fewer than half of the amalgam restorations removed from anterior teeth: 49% for cuspids and 46% premolars (**Fig. 2**). Nearly three-quarters of amalgam restorations removed from molars were balanced by new restorations in previously unrestored or restored teeth: 73% and 74% for mandibular and maxillary molars, respectively. Between 62% and 85% of 1-, 2-, 3-, and ≥ 4-surfaced amalgams were replaced, but there were no consistent trends.

Estimated Numbers of Amalgams Placed and Removed during 2002

On the basis of the number of weeks that each dentist reported working per year, the numbers of amalgam restorations that each dentist placed and removed during 2002 were estimated. It was estimated that each dentist removed 413 (95% confidence interval [CI] 359–466) amalgam restorations. However, 168 (95% CI 133–204) of the restorations were replaced with new amalgam restorations, and another 137 (95% CI 110–164) amalgam restorations were placed in teeth that had been previously unrestored; the net loss per dentist was 108 amalgams (95% CI 156–59).

Figure 1. Net change in numbers of amalgam restorations placed and removed by 878 Ontario dentists during a 7-day period. Placements are represented by positive values and removals by negative values.

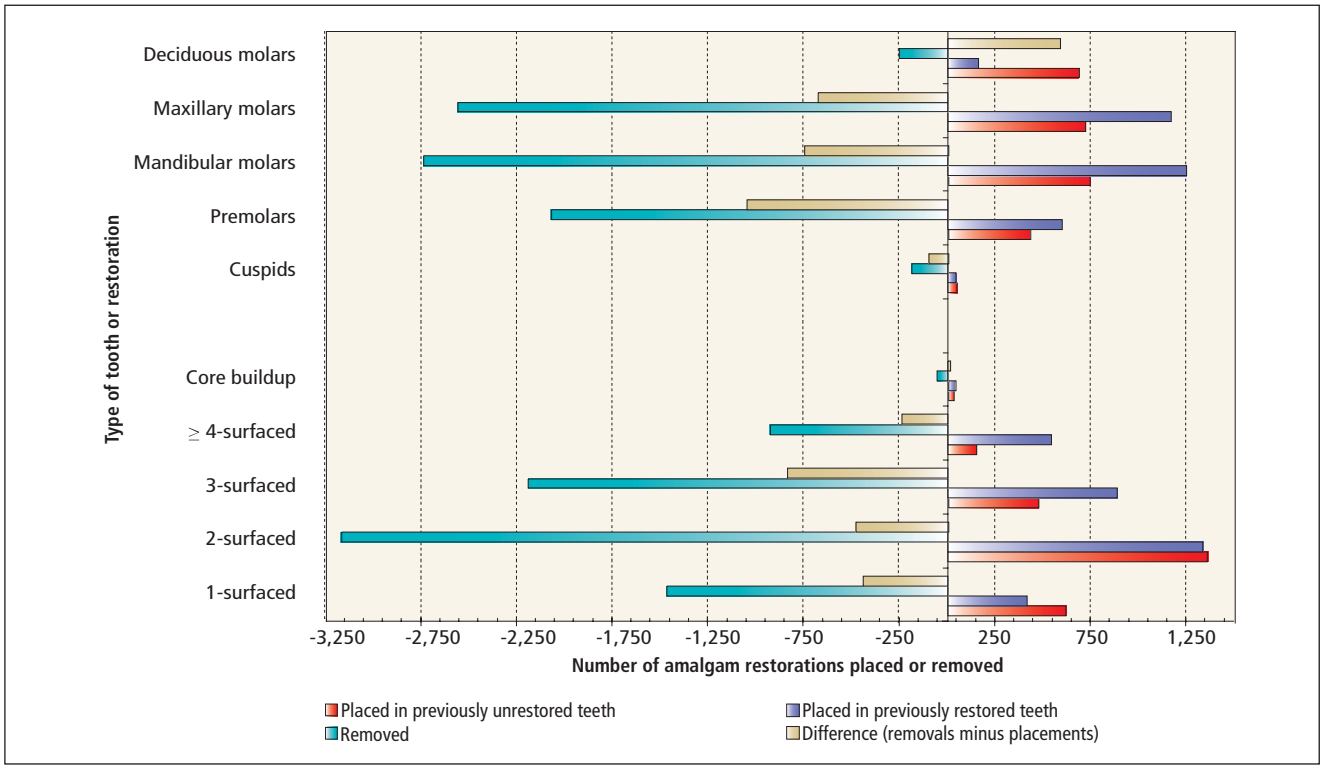
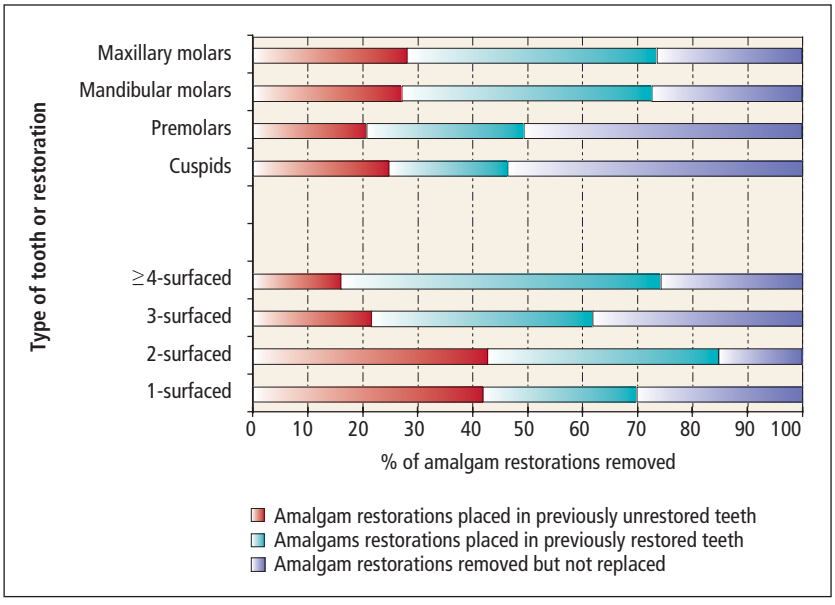


Figure 2. Proportion of amalgam restorations removed that were balanced by placement of new amalgam restorations in previously restored or unrestored teeth. These data exclude core buildups and deciduous molars, for which there were net gains in amalgam restorations.



Discussion

This study describes the pattern of placement and removal of amalgam restorations by Ontario dentists. A self-administered questionnaire was used to obtain information about numbers of amalgam restorations placed and removed during a 7-day period. Dentists' response to postal surveys is highly variable, ranging from 66% to 83% in some European studies;[18–20] however, the rates reported from some Canadian studies have been somewhat lower: 70%,[21] 66%,[22] 62%,[23] 55%,[25] and 16%.[26] Although the response rate in the present study (44%) can be considered moderate, it appears that the respondents were comparable to all dentists licensed to practise in Ontario during 2002. The participants were randomly selected. Those who responded were not significantly more likely than those who did not respond to have a metro Toronto postal address or to be general practitioners. As well, the numbers of amalgam restorations removed, replaced or placed as first restorations by early responders to the survey were not significantly different from those of late responders. This suggests that a higher response rate would only have increased the precision of the estimates, which seem unbiased. Ninety percent of the respondents were general practitioners, which is nearly the same as for

Table 4. Estimated numbers of amalgam restorations removed and placed by respondents during 2002 and estimates for all dentists licensed to practise in Ontario

	Annual estimates per responding dentist (n = 878)			Annual estimate for all 6,915 dentists licensed to to practise in Ontario in 2002		
	Lower 95% CL	Mean	Upper 95% CL	Lower 95% CL	Mean	Upper 95% CL
Removed from teeth previously restored with amalgam (A)	359	413	466	2,484,566	2,855,178	3,225,790
Placed in previously restored teeth (B)	133	168	204	919,204	1,163,665	1,408,126
Placed in previously previously unrestored teeth (C)	110	137	164	763,103	949,135	1,135,166
Net loss of amalgam restorationsa	–156	–107	–59	–1,075,193	–742,378	–409,563

CL = confidence limit
[a]Net loss = [(B + C) – A]

all Ontario dentists (89%). This value also corresponds with a 1995 survey of Canadian dentists,[22] which reported that 89% of respondents were general practitioners.

The findings reported here reflect the actual numbers of restorations that Ontario dentists removed, replaced or placed as initial restorations, determined prospectively for a 7-day period. Other researchers[27–31] have used mail interviews to study the activities of dentists. Although this approach is valid, reporting error cannot be ruled out; however, it probably did not influence observed trends.

On the basis of the results of this study (see **Table 4**), it was estimated that during 2002, dentists in Ontario removed approximately 2.8 million amalgam restorations; however, they placed about 2.1 million new ones, either as new restorations in previously unrestored teeth or as replacements for old amalgam restorations. The net loss of amalgam restorations reported here might have arisen from patients who demanded replacement of their old restorations with tooth-coloured materials. There is some evidence[15–17] that such demand occurs. As well, there was a trend in this study for a higher net loss in anterior teeth (cuspids and premolars), where appearance is the paramount consideration in tooth restoration. It was not possible to compare the use of amalgam with other restorative materials, as participants were not asked to report on all types of restorative materials used during the 7-day period.

Nevertheless, it appears that Ontario dentists are using alternatives to amalgam to some extent. Composite resins are the most likely alternatives, given that smaller-sized amalgam restorations (1- and 2-surfaced amalgams) and those in smaller teeth (cuspids and premolars) were replaced least frequently with amalgam. These results are consistent with findings from other countries, which indicate that the use of alternatives to amalgam is increasing.[16,28,29,32–35] While these alternatives may become more popular, amalgam is more durable than other direct restorative materials currently available. Research continues to show that newer materials have a shorter service life.[9–14,31,36,37] For example, a national survey of Finnish dentists revealed that half of failed amalgam restorations had lasted 15 years; comparable figures were 6 years for composite restorations and 7 years for glass ionomer restorations.[36] Therefore, where appearance is not the prime concern, longevity may be an important factor, materials with shorter longevity having a marked effect on the long-term cost of restorative treatment. Furthermore, frequent replacement of restorations may result in excessive loss of tooth tissues.

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Acknowledgement: *This study was funded by a grant from the Royal College of Dental Surgeons of Ontario, Canada.*

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The authors have no declared financial interests.

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