The ultimate guide to restoration longevity in England and Wales. Part 2

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THE ULTIMATE GUIDE TO RESTORATION LONGEVITY IN ENGLAND AND WALES:2: AMALGAM RESTORATIONS: TIME TO NEXT INTERVENTION AND TO EXTRACTION OF THE RESTORED TOOTH

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THE ULTIMATE GUIDE TO DIRECT RESTORATION LONGEVITY IN ENGLAND AND WALES: 2: AMALGAM RESTORATIONS

Abstract

Aim:

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

Methods:

A data set was established, consisting of General Dental Services'

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

Results:

Data for more than three million different patients and more than 25 million courses of treatment were included in the analysis. Included were all records for adults (aged 18 or over at date of acceptance). Over 7 million amalgam restorations were included over 15 years, of which 2.5 million had a re-intervention and, in over half a million cases, the restored tooth was extracted. The Kaplan-Meier Analysis indicated that, overall, 41% of all amalgam restorations had not required an intervention within the first fifteen years after placement. Principal factors which influenced survival of the restoration and the restored tooth were age of patient and size of cavity, with patients with a history of high annual dental treatment costs having amalgam restorations which survive less well than those of patients who have lower annual dental treatment costs.

Conclusions: Among the factors influencing amalgam restoration longevity are the size of the cavity, the age of the patient and the patient's history of treatment.

Introduction

Satisfactory survival of restorations is of importance to patients, dental professionals, epidemiologists, third-party funders, governments, and other interested parties (for example, increasingly at the present time, lawyers). The provision of accurate information on restoration survival is therefore of relevance, as are the factors which may influence this. It is also important that the data is derived from general dental practice (as opposed to secondary care), given that it is in this arena that the majority of dental treatment, worldwide, is provided and, given that this is where the majority of dentists operate and where the majority of restorations are placed. Using the methodology described in Paper 1 in this series[1], it has been possible to produce precise information regarding the survival of restorations and all the known factors which may influence this.

It is therefore the purpose of this paper to investigate the following:

Survival of amalgam restorations, both overall and by various patient, dentist and other factors by assessing:

a) Time to re-intervention and

b) Time to extraction of teeth restored with amalgam.

Results

Characteristics of the Sample Population

More than three million different patient IDs and more than 25 million courses of treatment were included in the analysis, each of which includes data down to individual tooth level. Included were all records for adults (aged 18 or over at date of acceptance).

Amalgam restorations

Overall, 7,292,564 amalgam restorations were included in the analysis, of which 2,532,836 had a re-intervention over the duration of the dataset. In 578,928 cases the restored tooth was extracted. The Kaplan-Meier Analysis indicated that, overall, 41% of all amalgam restorations had not required an intervention within the first fifteen years after placement (Table 1). In terms of time to extraction, the overall percentage survival at fifteen years was 84% (Table 2).

Influence of cavity size/classification

When the amalgam restorations are classified by type of restoration, larger restorations survived less well to re-intervention than smaller restorations (Figure 1 and Table 1).

Figure 1 Survival to Reintervention by Type of Cavity

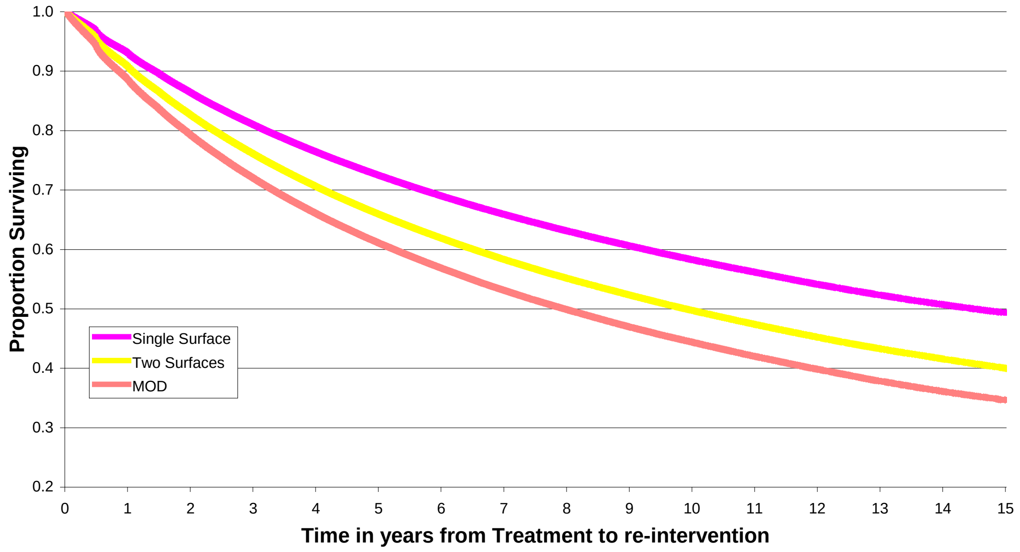


Table 1 Survival to Reintervention by Type of Cavity

	Survival (%) at				
Cavity Type	1 year	5 years	10 years	15 years	n
Single Surface	93	72	58	49	1,858,766
Two Surfaces	91	66	49	40	3,992,006
MOD	88	61	44	34	1,441,792
All Restorations	91	66	51	41	7,292,564

When amalgam restorations are examined with respect to interval to extraction (Figure 2 and Table 2), it is apparent that smaller restorations again perform better, with *circa* 15% of teeth which were restored with an occlusal amalgam being extracted at 15 years, compared with *circa* 19% of teeth with an MOD amalgam restoration.

Figure 2 Survival to Extraction by Type of Cavity

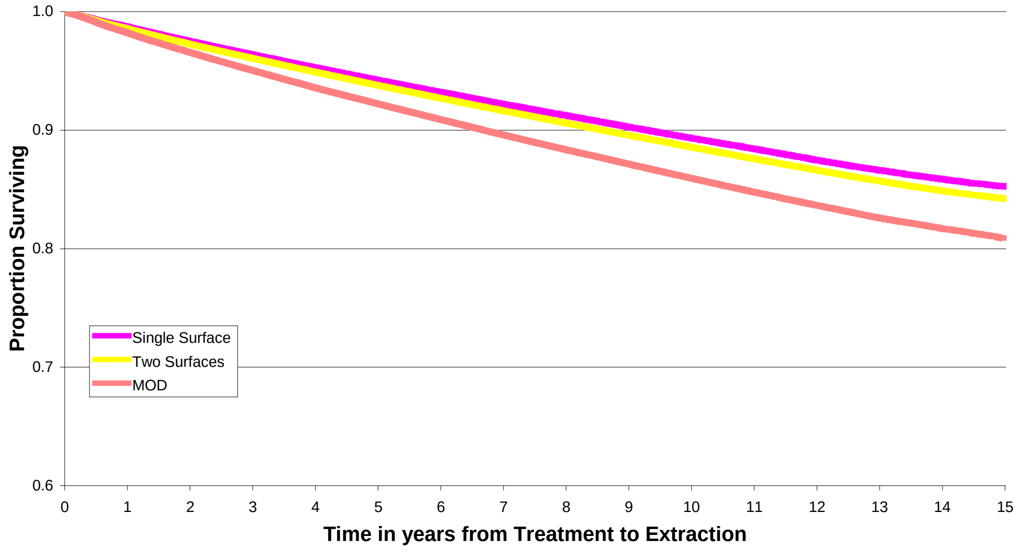


Table 2 Survival to Extraction by Type of Cavity

	Survival (%) at				
Cavity Type	1 year	5 years	10 years	15 years	n
Single Surface	99	94	89	85	1,858,766
Two Surfaces	98	94	88	84	3,992,006
MOD	98	92	86	81	1,441,792
All Restorations	98	93	88	84	7,292,564

Influence of tooth position

Regarding the influence of tooth position, it is apparent that restorations in the lower arch perform less favourably than those in the upper arch, both in terms of restoration survival and time of restored tooth to extraction. When individual teeth are examined, third molar teeth perform more favourably than restorations in other teeth in terms of restoration survival (Figure 3 and Table 3) with restorations in anterior teeth (central and lateral incisors and canine teeth) performing less well, with the proviso that the numbers of amalgam restorations in these teeth is smaller than in posterior teeth. When time to extraction of the restored tooth is examined, the data indicate a dramatic difference between anterior teeth and posterior teeth, with the first molar performing most favourably and molar and premolar teeth also showing times to extraction similar to those of the first molar, but third molars not performing so well (Figure 4 and Table 4),

Figure 3 Survival to Reintervention by Tooth Position

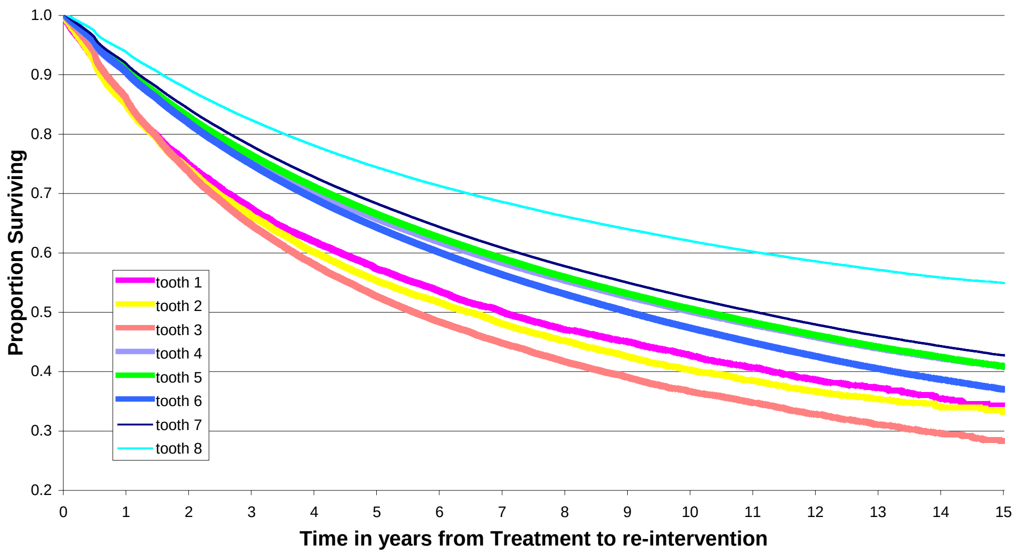


Table 3 Survival to Reintervention by Tooth Position

	Survival (%) at				
Tooth Position	1 year	5 years	10 years	15 years	n
tooth 1	85	57	43	34	16,950
tooth 2	85	55	40	33	17,267
tooth 3	86	52	36	28	43,284
tooth 4	90	66	50	41	802,164
tooth 5	91	66	50	41	1,300,062
tooth 6	90	64	47	37	2,305,057
tooth 7	91	68	52	42	2,132,946
tooth 8	93	74	61	54	674,834
All Restorations	91	66	51	41	7,292,564

Figure 4 Survival to Extraction by Tooth Position

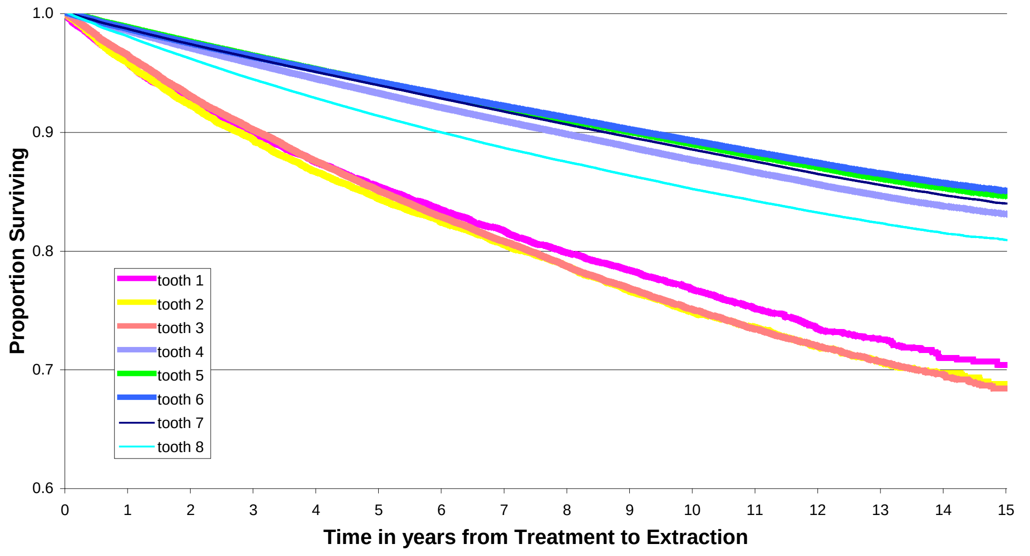


Table 4 Survival to Extraction by Tooth Position

	Survival (%) at				
Tooth Position	1 year	5 years	10 years	15 years	n
tooth 1	96	85	77	70	16,950
tooth 2	96	84	75	69	17,267
tooth 3	96	85	75	68	43,284
tooth 4	98	93	88	83	802,164
tooth 5	99	94	89	84	1,300,062
tooth 6	99	94	89	85	2,305,057
tooth 7	98	94	88	84	2,132,946
tooth 8	98	91	85	81	674,834
All Restorations	98	93	88	84	7,292,564

Influence of dentist factors (gender and age)

Regarding dentists' gender, there is little difference, though restorations placed by male dentists perform slightly worse than those placed by females, the difference being about one percentage point at 15 years, for both survival to next intervention and survival to extraction (Tables 5 and 6).

Table 5 Survival to Reintervention by Dentist Gender

	Survival (%) at				
Dentist Gender	1 year	5 years	10 years	15 years	n
Female Dentists	91	67	52	42	1,628,874
Male Dentists	91	66	50	41	5,663,690
All Restorations	91	66	51	41	7,292,564

Table 6 Survival to Extraction by Dentist Gender

	Survival (%) at				
Dentist Gender	1 year	5 years	10 years	15 years	n
Female Dentists	98	94	89	84	1,628,874
Male Dentists	98	93	88	84	5,663,690
All Restorations	98	93	88	84	7,292,564

With respect to age of dentist, there is a consistent, though modest, inverse correlation between the age of the dentist and the proportion of restorations surviving. This applies to both survival to reintervention (Figure 5 and Table 7) and survival to extraction (Figure 6 and Table 8).

Figure 5 Survival to Reintervention by Dentist Age

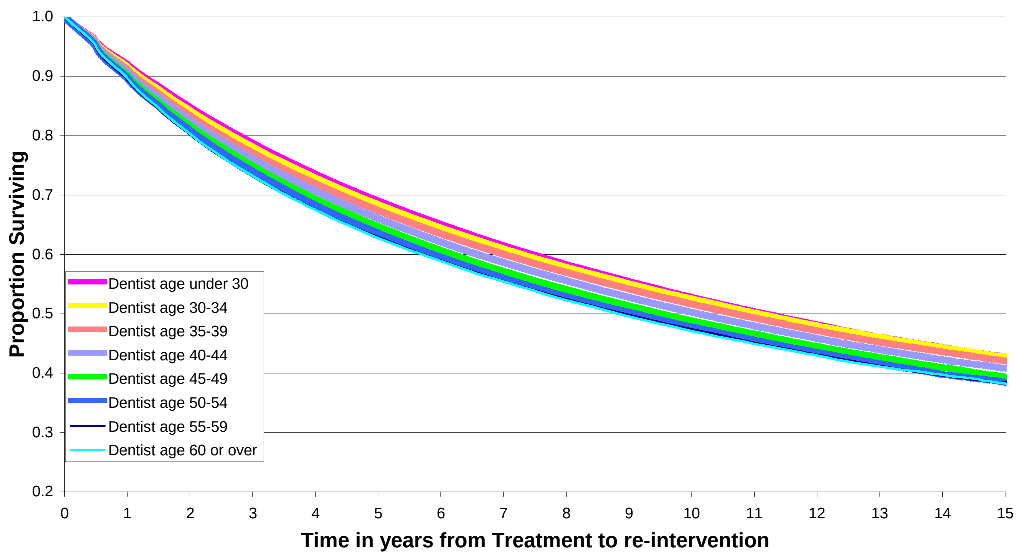


Figure 6 Survival to Extraction by Dentist Age

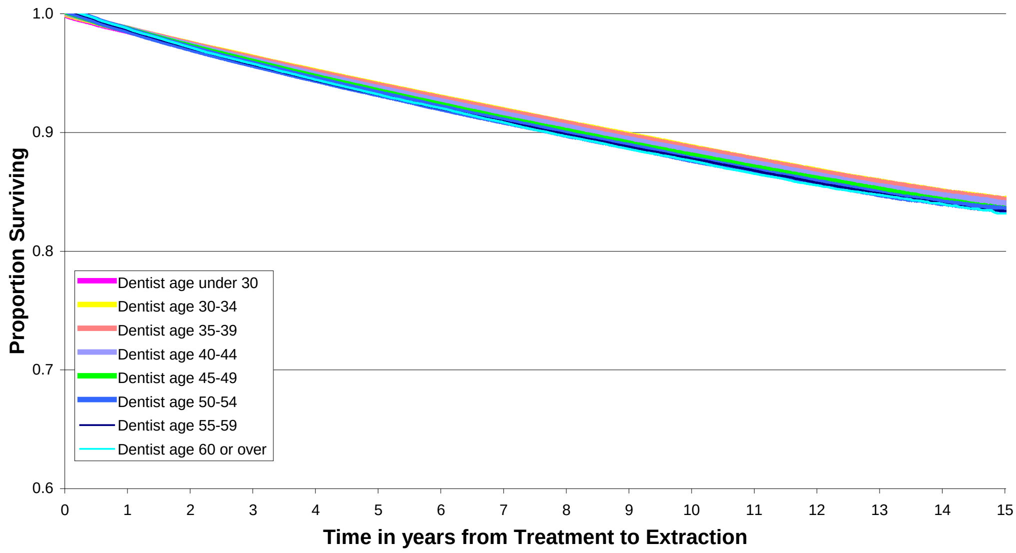


Table 7 Survival to Reintervention by Dentist Age

	Survival (%) at				
Dentist Age	1 year	5 years	10 years	15 years	n
Dentist age under 30	92	69	53	43	1,211,918
Dentist age 30-34	92	68	52	43	1,282,297
Dentist age 35-39	91	67	52	42	1,230,638
Dentist age 40-44	91	66	50	41	1,144,732
Dentist age 45-49	90	65	49	39	987,336
Dentist age 50-54	90	64	48	38	756,242
Dentist age 55-59	89	63	47	38	474,040
Dentist age 60 or over	90	63	47	38	205,361
All Restorations	91	66	51	41	7,292,564

Table 8 Survival to Extraction by Dentist Age

Dentist Age	Survival (%) at 1 year	5 years	10 years	15 years	n
Dentist age under 30	99	94	88	84	1,211,918
Dentist age 30-34	99	94	89	84	1,282,297
Dentist age 35-39	99	94	88	84	1,230,638
Dentist age 40-44	98	93	88	84	1,144,732
Dentist age 45-49	98	93	88	83	987,336
Dentist age 50-54	98	93	87	83	756,242
Dentist age 55-59	98	93	87	83	474,040
Dentist age 60 or over	98	93	87	83	205,361
All Restorations	98	93	88	84	7,292,564

Influence of patient factors

Patient gender does not appear to play a part, at least with regard to survival at times less than *circa* eight years, after which it is apparent that amalgam restorations in male patients do not perform so favourably (Table 9). When time to extraction is examined, the results indicate a small difference in time to extraction between males and females, with males losing teeth earlier (Table 10).

Table 9 Survival to Reintervention by Patient Gender

Patient Gender	Survival (%) at 1 year	5 years	10 years	15 years	n
Female Patients	91	66	51	42	3,759,805
Male Patients	91	66	50	40	3,532,759
All Restorations	91	66	51	41	7,292,564

Table 10 Survival to Extraction by Patient Gender

Patient Gender	Survival (%) at 1 year	5 years	10 years	15 years	n
Female Patients	98	94	88	84	3,759,805
Male Patients	99	93	88	83	3,532,759
All Restorations	98	93	88	84	7,292,564

Patient age plays a substantial part (Figure 7 and Table 11), with restorations in younger patients performing more favourably than those in older patients. Again, with regard to patient age, the results with regard to time to extraction are even more dramatic (Figure 8 and Table 12), with the results indicating that 10% of teeth restored with amalgam restorations in patients under the age of 20 years are lost at 15 years, compared with 30% in patients over the age of 70 years.

Figure 7 Survival to Reintervention by Patient Age

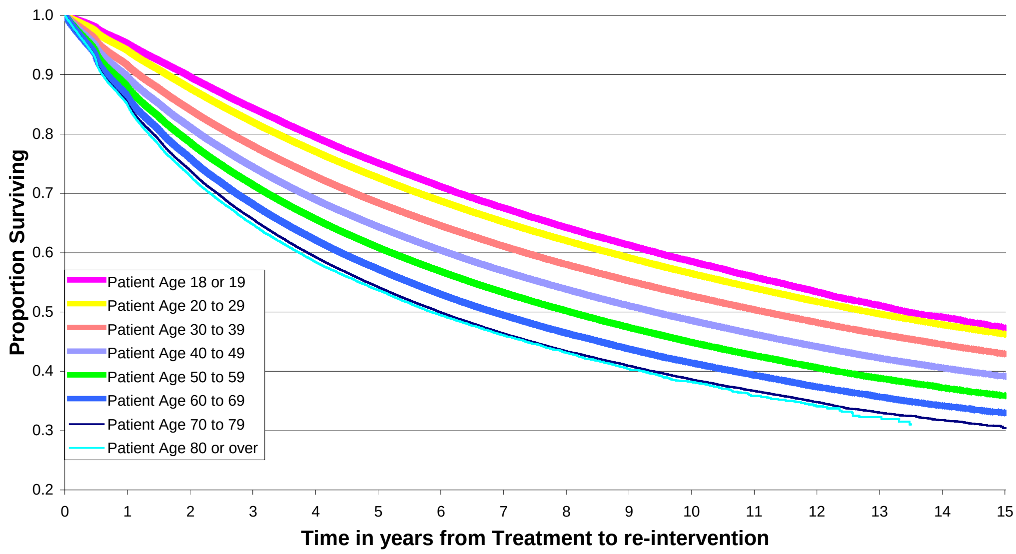


Figure 8 Survival to Extraction by Patient Age

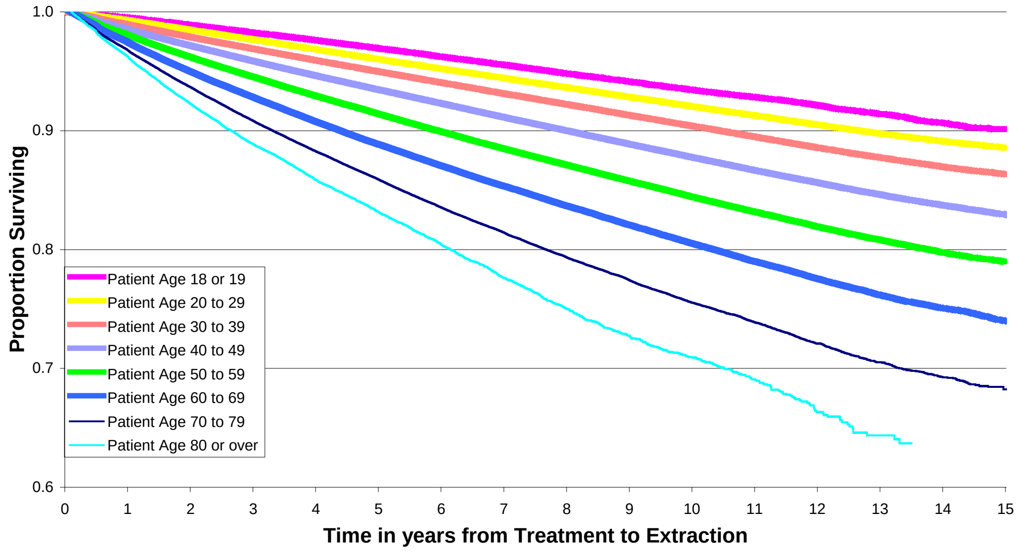


Table 11 Survival to Reintervention by Patient Age

	Survival (%) at				
Patient Age	1 year	5 years	10 years	15 years	n
18 or 19	95	75	59	47	250,920
20 to 29	94	73	56	46	1,804,825
30 to 39	92	68	53	43	1,958,736
40 to 49	90	64	49	39	1,485,651
50 to 59	88	61	45	36	964,383
60 to 69	86	57	41	33	539,752
70 to 79	85	54	39	30	235,199
80 or over	85	54	38	-	53,098
All Restorations	91	66	51	41	7,292,564

Table 12 Survival to Extraction by Patient Age

Patient Age	Survival (%) at 1 year	5 years	10 years	15 years	n
18 or 19	100	97	93	90	250,920
20 to 29	99	96	92	88	1,804,825
30 to 39	99	95	90	86	1,958,736
40 to 49	98	93	87	83	1,485,651
50 to 59	98	91	84	79	964,383
60 to 69	97	88	80	74	539,752
70 to 79	96	85	75	68	235,199
80 or over	96	83	70	-	53,098
All Restorations	98	93	88	84	7,292,564

Did the patient have to pay for treatment?

Patients may be exempt or remitted from payment within the GDS Regulations, so it may be of interest to examine whether differences exist between payment and non-payment groups. Analysis of the survival charts between those who paid for treatment and those who did not pay indicated little difference at 15 years with respect to time to reintervention (Table 13). However, when time to extraction is analysed, there is a bigger difference, of *circa* 3 percentage points, with restored teeth in patients who paid for treatment having a greater time to extraction compared with patients who were exempt from payment (Figure 9 and Table 14).

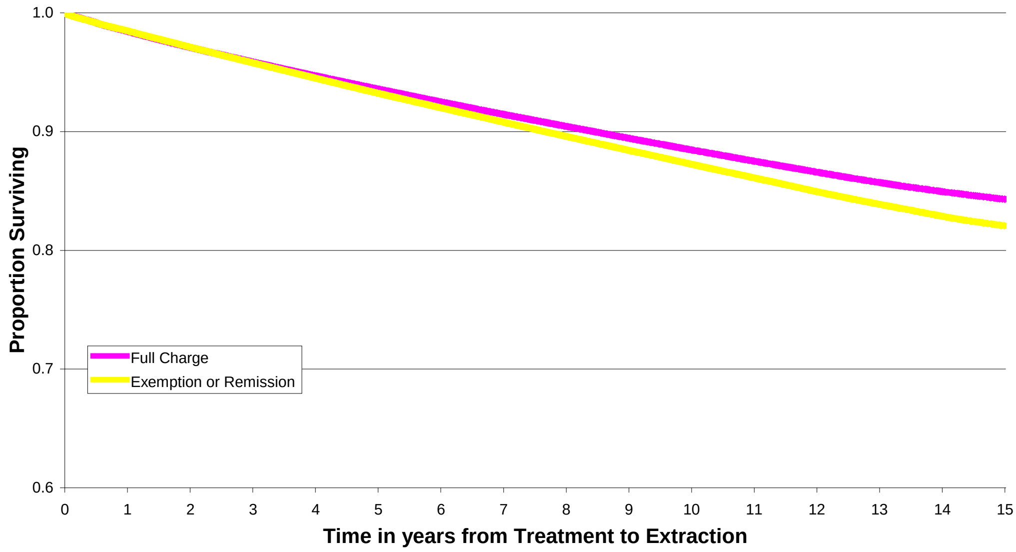
Table 13 Survival to Reintervention by Patient Charge-paying Status

Charge Paying Status	Survival (%) at 1 year	5 years	10 years	15 years	n
Full Charge	91	66	51	41	5,038,203
Exemption or Remission	91	66	50	40	2,254,361
All Restorations	91	66	51	41	7,292,564

Table 14 Survival to Extraction by Patient Charge-paying Status

	Survival (%) at				
Charge Paying Status	1 year	5 years	10 years	15 years	n
Full Charge	98	94	88	84	5,038,203
Exemption or Remission	98	93	87	82	2,254,361
All Restorations	98	93	88	84	7,292,564

Figure 9 Survival to Extraction by Patient Charge-paying Status



Patient's state of oral health

Two different proxies for the patient's state of oral health have been considered: the annual average cost of GDS dental treatment for the patient, and the median interval between courses of treatment for the patient.

Average Annual Fees

Figures 10 and 11 show clearly that the patient's history of dental treatment is a major factor in determining the likely survival of amalgam restorations, both to time to reintervention and time to extraction. For time to re-intervention, the difference, at fifteen years, is between 70% for those with low annual expenditure on dental treatment, and under 30% for those with high annual dental treatment fees (Table 15). For time to extraction the corresponding figures are 93% and 76%. Looked at in terms of tooth loss, patients with high annual dental expenditure face the prospect of losing 24% of their amalgam-restored teeth within 15 years, compared with 7% for patients with low annual dental fees (Table 16).

Figure 10 Survival to Reintervention by Patient Mean Annual Fees

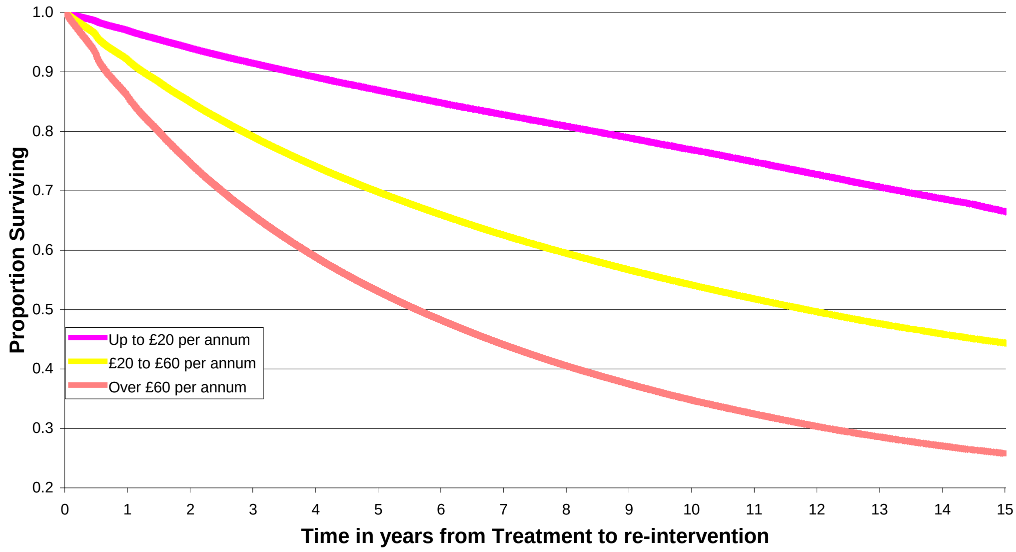


Figure 11 Survival to Extraction by Patient Mean Annual Fees

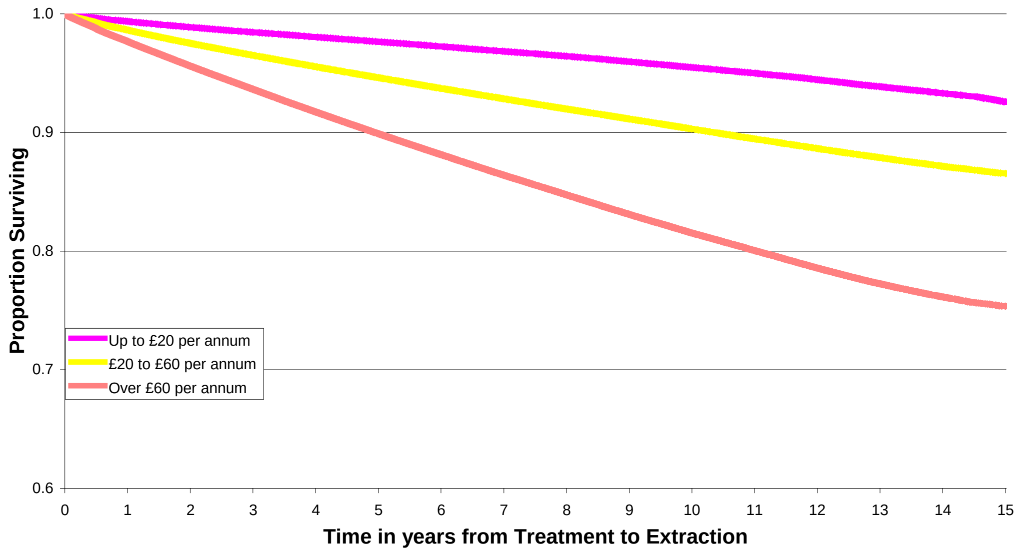


Table 15 Survival to Reintervention by Patient Mean Annual Fees

	Survival (%) at				
Mean Annual Fees	1 year	5 years	10 years	15 years	n
Up to £20 per annum	97	87	77	66	771,335
£20 to £60 per annum	92	70	54	44	3,891,174
Over £60 per annum	86	53	35	26	2,328,100
All Restorations	91	66	51	41	7,292,564

Table 16 Survival to Extraction by Patient Mean Annual Fees

	Survival (%) at				
Mean Annual Fees	1 year	5 years	10 years	15 years	n
Up to £20 per annum	99	98	95	93	771,335
£20 to £60 per annum	99	95	90	87	3,891,174
Over £60 per annum	98	90	82	75	2,328,100
All Restorations	98	93	88	84	7,292,564

Median interval between courses of treatment

Figures 12 and 13, and Tables 17 and 18, show that patients who attend more frequently than once every six months have considerably worse outcomes, in terms of survival to reintervention or extraction of amalgam restorations, than those who attend at longer intervals. With regard to the time to extraction, the survival of amalgam-restored teeth for patients attending at median intervals of over a year is initially better than for those attending at intervals between 6 months and a year, but by fifteen years the two curves cross, casting doubt on the long-term wisdom of infrequent attendance.

Figure 12 Survival to Reintervention by Patient Median Attendance Interval

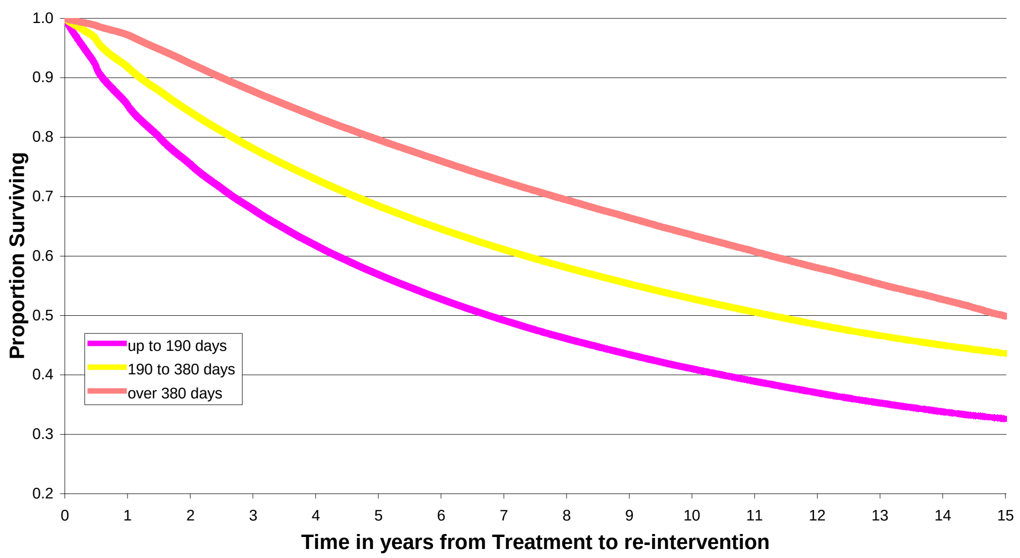


Figure 13 Survival to Extraction by Patient Median Attendance Interval

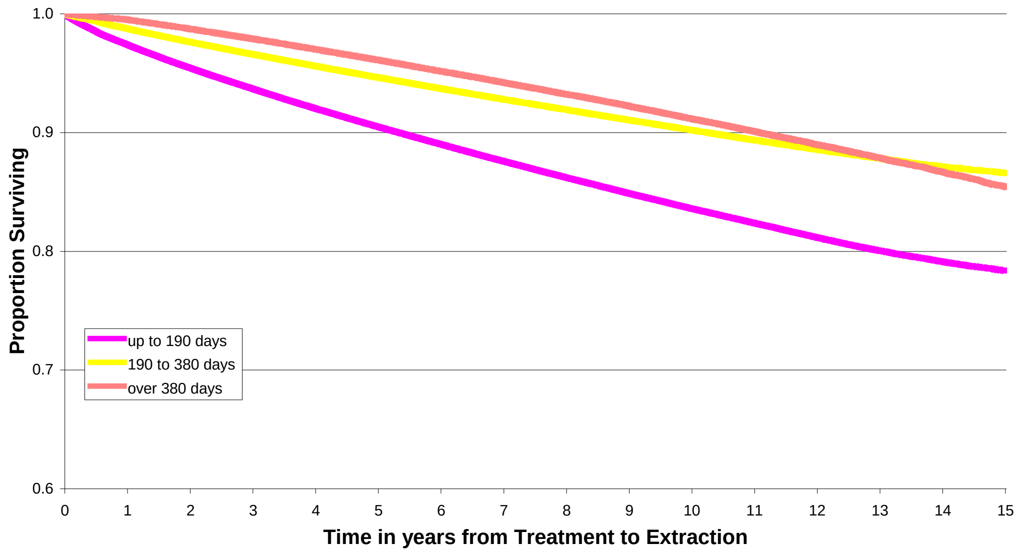


Table 17 Survival to Reintervention by Patient Median Attendance Interval

	Survival (%) at				
Median Attendance Interval	1 year	5 years	10 years	15 years	n
up to 190 days	85	57	41	33	2,425,431
190 to 380 days	92	68	53	44	3,480,198
over 380 days	97	80	64	50	1,084,980
All Restorations	91	66	51	41	7,292,564

Table 18 Survival to Extraction by Patient Median Attendance Interval

	Survival (%) at				
Median Attendance Interval	1 year	5 years	10 years	15 years	n
up to 190 days	97	90	84	78	2,425,431
190 to 380 days	99	95	90	87	3,480,198
over 380 days	100	96	91	85	1,084,980
All Restorations	98	93	88	84	7,292,564

Other factors

When the effect of placement of a root canal filling in the same course of treatment as the amalgam restoration is examined, the differences are dramatic with regard to time to re-intervention and time to extraction of the restored tooth. At 15 years the time to re-intervention is reduced by *circa* 15 percentage points (Figure 14 and Table 19) and the time to extraction of the root filled restored tooth is reduced again by *circa* 15 percentage points (Figure 15 and Table 20).

Figure 14 Survival to Reintervention by Presence of Root Filling

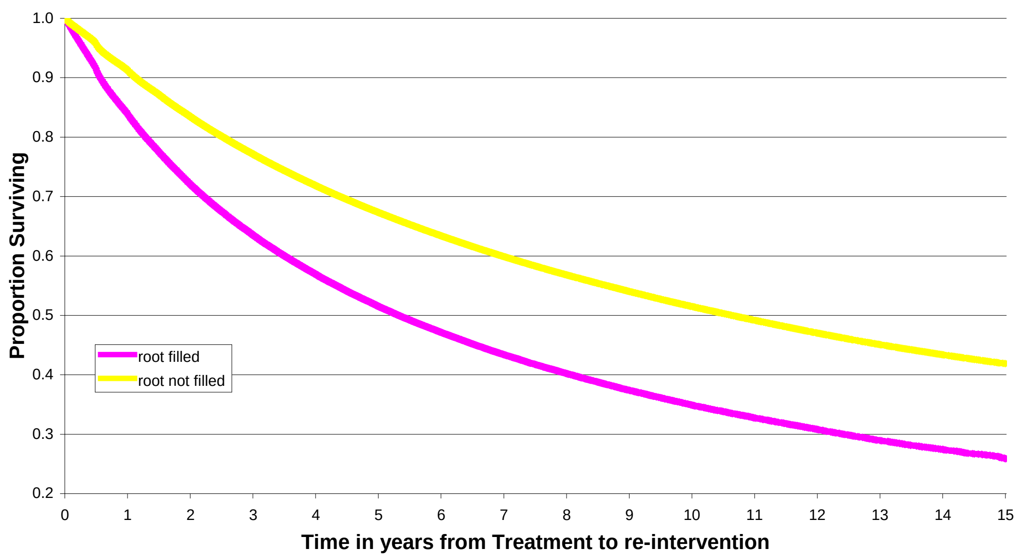


Figure 15 Survival to Extraction by Presence of Root Filling

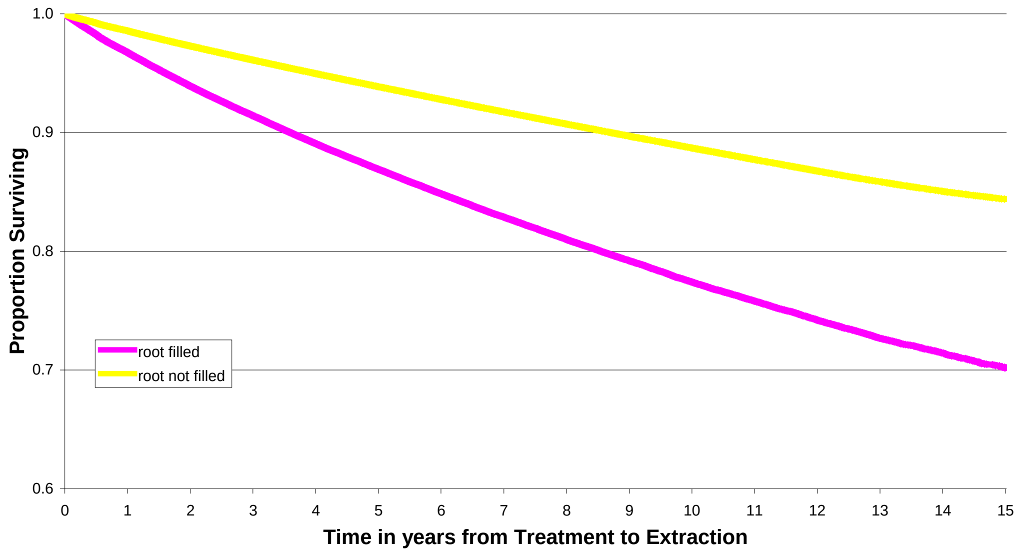


Table 19 Survival to Reintervention by Presence of Root Filling

	Survival (%) at				
Root filling in same course	1 year	5 years	10 years	15 years	n
root filled	84	52	35	26	419,190
root not filled	91	67	51	42	6,873,374
All Restorations	91	66	51	41	7,292,564

Table 20 Survival to Extraction by Presence of Root Filling

	Survival (%) at				
Root filling in same course	1 year	5 years	10 years	15 years	n
root filled	97	87	77	70	419,190
root not filled	99	94	89	84	6,873,374
All Restorations	98	93	88	84	7,292,564

Dentine pins and screws have been used to retain large amalgam restorations, in situations where the clinician has considered that there is insufficient tooth substance remaining for adequate mechanical retention of the restoration. It may therefore be considered to be of interest to examine the effects of pin or screw placement. In this regard, when Figure 16 is examined, it is apparent that such placement is associated with a *circa* 10 percentage point reduction (Table 21) in the survival of the restoration at 15 years, and with a *circa* 5 percentage point reduction in the time to extraction of the restored tooth (Figure 17 and Table 22).

Figure 16 Survival to Reintervention by Pin/screw Retention

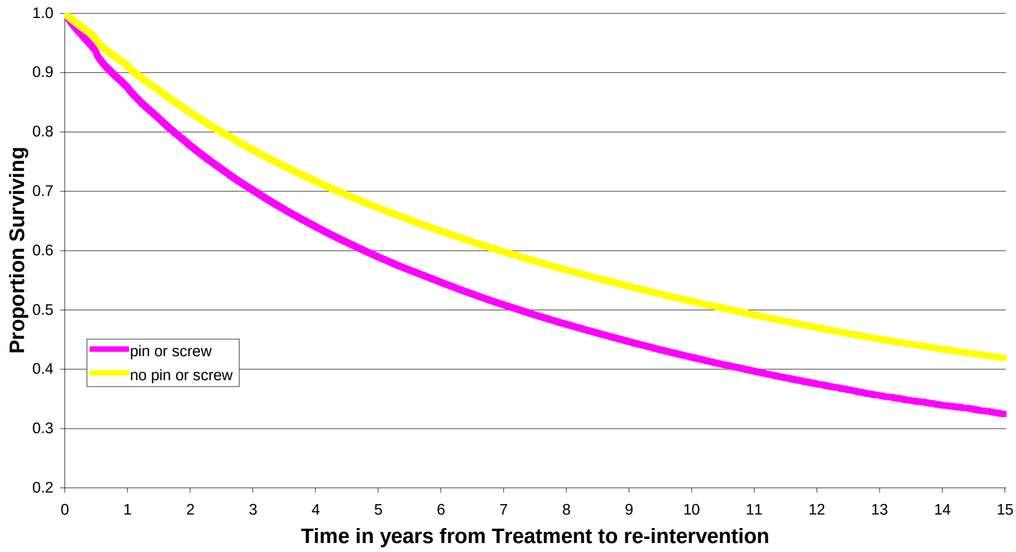


Figure 17 Survival to Extraction by Pin/screw Retention

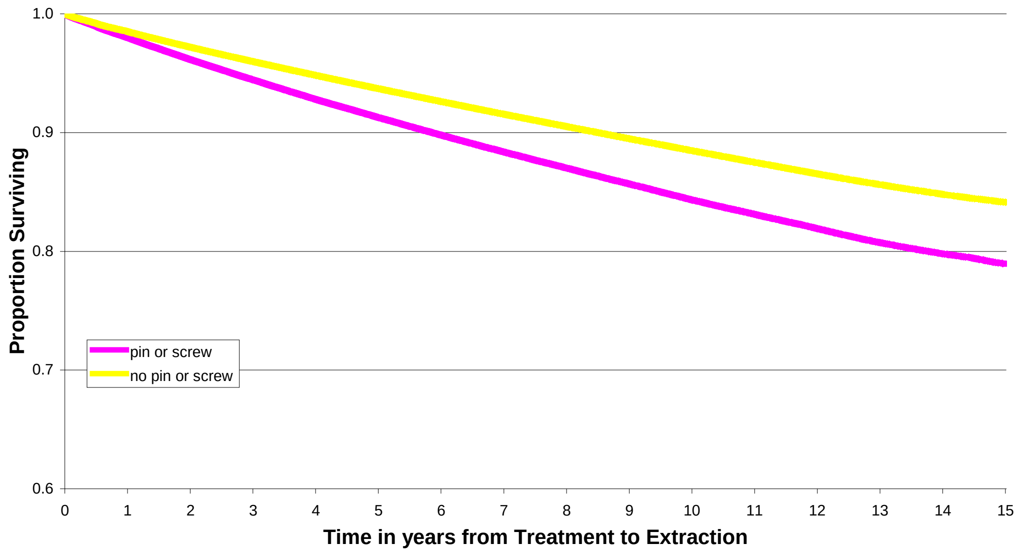


Table 21 Survival to Reintervention by Pin/screw Retention

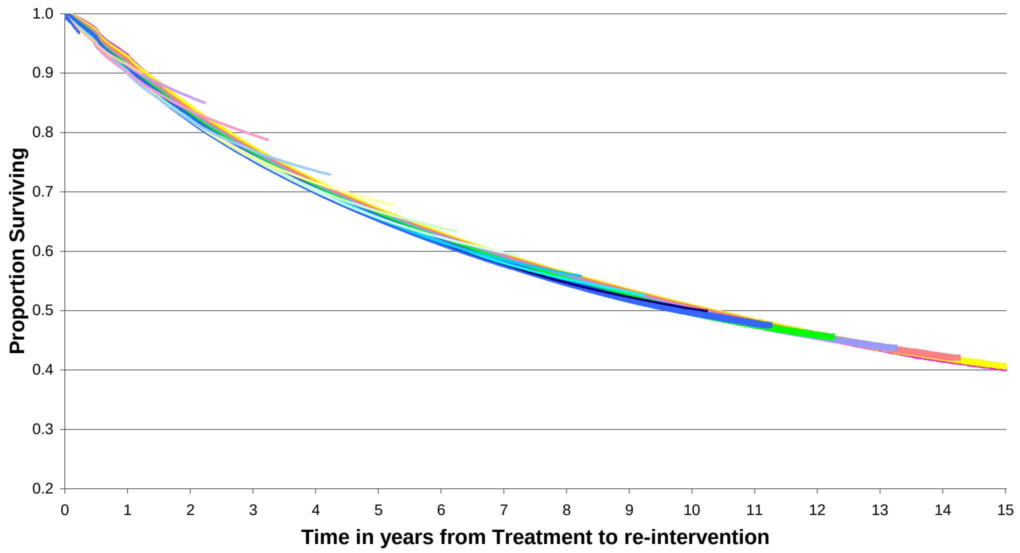
	Survival (%) at				
Pin or Screw	1 year	5 years	10 years	15 years	n
pin or screw	87	59	42	32	647,038
no pin or screw	91	67	51	42	6,645,526
All Restorations	91	66	51	41	7,292,564

Table 22 Survival to Extraction by Pin/screw Retention

	Survival (%) at				
Pin or Screw	1 year	5 years	10 years	15 years	n
pin or screw	98	91	84	79	647,038
no pin or screw	99	94	88	84	6,645,526
All Restorations	98	93	88	84	7,292,564

When the data are analysed with regard to year of placement of the amalgam restoration, no major differences are apparent, either in terms of time to reintervention or time to extraction of the restored tooth, between restorations placed in 1990 and those placed in 2006, and the years between these (Figure 18).

Figure 18 Survival to Extraction by Year of Acceptance



Discussion

This work presents the analysis of 25 million courses of treatment being linked over 15 years, using a new dataset which was released to the research community in August 2012 by the UK Data Service[2]. This dataset is the largest ever to become available for analysis of the survival of dental treatment, with this being the first publication on restoration survival related to the interrogation of this dataset. It is also the first publication to explore the effect of restoration type upon survival of the restored tooth to extraction, with this being considered to be a valuable exercise, given that it is survival of a tooth which is important, rather than the survival of a restoration *per se*. Because of the size of the dataset, not only can complex interactions be explored, but the robustness of resultant models and algorithms can be tested by replication. Given the prevalence of amalgam restorations in the community[3], these data may be considered to be representative of amalgam restorations in the population at large in England and Wales.

As pointed out in paper 1[1], although dentists in England and Wales have been remunerated using a different system since 2006, it may be considered that dentists will have continued to treat their patients in an ethical manner. Furthermore, the materials used for restoration of teeth, particularly dental amalgam, have changed little over the years since the data for this work ceased to be collected. In addition, the size of the present dataset is such that this has enabled the effect of restorations on years to extraction of the restored tooth to be calculated. In the analysis of restoration performance over the duration of the data collection (1990 to 2006), the charts (Figure 18) indicate no difference in performance of those years, another potential indication that the results remain valid at the present time.

Cavity size

The analysis confirms that, with regard to amalgam restorations, larger restorations performed less well than smaller restorations. This finding may not be a surprise to practising dentists who have read the literature or who have monitored their patients (and *their* restorations) for a period of time, but this is put into greater perspective when time to extraction of the restored tooth is examined. In this regard, a tooth with a large (for example MOD) amalgam restoration has a cumulative survival which is about five percentage points less at time of extraction, compared with smaller amalgam restorations. However, some single surface restorations may also be (volumetrically) larger than a minimal class II restorations: this may therefore explain why two-surface restoration survival is more closely aligned to that of a single surface rrstoration, rather than midway between a single-surface and a three surafce rstoration, as presented in Figure 2.

The reasons for the poorer survival of the three-surface, MOD, restoration may only be surmised, but could include the higher potential for cusp fracture of the heavily restored tooth[4,5], perhaps necessitating a crown, followed by the need for a root filling (with 19% of crowned teeth having been shown to require a root filling in *circa* five years[6]) and failure of such multiple treatments. These comments may also apply to the data which indicate, in respect of teeth which receive a root canal filling in the same course of treatment as an amalgam restoration, dramatically reduced survival of restoration and tooth. These data suggest that restoration of teeth before the pulp becomes involved is a worthwhile idea, or, indeed, applying the concept of sealing caries into a vital asymptomatic tooth (obviating the need for a root canal filling) as described in the review by Kidd and co-workers[7], is a concept worthy of strong consideration.

Also with regard to cavity size, dentine pins have been used to retain restorations in which there is insufficient residual tooth substance to retain the restoration. Figures 16 and 17 have indicated that restorations in which pins have been placed perform less well both in terms of survival of the restoration and survival of the restored tooth when compared with restorations which did not include pin placement. Pin placement may be considered technique sensitive, with the risk of placing the pin incorrectly and causing a traumatic exposure of the pulp, or, in the other direction, a perforation through the radicular dentine into the periodontal membrane. On the other hand, whether the adverse effect of pin placement is related to these traumatic factors of pin placement *per se*, or whether this effect simply relates to the fact that the clinician is attempting to restore a very large cavity is not known. On the other hand, it could be a combination of both.

Other factors can, of course, come into play, such as loss of the tooth because of periodontal problems, but, given the size of the dataset under analysis in the present work, the association between the size of the restoration and the time to loss of the restored tooth must surely be noteworthy. The clear message is to keep restorations as small as possible and this might include considering the use of adhesive techniques in conjunction with resin composite which enable the clinician to prepare less invasive cavities[8], (for example two minimal class II restorations, one mesial and one distal) rather than an MOD, and, following from that, reducing the potential for fracture which has been demonstrated following placement of MOD amalgam restorations[4,5]. In this regard, as an alternative to pin-retained amalgam restorations, there is evidence of a satisfactory success rate from a five-year clinical evaluation in which one third of the restorations involved the restoration of a large (adhesively retained) cusp replacement resin composite restorations[9].

Dentist factors

Regarding dentists' gender, amalgam restorations placed by female dentists and those placed by male dentists indicate little difference. However, dentists' age has been shown to play a part in the present investigation, with younger dentists placing amalgam restorations with greater survival and time to reintervention on or extraction of the restored tooth. This trend was apparent in work on the previous (much smaller) dataset[10] and the causes of this trend may only be surmised. First, the younger dentists will be more recent graduates who may still be following the teaching from dental school, which involves placement of rubber dam and, arguably, use of the most up-to-date techniques. In this regard, results of a recent survey of UK dentists[11] have indicated that only a relatively small proportion of respondents used rubber dam "routinely". In addition, the visual acuity of the older dentists may be less good than that of the younger dentists, given that this deteriorates with age, and the younger dentist may be in a position to treat fewer patients per session (i.e. spend more time placing the restoration) because their financial responsibilities may not be that of the older dentists. In addition, given that replacement of restorations has been demonstrated to account for *circa* 60% of restorations placed[12], the younger dentist may have been trained to adopt a more cautious, "wait and see" approach. On the other hand, recent research[13] examining the cavity and crown preparations of FD1 dentists (i.e those who are in their first year following graduation) in England identified deficiencies in technique, which would tend to challenge the findings of the present study, despite older dentists being expected to have more experience. Furthermore, older dentists tend to have older patients, and since older patients have restorations which survive less well, this may skew the results. However, work on the previous dataset identified that this did not entirely explain the picture[14], so it may be assumed that that is the case for the present work. Whatever the factors, the message is clear, younger dentists place more long-lasting amalgam restorations than their older colleagues!

Patient factors

Restorations in younger patients perform more favourably than those in older patients. Practising clinicians will readily potentially surmise the reasons, among these being:

- Younger patients' teeth are less likely to be weakened by previous restorations. Younger patients will potentially be more dextrous than older patients when it comes to oral healthcare maintenance

- Younger patients may be less likely to be on the multiple medications which may be necessary to maintain the health of older patients, with some of these potentially reducing salivary flow

- Some teeth may be lost in older patients because of periodontal disease: the dataset is unable to ascertain the reason for loss of a tooth

- Diet may play a factor

Another patient factor relates to whether the patient pays a patient charge for their treatment, given that this analysis indicates clearly that patients who are exempt from payment receive restorations with less good survival, as measured by time to re-intervention or, reduced time to extraction of the restored tooth, this method of assessment being particularly evident. Again, reasons may only be surmised – with the reasons tied into societal factors. In this regard, the patient who is exempt from payment is likely to be in a household of lower income and the Adult Dental Health Survey[3] has identified poorer oral health in such persons – they may not be so aware of the benefits of non-cariogenic diet and good oral healthcare. Given that the potential for loss of the restored tooth at 15 years is *circa* 3 percentage points different between non-payers and payers, it may be considered that this represents a need for education in oral healthcare among the groups who do not pay for their dental treatment.

The analyses of patient annual treatment cost and median interval between courses of treatment provide powerful evidence that the survival of an individual restoration or tooth is intimately linked with the state of oral health of the patient. From the dataset it is impossible to measure oral healthy directly, but it is reasonable to assume that there is a strong correlation between the need for treatment and its provision.

Tooth position

Regarding the influence of tooth position (Figure 4), it is apparent, in terms of restoration survival, that amalgam restorations in third molar teeth perform more favourably than restorations in other teeth, in terms of time to re-intervention, with restorations in anterior teeth (central and lateral incisors and canine teeth) performing less well. The reasons for this may only be surmised, but could be considered to be that these teeth erupt up to15 years later than first molar teeth, by which time the patient’s diet and oral hygiene might have improved, compared with childhood. On the other hand, when time to extraction is evaluated, third molar teeth perform less well, perhaps representing the fact that these teeth may be extracted for reasons other than restoration failure, such as pericoronitis.

Whichever way amalgam restoration viability is examined (time to re-intervention or time to extraction), restorations in anterior teeth perform less well than posterior teeth, with time to extraction being particularly obvious, with a *circa* twenty percentage point difference between anterior teeth and the best performing molar tooth. The reasons for this may only be surmised. Amalgam restorations cannot be considered to be aesthetic, therefore will generally be placed on the palatal aspect of anterior teeth, so some of these (proportion unknown) may have been placed in an access cavity in a tooth which has received a root filling, i.e. in a tooth which has already been compromised by caries or trauma. On the other hand, the fact that an anterior tooth has received an amalgam restoration may represent a tooth with a large carious cavity affecting its palatal surface. Whichever may be the scenario, amalgam restorations in anterior teeth do not perform as well as in posterior teeth. A subsequent paper will examine the survival of tooth coloured restorations in anterior teeth and compare the survival of those with restorations formed in amalgam.

Conclusions

- Larger amalgam restorations perform less well than smaller restorations.
- Amalgam restorations in anterior teeth perform less well than those in posterior teeth.
- Amalgam restorations in younger patients perform more favourably than those in older patients.
- Patients with a history of frequent attendance or high annual dental treatment costs have much poorer amalgam restoration survival than those who attend less frequently or who have low annual dental treatment costs.

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