

The ultimate guide to restoration longevity in England and Wales. Part 7: premolar teeth: time to next intervention and to extraction of the restored tooth

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Key points

Overall, over 3.5 million restorations involving premolar teeth were included in the analysis. With regard to time to re-intervention, 42% of restorations had survived at 15 years, and with regard to time to extraction of the restored tooth, cumulative survival was 82%. Factors influencing survival include age of patient, patient's treatment need, and age of dentist.

Overall, crowns placed on premolar teeth perform best to re-intervention after 15 years, but worst when the time to extraction of the restored tooth is examined. However, crowns represent a better option in terms of years to extraction of the restored tooth in the over 60 year age group.

With regard to tooth position, restored premolar teeth in the upper arch have less good survival time to extraction than those in the lower arch, whereas time to re-intervention on the restoration is similar in both arches.

Aim It is the aim of this paper to present data on the survival of restorations in premolar teeth 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 (GDS) 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 a restoration in a premolar tooth 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). In total, 3,591,372 restorations involving premolar teeth were included in the analysis. With regard to time to re-intervention, 42% of restorations had survived at 15 years, and with regard to time to extraction of the restored tooth, cumulative survival was 82%. **Conclusions** Overall, crowns placed on premolar teeth perform best to re-intervention after 15 years, but worst when the time to extraction of the restored tooth is examined. Factors influencing restoration longevity in premolar teeth include: age of patient, patient's treatment need, and age of dentist.

Introduction

Satisfactory survival of restorations is of importance to patients, dental professionals, epidemiologists, third-party funders, governments, and other interested parties. The provision of accurate information on restoration survival, and the factors which may influence this is therefore of relevance to many

persons and organisations. It is also important that the data are 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. Using the methodology described in Paper 1 in this series,¹ it has been possible to produce precise information regarding the survival of restorations in premolar teeth and the factors which may influence this.

It is therefore the purpose of this paper to investigate the survival of direct-placement restorations and crowns in premolar teeth, by assessing:

- Time to re-intervention and the factors associated with this
- Time to extraction and the factors associated with this.

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). Of these, 3,591,372 restorations involved premolar teeth.

Restorations in premolar teeth

When the survival of restorations in premolar teeth is examined with respect to time to re-intervention, it is apparent that, overall, 40% of restorations have survived at 15 years, with 50% having survived to ten years and 65% having

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Fig. 1 Time to re-intervention of restorations in premolar teeth, overall

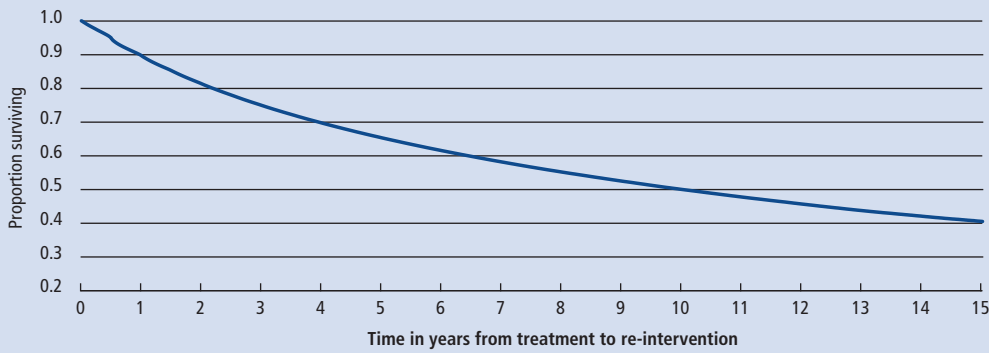


Fig. 2 Time to extraction, overall, of restored premolar teeth

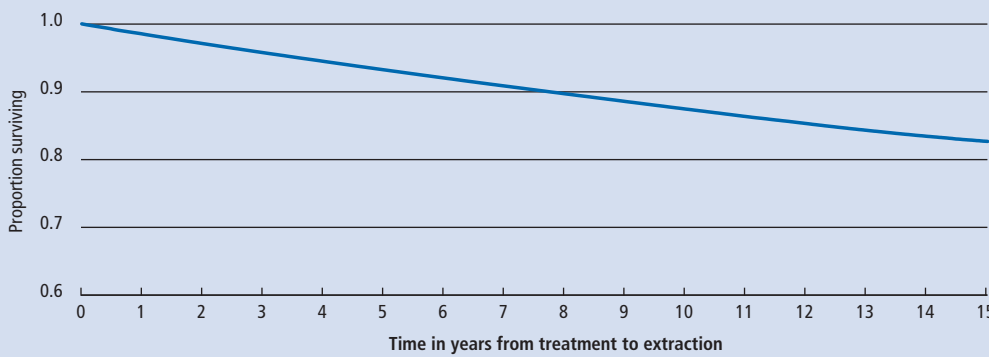


Fig. 3 Time to re-intervention of restorations in premolar teeth, with regard to the most commonly placed restorations

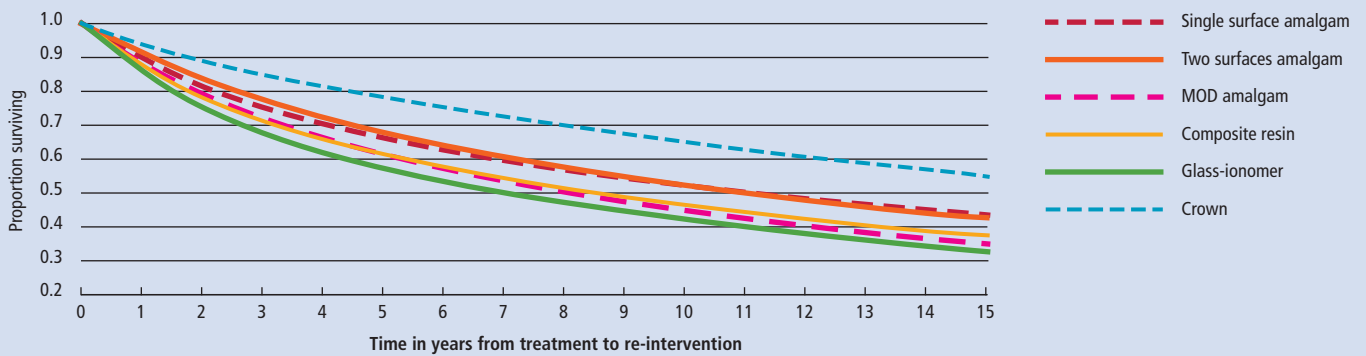
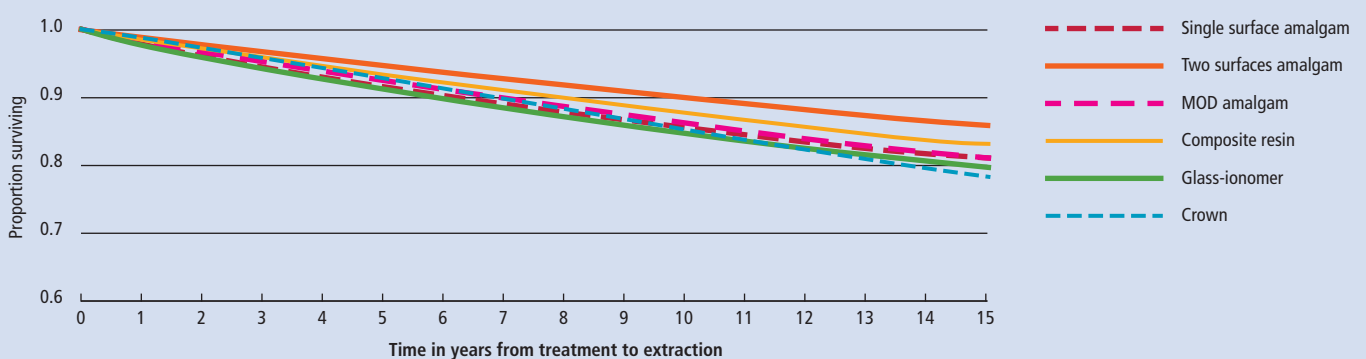


Fig. 4 Time to extraction of restored premolar teeth, with regard to the most commonly placed restorations



survived to five years (Fig. 1 and Table 1). When the data are re-analysed with regard to time to extraction, it is found that 83% of restored premolar teeth have survived for 15 years, with 87% having survived to ten years and 93% to five years (Fig. 2 and Table 2).

Over 16 different types of restoration (including a variety of crowns) could be placed in premolar teeth under the General Dental Services (GDS) regulations pertaining at the time of this study, so the analysis was confined to more commonly used restoration types, namely, amalgam restorations, glass ionomer (GI) restorations, resin composite restorations and crowns. The most frequently placed restorations were two surface (mostly MO or DO) amalgams ($n = 1,250,356$), MOD amalgam restorations ($n = 595,308$), closely followed by resin composite and glass ionomer, with the number of crowns being 371,410. In this regard, by far the most frequently-placed crown type was bonded porcelain (metal-ceramic). It should be noted that, under the regulations, GI and composite materials could not be placed in loadbearing situations in premolar teeth. With regard to re-intervention, it is apparent that crowns outperform other commonly provided restoration types (Fig. 3), with smaller amalgams performing more favourably than large, and with GI restorations performing least favourably. However, when the data are analysed with regard to time to extraction of the restored premolar tooth, the chart (Fig. 4) tells a different story. Crowns no longer represent the optimally performing restoration, indeed, they are the worst performing at 15 years, with class II amalgams and resin composite restorations performing most favourably in terms of time to extraction of the restored tooth. Tables 1 and 2 give the survival percentages at one, five, ten and 15 years for time to re-intervention and time to extraction, respectively. The tables also include n , the number of cases used in the analysis.

Restorations in premolar teeth with respect to patient age

When the data are analysed with regard to patient age and restoration survival to re-intervention, it is apparent that restorations in premolar teeth perform less well in older than in younger patients (Fig. 5 and Table 3). The same is true for survival to extraction (Fig. 6 and Table 4). When the data are re-analysed with regard to patient age (<40 and >40 years) and restoration type in premolar teeth, it is apparent that single surface

Table 1 Time to re-intervention of restorations in premolar teeth, with regard to the most commonly placed restorations

Type of treatment	Survival (%) at				
	1 year	5 years	10 years	15 years	n
1 surface amalgam	90	66	52	44	256,562
2 surface amalgam	91	68	52	43	1,250,356
MOD amalgam	88	61	45	35	595,308
Composite resin	87	61	46	37	629,033
Glass-ionomer	86	57	42	33	488,703
Crown	94	78	65	55	371,410
All restorations	90	65	50	40	3,591,372

Table 2 Time to extraction of restored premolar teeth, with regard to the most commonly placed restorations

Type of treatment	Survival (%) at				
	1 year	5 years	10 years	15 years	n
1 surface amalgam	98	92	86	81	256,562
2 surface amalgam	99	95	90	86	1,250,356
MOD amalgam	98	93	86	81	595,308
Composite resin	99	93	88	83	629,033
Glass-ionomer	98	91	85	80	488,703
Crown	99	93	85	78	371,410
All restorations	99	93	87	83	3,591,372

amalgams and crowns out-perform other restoration types in terms of survival to re-intervention in the under-40 years age group (Fig. 7). In this age group, MOD amalgams and GI restorations perform least favourably in terms of time to re-intervention. When the over-40 years age group is examined (Fig. 8) in terms of time to re-intervention, a crown represents an enhanced treatment option, of over 20 percentage points better survival than the next best performing restorative option, a two surface amalgam restoration.

We have already noted that when time to extraction of the restored premolar tooth is examined (Fig. 4), a crown no longer represents the optimum treatment option, indeed, it represents the worst performing option, with the cumulative survival at fifteen years of crowned premolar teeth being *circa* eight percentage points less than the best performing restoration, a two surface amalgam (Table 2). This effect remains when the under-40 age group is analysed with regard to restoration type (Fig. 9), but there is now a *circa* 13 percentage point difference in fifteen-year cumulative survival between crowns and single

surface amalgam restorations. Further analysis indicates that in the 20 to 29 year age group, crowns represent the worst outcome of any treatment modality in terms of years to extraction of the restored tooth (Fig. 10), with this effect being apparent also in the 30 to 39 years and 40 to 49 years age groups. However, at the opposite end of the age spectrum, crowns again represent a better option in terms of years to extraction of the restored tooth (Fig. 11) in the 60 to 69 year age group, with crowns narrowly outperforming two surface amalgams and composite restorations. Indeed, there is a steady improvement in the relative performance of crowns with increasing patient age. Tables 5 and 6 illustrate this by showing how the ten-year survival percentages vary with age of patient and type of treatment.

Influence of dentist factors (gender and age)

With regard to dentists' gender, there are no differences in survival of restorations to re-intervention in premolar teeth. However, when dentists' age is examined, the chart indicates that restorations in premolar teeth placed by

Fig. 5 Time to re-intervention of restorations in premolar teeth, with regard to patient age

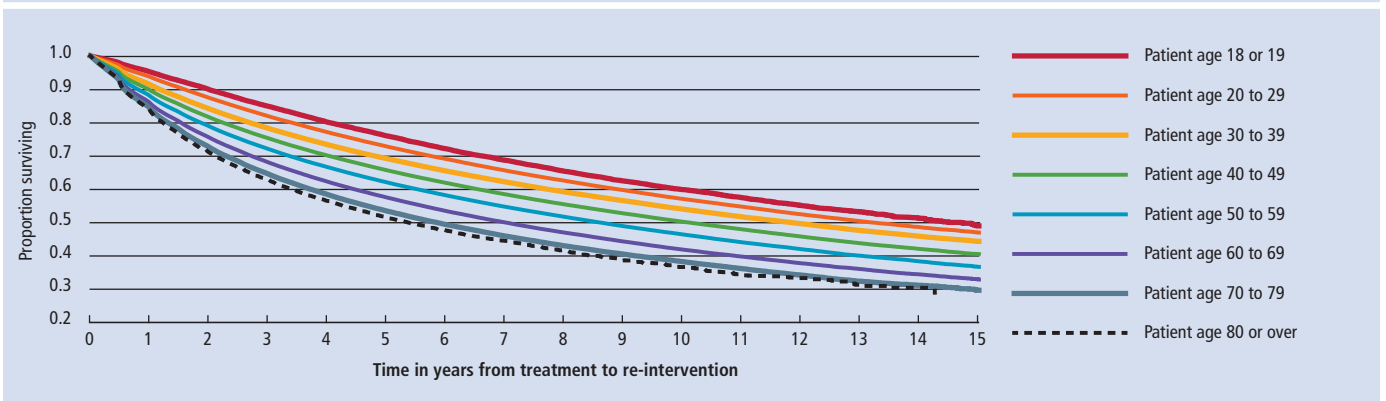


Fig. 6 Time to extraction of restorations in premolar teeth, with regard to patient age

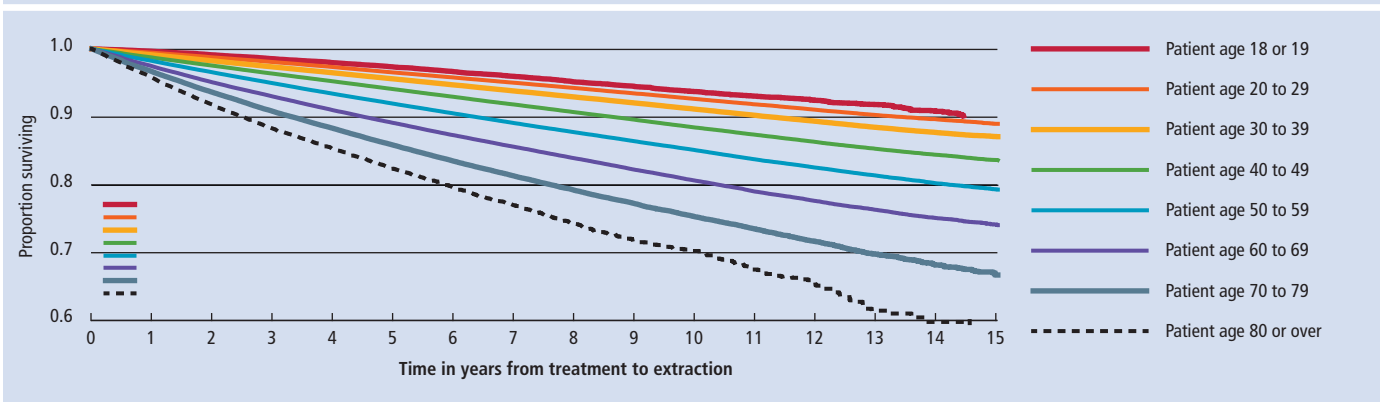


Fig. 7 Time to re-intervention of restorations in premolar teeth, in patients aged under 40 years of age

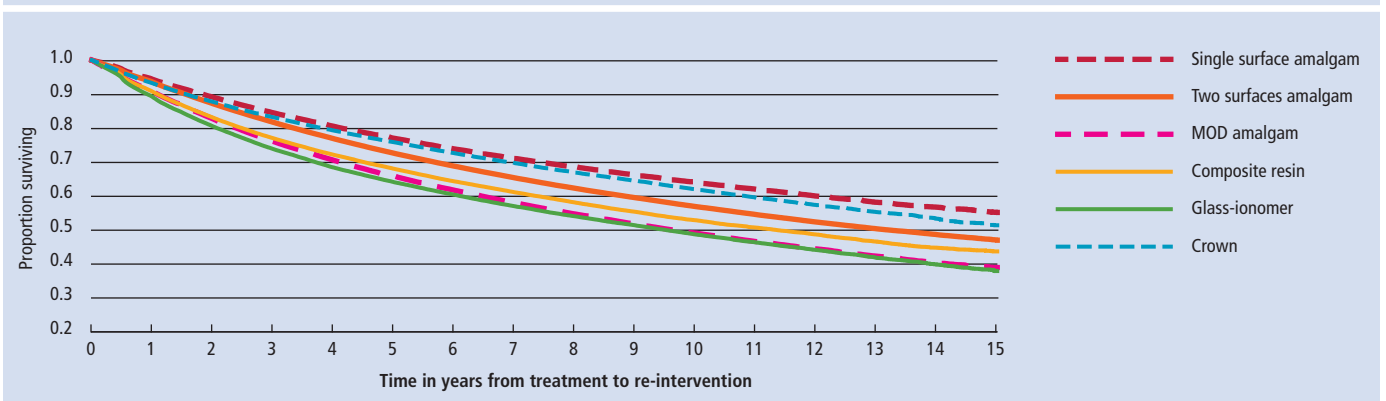


Fig. 8 Time to re-intervention of restorations in premolar teeth, in patients aged over 40 years of age

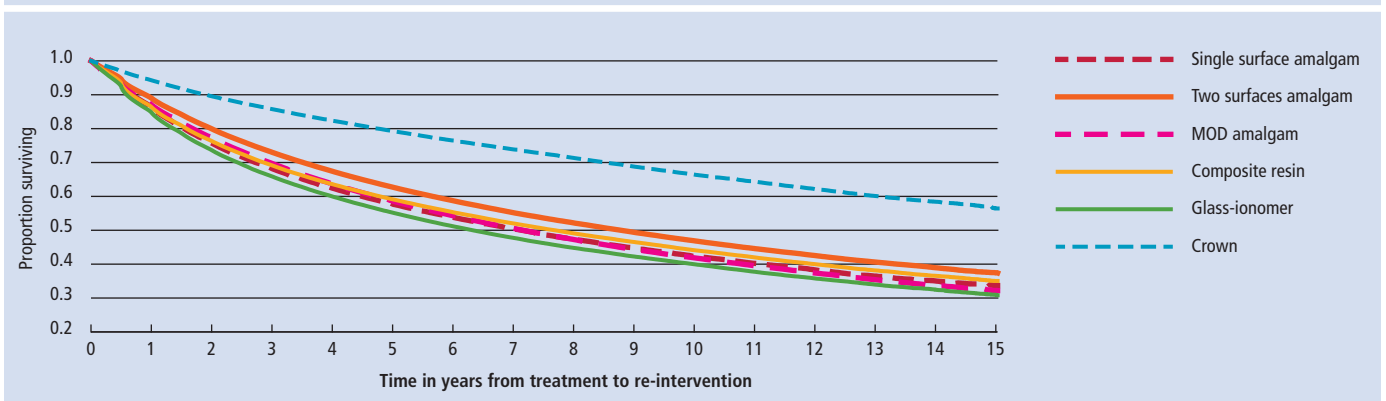


Table 3 Time to re-intervention of restorations in premolar teeth, with regard to patient age

Patient age	Survival (%) at				n
	1 year	5 years	10 years	15 years	
18 or 19	95	76	60	49	63,328
20 to 29	94	73	57	47	544,510
30 to 39	91	69	54	44	808,445
40 to 49	90	66	50	41	803,116
50 to 59	88	62	46	37	663,641
60 to 69	86	58	42	33	437,017
70 to 79	84	54	38	30	215,653
80 or over	84	52	37	–	55,662
All restorations	90	65	50	40	3,591,372

Table 4 Time to extraction of restorations in premolar teeth, with regard to patient age

Patient age	Survival (%) at				n
	1 year	5 years	10 years	15 years	
18 or 19	100	97	94	–	63,328
20 to 29	99	97	93	89	544,510
30 to 39	99	96	91	87	808,445
40 to 49	99	94	88	84	803,116
50 to 59	98	92	85	79	663,641
60 to 69	97	89	81	74	437,017
70 to 79	97	86	75	67	215,653
80 or over	96	82	70	–	55,662
All restorations	99	93	87	83	3,591,372

younger dentists outperform those placed by older dentists by *circa* three percentage points at 15 years. When time to extraction of the restored tooth is examined, similar differences exist in relation to dentists' age. Tables 7 and 8 give the survival rates at one, five, ten and 15 years.

Influence of patient paying for treatment or not?

When the influence of patients who are exempt from, or have remission of payment for treatment is examined, there is a small influence on restoration survival to re-intervention, with restorations in patients exempt from charges performing *circa* five percentage points worse at 15 years (Fig. 12 and Table 9). When this exercise is repeated with regard to time to extraction of the restored premolar tooth, the chart indicates a three percentage point difference at 15 years, with the teeth of

charge-payers surviving longer than those who do not pay (Fig. 13 and Table 10).

Influence of tooth position

With regard to tooth position, there is no difference in premolar restoration survival to re-intervention with respect to upper vs lower arch. The difference between individual tooth positions is minimal (Fig. 14).

However, when time to extraction is examined, it is apparent that survival of lower premolar teeth is, overall, *circa* three percentage points better than for upper premolar teeth with the upper first premolar tooth performing least well (Fig. 15 and Table 11).

Influence of patient treatment need

Annual spend on dental treatment may be considered as a proxy for patient treatment need; accordingly, the influence of this on restoration survival can be examined. With regard

to restoration survival to re-intervention, the chart (Fig. 16) indicates a dramatic difference between those with the least and the highest accumulation of treatment fees, with those with the highest spend having restorations which survive over forty percentage points less well at fifteen years than those with the least spend (Table 12). With regard to time of survival to tooth extraction, the chart (Fig. 17) for time of survival of the restored tooth is similarly dramatic. At fifteen years, patients with higher treatment need have teeth with nearly twenty percentage points worse survival than those patients with minimal treatment need (Table 13).

Other factors

Figure 18 presents the chart relating to whether a root filling was placed in the same course of treatment as the restoration placed in the premolar tooth, and indicates compromised survival of the restoration by a factor of *circa* 11 percentage points (Table 14). When time to extraction is examined, it is apparent that the placement of a root filling in the same course of treatment leads to a reduced life expectancy of the tooth, by *circa* 13 percentage points in cumulative survival (Fig. 19 and Table 15).

Finally, the data indicate that survival of restorations in premolar teeth has not improved, either in terms of time to re-intervention or time to extraction (Fig. 20), during the timespan of this study.

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. Not only does this allow a means of assessing restoration survival to re-intervention but it also facilitates the analysis by restoration type of survival of the restored tooth to extraction. In other words, survival of the tooth rather than survival of the restoration *per se*. This set of data faithfully represents the decisions and outcomes observed within the general dental services of England and Wales. It does not provide evidence as to what the outcome would be if two competing restorations were to be applied to two different teeth in identical circumstances. However, it is reasonable to assume that each decision has been made using the practitioner's best

Fig. 9 Time to extraction of restored premolar teeth in patients under 40 years of age, with regard to restoration type

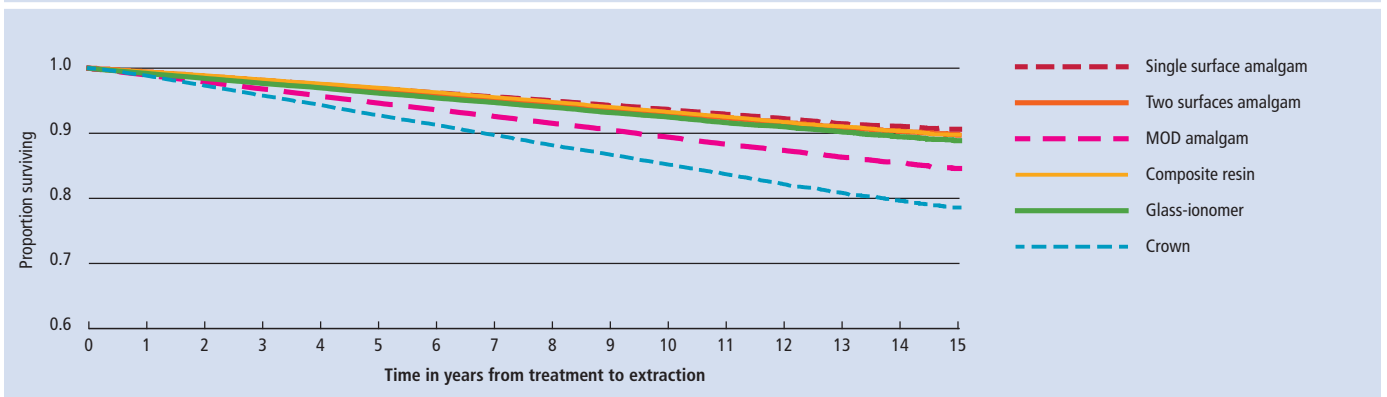


Fig. 10 Time to extraction of restored premolar teeth in patients of 20 to 29 years, with regard to restoration type

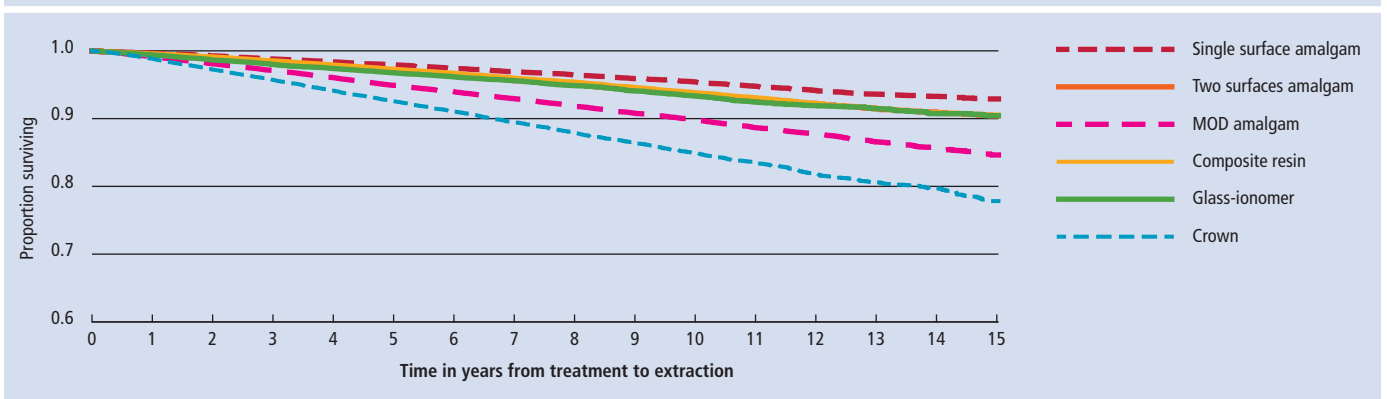
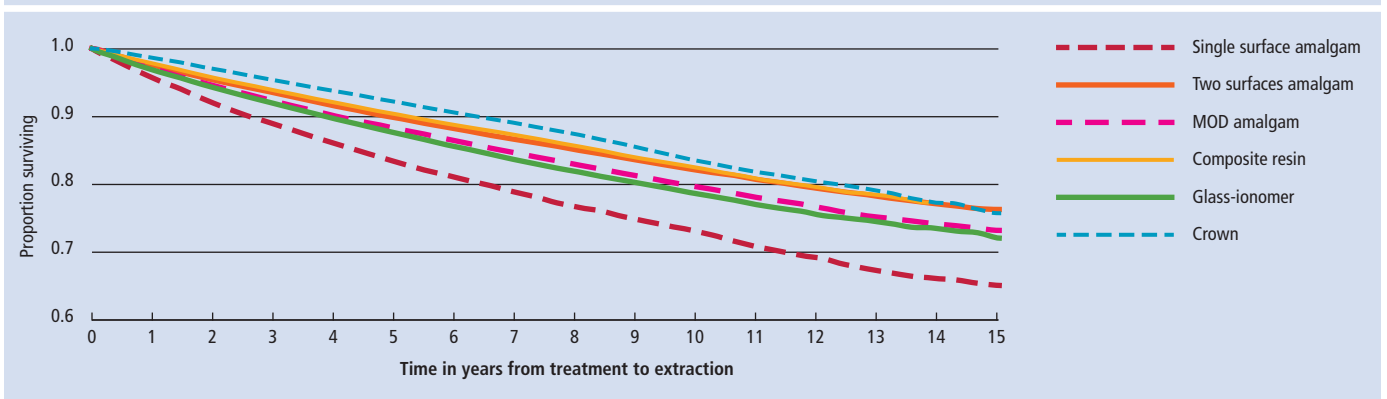


Fig. 11 Time to extraction of restored premolar teeth in patients of 60 to 69 years of age, with regard to restoration type



clinical judgement, mediated by the wishes of his patient. Throughout the present work, the data were collected at a time when there were stringent quality assurance mechanisms in place (the Dental Reference Service), so it may be assumed that clinicians acted in the best interests of the patient in the treatment that they prescribed.

While the results of the present work on restored premolar teeth, in respect of time to re-intervention and time to extraction of the restored tooth, may initially appear to be contradictory, the analysis confirms that

when a premolar tooth is restored with a crown, the time to re-intervention in the over 40 age group out-performs all other restoration types at all ages (Fig. 7). However, when time to extraction of the restored tooth is examined, important differences are observed (Figs 8 and 9). This is similar to the findings concerning molar teeth,³ but the contrast between survival to next re-intervention and survival to extraction is even starker for premolar teeth. Crowning a tooth leads to a reduced lifespan of the crowned tooth, in all age groups other than the over-60s, even

though the crown performs best in terms of restoration survival. The reasons for this may only be surmised. Compared with a full coverage (crown) restoration, the direct placement restoration has more factors which lead to failure, such as lengthy margins and secondary caries, whereas the crown may be considered to 'protect' underlying tooth substance. However, the data suggest that, when a crown fails, it is more likely to be due to a catastrophic failure, possibly due to ingress of caries, failure of the (dentine or material) core which then challenges the loss of tooth

Table 5 Ten-year survival to re-intervention of restored molar teeth, with regard to patient age and type of restoration

Treatment Type	Patient Age							
	18 or 19	20 to 29	30 to 39	40 to 49	50 to 59	60 to 69	70 to 79	80 or over
Single surface amalgam	70	68	60	49	42	36	32	35
Two surfaces amalgam	59	58	56	51	46	41	39	37
MOD amalgam	56	51	48	45	41	38	36	35
Composite resin	57	55	52	48	45	41	37	37
Glass-ionomer	52	49	49	45	41	37	33	33
Crown	66	61	62	66	68	66	65	65

Table 6 Ten-year survival to extraction of restored molar teeth, with regard to patient age and type of restoration

Treatment Type	Patient Age							
	18 or 19	20 to 29	30 to 39	40 to 49	50 to 59	60 to 69	70 to 79	80 or over
Single surface amalgam	96	95	92	86	80	73	66	61
Two surfaces amalgam	94	94	93	90	86	82	78	72
MOD amalgam	91	90	89	87	84	80	76	71
Composite resin	95	94	93	90	87	82	78	73
Glass-ionomer	93	93	92	88	84	79	72	68
Crown	86	85	85	86	86	84	81	81

Fig. 12 Time to re-intervention of restored premolar teeth, with regard to whether the patient is exempt from charges, or not

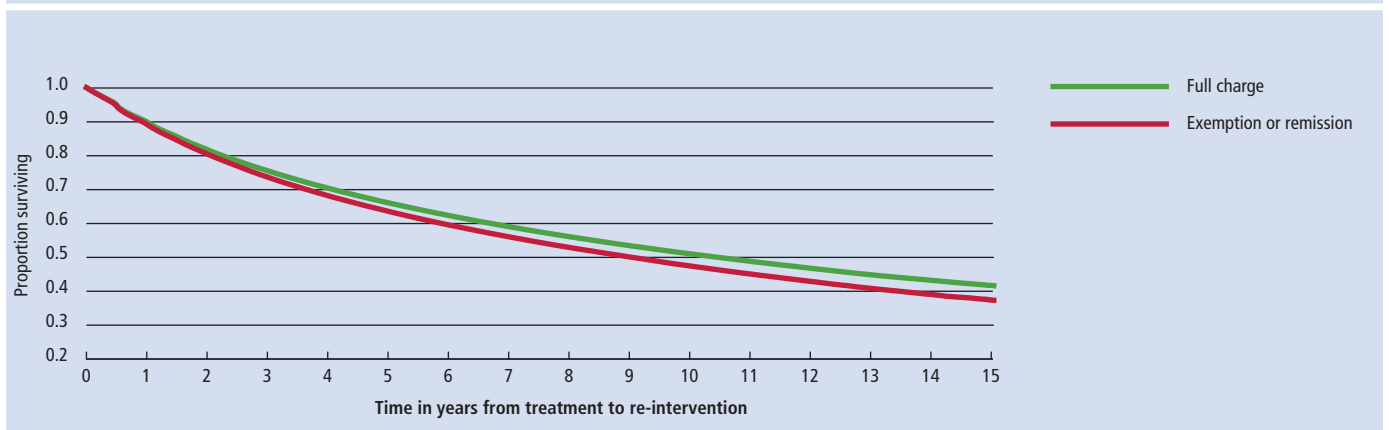


Fig. 13 Time to extraction of restored premolar teeth, with regard to whether the patient is exempt from charges, or not

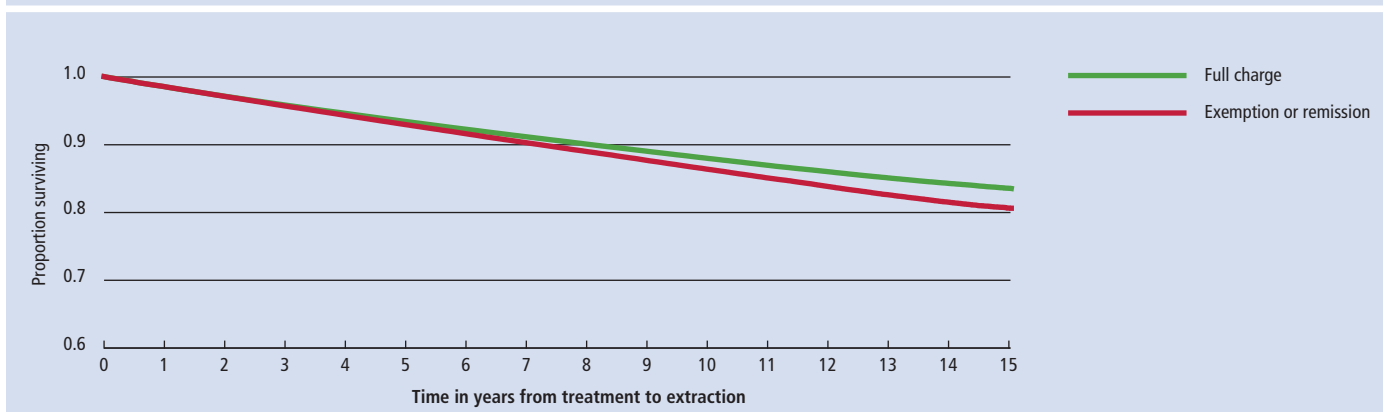


Fig. 14 Time to re-intervention of restorations in premolar teeth, with regard to tooth notation and dental arch

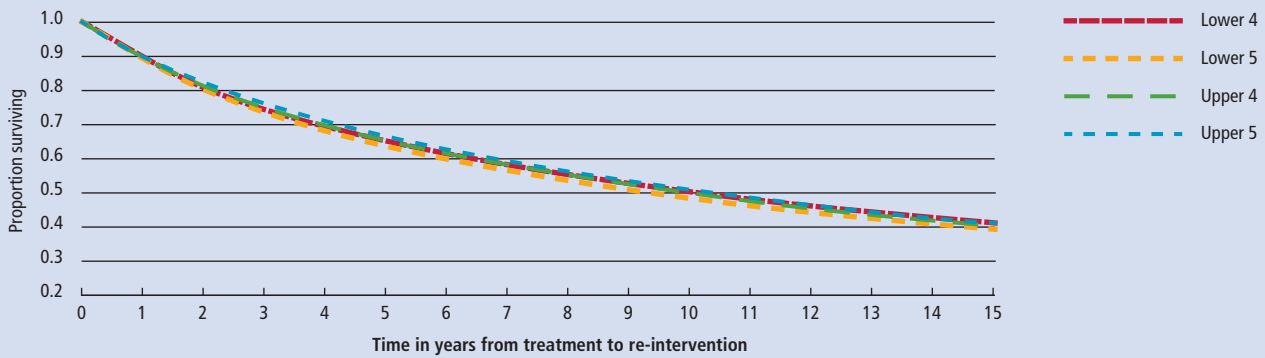


Fig. 15 Time to extraction of restored premolar teeth, with regard to tooth notation and dental arch

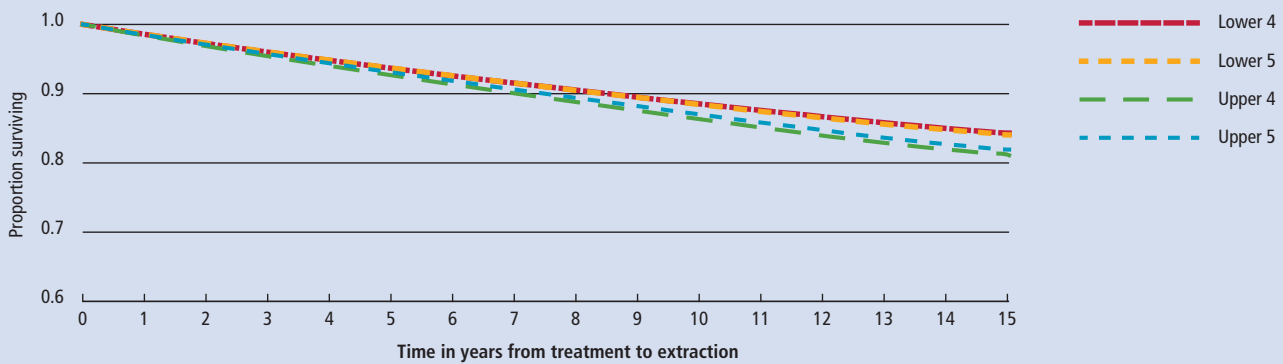


Fig. 16 Time to re-intervention of restorations in premolar teeth, with regard to annual spend on treatment

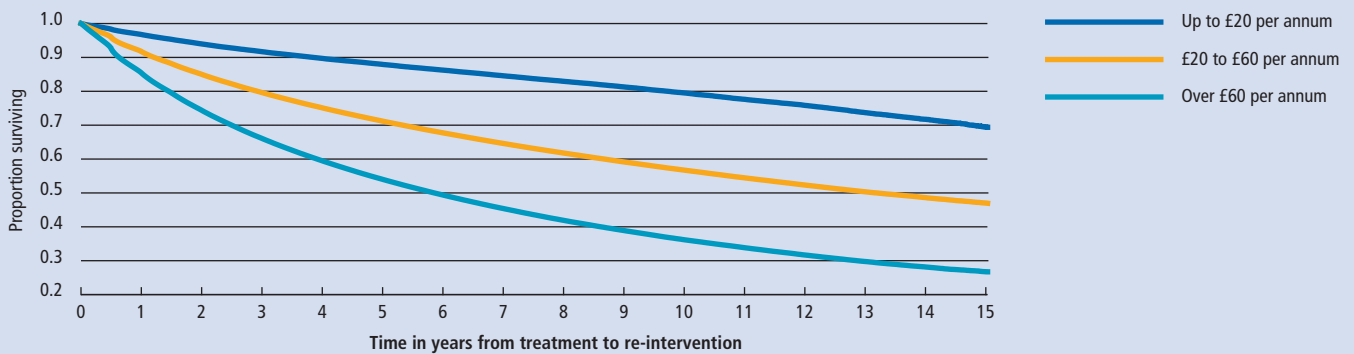
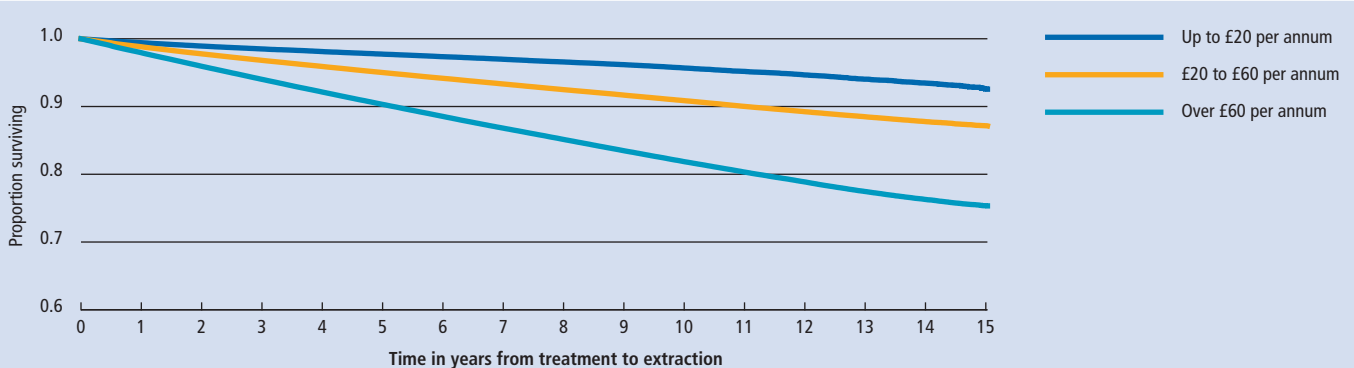


Fig. 17 Time to extraction of restored premolar teeth, with regard to annual spend on treatment



substance involved in tooth preparation for a crown. In addition, the preparation of a crown for a premolar tooth is likely to require the removal of an even higher proportion of tooth structure than for a molar tooth (given that the premolar tooth is smaller but the crown will be of similar thickness for molar and premolar teeth), this being a further reason to leave the crown as a restoration of last resort. At the end of the day, however, it is retention of the (restored) tooth as opposed to survival of the restoration which is arguably most important. In that regard, therefore, crowns may be considered to represent a suboptimal treatment option on premolar teeth for other than the over-60 age groups.

The data for crown replacement may be skewed towards non- or late-replacement. Replacement of a crown is likely to be a treatment decision which deserves more thought and discussion (in terms of the clinical experience, the time needed for appointments and/or cost, etc) than replacement of a direct-placement restoration, not only for the patient but also for the clinician. Replacement of a direct placement restoration is therefore more likely to be carried out than replacement of a crown.

In a premolar tooth, aesthetic concerns are less likely to play a part in a decision to replace a restoration than in anterior teeth, except in the upper first premolar tooth. In this regard, large (unsightly) carious cavities may have weakened the tooth to such an extent that a large restoration is needed, and/or a cusp is lost and a crown is considered by the clinician to replace a significant amount of lost tooth substance or improve the appearance of an upper first premolar tooth. However, the data from the present work indicate that a direct-placement restoration would provide a better option in terms of retention of the tooth in most age groups (other considerations being equal). The GDS regulations in force at the time of the study precluded the placement of tooth-coloured restorations in loadbearing surfaces of premolar teeth, therefore the placement of a cusp-replacement resin composite restoration was not an option. Recent research⁴⁻⁶ has indicated that such restorations might have provided satisfactory service if they had been available at the time within the regulations.

Figure 11 may initially appear counterintuitive, indicating that teeth with the smallest (single-surface) restorations survive least well to extraction. This figure relates to patients between 60 to 69 years: the placement of a

Table 7 Survival to re-intervention of restorations in premolar teeth, with regard to dentists' age

Dentist age	Survival (%) at				
	1 year	5 years	10 years	15 years	n
Dentist age under 30	90	67	51	41	595,186
Dentist age 30–34	90	67	51	42	652,627
Dentist age 35–39	90	66	51	41	629,482
Dentist age 40–44	90	65	50	41	569,558
Dentist age 45–49	89	64	49	39	475,537
Dentist age 50–54	89	63	48	39	355,521
Dentist age 55–59	89	62	47	38	219,421
Dentist age 60 or over	89	62	47	38	94,040
All restorations	90	65	50	40	3,591,372

Table 8 Survival to extraction of restorations in premolar teeth, with regard to dentists' age

Dentist age	Survival (%) at				
	1 year	5 years	10 years	15 years	n
Dentist age under 30	99	93	88	83	595,186
Dentist age 30–34	99	94	88	83	652,627
Dentist age 35–39	99	94	88	83	629,482
Dentist age 40–44	99	93	88	83	569,558
Dentist age 45–49	98	93	87	82	475,537
Dentist age 50–54	98	93	87	82	355,521
Dentist age 55–59	98	92	87	82	219,421
Dentist age 60 or over	98	92	86	82	94,040
All restorations	99	93	87	83	3,591,372

Table 9 Time to re-intervention of restored premolar teeth, with regard to whether the patient is exempt from charges, or not

Charge paying status	Survival (%) at				
	1 year	5 years	10 years	15 years	n
Full charge	90	66	51	42	2,431,165
Exemption or remission	89	64	47	37	1,160,207
All restorations	90	65	50	40	3,591,372

Table 10 Time to extraction of restored premolar teeth, with regard to whether the patient is exempt from charges, or not

Charge paying status	Survival (%) at				
	1 year	5 years	10 years	15 years	n
Full charge	99	93	88	84	2,431,165
Exemption or remission	99	93	86	81	1,160,207
All restorations	99	93	87	83	3,591,372

Fig. 18 Time to re-intervention of restorations in premolar teeth, with regard to whether the restored tooth also received a root canal filling on the same course of treatment

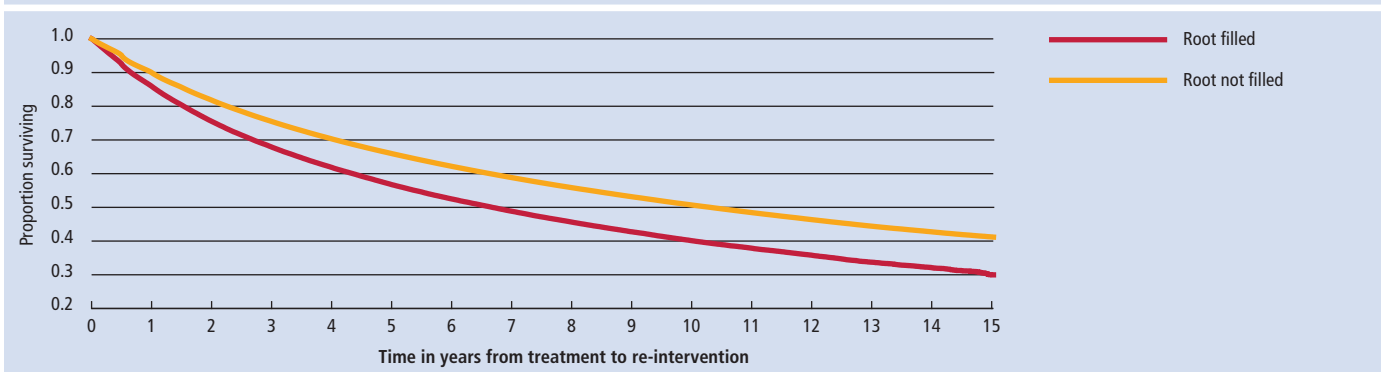


Fig. 19 Time to extraction of restored premolar teeth, with regard to whether the restored tooth also received a root canal filling on the same course of treatment

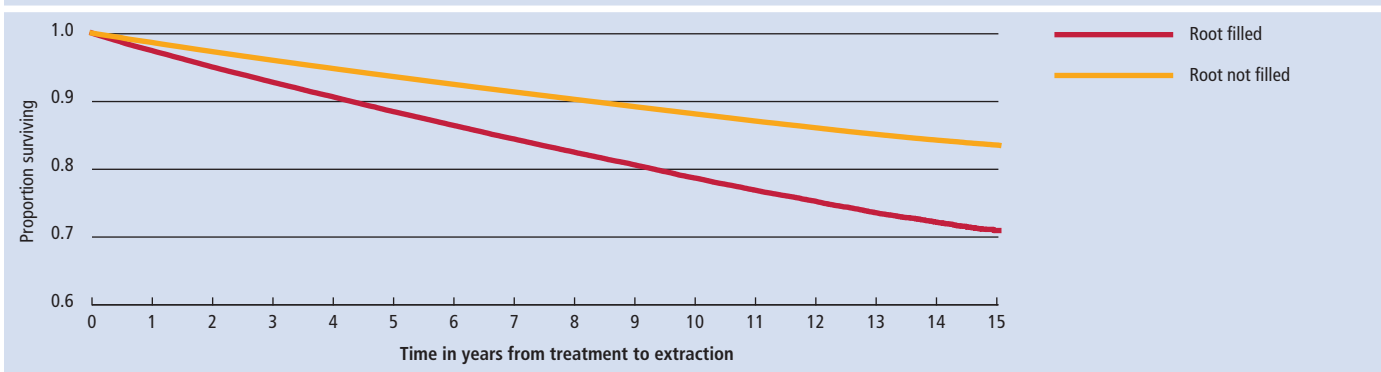
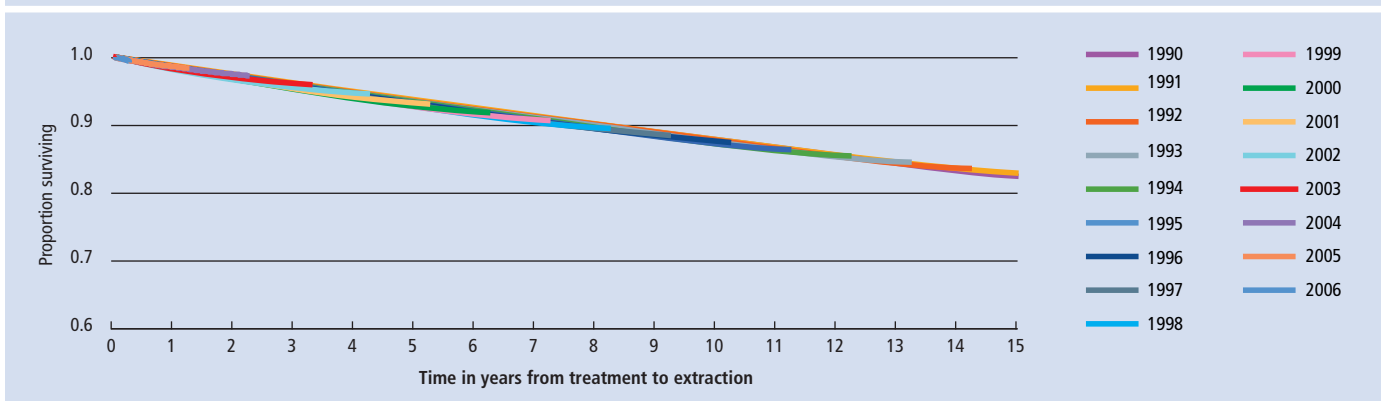


Fig. 20 Time to extraction of the restored premolar tooth, with regard to year of placement of the restoration



single-surface amalgam restoration in this age group is unlikely to be as a result of primary caries, and more likely to be a repair of an existing (much larger) restoration, so the single surface restoration may not represent the full restorative situation in a given tooth. Figure 11 should be contrasted with Figure 10, where for patients aged from 20 to 29 years single surface amalgam restorations survive best to extraction. This contrast may reflect the general deterioration of teeth with age (as illustrated in Figures 5 and 6). The older the tooth, the more likely that it has existing restorations.

The crowning of a tooth, with the attendant need to remove tooth substance in a tooth which might already be challenged, places the tooth one step further on the road towards extraction, with sequelae such as the need for root canal treatment. In that regard, Figures 18 and 19 indicate the poorer prognosis of a tooth which receives a root filling in the same course of treatment as the other restoration; on the other hand, it can be argued that it is better, in many cases, for the patient to retain a given tooth by having it root filled rather than having it extracted. The clear message is

to maintain the viability of a premolar tooth by keeping the tooth vital if possible and restore it with direct restoration until these become unviable, even if this course of action requires more re-interventions as the restorations fail.

While there are similarities between the performance of restorations in premolar teeth and in molar teeth³ (that is, all loadbearing posterior teeth), such as the performance of crowns, there are differences. Overall, restorations in premolar teeth perform slightly worse than those in molar teeth³ (40% vs 41% at fifteen years in terms of re-intervention but

both 83% in terms of time to extraction). For premolar teeth, the performance, in terms of time to extraction of the restored tooth, in premolars is better in the lower arch (Fig. 15). The reason for this is a matter for debate, but may be considered to indicate lower caries incidence in lower first premolar teeth as indicated by the lower numbers of restorations *per se* placed in lower premolar teeth than upper premolar teeth (1,612,242 restorations in lower premolars vs 1,979,130 in upper premolars) and the potential aesthetic factors which come into play in restorations in upper first premolar teeth, possibly leading to their replacement due to aesthetic reasons (as opposed to other reasons such as caries, tooth fracture etc). In addition, the higher failure of upper premolar teeth compared with their lower antagonists may be related to the anatomy of the teeth, with the upper 'bicuspid' anatomy and two roots of some upper premolars potentially leading to increased tooth cracking compared with that associated with the more caniniform lower premolar.

Several patient factors relate to restoration longevity. There are dramatic differences in restoration performance in premolars among patients, of different ages (Figs 5 and 6), exemption from payment (Figs 12 and 13) and treatment need (Figs 16 and 17), with those with high treatment need having restorations which perform less well in either of the measures (average annual treatment cost and average interval between attendances) described in this work. This could be regarded as a 'chicken and egg' situation – which came first? Patients with high caries activity will require more restorations than those with low caries activity and may be more likely to attend more frequently because of the need for emergency appointments. Either way, their restorations perform less well, perhaps indicating that some of those patients with high treatment need/high caries activity do not improve their diet or their oral hygiene and therefore continue to require restorations. Additionally, the patients with high caries activity will receive larger restorations, and these fail more readily than small restorations.

When the effect of MOD restorations in premolar teeth is examined, it is apparent that these perform poorly in terms of re-intervention and do not perform well with regard to time to extraction of the restored tooth (Figs 3 and 4). The attendant risk of cusp fracture following placement of MOD amalgam restorations has been demonstrated in surveys

Table 11 Time to extraction of restored premolar teeth, with regard to tooth position

Tooth position	Survival (%) at				
	1 year	5 years	10 years	15 years	n
L4	99	94	89	84	652,974
L5	99	94	88	84	959,268
U4	98	93	86	81	955,796
U5	99	93	87	82	1,023,334
All restorations	99	93	87	83	3,591,372

Table 12 Time to re-intervention of restorations in premolar teeth, with regard to annual spend on treatment

Mean annual fees	Survival (%) at				
	1 year	5 years	10 years	15 years	n
Up to £20 per annum	97	88	79	69	227,789
£20 to £60 per annum	92	71	57	47	1,729,311
Over £60 per annum	85	54	36	27	1,506,997
All restorations	90	65	50	40	3,591,372

Table 13 Time to extraction of restorations in premolar teeth, with regard to annual spend on treatment

Mean annual fees	Survival (%) at				
	1 year	5 years	10 years	15 years	n
Up to £20 per annum	99	98	96	93	227,789
£20 to £60 per annum	99	95	91	87	1,729,311
Over £60 per annum	98	90	82	75	1,506,997
All restorations	99	93	87	83	3,591,372

Table 14 Time to re-intervention of restorations in premolar teeth, with regard to whether the restored tooth also received a root canal filling on the same course of treatment

Root filling in same course	Survival (%) at				
	1 year	5 years	10 years	15 years	n
Root filled	86	57	40	30	260,928
Root not filled	90	66	51	41	3,330,444
All restorations	90	65	50	40	3,591,372

Table 15 Time to extraction of restorations in premolar teeth, with regard to whether the restored tooth also received a root canal filling on the same course of treatment

Root filling in same course	Survival (%) at				
	1 year	5 years	10 years	15 years	n
Root filled	97	88	79	71	260,928
Root not filled	99	94	88	84	3,330,444
All restorations	99	93	87	83	3,591,372

from The Netherlands and the UK.^{7,8} As it was for molar teeth, for premolar teeth the message to patients is again loud and clear: a cariogenic diet and/or poor oral hygiene leading to the presence of interproximal carious lesions is well worth avoiding. And, to clinicians, the message is also loud and clear: keeping an MOD restoration off a patient's tooth is a worthwhile course of action in premolar teeth. The provision of two (smaller) class II restorations rather than an MOD may therefore be considered optimum treatment. In contemporary dentistry, this could involve placement of two class II (adhesive) resin composite restorations which can be placed with minimal destruction of tooth substance over and above that which has been lost through caries or trauma. In this regard, the NHS regulations in force at the time of the data collection for this study did not permit tooth-coloured restorations in loadbearing situations. The data on composite restorations presented here relates to restorations in non-load-bearing situations such as Class V cavities.

It is interesting to note the differences in restoration survival (both to re-intervention and to extraction) among younger and older dentists, with restorations placed by younger dentists outperforming those placed by older

dentists. This factor was also apparent with amalgam restorations, and was discussed in that paper.⁹ It is also interesting to note that over the 15-year time span of this work, performance of restorations did not improve (Fig. 19). This consistency over time inspires some confidence in the continuing relevance of these findings to current dental practice.

Conclusions

Overall, about 40% of restorations in premolar teeth have survived at 15 years. Factors influencing survival are patient age, dentist age, patient treatment need and restoration type.

With regard to tooth position, restored premolar teeth in the upper arch have less good survival time to extraction than those in the lower arch, whereas time to re-intervention on the restoration is similar in both arches.

In premolar teeth, when time of the restored tooth to extraction is examined, crowns do not represent the optimally performing restoration in under-60 year age groups, leading to earlier loss of the tooth; it is only in the older age groups (60 years and over) that a crown presents reasonable survival to extraction of the restored tooth, compared with other restorations.

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