The ultimate guide to restoration longevity in England and Wales. Part 4

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THE ULTIMATE GUIDE TO RESTORATION LONGEVITY IN ENGLAND AND WALES:4: RESIN COMPOSITE 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: RESIN COMPOSITE RESTORATIONS

Abstract

Aim: It is the aim of this paper to present data on the survival of resin composite 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.

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). Overall, 3.5 million restorations in resin composite were included, of which 38% had a re-intervention over the 15-year duration of the dataset. Kaplan-Meier Analysis indicates that *circa* 35% survive 15 years without re-intervention, and *circa* 83% without extraction. Variation by tooth position, dentist characteristics, patient characteristics and associated treatment were explored.

Conclusions: Overall, *circa 35*% of resin composite restorations teeth have survived at 15 years, with factors influencing survival including patient age, dentist age, and patient treatment and attendance history.

Introduction

Satisfactory survival of all types of tooth 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. It is also important that the data is derived from general dental practice, given that it is in this arena that the majority of dental treatment, worldwide, is provided and, given that is where the majority of dentists operate and where the majority of restorations are placed.

Resin composite was introduced to the dental profession in the 1960s as a tooth-coloured (and therefore, potentially aesthetic) restorative material, for use in all classes of cavity: however, adverse research findings, principally in relation to the excessive wear which was evident when this material was used in class II cavities[1], meant that its use was confined to class III, IV and V cavities until the wear problem was addressed *circa* 25 years later[2,3]. Accordingly, since the 1990s, resin composite has increasingly become the aesthetic alternative to dental amalgam in loadbearing situations in posterior teeth[4,5], due, in part, to its superior aesthetics when compared with dental amalgam and, in part, to patient concerns about the use of a mercury-containing material in their teeth. However, its use for restoration of posterior teeth in loadbearing situations was precluded during the period of the present investigation: accordingly, the data presented here relate to resin composite restorations placed in Class III, IV and V cavities in anterior teeth and class V cavities in posterior teeth.

Using the methodology described in Paper 1 in this series[6], it has been possible to produce precise information regarding the survival of resin composite (hereafter called *composite*) restorations and the factors which may influence this. The

restorations included in this work were predominantly (74%) placed in anterior teeth in class III, IV and V cavities. In teeth in the so-called aesthetic zone, patients may be particularly interested in the appearance of their restorations and the overall aesthetics of their anterior teeth: compromised aesthetics may therefore be another reason (other than secondary caries, defective margins etc.) why a restoration may be replaced/have a re-intervention.

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

- Survival of direct-placement composite restorations, by assessing time to re-intervention, and patient and dentist factors associated with this
- Time to extraction of teeth restored with direct-placement composite restorations, and the factors which influence 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, 3,504,225 restorations were formed in composite.

Composite restorations, overall

Of these 3,504,225 composite restorations included in the analysis, 1,333,987 had a re-intervention within the observation period and, in 247,962 cases the restored tooth was extracted. When the survival of composite restorations is examined with respect to time to re-intervention, the Kaplan-Meier Analysis indicates that, overall,

circa 35% of composite restorations have survived at 15 years, with *circa* 45% having survived to 10 years and *circa* 62 % to 5 years (Figure 1 and Table 1). When the data are re-analysed with regard to time to extraction, it is apparent that *circa* 83% of teeth restored with a composite restoration have survived for 15 years (Figure 2 and Table 2).

Table 1 Survival of composite restorations, overall, with respect to time to re-intervention, compared with other restorations

	Survival (%) at				
Type of Treatment	1 year	5 years	10 years	15 years	n
Amalgam	91	66	51	41	7,292,564
Composite Resin	**87**	**59**	**43**	**34**	**3,504,225**
Glass-ionomer	84	53	37	28	1,592,566
Crown	93	77	63	53	1,202,005

Figure 1 Survival of composite restorations, overall, with respect to time to re-intervention, compared with other restorations

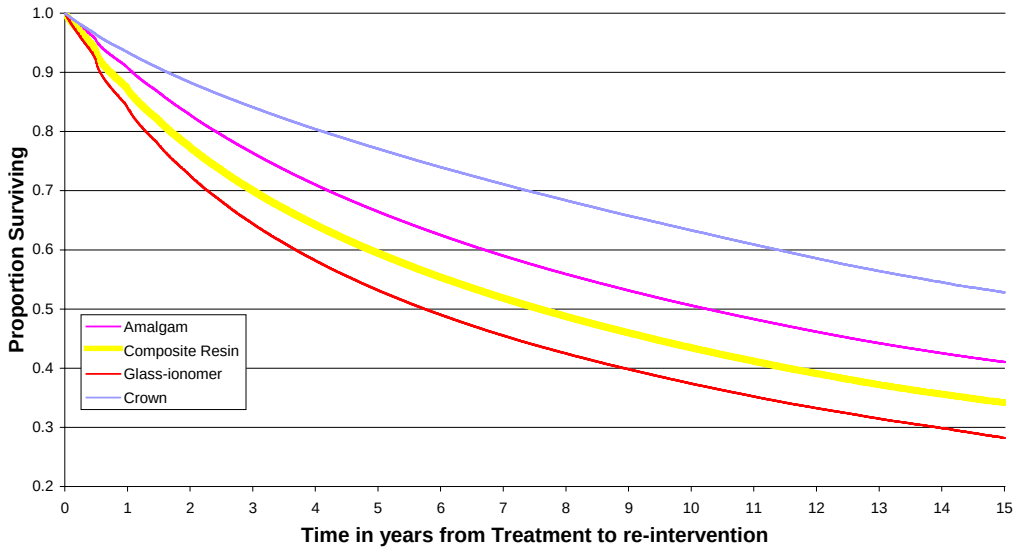
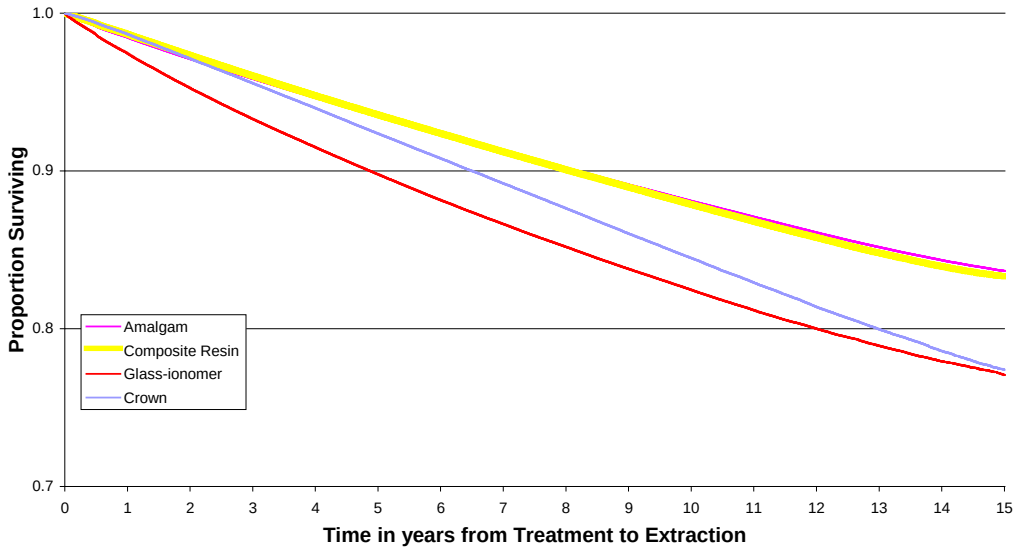


Table 2 Time to extraction of teeth restored with composite restorations, compared with other restorations

Type of Treatment	Survival (%) at 1 year	5 years	10 years	15 years	n
Amalgam	98.5	93.5	88.1	83.7	7,292,564
Composite Resin	**98.7**	**93.6**	**87.9**	**83.3**	**3,504,225**
Glass-ionomer	97.5	89.8	82.5	77.1	1,592,566
Crown	98.7	92.4	84.5	77.4	1,202,005

Figure 2 Time to extraction of teeth restored with composite restorations, compared with other restorations



Influence of cavity size/classification

When the composite restorations are classified by type of restoration, (potentially larger) class IV restorations survived less well to re-intervention than potentially smaller class III and class V restorations (Figure 3 and Table 3), the difference being in the order of ten percentage points. However, when the chart relating to the time to extraction of the restored tooth is examined (Figure 4 and Table 4), it is apparent that teeth restored with restorations involving an incisal corner or incisal edge perform marginally better - in the order of one percentage point.

Table 3 Time to reintervention of composite restorations involving or not involving an incisal corner or edge

	Survival (%) at				
Angle or Edge	1 year	5 years	10 years	15 years	n
angle or edge	82	52	36	28	593,918
no angle or edge	88	61	45	35	2,910,307
All Restorations	87	59	43	34	3,504,225

Figure 3 Time to reintervention of composite restorations involving or not involving an incisal corner or edge

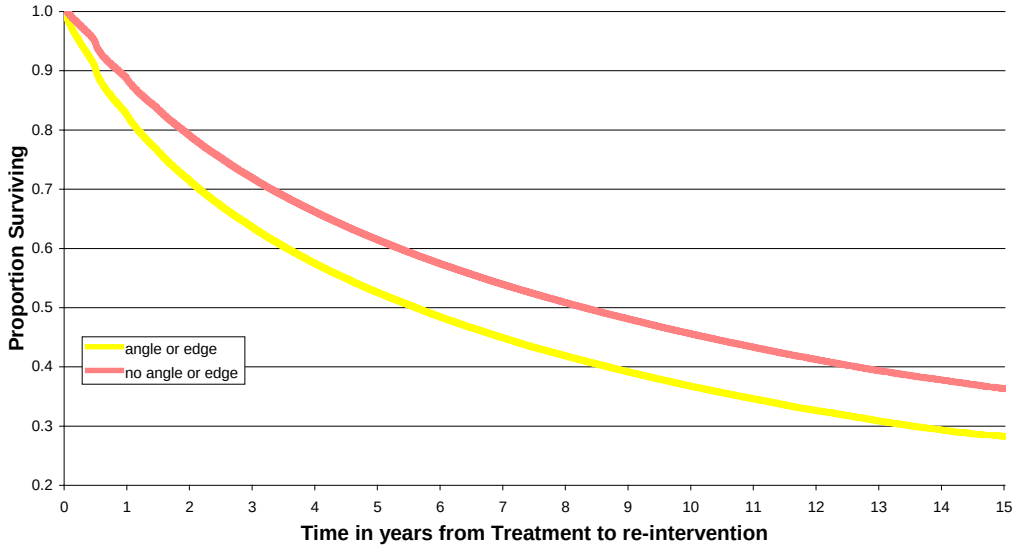
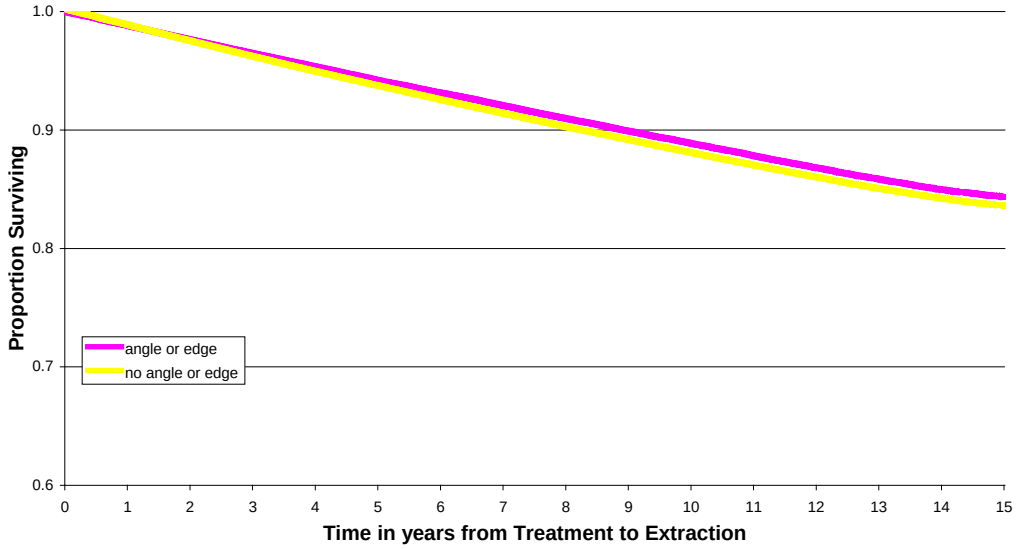


Table 4 Time to extraction of teeth restored with composite restorations involving or not involving an incisal corner or edge

	Survival (%) at				
Angle or Edge	1 year	5 years	10 years	15 years	n
angle or edge	99	94	89	84	593,918
no angle or edge	99	93	88	83	2,910,307
All Restorations	99	94	88	83	3,504,225

Figure 4 Time to extraction of teeth restored with composite restorations involving or not involving an incisal corner or edge



Influence of dentist factors (gender and age)

Regarding dentists' gender, there are no differences in survival of composite restorations to re-intervention with regard to dentist's gender. With respect to age of dentist, there is a consistent inverse correlation between the age of the dentist and the proportion of restorations surviving. This applies both to survival to reintervention (Figure 5), with composite restorations placed by younger dentists outperforming those placed by older dentists by *circa* 5% at 15 years (Table 5), and also survival to extraction (Figure 6 and Table 6), in which the effect is accentuated.

Table 5 Survival of composite restorations to reintervention, in relation to dentist age

	Survival (%) at				
Dentist Age	1 year	5 years	10 years	15 years	n
Dentist age under 30	87	61	45	35	559,688
Dentist age 30-34	88	61	45	36	633,209
Dentist age 35-39	87	60	44	35	629,917
Dentist age 40-44	87	59	44	34	577,739
Dentist age 45-49	87	58	42	33	467,935
Dentist age 50-54	86	57	41	32	337,796
Dentist age 55-59	87	57	40	32	211,194
Dentist age 60 or over	86	56	39	30	86,747
All Restorations	87	59	43	34	3,504,225

Figure 5 Survival of composite restorations to reintervention, in relation to dentist age

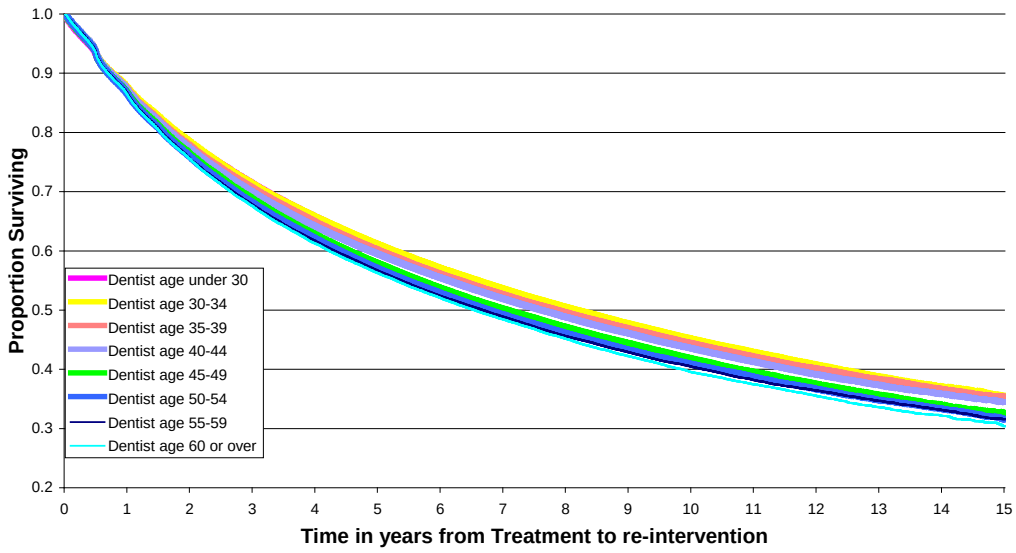
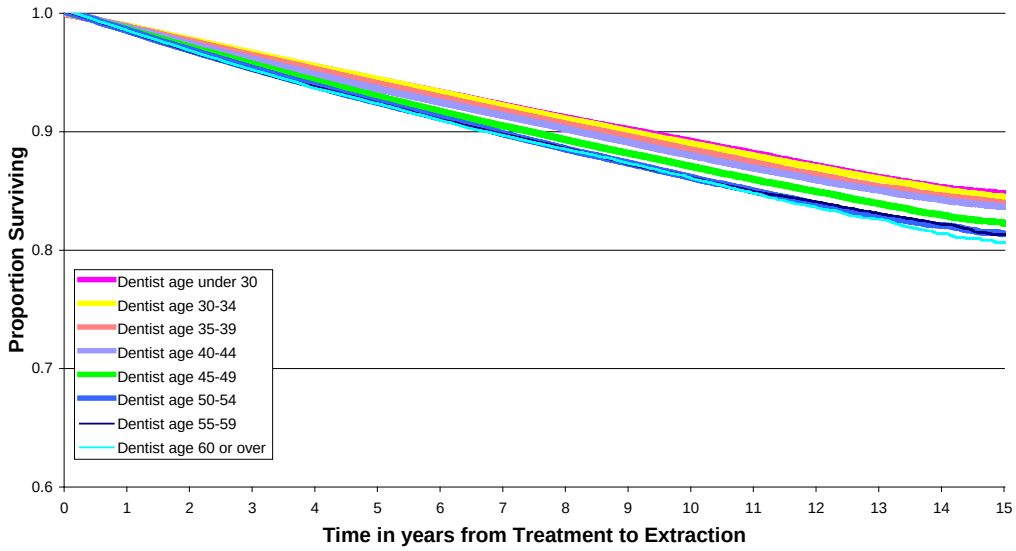


Table 6 Time to extraction of teeth restored with composite restorations in relation to dentist age

Dentist Age	Survival (%) at 1 year	5 years	10 years	15 years	n
Dentist age under 30	99	94	89	85	559,688
Dentist age 30-34	99	94	89	84	633,209
Dentist age 35-39	99	94	88	84	629,917
Dentist age 40-44	99	93	88	84	577,739
Dentist age 45-49	98	93	87	82	467,935
Dentist age 50-54	98	92	86	81	337,796
Dentist age 55-59	98	92	86	81	211,194
Dentist age 60 or over	98	92	86	80	86,747
All Restorations	99	94	88	83	3,504,225

Figure 6 Time to extraction of teeth restored with composite restorations in relation to dentist age



Influence of patient factors

With regard to survival of restorations, patient gender does not appear to play a part for the first part of the observation period, after which, it is apparent that composite restorations in male patients perform less favourably, with the difference at 15 years

being about two percentage points (Figure 7 and Table 7). When time to extraction of teeth restored with composite restorations is examined, the results indicate a similar difference in time to extraction between males and females, with males losing teeth earlier (Figure 8 and Table 8).

Table 7 Survival of composite restorations to reintervention, in relation to patient gender

	Survival (%) at				
Patient Gender	1 year	5 years	10 years	15 years	n
Female Patients	87	60	44	35	1,818,514
Male Patients	87	59	42	33	1,685,711
All Restorations	87	59	43	34	3,504,225

Figure 7 Survival of composite restorations to reintervention, in relation to patient gender

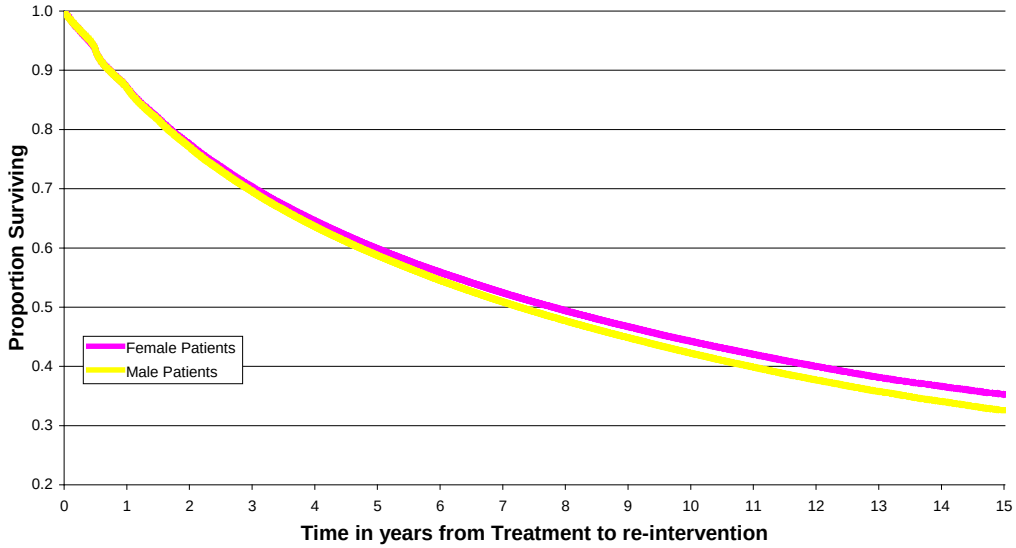
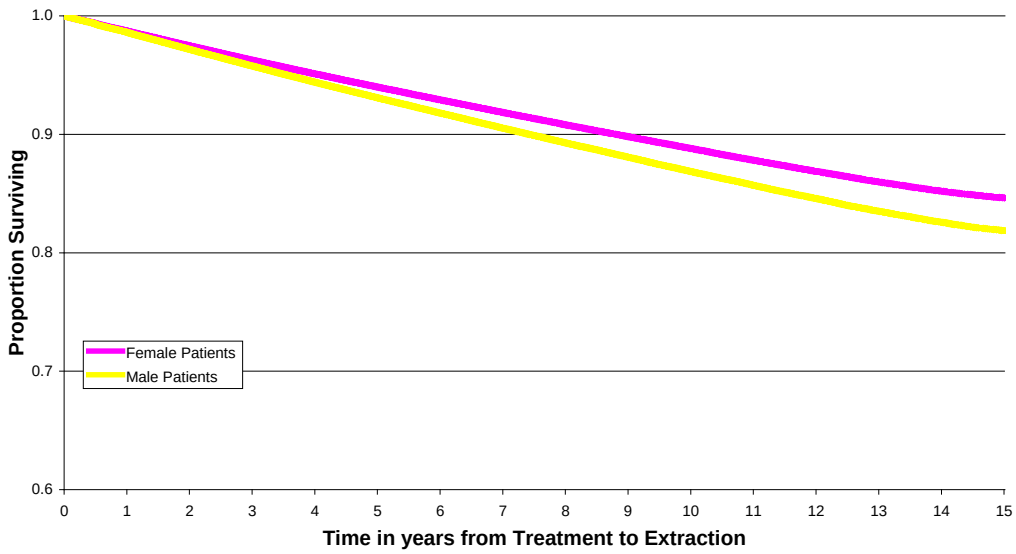


Table 8 Time to extraction of teeth restored with composite restorations in relation to patient gender

Patient Gender	Survival (%) at 1 year	5 years	10 years	15 years	n
Female Patients	99	94	89	85	1,818,514
Male Patients	99	93	87	82	1,685,711
All Restorations	99	94	88	83	3,504,225

Figure 8 Time to extraction of teeth restored with composite restorations in relation to patient gender



Patient age plays a substantial part, with restorations in younger patients performing more favourably than those in older patients, both in terms of time to reintervention (Figure 9 and Table 9) and time to extraction of the restored tooth (Figure 10 and Table 10). In that regard, the difference in years to extraction between the oldest and youngest age groups is *circa* 40 percentage points in terms of cumulative survival at 15 years. Looked at in terms of tooth loss, the oldest age groups can expect to lose over 30% of their restored teeth, compared with under 10% tooth loss for the younger age groups.

Table 9 Survival of composite restorations to reintervention, in relation to patient age

	Survival (%) at				
Patient Age	1 year	5 years	10 years	15 years	n
18 or 19	90	67	51	41	67,737
20 to 29	91	67	51	41	458,224
30 to 39	90	66	50	41	654,658
40 to 49	88	63	46	37	692,509
50 to 59	86	58	41	31	667,679
60 to 69	84	52	35	26	540,095
70 to 79	82	47	31	23	326,098
80 or over	81	44	29	-	97,225
All Restorations	87	59	43	34	3,504,225

Figure 9 Survival of composite restorations to reintervention, in relation to patient age

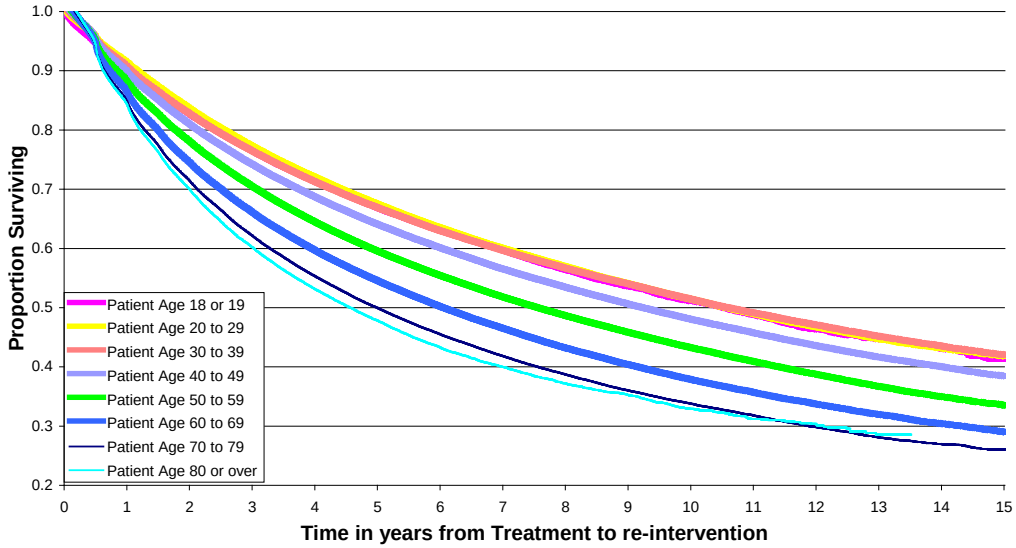
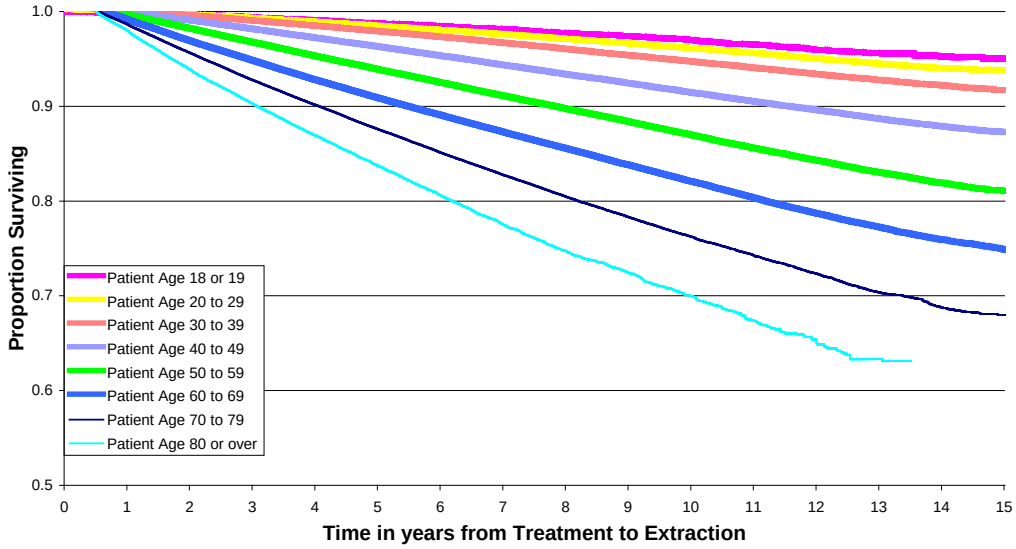


Table 10 Time to extraction of teeth restored with composite restorations in relation to patient age

	Survival (%) at				
Patient Age	1 year	5 years	10 years	15 years	n
18 or 19	100	99	97	95	67,661
20 to 29	100	98	96	93	458,224
30 to 39	100	97	94	91	654,658
40 to 49	99	95	90	86	692,509
50 to 59	99	93	86	80	667,679
60 to 69	98	89	80	73	540,095
70 to 79	97	86	74	66	326,098
80 or over	96	82	68	-	97,225
All Restorations	99	94	88	83	3,504,225

Figure 10 Time to extraction of teeth restored with composite restorations in relation to patient age



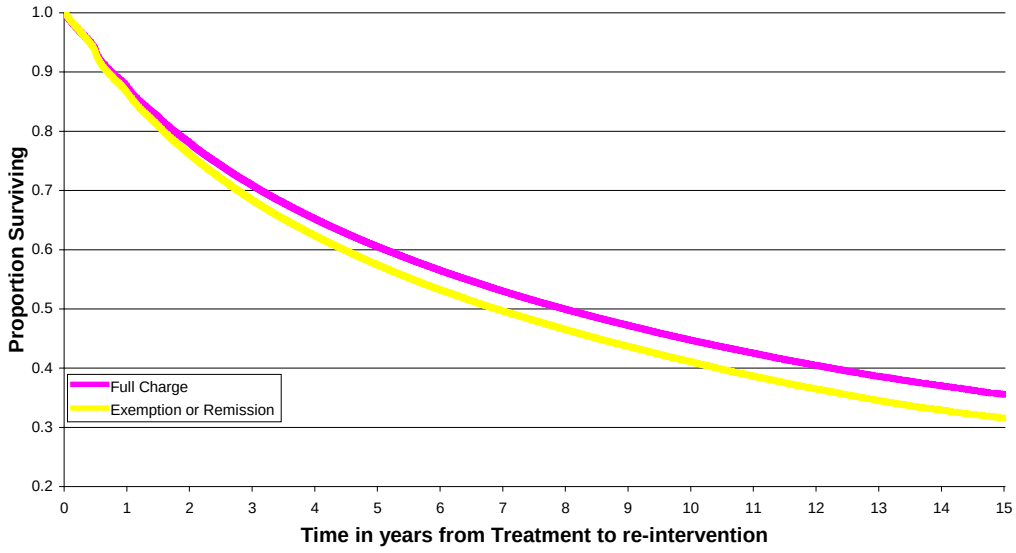
Did the patient have to pay for treatment?

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 of composite restorations between those who paid for treatment and those who did not pay (Figure 11 and Table 11) indicated a difference of *circa* four percentage points at 15 years with respect to time to reintervention. When time to extraction is analysed, the difference in cumulative survival is similar, with restored teeth in patients who paid for treatment having a greater time to extraction compared with patients who were exempt from payment.

Table 11 Survival of composite restorations to reintervention, in relation to whether the patient paid for treatment, or not

	Survival (%) at				
Charge Paying Status	1 year	5 years	10 years	15 years	n
Full Charge	88	60	45	35	2,368,737
Exemption or Remission	86	57	41	31	1,135,488
All Restorations	87	59	43	34	3,504,225

Figure 11 Survival of composite restorations to reintervention, in relation to whether the patient paid for treatment, or not



Patient's state of oral health

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

Average Annual Fees

Figure 12 presents the time to reintervention on composite restorations in patients with high average annual treatment need and those with low annual average treatment need, with the difference in time to reintervention being over forty percentage points (Table 12). The chart for time to extraction for patients with high and low annual treatment need (Figure 13) is just as dramatic, with a 19 percentage points difference in cumulative survival at 15 years (Table 13).

Table 12 Survival of composite restorations to reintervention, in relation to patient's average annual treatment cost

	Survival (%) at				
Mean Annual Fees	1 year	5 years	10 years	15 years	n
Up to £20 per annum	96	86	76	64	213,780
£20 to £60 per annum	90	67	51	41	1,631,732
Over £60 per annum	82	47	29	21	1,544,015
All Restorations	87	59	43	34	3,504,225

Figure 12 Survival of composite restorations to reintervention, in relation to patient's average annual treatment cost

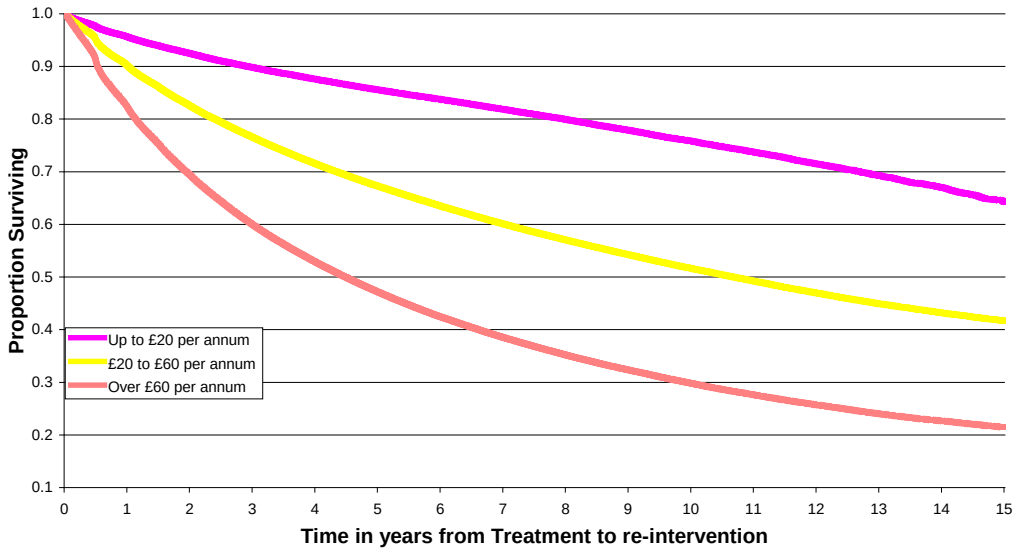
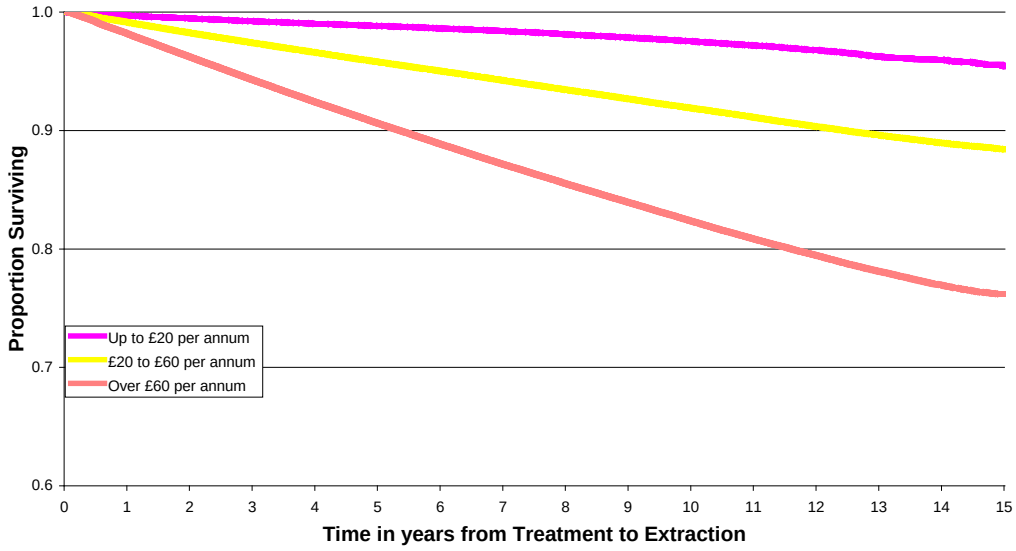


Table 13 Time to extraction of teeth restored with composite restorations, in relation to patient's average annual treatment cost

	Survival (%) at				
Mean Annual Fees	1 year	5 years	10 years	15 years	n
Up to £20 per annum	100	99	97	95	213,780
£20 to £60 per annum	99	96	92	88	1,631,732
Over £60 per annum	98	90	82	76	1,544,015
All Restorations	99	94	88	83	3,504,225

Figure 13 Time to extraction of teeth restored with composite restorations, in relation to patient's average annual treatment cost



Influence of tooth position

With regard to tooth position, there is a difference of *circa* 7 percentage points in survival of composite restorations in lower teeth and upper teeth, with restorations in lower incisor teeth performing better in terms to time to re-intervention (Figure 14 and Table 14). There is a small difference in restoration survival, overall, between central and lateral incisor teeth (Figure 15 and Table 15), with restorations in central incisor teeth performing *circa* 2 percentage points less well than those in lateral incisor teeth.

Table 14 Survival of composite restorations to reintervention, in relation to upper and lower jaws

Quadrant	Survival (%) at 1 year	5 years	10 years	15 years	n
Lower Left	87	62	47	39	546,209
Lower Right	87	62	47	39	534,996
Upper Left	87	59	42	33	1,209,854
Upper Right	87	58	42	32	1,213,166
All Restorations	87	59	43	34	3,504,225

Figure 14 Survival of composite restorations to reintervention, in relation to upper and lower jaws

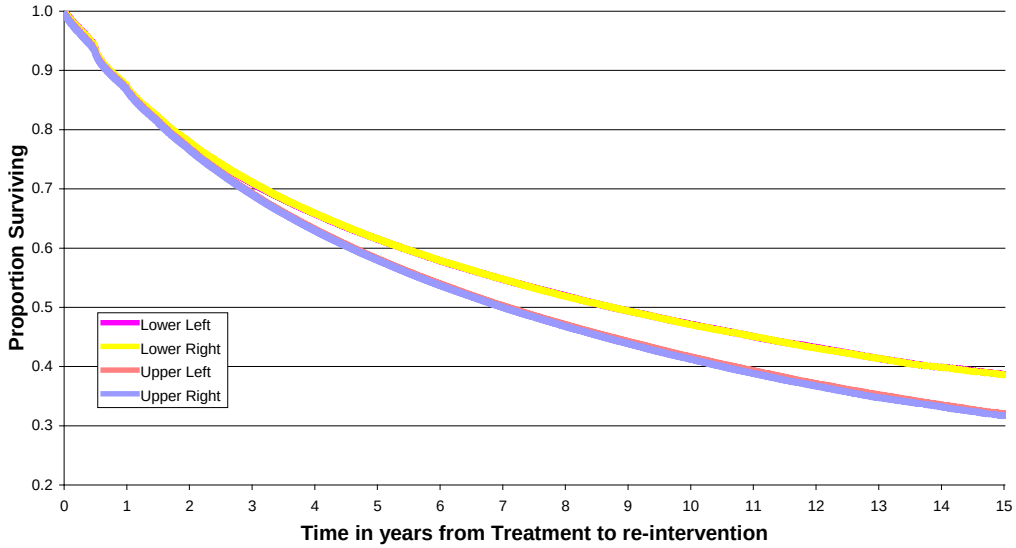
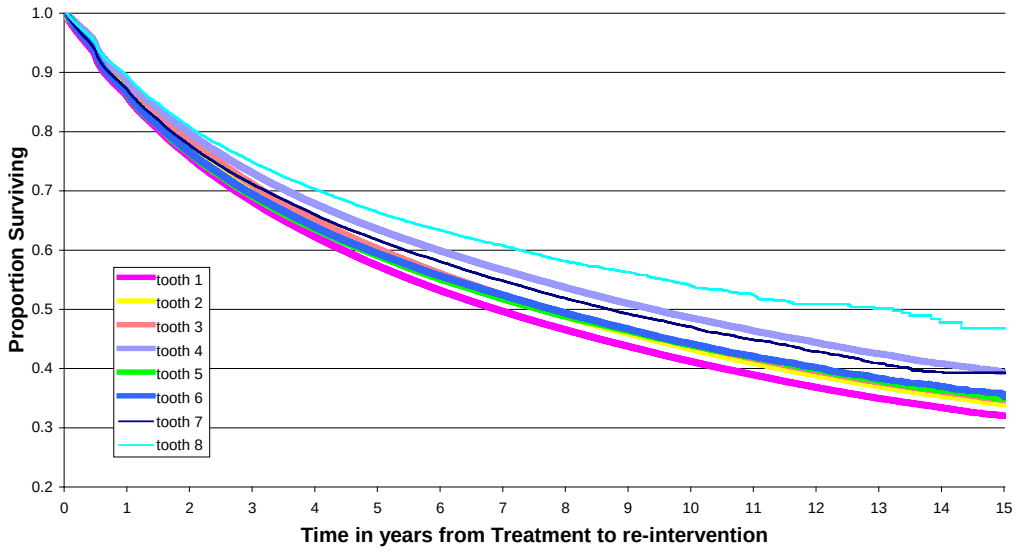


Table 15 Survival of composite restorations to reintervention, in relation to tooth position

Tooth Position	Survival (%) at 1 year	5 years	10 years	15 years	n
tooth 1	86	57	41	32	945,253
tooth 2	87	60	43	34	802,126
tooth 3	88	60	44	34	830,843
tooth 4	88	63	48	39	382,895
tooth 5	86	59	44	35	246,138
tooth 6	86	59	44	35	184,402
tooth 7	87	61	47	39	92,050
tooth 8	89	66	53	46	20,518
All Restorations	87	59	43	34	3,504,225

Figure 15 Survival of composite restorations to reintervention, in relation to tooth position

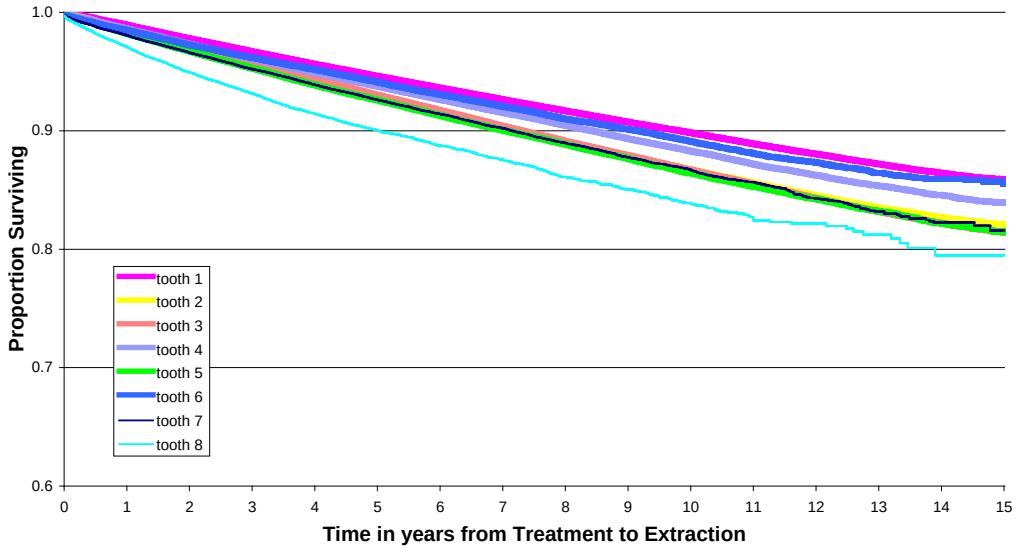


When time to extraction of teeth restored with composite restorations is examined (Figure 16 and Table 16), the chart indicates optimum performance of central incisor and first molar teeth and third molar teeth performing least well.

Table 16 Time to extraction of teeth restored with composite restorations in relation to tooth position

Tooth Position	Survival (%) at 1 year	5 years	10 years	15 years	n
tooth 1	99	95	90	86	945,253
tooth 2	99	93	87	82	802,126
tooth 3	99	93	87	82	830,843
tooth 4	99	94	88	84	382,895
tooth 5	98	93	87	82	246,138
tooth 6	99	94	89	86	184,402
tooth 7	98	93	87	82	92,050
tooth 8	97	90	84	80	20,510
All Restorations	99	94	88	83	3,504,225

Figure 16 Time to extraction of teeth restored with composite restorations in relation to tooth position



Other factors

When the difference between teeth which have had a root canal filling placed in the same course of treatment as the composite restoration, the chart indicates a *circa* 9 percentage points difference in overall survival of restorations (Figure 17 and Table 17), with restorations in teeth which have received root fillings performing less well. When time to extraction of the restored tooth is examined (Figure 18 and Table 18), there is a 13 percentage points difference at 15 years, again with the root filled teeth performing less well. Figure 18 implies a near doubling of the risk of tooth loss throughout the first 15 years.

Table 17 Survival of composite restorations to reintervention, in relation to whether the tooth received a root canal filling in the same course of treatment as the composite restoration

	Survival (%) at				
Root filling in same course	1 year	5 years	10 years	15 years	n
root filled	84	51	34	25	97,312
root not filled	87	60	44	34	3,406,913
All Restorations	87	59	43	34	3,504,225

Figure 17 Survival of composite restorations to reintervention, in relation to whether the tooth received a root canal filling in the same course of treatment as the composite restoration

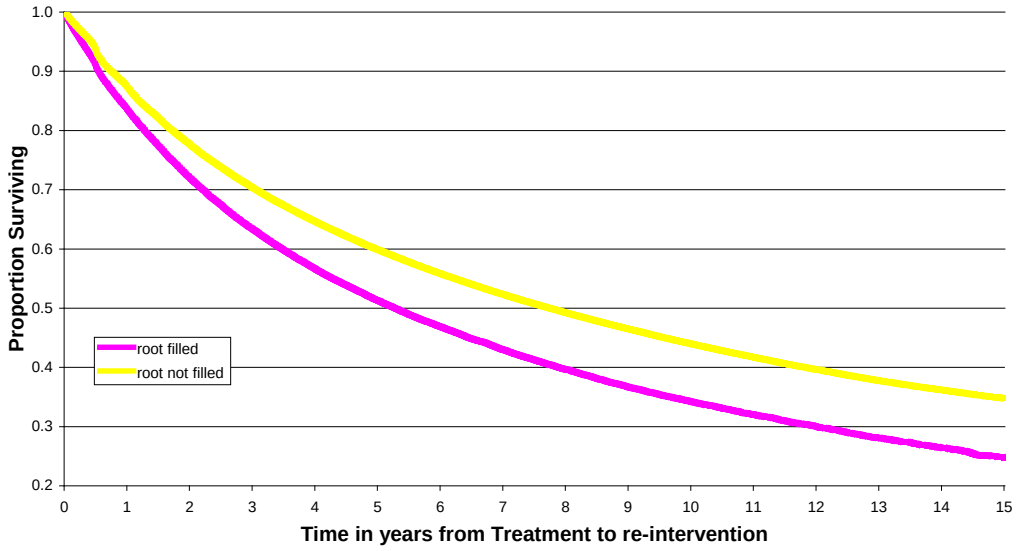
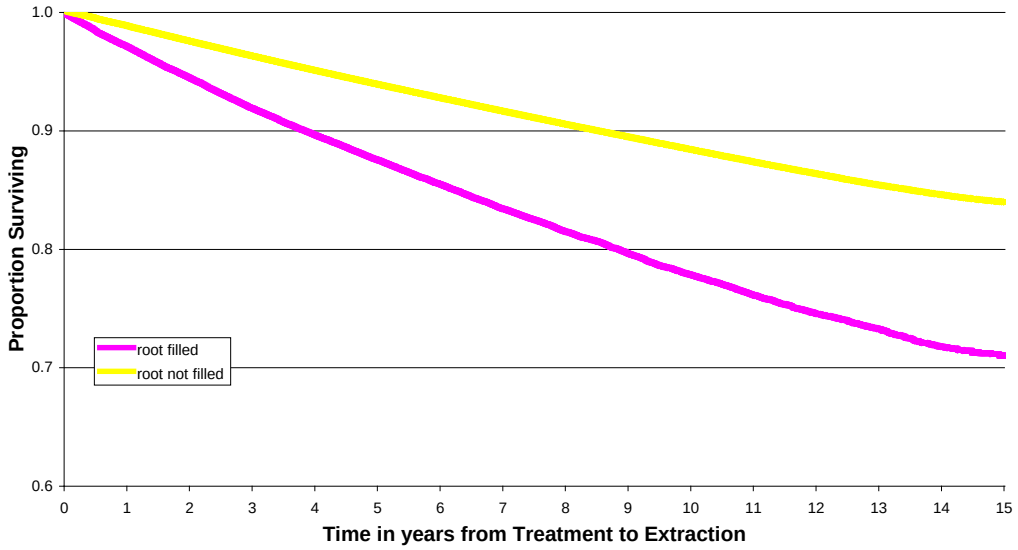


Table 18 Time to extraction of teeth restored with composite restorations in relation to whether the tooth received a root canal filling in the same course of treatment as the composite restoration

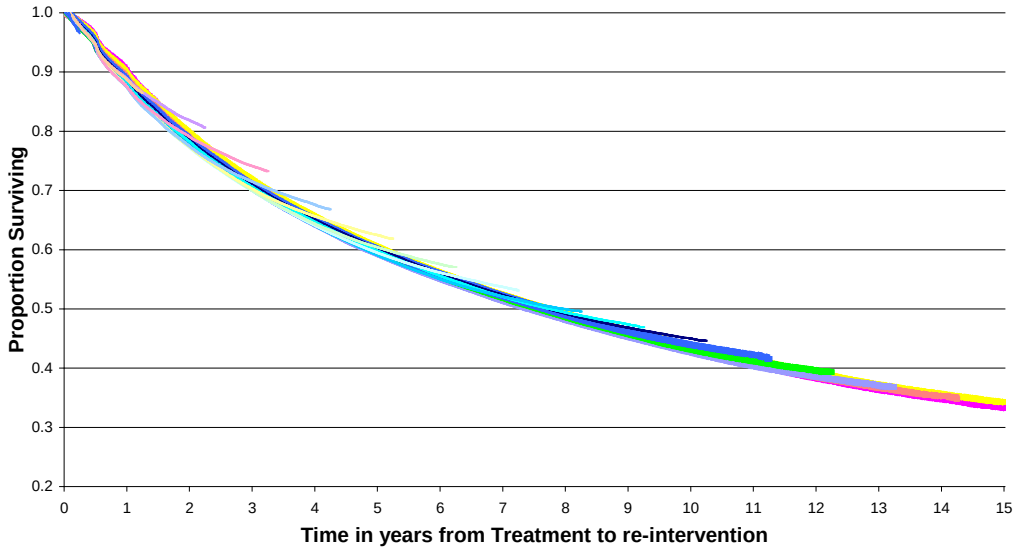
	Survival (%) at				
Root filling in same course	1 year	5 years	10 years	15 years	n
root filled	97	87	78	71	97,312
root not filled	99	94	88	84	3,406,913
All Restorations	99	94	88	83	3,504,225

Figure 18 Time to extraction of teeth restored with composite restorations in relation to whether the tooth received a root canal filling in the same course of treatment as the composite restoration



Finally, the charts illustrating the performance of restorations, overall, in incisor teeth do not indicate any differences in performance over the time of the study, either in terms of survival of restorations to re-intervention (Figure 19) or time of the restored tooth to extraction.

Figure 19 Survival of composite restorations to reintervention, in relation to the year of placement of the restoration



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[7]. This dataset is the largest ever to become available for analysis of the survival of dental treatment for such a long duration. Not only does this facilitate a means of assessing restoration survival to re-intervention but it also allows the analysis of restoration type on survival of the restored tooth to extraction. In other words, survival of the tooth rather than survival of the restoration *per se*, with the former arguably being the more important.

This paper deals only with composite restorations: given that it may be considered that resin composite is the most aesthetic restorative material available to dentists, composite will principally be placed in class III and IV cavities in incisor teeth and canines. It may also be placed in molar and premolar teeth, but the composite restorations in the dataset will be in class V cavities. It therefore should be borne in

mind that the General Dental Services Regulations in force at the time of the present study precluded the use of resin composite materials in loadbearing situations in posterior teeth, in other words, the cavity types under investigation were Class III, IV and class V, thus rendering direct comparison with amalgam restorations (which may be placed in loadbearing situations) inappropriate.

Changes in composite materials

During the time span of the present study, it could be considered that there have been advances in the composite materials employed, particularly with regard to filler size and composition. In addition, it could be argued that dentine bonding agents have improved in terms of reliability in the years between 1991 (when these materials were relatively poorly developed) to 2006, when dentine bonding agents more resembled the materials which are available today[8]. It is therefore surprising that no improvement in the overall performance of composite restorations has been demonstrated (Figure 19), this in itself reinforcing the validity of the present work to General Dental Practice in England and Wales today. It also may be considered to demonstrate that, no matter what material is employed by the dentist, (s)he will provide ethical treatment to the top of his/her ability.

Dentist age

The present paper presents details of composite restoration performance in relation to dentist age, with younger dentists placing restorations which provide better service. There are similarities here to other materials, such as those presented for amalgam and GI in this series of papers[9,10], with the discussion in those papers presenting potential reasons for this trend, such as younger dentists being aware of

latest techniques, and, taking care to isolate optimally (especially important for dentine bonding and placement of composite restorations).

Patient factors

Composite restorations have also been found to perform optimally in younger patients (Figures 9 and 10), with the difference in survival of the restoration being *circa* 20 percentage points between the youngest and oldest age groups and the difference in time to extraction of the restored tooth being *circa* 35 percentage points. These data may not seem surprising to practising clinicians who know that teeth “get tired” and potentially more heavily filled/prone to fracture and prone to periodontal disease with increasing patient age. Difference in gender is less remarkable (Figures 7 and 8), although composite restorations in males perform less well than those in females, possibly because of reduced forces being placed by female patients. This result might tend to explode the myth that females might be more conscious of the appearance of their fillings and request their replacement for aesthetic reasons – obviously not so!

Also with regard to patients, those who have to pay for treatment receive restorations which perform better than those placed in patients who do not have to pay (Figure 11). This is unlikely to be due to differences in the dentist’s care of the patient, but more likely to be related to socio-economic factors, given that those patients who do not have to pay be come from lower socio-economic groups, whose oral health is generally less good[11].

With regard to composite restorations in patients with high average annual treatment need and those with low annual average treatment need (Figures 12 and 13), the results are dramatic, with the difference in time to reintervention being *circa* 50

percentage points at 15 years and time to extraction for being a *circa* 23 percentage points difference in cumulative survival at 15 years. This may represent a "chicken and egg" situation: patients whose general oral care is suboptimal will be predisposed to caries and recurrent caries, necessitating the repair or replacement of restorations earlier. This is quite obviously the case with composite restorations, with the effect being more pronounced than with amalgam[9], in which the difference between high and low treatment need patients is *circa* 40 percentage points for time to re-intervention and *circa* 17 percentage points difference in time to extraction of the restored tooth. The question therefore must be asked – do amalgam restorations therefore confer a greater cariostatic effect than composite restorations? However, when the composite restoration data are compared with those for GI[10], it is apparent that the difference in survival of GI restorations placed in patients with high and low treatment need is greater than with composite restorations, namely, *circa* 45 percentage points difference in restoration survival to re-intervention for GI, and with a difference of *circa* 23 percentage points of GI-restored teeth being extracted at 15 years. This would tend to indicate that the fluoride content of the GI restorations does not confer cariostasis as compared with amalgam (and composite), confirming the views of Randall and Wilson[12] and Papagiannoulis and co-workers[13].

Cavity factors

The data presented in this paper indicate that (potentially larger) class IV restorations do not perform as well as (potentially smaller) class III and V restorations, in terms of time to re-intervention, with the difference being *circa* 10% at 15 years (Figure 3). While this may not be considered surprising, the data with regard to time to extraction of the restored tooth present more of a challenge, with Figure 4 indicating that teeth restored with restorations involving an incisal corner or

edge perform marginally better - in the order of 1%. Perhaps the pathogenesis of the two restoration types provides an explanation. Class III restorations will principally be placed because of interproximal caries in an incisor tooth, and class V restorations because of carious or non-carious tooth substance loss, while a class IV or incisal edge restorations will be placed because the incisal corner of an incisor tooth has fractured, possibly following the placement of a large class III restoration, or because the affected tooth has suffered trauma. The difference in time to extraction is small but could be potentially be explained by the potentially carious and potentially non-carious nature of the two types of restoration. Another factor which could help to explain this finding is that Class IV restorations will predominantly have been placed in incisor teeth, whereas composites placed in teeth posterior to the incisors and canines will have been in Class V cavities (given that the Regulations precluded placement of composites in loadbearing cavities in posterior teeth). Examination of Table 16 indicates that posterior teeth restored with composite restorations have survival rates of 82% to 86%, with first premolar teeth (84% teeth surviving at 15 years [n=382,895]) and first molar teeth (86% of teeth surviving at 15 years [n=184,402]) performing well. Whereas, lateral incisor teeth have larger numbers in the dataset (n=802,126) and 82% of teeth surviving at 15 years: the larger number of incisor teeth therefore has skewed the overall findings.

Tooth position

In the present study, Figures 14, 15 and 16 present the survival of composite restorations with regard to jaw and tooth position, but it should be borne in mind that composite restorations in teeth posterior to the canine teeth will be limited to class V, and the numbers will therefore be relatively small for 8s. With regard to tooth position, there is a difference of *circa* 7 percentage points in survival of composite

restorations in lower teeth and upper teeth, with restorations in lower incisor teeth performing better in terms to time to re-intervention. This is perhaps contrary to the perceived wisdom that restorations in (small) lower anterior teeth are more difficult place and more difficult to isolate than upper teeth, and therefore more likely to be contaminated during placement. The present data tend to indicate that there are no real problems in isolating lower anterior teeth – perhaps the difficulties arise further back in the mouth? There is a small difference in restoration survival, overall, between central and lateral incisor teeth (Figure 15), with restorations in central incisor teeth preforming *circa* 2% less well than those in lateral incisor teeth. Composite restorations in third molar teeth perform better than composite restorations in other teeth, but the numbers of these restorations is probably sufficiently small to be disregarded and, as in other molar teeth and premolars, these restorations will be confined to class V cavities. In addition, other factors can come into play to lead to extraction, such as periodontal problems. In this regard, there is limited evidence that loss of attachment occurs more in mandibular incisor teeth then in maxillary central incisors[14]: this may therefore account for the fact that restorations in lower incisor teeth have better survival time to reintervention, but less good survival to extraction.

Other factors

Finally, as with other restorative materials, the placement of a root canal filling in the same course of treatment as a composite restoration has an adverse effect upon time to re-intervention on the restoration and time to extraction of the restored tooth (Figures 17 and 18). The message is therefore the same as for other restorative materials, try to educate patients to attend a dentist before the size of the cavities in their teeth predispose to pulpal exposure and to educate dentists to carry out

optimum preventive strategies and minimally invasive restorative treatment modalities.

Comparison with other work

There are no papers which can be directly compared with the present work. Demarco and colleagues carried out a systematic review of the survival of anterior composite restorations in 2015, including 17 studies and 1821 restorations[15]. Their overall failure rate was 24.1%, with at least three years of follow up, and annual failure rates varying from zero to 4.1%, not dissimilar to the results of the present work. However, the results of the present study present treatment results only from the general dental practice environment, while a majority of Demarco's results evaluated resin composite restorations in anterior teeth using prospective data from European dental schools and research institutes.

Conclusions

- Overall, *circa 35*% of restorations in incisor teeth have survived at 15 years.
- Factors influencing survival are patient age, dentist age, and patient treatment need.
- Composite restoration type (Class III, IV or V) has a minimal effect upon on time to extraction of the restored tooth

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