

The ultimate guide to restoration longevity in England and Wales. Part 9: incisor teeth: restoration time to next intervention and to extraction of the restored tooth

P. S. K. Lucarotti*¹ and F. J. T. Burke¹

Key points

Overall, more than 2.5million restorations in incisor teeth were included in the analysis. With regard to time to re-intervention, 35% of restorations had survived at 15 years, and with regard to time to extraction of the restored incisor tooth, cumulative survival was 81% at 15 years.

With regard to re-intervention, crowns outperform other commonly provided restoration types by *circa* 15 percentage points at 15 years. However, in all age groups at 15 years, crowning an incisor tooth leads to an earlier time to extraction of the restored tooth and direct-placement composite restorations are performing 9 percentage points more favourably.

Among the factors influencing survival of restorations in incisor teeth were patient age, dentist age, patient treatment need and presence of a root filling.

Aim It is the aim of this paper to present data on the survival of restorations in incisor teeth by analysis of the time to re-intervention on the restorations and time to extraction of the restored incisor 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 a restoration in an incisor 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. Overall, 2,526,576 restorations of incisor teeth in adults were included. At 15 years, survival of restorations in incisor teeth without re-intervention was 35%, and for restored incisor teeth survival to extraction was 81%. **Conclusions** Approximately 35% of restorations in incisor teeth survived without re-intervention at 15 years, and 81% of restored incisor teeth survived for 15 years without extraction. Factors influencing survival include patient age, dentist age, and patient treatment need. Crowning an incisor tooth leads to an earlier time to extraction of the restored tooth.

Introduction

Satisfactory survival of restorations in incisor teeth 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 that 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 in incisor teeth and the factors which may influence this. In incisor teeth, 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 survival of direct-placement restorations, crowns and veneers in incisor teeth, by assessing:

- Time to re-intervention, and patient and dentist factors associated with this
- Time to extraction of incisor teeth restored with direct-placement restorations, crowns and veneers, 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, 2,526,576 restorations involved incisor teeth.

Restorations in incisor teeth, overall

In the dataset used for the present work, resin composite restorations were the most frequently provided restorations ($n = 1,747,379$), while 286,795 glass ionomer restorations, 400,230 crowns and 57,955 porcelain veneers were included. When the survival of restorations in incisor teeth is examined with respect to time to re-intervention, it is apparent that, overall, 35% of restorations have survived at

¹Primary Dental Care Research Group, University of Birmingham School of Dentistry, College of Medical and Dental Sciences, Pebble Mill, Birmingham, B5 7EG, UK
*Correspondence to: Dr Steve Lucarotti
Email: steve@lucarotti.myzen.co.uk

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

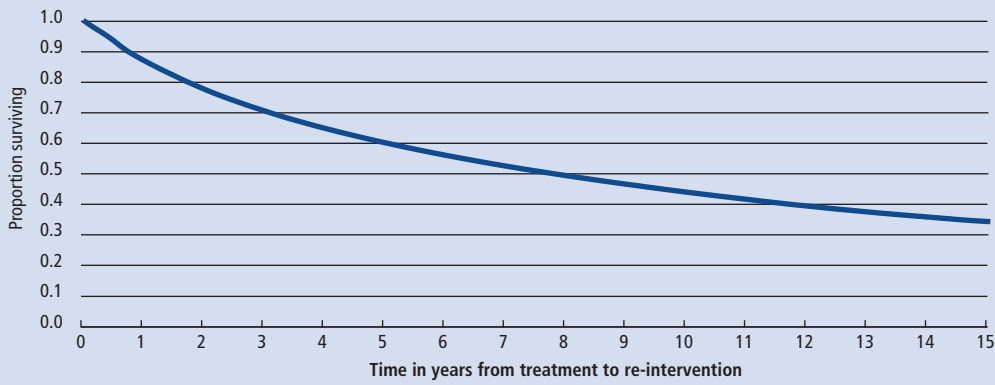


Fig. 2 Time to extraction of restorations in incisor teeth, overall

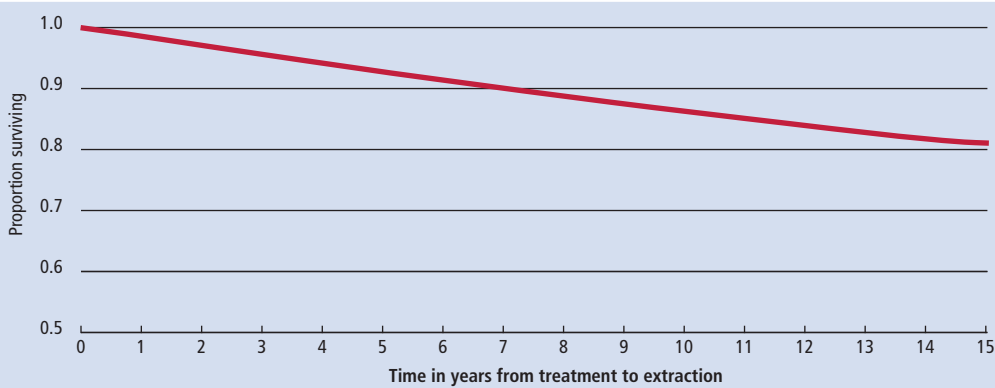


Fig. 3 Time to re-intervention of restorations in incisor teeth, with regard to treatment type

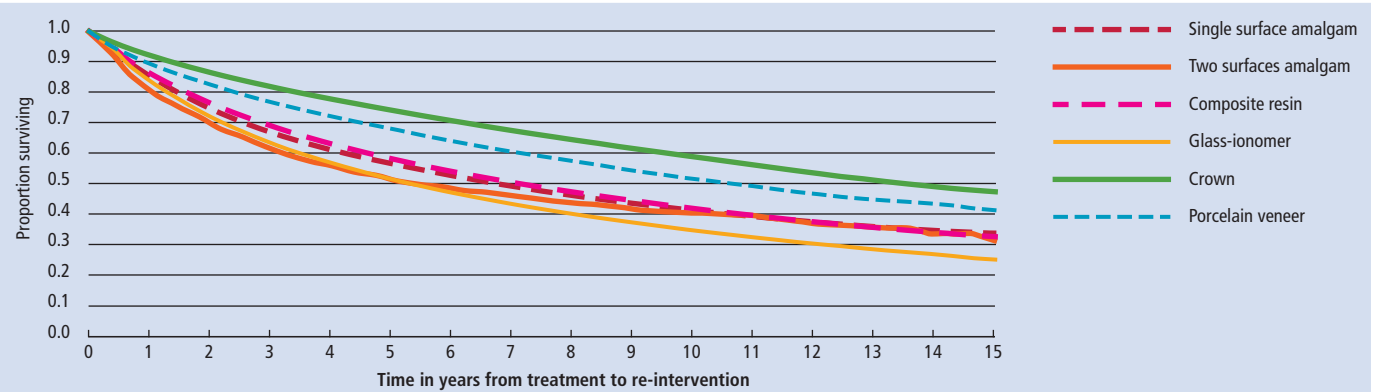
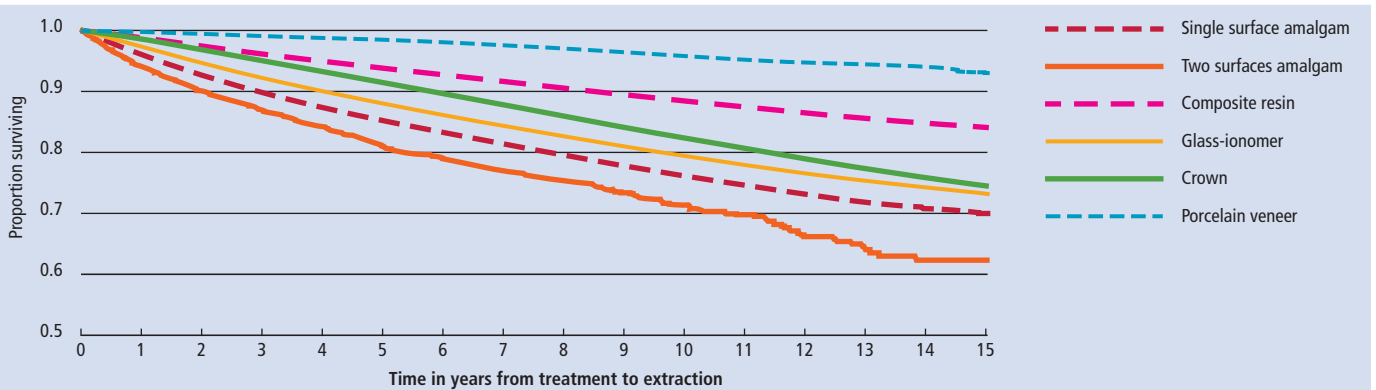


Fig. 4 Time to extraction of restored incisor teeth, with regard to the most commonly placed restorations



15 years, with 44% having survived to ten years and 60% to five years (Fig. 1 and Table 1). When the data are re-analysed with regard to time to extraction, it is apparent that 81% of restored incisor teeth have survived for 15 years, with 86% having survived to ten years and 93% to five years (Fig. 2 and Table 2).

When the data on the more commonly-used restoration types for incisor teeth are analysed with regard to re-intervention, it is apparent that crowns outperform other commonly provided restoration types by around fifteen percentage points at 15 years (Fig. 3 and Table 1), with glass ionomer performing least favourably. Specifically, for the three most common restorations of incisor teeth, 48% of crowns have survived without a re-intervention at 15 years, as have 33% of composites (the data include Class II and Class IV), and only 25% of glass-ionomers. As for porcelain veneers, 41% have survived at 15 years.

However, when the data are analysed with regard to time to extraction of the restored tooth, the chart (Fig. 4) tells a different story. Crowns no longer represent the optimally performing restoration, since, at 15 years, resin composite restorations (overall) are performing *circa* nine percentage points more favourably than crowns in terms of time to extraction of the restored tooth and veneers are performing optimally, with only 7% of teeth restored with a veneer being extracted at 15 years, compared with 25% of teeth which have received a crown and 16% of teeth which received a resin composite restoration (Table 2).

Restorations in incisor teeth with respect to patient age and gender

When the data are analysed with regard to patient age and restoration survival to re-intervention, it is apparent that restorations in incisor teeth perform less well in older than in younger patients (Fig. 5 and Table 3). A similar relationship can be seen between patient age and survival of incisor teeth to extraction (Fig. 6 and Table 4).

The analysis by restoration type was then repeated for different patient age groups (Tables 5 and 6). Veneers and crowns outperform all other restoration types in all age groups in terms of time to re-intervention. With regard to patient age and time to extraction of the restored tooth, Figure 4, which includes the data from all age groups, indicates that the direct placement composite restoration performs approximately ten percentage points better than a crown, with the teeth restored with a veneer performing best.

Table 1 Time to re-intervention of restorations in incisor teeth, with regard to treatment type

Type of treatment	Survival (%) at				
	1 year	5 years	10 years	15 years	n
Single surface amalgam	85	57	41	34	31,667
Two surfaces amalgam	81	52	41	32	2,549
Composite resin	87	58	42	33	1,747,379
Glass ionomer	84	52	35	25	286,795
Crown	92	74	59	48	400,230
Porcelain veneer	89	68	52	41	57,955
All restorations	87	60	44	35	2,526,576

Table 2 Time to extraction of restorations in incisor teeth, with regard to treatment type

Type of treatment	Survival (%) at				
	1 year	5 years	10 years	15 years	n
Single surface amalgam	96	85	76	70	31,667
Two surfaces amalgam	94	81	71	62	2,546
Composite resin	99	94	88	84	1,747,379
Glass ionomer	97	88	79	73	286,795
Crown	98	91	82	75	400,230
Porcelain veneer	100	98	96	93	57,806
All restorations	99	93	86	81	2,526,576

Table 6 shows that in the under-40 age group, crowns represent the worst outcome to extraction of any treatment modality with Figure 7, which presents the data in the 30 to 39-year-old age group, being typical. As the patient groups get older, the relative performance of teeth restored with crowns starts to improve in terms of time of the restored tooth to extraction, but this is never better than veneers or direct-placement resin composite restorations, as illustrated in Figure 8 for patients aged 60 to 69. In other words, crowning of incisor teeth represents a relatively poor option in terms of time to extraction of the restored tooth. Throughout the analyses, teeth restored with a veneer perform better than any other in terms of time to extraction of the restored tooth.

With respect to patient gender, there is, at 15 years, approximately three percentage points difference between male and female patients in survival to re-intervention on incisor teeth (Fig. 9 and Table 7). When the data are examined in terms of time to extraction of the restored incisor tooth, it is apparent that restored teeth in female patients perform *circa* four percentage points better than in male patients, equating to about four years' difference in survival of the restored tooth (Fig. 10 and Table 8).

Influence of dentist factors (gender and age)

Regarding dentists' gender, there are no differences in survival of restorations to re-intervention in incisor teeth with regard to dentists' gender. When dentists' age is examined, the chart indicates that restorations in incisor teeth placed by younger dentists outperform those placed by older dentists by up to six percentage points at 15 years (Fig. 11 and Table 9). When time to extraction of the restored tooth is examined, the situation is similar in relation to dentists' age, with restorations placed in incisor teeth by older dentists performing less well than those placed by dentists in the younger age groups (Fig. 12 and Table 10).

Did the patient have to pay for treatment?

Patients may be exempt or remitted from payment within the GDS regulations. When the influence of patients who are exempt from, or have remission of payment for treatment is examined, there is approximately three percentage points difference on restoration survival to re-intervention at 15 years, with restorations placed in incisor teeth for patients who were exempt from payment performing better

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

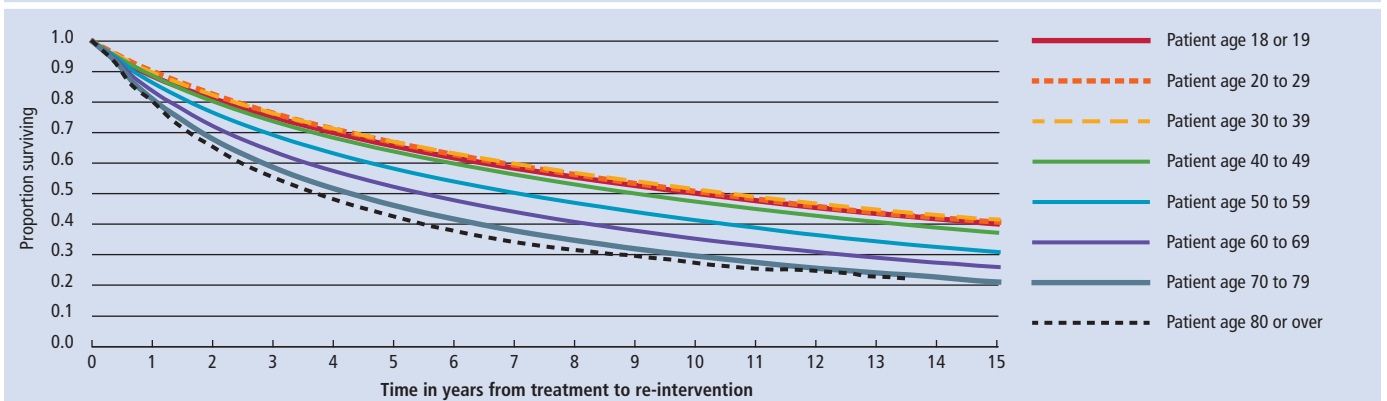


Fig. 6 Time to extraction of restored incisor teeth, with regard to patient age

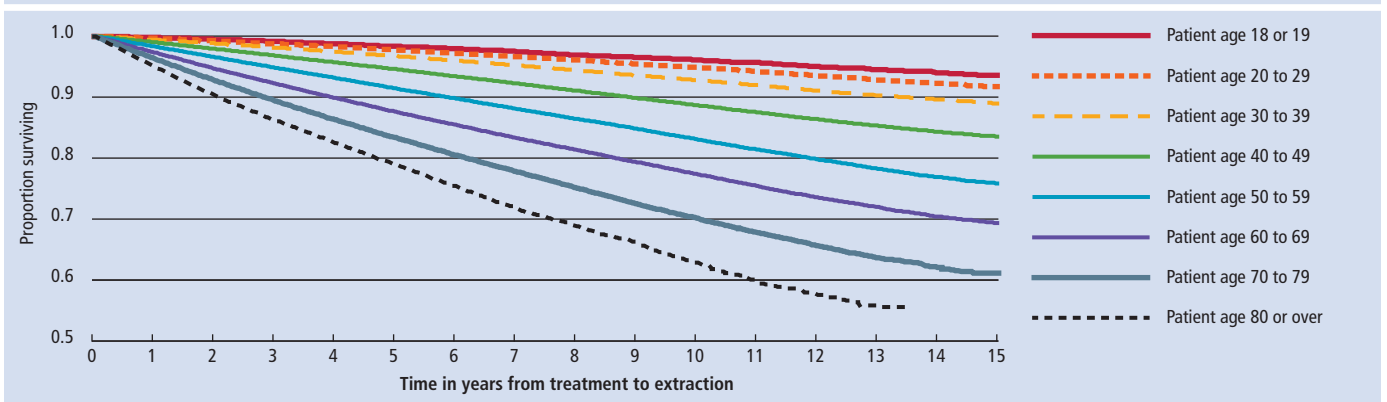


Fig. 7 Time to extraction of restored incisor teeth, with regard to patient age (30 to 39 years) and restoration type

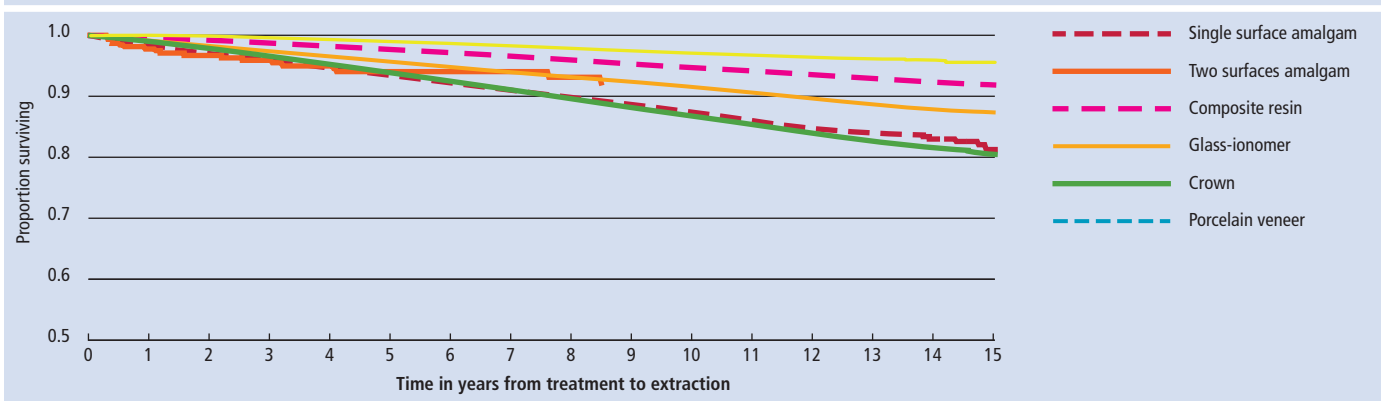
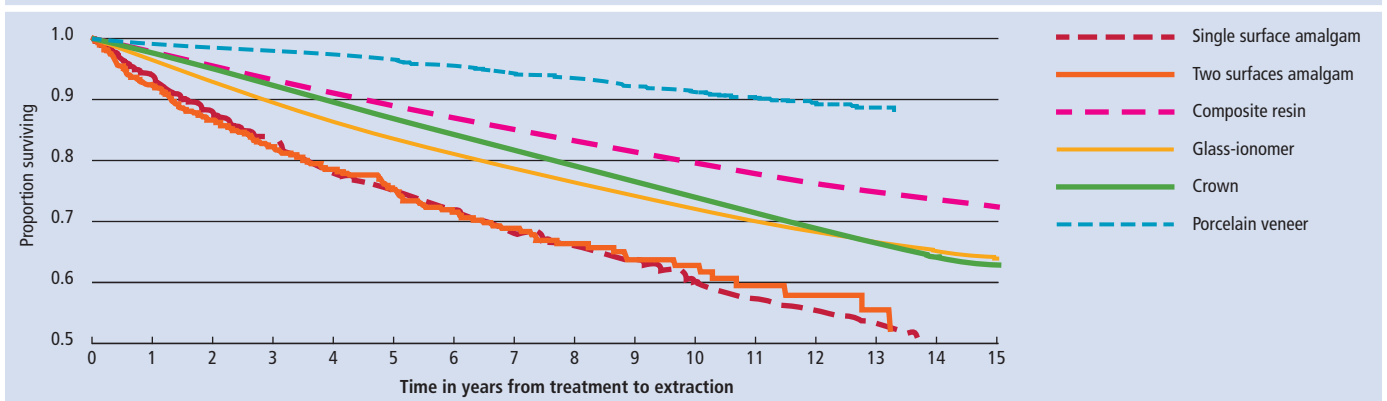


Fig. 8 Time to extraction of restored incisor teeth, with regard to patient age (60 to 69 years) and restoration type



(Table 11). When this exercise is repeated with regard to time to extraction of the restored incisor tooth, the chart indicates a *circa* one percentage point difference at 15 years, with the teeth of charge-payers surviving longer than those who do not pay (Table 12).

Patient's state of oral health

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

Average annual treatment fees

Figure 13 indicates that the patient's history of dental treatment is a major factor in determining the likely survival of restorations to re-intervention in incisor teeth. At fifteen years, this is between 64% for those with low annual expenditure on dental treatment, and 24% for those with high annual dental treatment fees (Table 13). For time to extraction of the restored incisor tooth, the difference is approximately 23 percentage points between those with high annual treatment fees and those with low annual treatment fees, with the latter having restored teeth which perform more favourably (Fig. 14 and Table 14). Looked at in terms of tooth loss, patients with high annual dental expenditure face the prospect of losing 27% of their restored incisor teeth within 15 years, compared with only 4% for patients with low annual dental fees.

Influence of tooth position

With regard to tooth position, there is a difference of *circa* six percentage points in survival of restorations in lower incisor teeth and upper incisor teeth, with restorations in lower incisor teeth performing better in terms of time to re-intervention (Fig. 15 and Table 15). There is no difference in restoration survival, overall, between central and lateral incisor teeth.

However, when individual incisor teeth position are examined (Fig. 16 and Table 16), it is apparent that, with regard to restoration survival, restorations in lower central incisor teeth perform better than those placed in lower lateral incisor teeth, with restorations in both these teeth performing better than upper incisor teeth.

With regard to survival to extraction with respect to individual incisor teeth, the results are less clear, with restored lower lateral incisor teeth performing worse and restored upper central incisor teeth performing better than the

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

Patient age	Survival (%) at				n
	1 year	5 years	10 years	15 years	
18 or 19	89	66	50	40	62,542
20 to 29	90	67	51	41	391,375
30 to 39	90	67	52	42	497,857
40 to 49	89	64	48	37	475,338
50 to 59	87	58	41	31	433,643
60 to 69	84	52	35	26	360,012
70 to 79	81	46	30	21	230,391
80 or over	80	43	28	–	75,418
All restorations	87	60	44	35	2,526,576

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

Patient age	Survival (%) at				n
	1 year	5 years	10 years	15 years	
18 or 19	100	98	96	94	62,499
20 to 29	100	98	95	92	391,375
30 to 39	99	97	93	89	497,857
40 to 49	99	95	89	84	475,338
50 to 59	98	91	83	76	433,643
60 to 69	97	88	77	69	360,012
70 to 79	96	83	70	61	230,391
80 or over	95	79	63	–	75,418
All restorations	99	93	86	81	2,526,576

other two incisor teeth positions (Fig. 17 and Table 17). Overall, in terms of time to extraction of the restored tooth, upper incisor teeth exhibit more favourable times to extraction than lower incisor teeth (Table 18).

Other factors

Concerning the difference between teeth which were root filled on the same course of treatment as the restoration that has been placed, the chart indicates a *circa* five percentage point difference at 15 years in survival of restorations to re-intervention (Fig. 18 and Table 19), with restorations in teeth which have received root fillings performing less well. When time to extraction of the restored tooth is examined (Fig. 19 and Table 20), the chart indicates a *circa* 13% difference at 15 years, this equating to about seven years, again with the root filled teeth performing less well.

Finally, the charts illustrating the performance of restorations, overall, in incisor teeth do not

indicate improvement in performance over the time of the study, either in terms of survival of restorations to re-intervention (Fig. 20) or time of the restored tooth to extraction.

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 among the largest ever to become available for analysis of the survival of dental treatment. 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. In the present work, on incisor teeth, amalgam restorations have largely been ignored, as their numbers are small

Fig. 9 Time to re-intervention of restored incisor teeth, with regard to patient gender

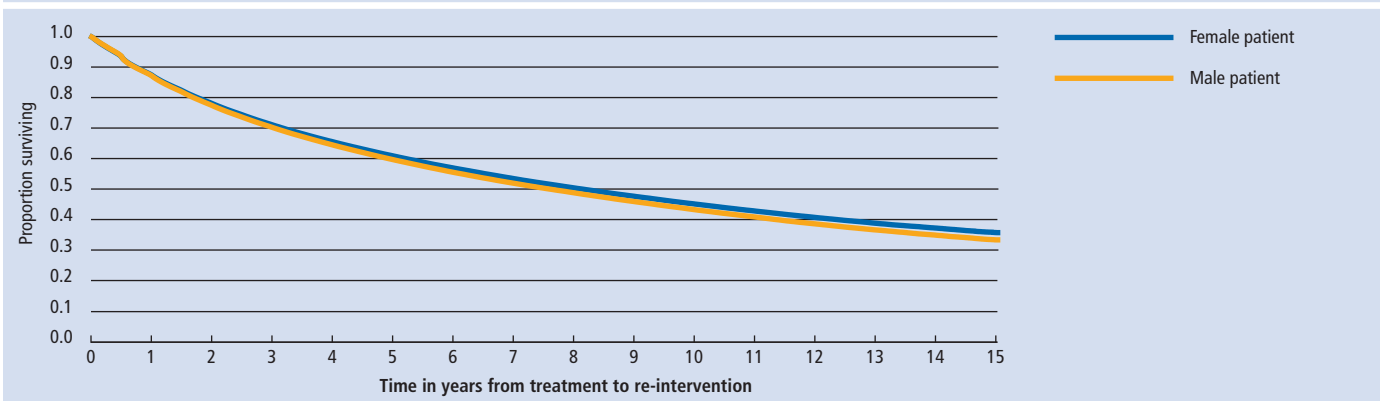


Fig. 10 Time to extraction of restored incisor teeth, with regard to patient gender

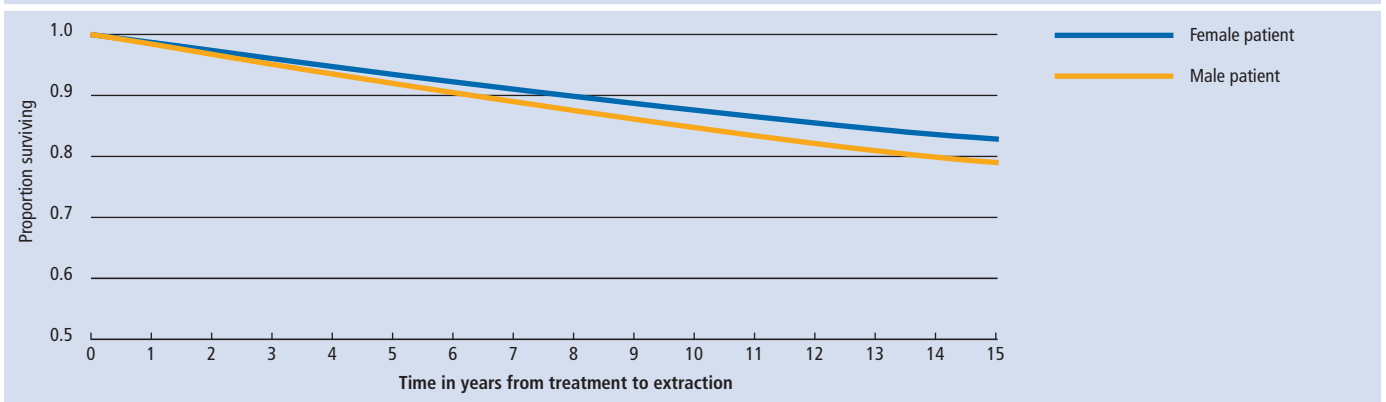


Fig. 11 Time to re-intervention of restorations in incisor teeth, with regard to dentist age

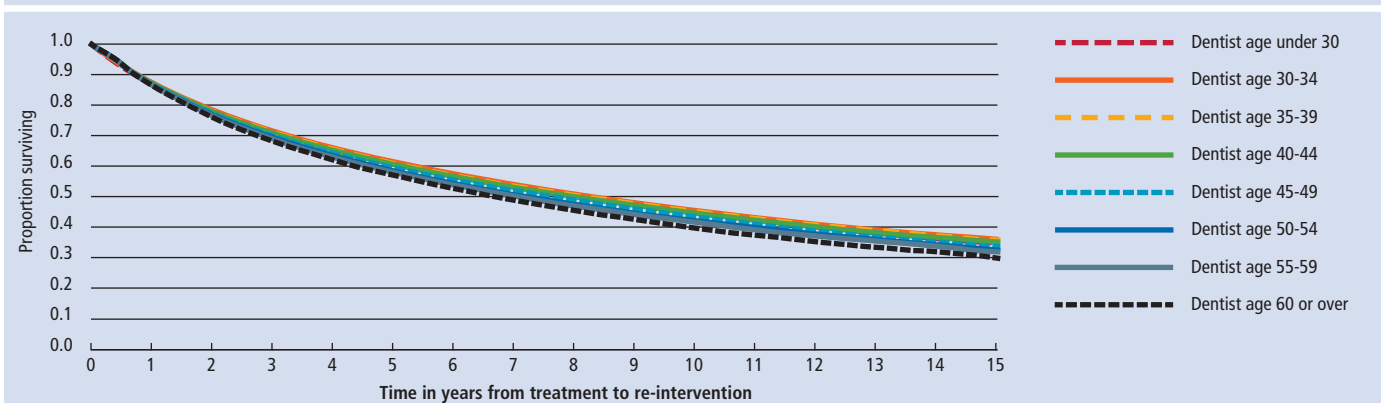


Fig. 12 Time to extraction of restored incisor teeth, with regard to dentist age

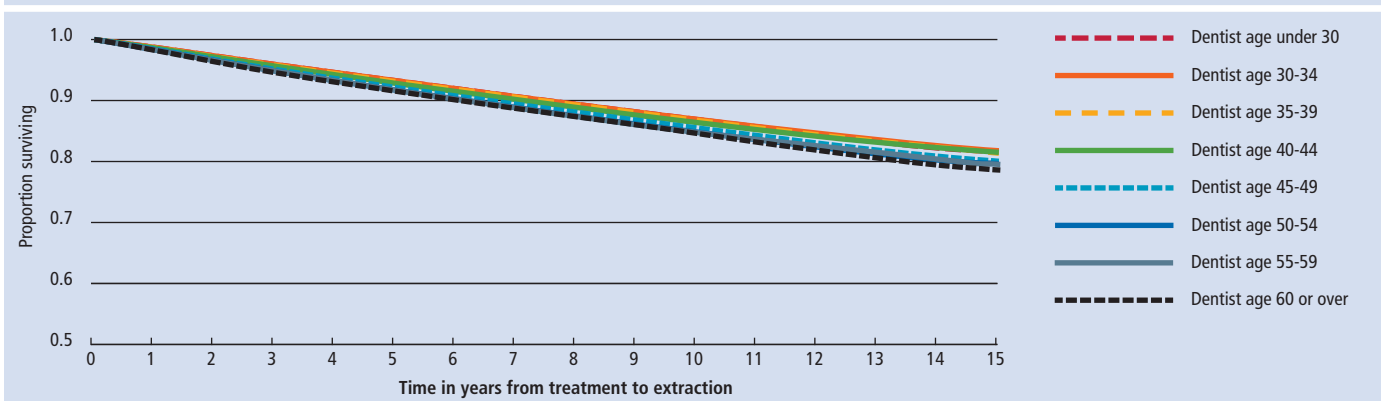


Table 5 Ten-year survival to re-intervention of restored incisor teeth, with regard to patient age and type of restoration

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	56	55	50	44	35	29	22	–
Two surfaces amalgam	82	60	61	51	38	28	23	–
Composite resin	48	49	49	45	39	33	28	26
Glass-ionomer	43	44	43	39	34	30	25	25
Crown	61	61	62	60	57	54	50	50
Porcelain veneer	54	52	53	51	49	46	37	–

Table 6 Ten-year survival to extraction of restored incisor 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	94	93	87	80	68	60	47	43
Two surfaces amalgam	100	95	92	83	67	63	49	–
Composite resin	97	96	95	91	86	80	73	66
Glass-ionomer	96	94	92	85	78	72	64	58
Crown	91	89	87	83	78	74	69	63
Porcelain veneer	99	98	97	94	92	91	80	–

(n = 34,216) in comparison to other restoration types, and the authors consider that they have minimal effect on restoration or tooth survival. In some cases, single surface amalgam restorations are likely to have been as restorations for access cavities following placement of a root filling. This, in itself, may have an adverse effect on survival of the tooth, but the influence of this is beyond the scope of the present paper.

Restoration survival

The results of the present work, in terms of time to re-intervention and time to extraction of the restored tooth, may initially appear to be contradictory, given that the analysis confirms that, when an incisor tooth is restored with a crown, the time to re-intervention outperforms all other restoration types at all ages. However, when time to extraction of the restored tooth is examined, the picture is very different. For all age groups, crowning a tooth, as opposed to placement of a (direct-placement) composite restoration or a veneer, is indicative of a reduced lifespan of the crowned tooth, even though the crown performs better in terms of restoration survival to re-intervention than a direct placement resin-composite restoration, but not as well as a veneer. In other words, when the incisor tooth is crowned, there will be fewer re-interventions than with a direct-placement resin-composite restoration, but the

Table 7 Time to re-intervention of restored incisor teeth, with regard to patient gender

Patient gender	Survival (%) at				
	1 year	5 years	10 years	15 years	n
Female patient	87	61	45	36	1,314,159
Male patient	87	60	43	33	1,212,417
All restorations	87	60	44	35	2,526,576

Table 8 Time to extraction of restored incisor teeth, with regard to patient gender

Patient gender	Survival (%) at				
	1 year	5 years	10 years	15 years	n
Female patient	99	93	88	83	1,639,693
Male patient	98	92	85	79	886,883
All restorations	99	93	86	81	2,526,576

lifespan of the tooth is compromised and it may be assumed that the crowned tooth is subject to a more catastrophic failure than one restored with resin composite or a veneer. Clinicians and patients should be aware of this. For a complete discussion of crowns, including the effect of posts, readers are directed to the paper on crowns in this series.³

It is apparent, when the performance of veneers is examined, that these perform optimally throughout, which would tend to

indicate that their more minimal preparation than a crown, which depends upon bonding the veneer to enamel which has been etched with phosphoric acid, does not compromise the strength of the restored tooth. In other words, the lesson is clear for all clinicians that maintaining the structurally stiff enamel layer of an incisor tooth rather than removing it (as is part of the crown preparation) helps protect the restored tooth from the need for early extraction. However, given that a veneer is

Fig. 13 Time to restoration re-intervention with regard to average patient spend on dental treatment

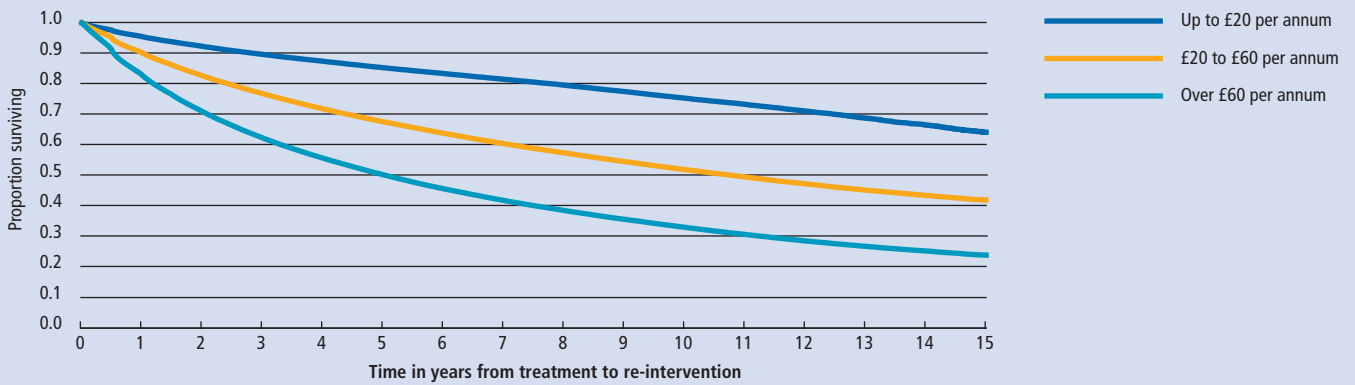


Fig. 14 Time to extraction of restored incisor teeth, with regard to average patient spend on dental treatment

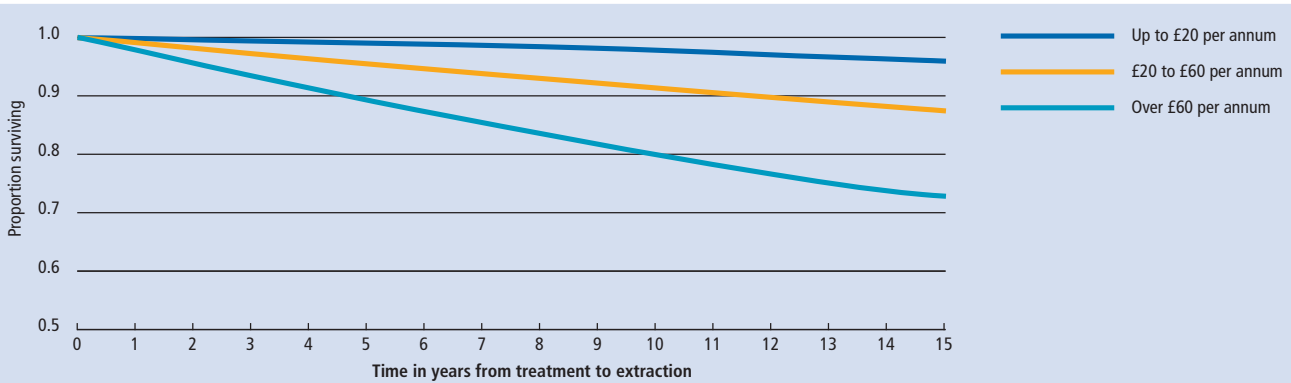


Fig. 15 Time to restoration re-intervention with regard to dental arch

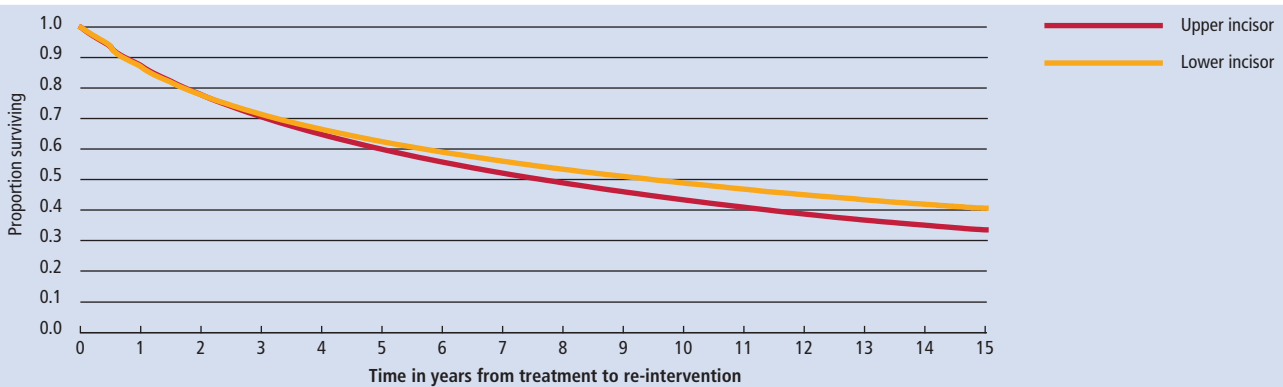
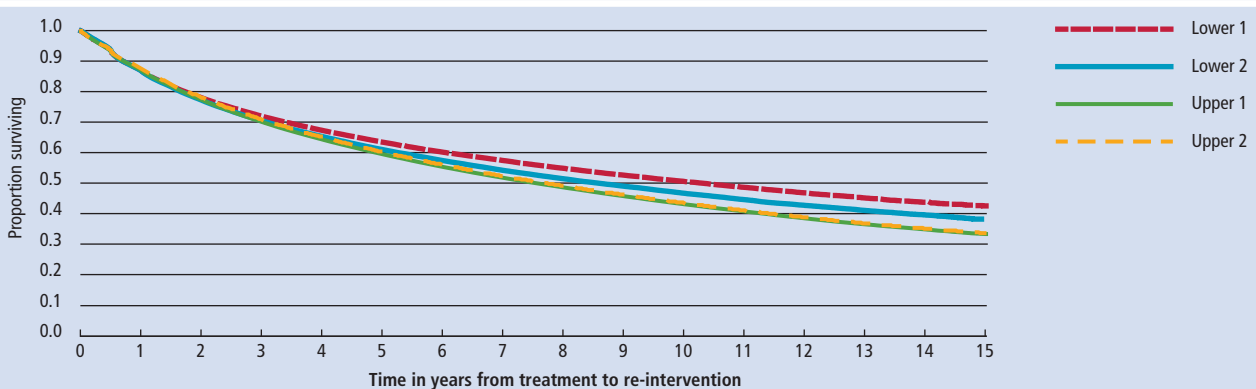


Fig. 16 Time to restoration re-intervention with regard to tooth position



often an elective restoration placed to enhance the appearance of the restored tooth, it should be questioned whether a *circa* 59% failure rate at 15 years represents a good treatment outcome. On the other hand, the lifespan of the tooth is compromised less by the placement of a veneer than any other restoration type, given that teeth restored with veneers have the best

survival to extraction of any type of restoration in anterior teeth. The reasons for this are a matter of surmise, but it is likely to be related to the substantially reduced preparation when compared with a crown and the maintenance of the enamel of the tooth, as discussed above.

Compared with a full coverage (crown) restoration, the direct placement restoration

has more factors which may fail, such as lengthy margins and caries, notwithstanding the patient requesting replacement of the restoration because (s)he is unhappy with its appearance. In a text book from a bygone era, a crown has been considered to ‘protect’ and ‘strengthen’ underlying tooth substance,⁴ adding that ‘by completely enveloping the tooth, the crown holds together the portions weakened by the inroads of caries.’ However, when a tooth is prepared for a crown, there is a concomitant reduction of tooth substance, which, in respect of the results of the present work on incisor teeth would appear to indicate that the tooth is more likely to be extracted. Could this relate to the loss of tooth substance during crown preparation, or could this be related to the potential for pulp death, given that Bergenholtz⁵ has considered that ‘iatrogenic “dentistogenic” injury to the dental pulp during crown preparation was not an insignificant problem in clinical dentistry.’ His data indicated that pulpal necrosis occurred with a frequency of 10–15% over a period of five to ten years, while Saunders and Saunders⁶ reported a 19% loss of pulp vitality when a tooth has been crowned. At the end of the day, however, it is retention of the (restored) tooth as opposed to survival of the restoration which may be considered to be most important.

The reasons for crowning an incisor tooth in a young patient may only be surmised – in an anterior tooth it may be due to trauma or gross caries in a patient with high aesthetic demands. However, the results of this work indicate that an advisable approach is restoration of the incisor tooth with a direct placement restoration until the clinician considers that there is insufficient tooth substance remaining to retain a direct restoration. On the other hand, large carious cavities and/or a traumatic incident may have weakened the tooth to such an extent and a crown is

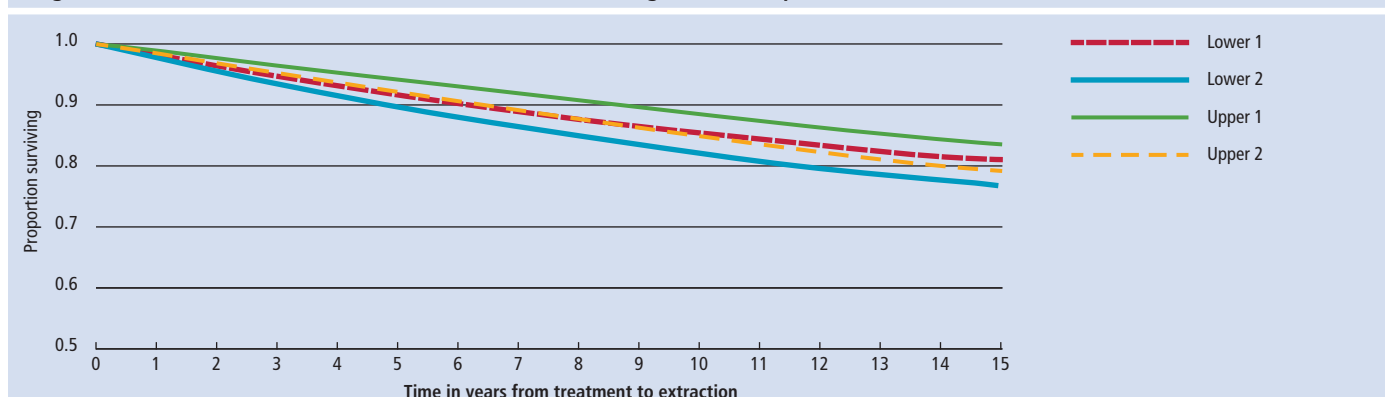
Table 9 Time to re-intervention of restorations in incisor teeth, with regard to dentist age

Dentist age	Survival (%) at				
	1 year	5 years	10 years	15 years	n
Dentist age under 30	87	61	45	35	422,699
Dentist age 30–34	87	61	45	36	464,958
Dentist age 35–39	87	61	45	36	449,827
Dentist age 40–44	88	61	45	35	406,190
Dentist age 45–49	87	60	43	34	329,594
Dentist age 50–54	87	59	42	33	241,059
Dentist age 55–59	87	58	42	32	149,107
Dentist age 60 or over	87	57	40	30	63,142
All restorations	87	60	44	35	2,526,576

Table 10 Time to extraction of restored incisor teeth, with regard to dentist age

Dentist age	Survival (%) at				
	1 year	5 years	10 years	15 years	n
Dentist age under 30	99	93	87	82	422,699
Dentist age 30–34	99	93	87	82	464,958
Dentist age 35–39	99	93	87	81	449,827
Dentist age 40–44	99	93	86	82	406,190
Dentist age 45–49	98	92	86	80	329,594
Dentist age 50–54	98	92	85	80	241,059
Dentist age 55–59	98	92	85	80	149,107
Dentist age 60 or over	98	92	85	79	63,142
All restorations	99	93	86	81	2,526,576

Fig. 17 Time to extraction of the restored incisor tooth with regard to tooth position



considered by the clinician to replace a significant amount of lost tooth substance. The results of the present study indicate that this is now outmoded thinking and that restoration of the incisor tooth by a direct restoration is advisable if the longevity

of the tooth is to be assured. Whatever the age of the patient, *circa* 15% of crowned teeth are lost in 15 years. It could be considered that this figure represents the irreducible risk in an incisor tooth when its tooth substance is removed.

Other factors

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 than in maxillary central incisors.⁷ This may therefore account for the fact that restorations in lower incisor teeth have better survival time to re-intervention, but less good survival to extraction. A further factor may be involved: it may be considered that upper incisor teeth are at greater risk to traumatic injury than lower incisor teeth, especially in patients with certain occlusal classifications and/or a large overjet.

An additional patient factor is their treatment need. There are dramatic differences in restoration performance among patients, with those with high treatment need having restorations which perform less well in either of the methods described in this work. This could be regarded as a 'chicken and egg' situation – which came first? Patients with high caries activity will, if they attend a dentist for treatment, 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 mend their diet or improve their oral hygiene and therefore continue to require restorations. On the other hand, the patients with high caries activity will receive larger restorations, and these are likely to fail more readily than small restorations.

It is considered interesting to note the differences in restoration survival (measured by both of the methods utilised in this work) 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.⁸

Finally, when survival of restorations to re-intervention is examined with regard to the year of placement of the restoration, it is clear that there is very little variation over the course of the observation period. This implies year-on-year consistency of the findings, and hence suggests that the patterns found in this study may be expected to persist into future years.

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

Table 11 Time to re-intervention of restored incisor teeth, with regard to whether the patient is exempt from charges, or not

Charge paying status	Survival (%) at				n
	1 year	5 years	10 years	15 years	
Full charge	88	61	45	36	1,639,693
Exemption or remission	86	59	43	33	886,883
All restorations	87	60	44	35	2,526,576

Table 12 Time to extraction of restored incisor teeth, with regard to whether the patient is exempt from charges, or not

Charge paying status	Survival (%) at				n
	1 year	5 years	10 years	15 years	
Full charge	98	93	86	81	1,639,693
Exemption or remission	99	93	86	80	886,883
All restorations	99	93	86	81	2,526,576

Table 13 Time to restoration re-intervention with regard to average patient spend on dental treatment

Mean annual fees	Survival (%) at				n
	1 year	5 years	10 years	15 years	
Up to £20 per annum	95	85	75	64	136,964
£20 to £60 per annum	90	67	52	42	1,096,047
Over £60 per annum	83	50	33	24	1,204,311
All restorations	87	60	44	35	2,526,576

Table 14 Time to extraction of restored incisor teeth, with regard to average patient spend on dental treatment

Mean annual fees	Survival (%) at				n
	1 year	5 years	10 years	15 years	
Up to £20 per annum	100	99	98	96	136,932
£20 to £60 per annum	99	95	91	87	1,096,047
Over £60 per annum	98	89	80	73	1,204,311
All restorations	99	93	86	81	2,526,576

Table 15 Time to restoration re-intervention with regard to dental arch

Dental arch	Survival (%) at				n
	1 year	5 years	10 years	15 years	
Upper Incisor	87	60	43	34	2,048,881
Lower Incisor	87	62	49	40	477,695
All restorations	87	60	44	35	2,526,576

in 2015, including 17 studies and 1821 restorations.⁹ 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%. The results of the current study present treatment results only from the general dental practice environment, while Demarco's results were predominantly from dental schools or hospitals. However, the results from the present work fall within these parameters, indicating that results of treatment from England and Wales bear favourable comparison with treatment results from academia all over the world.

One further paper may be considered worthy of mention, that being by Smales and Berekally, who described the long-term survival of direct and indirect restorations placed for tooth wear patients.¹⁰ In this retrospective study, resin composite restorations were placed for 17 patients and metal-ceramic crowns for eight patients, with the mean age of the patients being 64.9 years. Results indicated that 58.9% of resin composite restorations survived for ten years, compared with 70.3% of crowns in anterior teeth, with the authors stating that the resin composite restorations were 'usually replaced or repaired,'

while the crowned teeth 'often required root canal treatment or extraction.' While the numbers in this study are small compared with those in the

present work, the message is similar, namely, that crowns fail more catastrophically than teeth restored with direct placement composite.

Table 16 Time to restoration re-intervention with regard to tooth position

Tooth position	Survival (%) at				n
	1 year	5 years	10 years	15 years	
L1	87	64	51	43	235,585
L2	87	61	47	38	242,110
U1	87	60	43	33	1,124,456
U2	88	60	44	34	924,425
All restorations	87	60	44	35	2,526,576

Table 17 Time to extraction of the restored incisor tooth with regard to tooth position

Tooth position	Survival (%) at				n
	1 year	5 years	10 years	15 years	
L1	98	92	85	81	235,585
L2	98	90	82	77	242,110
U1	99	94	88	84	1,124,456
U2	98	92	85	79	924,425
All restorations	99	93	86	81	2,526,576

Fig. 18 Time to restoration re-intervention with regard to whether the restored tooth also had a root filling placed on the same course of treatment

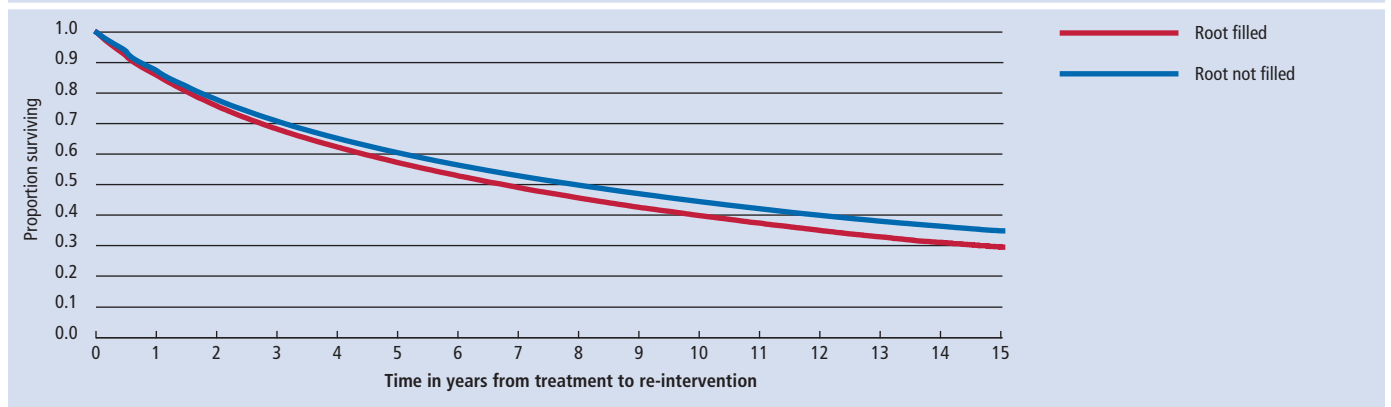


Fig. 19 Time to extraction of the restored incisor tooth, with regard to whether the restored tooth also had a root filling placed in the same course of treatment

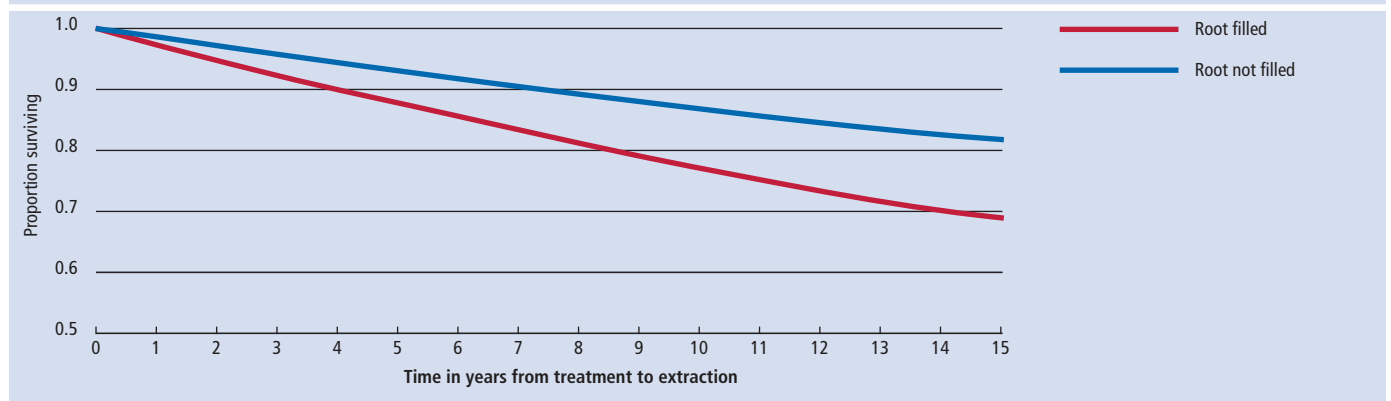


Fig. 20 Time to restoration re-intervention with regard to year of placement of the restoration

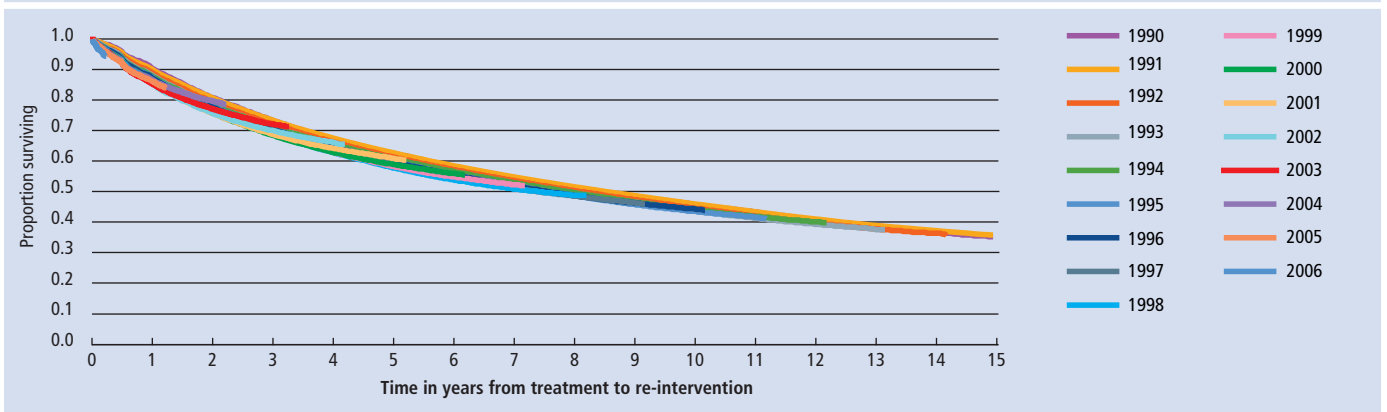


Table 18 Time to extraction of the restored incisor tooth with regard to upper/lower jaw

Dental arch	Survival (%) at				n
	1 year	5 years	10 years	15 years	
Upper Incisor	99	93	87	82	2,048,881
Lower Incisor	98	91	84	79	477,695
All restorations	99	93	86	81	2,526,576

Table 19 Time to restoration re-intervention with regard to whether the restored tooth also had a root filling placed on the same course of treatment

Root filling in same course	Survival (%) at				n
	1 year	5 years	10 years	15 years	
Root filled	86	57	40	30	147,103
Root not filled	87	61	45	35	2,379,473
All restorations	87	60	44	35	2,526,576

Table 20 Time to extraction of the restored incisor tooth, with regard to whether the restored tooth also had a root filling placed in the same course of treatment

Root filling in same course	Survival (%) at				n
	1 year	5 years	10 years	15 years	
Root filled	97	88	77	69	147,103
Root not filled	99	93	87	82	2,379,473
All restorations	99	93	86	81	2,526,576

Finally, the comments of Opdam and Hickel may be worthy of note.¹¹ In writing about operative dentistry in the present changing environment, they state that, in the past, it was assumed that crowns protected damaged teeth and that ‘the bur can remove more tooth substance in a few seconds than caries can destroy in months or years.’ The results of the present work, especially with regard to the performance of crowns on incisor teeth, reinforce these statements, in supporting the least invasive treatment involving the least removal of (sound) tooth substance. The longevity of

the tooth, rather than the longevity of the restoration, should be the aim for all clinicians.

Conclusions

- Approximately 35% of restorations in incisor teeth survived without re-intervention at 15 years, and 81% of restored incisor teeth survived for 15 years without extraction
- Factors influencing survival include patient age, dentist age, and patient treatment need
- Restoration type has a profound influence on time to extraction of the restored tooth.

Crowning an incisor tooth, as opposed to placement of a direct restoration, will lead to an earlier time to extraction of the restored tooth: the younger the patient, the greater the risk relative to alternative restorations

- Overall, in terms of time to extraction of the restored tooth, upper incisor teeth exhibit more favourable times to extraction than lower incisor teeth
- Veneers perform more favourably than other restorations in terms of time to extraction of the extracted tooth.

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