How long do routine dental restorations last? A systematic review

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Objective To conduct a systematic review of the literature on the longevity of routine dental restorations in permanent posterior teeth, and to identify and examine factors influencing its variability.

Method Accepted guidelines were followed. An advisory group oversaw the project. Simple Class I and Class II amalgam, composite resin, glass ionomer and cast gold restorations were covered. Comprehensive searching of electronic databases, hand-searching, and location of 'grey' literature, generated 124 research reports. Those considered relevant were assessed for validity and quality according to agreed criteria. The analysis was descriptive.

Results Eight of 58 relevant research reports were categorised, according to agreed criteria, as being of satisfactory validity and quality. They suggested that 50% of all restorations last 10 to 20 years, although both higher and lower median survival times were reported. The findings were supported by the totality of studies reviewed. However, variability was substantial. Restoration type, materials, the patient, the operator, the practice environment and type of care system appeared to influence longevity.

Conclusions Many studies were imperfect in design. Those considered to be the most appropriate for analysis were too limited to undertake a formal statistical exploration. Therefore there remains a need for definitive randomised controlled trials of restoration longevity, of sound design and adequate power, employing standardised assessments and appropriate methods of analysis.

The durability, or longevity, of a dental restoration is clearly a salient factor in determining its effectiveness as a presumed long-term treatment for caries. Yet despite the very large number of fillings placed annually by the profession, how long a routine restoration can, or should, be expected to stay functionally intact remains a matter of uncertainty. In order to collate, assess and draw conclusions from the available evidence, it was evident that a systematic review of the literature on longevity should be undertaken, no previous exercise of this kind having been identified. A comprehensive search was therefore initiated which revealed a body of work that might be suitable for inclusion.[1–124] This paper aims to provide a condensed, easily assimilable version of the full review,[125] the objectives of which were to establish from research reports of satisfactory quality the longevity of different types of routine dental restoration in permanent posterior teeth, and its variability; and to identify and examine factors (referred to as effect modifiers) influencing the durability of restorations.

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Method

Conduct of the review

The review was conducted in general accordance with guidelines promulgated by the NHS Centre for Reviews and Dissemination (CRD),[126] and the Cochrane Collaboration.[127] An advisory group was formed at the outset to assist the principal researcher (NAA) and act as consultants to the project. The group consisted of the remaining authors of the current report whose collective knowledge was considered to cover the areas of relevant expertise. Its task was to decide the scope of the review and the specific questions to be addressed; to approve and finalise the protocol; to monitor progress in identifying studies and deciding on their suitability for inclusion (assessment of validity); to discuss the proposals for analysis of the material and completion of the review; and to agree the final report. A meeting of the group and principal researcher took place at each stage. In addition, advice and guidance was obtained from the Systematic Review Unit at the Institute of Child Health, University College London.

Inclusion and exclusion criteria

Resources were limited and it was necessary to place some constraints on the scope of the review. Evaluations of the clinical performance of Class I (occlusal) and Class II (mesial-occlusal, distal-occlusal, mesial-occlusal-distal) restorations in permanent teeth, the commonest type of conservative treatment, predominate in the literature. It was therefore determined that the review should be confined to an assessment of the longevity of simple amalgam, composite resin, glass ionomer and cast gold restorations of those two types. A simple restoration was defined as one not requiring any form of additional retention measures.

Search strategy

Through a comprehensive search, an attempt was made to identify all relevant studies irrespective of language. Available electronic databases, MEDLINE, EMBASE, CINAHL, DISSERTATION ABSTRACTS and ERIC were searched from their date of inception together with ISTP. Conference proceedings were searched using the citation index SCISEARCH. The subject headings or key components used included *dental restoration, longevity, failure, durability, survival analysis, and life table analysis.* In addition, the Cochrane Controlled Trials Register (CCTR) in the Cochrane Library (1998 Issue 2) was scrutinised for any relevant trials and cross checked with those already retrieved.

Bibliographies of research reports identified through the search

were checked for further relevant references. These were sought as a citation on the SCISEARCH database. An attempt was also made to obtain copies of unpublished or unlisted studies, referred to as 'grey literature', by writing to key authors in the subject area. Five authors from the UK and 15 from overseas were approached. 'Grey literature' was taken to include any pertinent material not indexed on the main databases. Apart from this, no attempt was made to contact the author of any publication to seek additional information about a study. To complete the process, prospective hand-searching of all studies by key authors identified in the review was carried out and cross referencing performed with studies identified from the previous search strategies. It was established from the MEDLINE system for identifying systematic reviews[126] that none within the subject area had been carried out previously.

Study selection

The literature search produced many studies that did not meet the criteria agreed by the advisory group or were outside the scope of the review. From the totality of material obtained from the search process, using agreed criteria each member assessed independently, which studies should go forward for further evaluation. Testing the level of agreement on the content of the list between the principal investigator and each of the four other assessors yielded kappa values of 0.60, 0.40, 0.75 and 0.65 respectively, indicating fair to reasonable agreement.[128] The studies were then grouped according to those selected by three or more of the five assessors and those selected by two or fewer. The first selection, intended for prospective inclusion, was then further checked for duplication. Only the latest article was retained where several updating the same study had been published over time. However, multiple publications reporting different aspects of the same study were admitted as separate work. If agreement could not be reached by the assessors a study was excluded.

Assessment of validity and quality

The criteria used by the advisory group in the assessment of quality are presented in Table 1. For the purposes of the review, only studies that had a period of observation of at least 5 years were considered. The type of design (A) was divided into six sub-categories plus abstracts (designated as 7). Fulfilment of each criterion from B through to I inclusive, was categorised simply as 'yes' or 'no'. With regard to the outcome measures reported (I), use of an appropriate method of expressing longevity was considered important since unorthodox measures militate against valid comparisons between studies. In longitudinal studies, appropriate expressions of longevity were regarded as those which involved a formal statistical analysis of survival, such as life table or product-limit (Kaplan-Meier) estimates of survival functions. The Survival Distribution Function (SDF), often referred to simply as 'survival', for a specified time interval (t) is an estimate of the probability that an individual restoration from the population will have a lifetime exceeding t.[129] The survival time associated with SDF = 0.5 is frequently termed the median survival time (MST), in other words the lifetime which any individual restoration has a 50% chance of exceeding (designated as 8 in Table 1). Another appropriate expression is the proportion of the initial number of restorations that remain in service after specific survival times, for example, 5- or 10-year cumulative survival percentages (designated as 9).[67] In cross-sectional studies involving retrospective case record examination, the term median age or longevity (designated as 10) is commonly encountered. It is the functional period of the 50th percentile of restorations deemed to have failed. Whatever expression of longevity is used, precautions must be observed regarding adequate length of observation and the effect of data being censored as a result of premature withdrawal.[67] Data extraction was performed by the principal researcher (NAA) using a previously prepared proforma (see Table 2). Reliability of data extraction was re-checked and any disagreements referred to the group for final decision.

Table 1 Criteria of assessment of validity and quality of studies for inclusion in the review

A Design type — hierarchical classification

Satisfactory investigations
1 Randomised controlled trials
2 Non-randomised controlled trials
3 Longitudinal experimental clinical studies
4 Longitudinal prospective studies

Less satisfactory investigations
5 Longitudinal retrospective studies

Least satisfactory investigations
6 Cross-sectional studies
7 Reports consisting only of an abstract

B Was the study described as randomised? Yes/no

C Were the examiners calibrated? (studies with one or more assessors) Yes/no

D Were the terms 'failure' and 'survival' of restorations clearly defined? Yes/no

E Were the criteria for replacement clearly defined? Yes/no

F Were effect modifiers considered? Yes/no

G Was the assessment based on clinical examinations? Yes/no

H Was the effect of censoring data considered? Yes/no

I Appropriate outcome measure used? Yes/no

8 Median survival time (MST) or median longevity
9 Cumulative survival rate
10 Survival/failure rate

Data synthesis and analysis

The cut-off point determined by the advisory group to delineate studies of 'adequate' quality from those of 'unsatisfactory ' quality was a score of six 'yes' ratings and above on the assessment criteria. Characteristics recorded were design type; practice setting; consideration of effect modifiers; comparison of alternative materials; randomisation in sampling (ie random allocation of patients or teeth to a filling material); period of observation; appropriateness of analysis; and the main findings (see Table 3). Heterogeneity among the studies, particularly in respect of the varying quality and presentation of results, precluded use of statistical methods of pooling data, such as meta-analysis. In order to better explain the data, descriptive analysis was used with the studies grouped according to:

- The 'adequacy' of quality, based on an assessment score of at least six 'yes' responses
- The main outcome measure used in the studies considered to be of 'adequate' quality, and the longevity of restorations estimated in these studies
- The defining of 'failure', 'survival' or criteria for replacement, and the consideration of effect modifiers.

Results

Study selection

Fifty-eight research reports were selected by three or more of the five assessors as meeting the agreed criteria for inclusion in the review.[1–58] Of these, eight were eventually considered to be of adequate validity and quality. Sixty-six reports were excluded.[59–124]

Table 2 Assessment of validity and quality of studies meeting the criteria for inclusion. Within the hierarchical classification of study design (A, 1–7), the citations are listed alphabetically

Citation and reference	Assessment criteria A	B	C	D	E	F	G	H	I
Hamilton *et al.* (1983)[17]	1	✓		✓	✓		✓		✓ (10)
Hendriks *et al.* (1985)[19]	1	✓				✓	✓		
Wilson *et al.* (1996)[57]	1	✓		✓		✓			
Welbury *et al.* (1990)[55]	2			✓		✓			✓ (8)
Wilson & Norman (1991)[56]	2		✓	✓	✓	✓	✓		✓ (10)
Akerboom *et al.* (1993)[1]	3			✓	✓	✓	✓		
Davies (1984)[7]	4	✓				✓			
Elderton (1983)[12]	4	✓		✓	✓			✓	✓ (8)
Jokstad & Mjor (1991)[21]	4	✓			✓	✓	✓	✓	✓ (8)
Mjor & Jokstad (1993)[31]	4			✓	✓		✓		
Nordbo *et al.* (1998)[38]	4				✓		✓		
Osborne & Norman (1990) [40]	4	✓				✓	✓		
Osborne *et al.* (1991)[41]	4	✓			✓	✓	✓		
Smales (1991)[50]	4			✓		✓	✓	✓	✓ (9)
Van Dijken (1991)[53]	4			✓	✓	✓	✓		✓ (10)
Allan (1977)[2]	5			✓					✓ (8)
Bentley & Drake (1986)[3]	5		✓	✓	✓	✓	✓	✓	✓ (8)
Bjertness & Sonju (1990)[4]	5			✓				✓	✓ (8)
Crabb (1981)[6]	5			✓	✓				✓ (10)
Dawson & Smales (1992)[8]	5			✓	✓	✓		✓	✓ (8)
Dawson & Smales (1992)[9]	5			✓	✓	✓		✓	✓ (8)
Drake (1988)[10]	5			✓	✓	✓	✓	✓	✓ (8)
Drake (1988)[11]	5			✓	✓	✓	✓	✓	✓ (8)
Gray (1976)[16]	5			✓	✓		✓	✓	✓ (8)
Hawthorne & Smales (1997)[18]	5	✓		✓	✓	✓		✓	✓ (8)
Hunter (1985)[20]	5			✓	✓	✓		✓	✓ (8)
Lavelle (1976)[24]	5				✓				✓ (8)
Letzel *et al.* (1997)[26]	5	✓		✓	✓	✓		✓	✓ (10)
Letzel *et al.* (1989)[25]	5			✓		✓	✓		✓ (10)
Mahmood & Smales (1994)[27]	5			✓	✓	✓		✓	✓ (8)
Mayhew (1995)[28]	5	✓			✓	✓		✓	✓ (8)
Paterson (1984)[42]	5			✓		✓		✓	✓ (8)
Robbins & Summit (1988)[47]	5	✓	✓	✓			✓	✓	✓ (8)
Robinson (1971)[48]	5			✓	✓				✓ (8)
Smales *et al.* (1991)[51]	5			✓			✓	✓	✓ (8)
Smales (1991)[52]	5			✓		✓	✓	✓	✓ (9)
Walls *et al.* (1985)[54]	5			✓		✓		✓	✓ (8)
Meeuwissen (1985)[130]	5			✓		✓		✓	✓ (10)
Burke *et al.* (1998)[5]	6				✓	✓	✓		✓ (8)
Friedl *et al.* (1994)[14]	6				✓	✓	✓		✓ (8)
Friedl *et al.* (1995)[15]	6				✓	✓	✓		✓ (8)
Jokstad *et al.* (1994)[22]	6	✓				✓	✓		✓ (8)
Klausner *et al.* (1987)[23]	6						✓		✓ (8)
Lavelle (1976)[24]	6			✓					
Mjor (1997) [29]	6						✓		✓ (8)
Mjor & Medina (1993)[33]	6				✓		✓		✓ (8)
Mjor & Toffenetti (1992)[35]	6			✓			✓		✓ (8)
Mjor & Toffenetti (1992)[36]	6			✓			✓		✓ (8)
Mjor & Um (1993)[37]	6				✓		✓		✓ (8)
Nordbo & Lyngstadaas (1992) [39]	6			✓		✓	✓		✓ (8)
Pieper *et al.* (1991)[43]	6		✓	✓	✓		✓		✓ (10)
Pink *et al.* (1994)[44]	6	✓			✓	✓	✓		✓ (8)
Qvist *et al.* (1990)[45]	6				✓	✓	✓		✓ (8)
Qvist *et al.* (1990)[46]	6				✓	✓	✓		✓ (8)
Rytomaa *et al.* (1984)[49]	6		✓		✓	✓	✓		
York & Arthur (1993)[58]	6						✓		
Mjor & Moorhead (1998)[34]	7					✓	✓		✓ (8)

✓ = 'yes'
blank = 'no'
For key to assessment codes, including numbers in parenthesis, see Table 1

Of the 58 studies initially selected, three were subsequently discarded as they were not primary data sources.[13,30,32] The investigation by Lavelle consisted of a longitudinal retrospective and a cross-sectional study and these were considered separately.[24] One study came to light after completion of the search process.[130] The final list of studies which were assessed for validity and quality is presented in Table 2 together with their ratings according to the assessment criteria presented in Table 1.

Assessment of validity and quality

Scrutiny of the assessment ratings of the studies, shown in Table 2, indicated that the majority satisfied between three and five of the 'yes/no' criteria. The modal score of four was obtained by 14 studies; 25% of those selected. Longitudinal retrospective designs, the largest proportion of the studies included (36%), had a modal score of five 'yes' ratings (32%). Cross-sectional investigations had a modal score of four. Only eight studies achieved at least six 'yes' scores and thus satisfied the criteria of being of 'adequate' quality. Of these, six were of longitudinal retrospective design,[3,10,11,18,26,47] one was a longitudinal prospective study,[21] and one was a non-randomised clinical trial.[56] None of the randomised controlled trials or cross-sectional studies originally selected achieved this score. The studies by Bentley and Drake[3] and Drake[10, 11] were regarded as being independent.

Outcome measures

The main outcome measure reported in the eight reports judged of 'adequate' quality was median survival time (MST). This was used in six studies (Bentley and Drake,[3] Drake,[10,11] Hawthorne and Smales,[18] Jokstad and Mjor,[21] Robbins and Summitt,[47]). Only two reported survival/failure rate as the sole outcome measure (Letzel *et al.*,[26] Wilson and Norman,[56]) while four used both MST and survival/failure rate.[3,10,11,21.]

Findings on longevity

Table 3 shows the high degree of variability reported between the validated studies which made it difficult to determine an average period of time over which restorations would last. Nevertheless, the results suggest that 50% of all restorations can be expected to survive between 10 and 20 years although both lower and higher values were recorded. For amalgam restorations, the results suggested a range of 50% survival from a low of 5–8 years recorded by Jokstad and Mjor for seven practitioners in public and private practice in Scandinavia,[21] to around 23 years reported by Hawthorne and Smales[18] for 20 dentists in three private Adelaide dental practices. An intermediate value of 11.5 years was reported by Robbins and Summitt[47] in a study of Australian military personnel. For other filling materials, the findings were conflicting. Hawthorne and Smales[18] reported a MST of 17 years for composite restorations and 14 for cast gold; both less than for amalgam. They also showed that the durability of glass ionomer was rather less than that of composite resin and it should not be considered for posterior occlusal or approximal restorations. On the other hand Bentley and Drake[3] reported that 91% of cast gold, 72% of amalgam and 56% of composite fillings survived at the conclusion of their 10-year study.

Other considerations

The defining of 'failure', 'survival' or criteria for restoration replacement, and the examination of effect modifiers in studies were also considered in the review. The term 'failure' rather than 'survival' was generally used, although in the eight validated studies, the definitions of these varied. The preferred criteria were those of Robinson,[48] and the USPHS system used by Wilson and Norman.[56] Letzel *et al.*[26] and Robbins and Summitt,[47] defined their own criteria for replacement.

Some influence from effect modifiers was suggested by the validated studies. For example, occlusal amalgams lasted significantly

Table 3 Data extraction from studies assessed as being of 'adequate' quality

Citation and reference	Bentley & Drake (1986)[3]	Drake (1988)[10]	Drake (1988)[11]	Hawthorne & Smales (1997)[18]
Design type	Longitudinal retrospective	Longitudianal retrospective	Longitudinal retrospective	Longitudinal retrospective
Practice setting	Dental school	Dental school	Dental school	Private practice
Effect modifiers considered	Gender, age, tooth type, surfaces	Tooth type	High & low failure rate groups	Age, frequency of attendance, operator
Materials investigated	Amalgam, composite, cast gold	Amalgam, composite, cast gold	Amalgam, composite, cast gold	Amalgam, composite, glass ionomer, cast gold
Random sampling?	No	No	No	Yes
Period of observation	10 years	29 years	29 years	12 years or more
Appropriate analysis?	Yes Life table analysis 10-year survival rate (P10)	Yes Survival distribution functions	Yes Survival distribution functions	Yes Life table analysis
Main findings	MST: 20 years for all restorations P10 values were: cast gold, 91.1%, amalgam, 72.0%, composite, 55.9%	P10 not significantly different between maxillary & mandibular posteriors MST (years): max molars, 21.9 man molars, 20.6 max premls, 23.7 man premls, 22.2	Low failure rate group, MST: 26.6 years P10: 83.7% High failure rate group, MST: 11.9 years P10: 55.7%	MST (years): Amalgam, 22.5 SE 1.07 Comp, 16.72 SE 1.37 Gold, 13.75 SE 4.65 Glass ion, 75th quartile, 11.25

Table continued

longer than multi-surface amalgams, and single surface composites fared better than multi-surface ones.[3] Durability was reduced in dental students' patients more than 60-years-old[3] but was reportedly increased in patients more than 38-years-old treated by Scandinavian dentists.[21] In the latter study, survival was also shown to be dependent on the operator and on caries activity.

Discussion

Analytical considerations

Stepwise plots (Kaplan Meier curves) of SDF against time have deservedly become popular in studies of restoration longevity but it is important that researchers interpret them correctly. The SDF, being a probability, must range from 0 to 1 but is not, as it may appear, an indicator of the *proportion of restorations surviving* after specific time intervals[11] unless, improbably, 100% of restorations have been followed up and all have failed. Survival analysis methods, unlike simple proportions, are able to make use of survival information from cases that are right-censored as a result of loss from recall before failure, as well as from units that remain in service at the end of the study period. Both MST and cumulative survival percentages have been reported in the studies reviewed. However there are difficulties in comparing results from investigations that depend on only one of these analytical approaches, as discussed fully by Djemal *et al.*[131] An additional complication is that when failure rates are low, it may be necessary to wait a long time before it is possible to compute the MST.

On a further point, it is worth noting that MST is not the median of the recorded survival times for the whole group of restorations, nor for the failed or surviving subgroups. It is also not the 'half-life', or time taken for 50% of restorations to fail, a statistic which requires observation of the sample until that failure proportion is reached. An alternative life-table method is to generate an estimate of the time elapsed before reduction of the number of restorations to one-half. This is the Median Residual Lifetime (MRL). The danger of confusing terms containing the adjective 'median', such as MRL and median age or longevity, is clear. A 5-year cut-off point on observation times was imposed since it was considered that any attempt to assess longevity from a shorter study period would be unacceptably imprecise.

Table 3 continued

Citation and reference	Jokstad & Mjor (1991) [21]	Letzel *et al.* (1997) [26]	Robbins & Summit (1988) [47]	Wilson & Norman (1991) [56]
Design type	Longitudinal prospective	Longitudinal retrospective	Longitudinal retrospective	Non-randomised controlled trial
Practice setting	Private & public practice, school dental service	–	Military base	Dental hospital
Effect modifiers considered	Operator, age, caries activity, alloy type	Alloy type	No	Tooth type, Restoration type & size
Materials investigated	Conventional amalgam, non-gamma 2 pre-capsulated	Amalgam - 24 types of alloy	Amalgam	Composite (Occlusin)
Random sampling?	Yes	Yes	Yes	No
Period of observation	7–10 years	15 years	5 years	5 years
Appropriate analysis?	Yes Life table analysis, ANOVA, Wilcoxon tests, Mantel-Cox chi square	Yes Survival analysis	Yes Life table analysis	Yes Survival analysis
Main findings	Causes of failure – patient-related – operator-related – material-related 90% survival: 4 years MST: 5–8 yrs for Class II	85% survival: 13 years for Zn containing high Cu	MST: 11.5 years	90% survival: 5 years

P10 = 10-year cumulative survival percentage; MST = median survival time; SE = standard error of the mean; comp = composite resin; glass ion = glass ionomer

Study selection

In assessing the quality and validity of studies for inclusion in the review, considerable importance was given to the clinical examiners being trained and calibrated, and using well-defined and standardised criteria for 'failure', 'survival' or restoration replacement. Elderton[73] considered that without proper and universally acceptable guidelines, assessment of the quality of restorations would remain very subjective. Nevertheless, Mjor[29] and Allander *et al.*[60] have suggested that examiners who are not standardised have the advantage of using their own judgment and therefore represent the true position in clinical practice. There is little doubt that ecological studies of the natural history of restorations in the practice situation can give valuable insight into effect modifiers such as the dental care system or environment, and the influence, if any, of the way in which practitioners are remunerated, although such studies may not rate highly in the hierarchy of acceptable evidence.

Effect modifiers

Overall there was a high degree of variation and non-standardised use of definitions among the investigations reviewed and the statistical significance, or non significance, of effect modifiers depended to a great extent on study design. Therefore, although any generalisations would appear to be of questionable value, taking into account the totality of studies selected, the review did give some fairly strong indications of factors that probably influence longevity. As regards the patient, effect modifiers include age[3,21] and having a high caries activity which has a negative influence on restoration survival.[11,21] Secondary caries was the most frequently cited reason for failure or replacement[5,14,15,22–24,29,44,46,58] followed by fractured fillings. However, two studies reported fractured fillings as the prime reason.[31,49] From the operator viewpoint, inserting restorations that have the maximum likelihood of survival is one of the most important factors in securing a health gain for the patient and here the choice of filling material is clearly relevant. Another factor is the avoidance of surgical treatment of carious lesions confined to enamel. This results in the avoidable destruction of tooth tissue and negates any possible health gain from the intervention.[132] It is evident that dentists' attitudes, the circumstances in which they practice and the system of their remuneration, and also patient behaviour in seeking treatment, are possible effect modifiers in determining the decision to place or replace restorations. The MST of amalgam fillings provided in the General Dental Service in Scotland under fee for service conditions was found by Elderton[12] to be less than 5 years. Also patients who changed dentists were likely to receive nearly twice as many restorations as those who stayed with the same practitioner.[7] On the other hand, the MST of restorations provided for military personnel by salaried dental officers has been

reported as between 10 and 20 years,[9,28,47] irrespective of changes of practitioner.[9] The differing modes of remuneration may partly explain the difference.[9]

Longevity of restorations

Most of the studies categorised as being of 'adequate' quality were comparative. They used appropriate outcome measures and tended to employ few clinical examiners working to carefully defined criteria. Other studies reviewed met fewer of the quality assessment criteria, but it is nonetheless instructive to consider their findings on longevity. Those which used median survival time as the outcome measure are the most readily grouped. With regard to amalgam fillings, a few reported a MST of 5 years or less,[4,12,14,36,37] the majority a MST in the range of 6–10 years,[2,5,6,20,23,24,27,29,42, 44,45,48,49,55,58] and others a MST in the range of 11–20 years.[9,16,22,28,34,51] Fewer studies involved tooth-coloured filling materials. For resin composite, a handful reported a MST of 5 years or less,[12,15,35,37,44] and the majority a MST in the range of 6–10 years.[22,27,29,34,38,42,46,55,58] One study reported a MST of more than 14 years.[9] There is little useful evidence on the durability of glass ionomer restorations since most studies report an observation period short of 5 years. As regards cast gold restorations, one study reported a MST of less than 10 years.[6] However, three others have reported MSTs of between 10 and 20 years,[22,27,33] while one reported a median age of 34 years for gold restorations in a selected practice.[39]

Conclusion

A major difficulty in conducting the review was trying to draw valid conclusions from a large mass of disparate data, much of which was generated in studies with imperfections in their design. For example, even in those investigations which were for the most part methodologically sound, there was little indication that the unit of analysis adopted was the person rather than the individual restoration. The possibility of colinearity in the properties of restorations within the same mouth was not generally recognised. While it is acknowledged that conducting scientifically rigorous investigations in this subject area is fraught with great practical difficulty, there remains a challenging need for definitive comparative studies of the longevity of routine dental restorations, designed as long term, randomised controlled trials, using sample sizes of adequate power, trained and calibrated assessors, well-defined standard criteria of survival/failure, and appropriate outcome measures and methods of analysis.

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HENRY TONKS — THE FACIAL INJURY ARTIST by Vincent H Ward

Modern artist, Henry Tonks was born on April 8, 1862. His centenary in April 1962 prompted 'a correspondent' to write an article entitled 'A Teacher who fought against the Tide' in the *British Dental Journal* of that period. While the author emphasised the image of Tonks as a school-master over that of the artist, the Army Dental Service had a different appreciation of his talent and quality of work.

Facial Wounds:

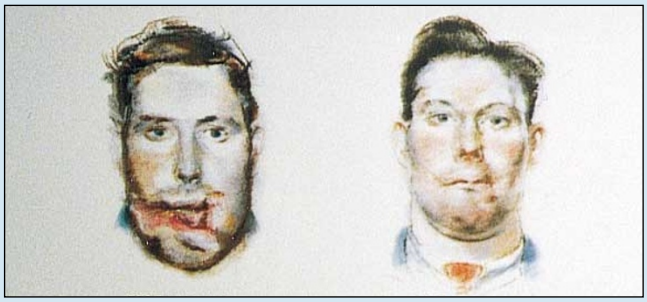
In the 1914-1918 war, 15% of those who survived to be evacuated for treatment had received facial injuries. Gunshot wounds of the face are characterised by gross soft tissue damage and shattering of the underlying bones. Frequently there is loss of both bone and overlying soft tissue, which can be extensive and cause great difficulties for repair. Subsequent treatment to restore adequate function and replace missing tissue to improve the appearance was laborious and could take many months.

Sir Harold Gillies and Sir William Kelsey Fry:

The surgeon, Harold Gillies and the dentist, William Kelsey Fry were the key figures in this field. Both successfully treated thousands of personnel injured in the war and developed effective treatment principles and techniques that are still relevant today. A new specialist hospital, the Queen's Hospital Sidcup was opened in 1917.

Henry Tonks

Tonks met Gillies in 1916. He was a qualified surgeon but had switched careers from surgery to art. While at Aldershot and later at Sidcup, he made drawings of hospital scenes and patients during treatment.



Tonks Pastels

A series of 69 pastel drawings of injuries were made as a clear record of injuries, treatment plans and stages of treatment. From the late 1960s they were displayed in the Royal Army Dental Corps Museum in Aldershot, and then at the Royal College of Surgeons of England.

In July 1999, Mrs Stella Mason BA AMA, the Keeper of the College Collections, visited the RADC Museum and handed over to the Director Army Dental Service (above) a summary of the Tonks drawings and the story behind the collection.

The originals can be seen in their true art form at the Royal College of Surgeons of England, Lincolns Inn Field, London.