Survival Rates for Porcelain Laminate Veneers with Special Reference to the Effect of Preparation in Dentin: A Literature Review

F. J. TREVOR BURKE, DDS, MSc, MDS, MGDS, FDS RCS (Edin.), FDS RCS (Eng.), FFGDP (UK), FADM

ABSTRACT

The porcelain laminate veneer is an elective restoration, often placed in the absence of disease for purely esthetic reasons. As such, it would appear desirable that the success rate of the technique was 100%. It is therefore the purpose of this paper to review the literature on porcelain laminate veneer survival by searching dental databases containing clinical trials of porcelain veneer restorations. References of selected trials were also screened to identify relevant studies. Each paper that was included was examined to ascertain if preparation into dentin affected survival. A total of 24 papers were included in the review. It was concluded that survival rates of porcelain laminate veneers are rarely 100%, and there is reasonable evidence indicating that a veneer preparation into dentin adversely affects survival.

CLINICAL RELEVANCE

A review of the literature has indicated that porcelain laminate veneer survival is rarely 100%. Accordingly, patients should be made aware of this before embarking on this elective restorative technique. Clinicians should also be aware that the ideal preparation for porcelain veneers remains within enamel.

(J Esthet Restor Dent 24:257-265, 2012)

INTRODUCTION

The realization that bonding of restorative materials to enamel was a possibility, following the description of this by Buonocore in 1955,¹ opened the door to a wide variety of adhesive dental procedures, including the introduction of porcelain laminate veneers by Calamia in 1983² and Horn,³ following an idea by Pincus.⁴ The restorations typically consisted of thin shells of porcelain, the fitting surface of which had been etched with hydrofluoric acid and treated with silane, and the restoration bonded to enamel (which had been etched with phosphoric acid) using a resin-based luting material. Porcelain veneers have been praised by Friedman, as "the premier esthetic restoration of the 20th century," but he added that the 21st century has seen a disturbing trend that is beginning to tarnish their reputation,⁵ with some individuals appearing to ignore the basic fundamentals that have made veneers successful for more than two decades, namely, conservative restorations.

INDICATIONS AND PREPARATIONS

Calamia² and Horn,³ the first clinicians to describe the porcelain veneer technique, considered that the following were indications for provision of porcelain veneers:

1 Masking discolorations such as fluorosis and tetracycline staining

Professor, Primary Dental Care Research Group, University of Birmingham, School of Dentistry, College of Medical and Dental Sciences, St. Chad's Queensway, Birmingham, UK

- 2 Hypocalcification
- 3 Fractures
- 4 Malformed teeth
- 5 Amelogenesis imperfecta

Their preparation guidelines stated:

- 1 Slight modification of labial enamel to reduce bulges
- 2 Shallow chamfer 0.5 mm incisal or occlusal to the cervical line of the tooth in the gingival enamel
- 3 Slight incisal overlap to ensure that the composite margins are not subjected to occlusal forces
- 4 Proximal preparation terminated facial to the contact areas

However, the trend for using porcelain laminate veneers for so-called "Instant Orthodontics" appears to have led clinicians to use veneer preparations that are substantially deeper than those described earlier, with the preparations being into dentin in large areas. In this respect, Brunton and colleagues concluded, in a study of depth of preparation of casts for porcelain laminate veneers at a large UK-based commercial laboratory, that there was wide variation in preparation depths for porcelain veneers and that, in 24% of their sample, the tooth had been over-prepared, with the deepest of these preparations exposing dentin over most of the prepared surface.⁶ They defined over-preparation as preparation deeper than 1.0 mm, and it is worth noting that Weinberg⁷ considered that reduction in excess of 0.5 mm led to the exposure of dentin in the cervical area of the tooth.

Given the elective nature of porcelain veneer restorations, placed only for esthetic reasons, it could therefore be considered more than unfortunate if the success rate is not 100%, because the patient has elected to place him/herself on the cycle of restorative dentistry which they cannot get off, because no restoration lasts forever. It was therefore considered appropriate to review the literature in order to determine the success rates of porcelain laminate veneers and the factors which may influence their survival, with special reference to whether preparation into dentin influenced survival.

METHODS

A MEDLINE search was carried out in order to identify clinical trials of the survival of porcelain veneer restorations. This review was limited to the Cochrane Central Register of Controlled Trials and the Pubmed MEDLINE database (1991 to June 2011) with a restriction that the language of publication should be English. Databases were also searched for meta-analyses of clinical trials of porcelain veneer restorations. References of selected trials were also screened to identify relevant studies. Research abstracts were not included.

One reviewer (FJTB) screened the titles and abstracts (where available) identified through the electronic searches. Where articles were deemed relevant to the study, full papers were obtained. These papers were again reviewed and details of whether preparation into dentin had an effect on survival recorded.

RESULTS

The results are presented in Table 1.8-31 Veneer survival was found to be less than 100% in all but two of the studies which were reviewed. Regarding whether preparation into dentin had an effect on survival was recorded, 8 of the 24 studies were considered to involve dentin preparations, although, in a number of papers, a decision was made on circumstantial evidence gained from photographs included in the paper or comments on treatment for Instant Orthodontics, as mentioned in Table 1. A majority of studies (15 from 24) did not mention whether preparation into dentin influenced survival, possibly because this was not part of the data that were collected, or because the author(s) did not see this as a point for discussion. Pertinent comments on the studies reviewed are presented in the table, however, the following additional comments on some of the publications might be of relevance:

 The "limited clinical trial" described by Walls³² was for the management of fractured and worn anterior teeth. The illustrations included in the clinical technique paper³² clearly indicate that the

Author(s) & date of publication	Duration of study	Overall failure rate	Comments (comments on dentin effect or otherwise in bold)
Dunne & Millar; 1993 ⁸	4 years	27% failure at 4 years	Five hundred fifty porcelain veneers placed in 170 patients. Veneers not placed if <50% of sound enamel remaining. Three hundred fifteen veneers in 96 patients evaluated at 63 months. Eighty-three percent "problem free." One-third of patients experienced a problem. Of the problem veneers, 8% had a defect but were reparable, 11% were considered irreparable. Yearly incidence of problems was 26%, 19%, 20%, 12%, and 24%. Increased failure rates were associated with veneers placed on existing restorations, where TSL had occurred (i.e., dentin exposed) or where inappropriate luting agents were used. Staff had fewer problem veneers than house officers and students.
Nordbø et al., 1994 ⁹	3 years	1.5%	One hundred thirty-five veneers in 41 patients, no incisal preparation. Minor incisal chipping in four teeth at 3 years, two of which required replacement of the veneer: No mention of dentin effect.
Walls, 1995 ¹⁰	5 years	14%	Fifty-four restorations placed, 43 reviewed at 5 years. Two complete and four partial failures. No mention of dentin effect, although worn teeth were treated which may have had dentin exposed. Dentin effect present in overall results.
Pippin et al., 1995 ¹¹	Up to 5 years, retrospective evaluation	No failures	Thirty patients with 60 veneers. No mention of dentin effect.
Shaini et al., 1997 ¹²	6.5 years	43% (max. central incisors), 24.4% (max. lateral incisors), 19% max. canines	Ninety percent fitted to unprepared teeth. Three hundred seventy-two porcelain veneers placed on defective and discolored teeth in 102 patients between 1984 and 1992. Survival probability low in comparison with a similar study in which tooth preparation was undertaken. Higher failure rate with inexperienced operators and in teeth with reduced enamel for bonding. Considerable number of problems resolved by repair:
Peumans et al., 1998 ¹³	5 years	7%	Majority of failures recurrent caries, porcelain fracture, and leakage. Retention rate was 100%, and maintenance of esthetics was perfect. Some discussion of effect of dentin exposure, but no mention of whether there were dentin surfaces in this study.
Friedman, 1998 ¹⁴	Up to 15 years	Aggregate failure rate of 7%	"Approximately" 3,500 veneers. Approximately 245 failures: 67% of failures were due to fracture, 22% microleakage, 11% debonding. Higher incidence of failure when preparation was on dentin.
Kihn & Barnes, 1998 ¹⁵	4 years	No failures reported	Fifty-nine veneers in 12 patients placed by one practitioner. Two "insignificant" porcelain fractures noted. No color change observed. No mention of dentin effect.
Meijering et al., 1998 ¹⁶	2.5 years	6%	One hundred eighty veneers (one-third in porcelain, the others composite) in 112 patients placed by seven dentists. Veneers on non-vital teeth had greater risk of failure. Preparation of the incisal edge not considered necessary. Type of veneer not significant in survival. No mention of dentin effect.
Fradeani, 1998 ¹⁷	6 years	1%	Eighty-three IPS Empress (Ivoclar Vivadent, Schaan, Liechtenstein) veneers in 21 patients. USPHS criteria used. One failure. Preparations confined to enamel where possible.
Kreulen et al., 1998 ¹⁸	3 years	8% failure	Meta-analysis: nine studies on 1,552 porcelain veneers included. No mention of dentin effect.
Dumfahrt & Schaffer, 2000 ¹⁹	I to I0 years	Overall failure rate was 4%. Kaplan–Meier survival rate 91% at 10 years.	Two clinicians placed 205 porcelain veneers in 72 patients, 191 reviewed. Five restorations fractured. No total debonding. Failure rate increased ($p < 0.01$) when finish line crossed an existing filling and ($p = 0.058$) when parts of the preparation surface were in dentin. The weak link in bonding veneers was considered to be the dentin/cement bond. Occlusion played a part in most failures. Marginal integrity and discoloration worse when margin on dentin. Kaplan–Meier survival 91% at 10 years. It was concluded that PLVs offer a predicable and successful treatment that preserves a maximum of tooth substance.

TABLE I. Authors, duration of study, failure rates, and comments on, the papers included in the study

TABLE	۱.	Continue	
-------	----	----------	--

Author(s) & date of publication	Duration of study	Overall failure rate	Comments (comments on dentin effect or otherwise in bold)		
Aristidis & Dimitra, 2002 ²⁰	5 years	2%	One hundred eighty-six veneers in 61 patients. Two fractures repaired, one fractured veneer replaced. No mention of dentin effect.		
Peumans et al., 2004 ²¹	10 years	None lost, but 64% ''clinically acceptable'' at 10 years.	Single clinician placed 87 veneers in 25 patients in 1990/1, incisors, canines, and 1st premolars. All placed to improve esthetics or correct malaligned teeth. Isolation by rubber dam, 93% recall at 10 years—13 of 22 patients versus satisfied with esthetics. Fracture rate increased from 4% at 5 years to 34% at 10 years, but most (23%) were clinically acceptable. Percent with excellent margin decreased from 14% at 5 years to 4% at 10 years. Two veneers replaced by crowns. Large exposed dentin surface may have contributed to 2 failures.		
Smales & Etemadi, 2004 ²²	Up to seven tears, mean of 4 years	Nine failures (8%)	One hundred ten feldspathic porcelain veneers in 50 patients in a specialist prosthodontic practice. Two preparation designs and two operators. Retrospective evaluation of case records. All six bulk failures were in veneers without incisal coverage. More failures for operator A than operator B. No mention of dentin effect.		
Wiedhahn et al., 2005 ²³	9 years	Kaplan–Meier survival rate 94% at 9 years	Seven hundred fifteen CAD CAM (Cerec, Sirona, Bensheim, Germany) veneers placed by one operator. Only the abstract was written in English.		
Fradeani et al., 2005 ²⁴	Mean of 5.7 years	5.6%	One hundred eighty-two veneers in 46 patients. Veneers made in Empress (143) and feldspathic porcelain (39). All five failures were in the Empress group. Kaplan–Meier survival—94% at 12 years. Veneers bonded mostly to dentin which the authors considered to be related to the cause of fractures.		
Chen et al., 2005 ²⁵	2.5 years	Low recall rate, results unclear:	Five hundred forty-six tetracycline-stained teeth in 54 patients. One hundred seventy-six teeth evaluated at 2.5 years. Overall results at 2.5 years unclear; but four veneers debonded at 6 months. No mention of dentin effect.		
Murphy et al., 2005 ²⁶	5-year retrospective evaluation	I I% failure	Twenty-nine patients, 62 veneers delivered by undergraduate students. Correlation between failure and presence of preexisting composite restorations. No mention of dentin effect.		
Layton & Walton, 2007 ²⁷	Up to 16 years	$91\% \pm 3\%$ survival at 12 years. Survival rate decreased to 73% at 15 years due to the death of one patient and the low number of veneers.	Three hundred four veneers placed on incisors, canines, and premolars by one clinician. At least 80% of each preparation was in the enamel. No mention of dentin effect.		
Guess & Stappert, 2008 ²⁸	5 years	3% with overlap preparations, nil for full veneer preparations	Sixty-six "extended" IPS Empress veneers in 25 patients. Two preparation designs—incisal overlap and more extensive preparation. Authors stated that partial adhesion to dentin or extensive composite restorations increased susceptibility to failure.		
Aykor & Ozel, 2009 ²⁹	5 years	No failures recorded	Three hundred veneers in 30 patients. Each patient received 10 veneers in the maxillary arch. Labial enamel reduced by 0.75 mm. Half bonded using a total etch adhesive, half with a self-etch adhesive and luted with a hybrid composite. No difference in the two groups using USPHS criteria. All finished on enamel.		
Cotert et al., 2009 ³⁰	Mean of 67 weeks	6%	Two hundred veneers in 40 patients. Most frequent cause of failure was debonding (11 of the 12 failures). No effect of dentin preparation on failure rate.		
Burke & Lucarotti, 2009 ³¹	10 years	47% failures	Analysis of a database of National Health Service dental treatment included over 2,500 porcelain veneers. No mention of dentin influence.		
CAD CAM=Computer Aided Design Computer Aided Manufacture; PLVs=Porcelain Laminate Veneers; TSL=Tooth Surface Loss; USPHS=United States Public Health Service.					

preparations were into dentin. Six failures were recorded in 43 restorations which were assessed, a higher failure rate than many of the other included papers, although the paper does not appear to attribute this to the bonding of the veneers to dentin.

- 2 Studies carried out on veneers placed 15 or more years ago, for example, the Friedman study which was published in 1998,14 and which reviewed veneers at up to 15 years, although of value, may not represent the more sophisticated bonding techniques which are available today. In this respect, this early Friedman study presented somewhat vague statistics, stating that "approximately 3,500 veneers were observed and that not all veneers had been in place for 15 years." Failure was classified into fracture, microleakage, and debonding, rather than using more traditional classifications for failure such as the United States Public Health Service (USPHS) criteria. Despite these shortcomings, the paper may however be considered to represent a considerable body of evidence and experience in veneer techniques, so the author's statements that "adhesive fractures are rarely observed when the veneer is bonded to etched enamel," and that "in the absence of surface enamel, the tooth may be more prone to flexure during loading" should not be taken lightly. The author added that debonding at the tooth interface seemed to occur when 80% or more of the tooth substrate is dentin.
- 3 Peumans and colleagues,²¹ in their 10-year prospective clinical trial of porcelain veneers, reviewed 81 restorations at 10 years, all restorations having been placed by the same operator. No restorations were lost, but it was noted that the fracture rate increased substantially from 4% at 5 years to 34% at the 10-year recall. However, most of these fractures were clinically acceptable, and a visible fracture line was visible in 21% of restorations, with 11% of these fractures being clinically unacceptable at 10 years, this having been considered to occur because of shrinkage of the luting composite and by thermal and mechanical loading. Prevention of this has been considered to be by controlled and uniform tooth reduction with a minimal thickness of luting composite.³³ Two of the

veneers were replaced by crowns. A large and unacceptable marginal defect was noted in 16 veneers out of 81 (20%). Three teeth required RCT, and, during this treatment, one tooth fractured and needed restoration with a crown. However, overall, only 4% of the veneers needed to be replaced at 10-year recall. The authors stated that "high stresses at bucco-cervical periphery can lead to fracture, especially when dentin exposed in the cervical region." In this study, Scotchbond 2 (3M, St. Paul, MN, USA) was used—its bond was stated to be less to dentin than to enamel.

4 An increased tendency for gingival recession was noted in veneered teeth, with Dumfahrt and Schaffer¹⁹ noting a similar phenomenon in their 10-year study, in which they note gingival recession in 31% of teeth restored with porcelain veneers. Despite these failings, patient satisfaction was high. Factors such as occlusion, preparation design, presence of composite fillings, and the adhesive used affect performance.

DISCUSSION

This study has reviewed survival rates of porcelain laminate veneers by reviewing papers published within the past 20 years. Although there is a body of literature on veneer survival previous to that date,^{34–39} it was considered that more recent papers would have employed contemporary clinical techniques which would be more likely to be of relevance to today's clinical practice.

The overall conclusion of the review is that porcelain laminate veneer survival is not 100% in all but two of the papers which were included, with this finding being similar to that of a review published in 2000.⁴⁰ The question therefore must be asked—is this survival rate good enough for a restoration which is generally an elective one, rather than one which is deemed necessary for the treatment of disease?

The Glossary of Prosthodontic Terms⁴¹ defines a porcelain laminate veneer as a "thin bonded ceramic restoration that restores the facial surface and part of

the proximal surfaces of teeth requiring esthetic restorations." A substantial proportion of the papers included in this review appear to place a reduced emphasis on "thin restorations" keeping the preparation on the facial surface and within enamel, and, with this in mind, it was considered by Layton and Walton²⁷ that "there is a high probability that the survival of 'modern' veneers will be far lower than those placed using the original protocol." In this regard, survival was noted as being reduced by preparation into dentin in 8 of the 24 papers which were reviewed, this being a similar finding to that by Peumans and colleagues, who stated that "the quality of restoration was inferior if dentin exposed to a large extent," further stating that "current dentin bonding agents are not yet able to prevent microleakage at the dentin margins in the long term,"⁴⁰ a proviso which is much the same in 2012. The question must therefore be asked—can preparation of veneers into dentin ever be justified?

The work by Ferrari and coworkers⁴² is of particular relevance to this discussion. They sectioned and measured the thickness of the labial enamel of 114 extracted incisor and premolar teeth at three sites, the gingival third, the middle third, and incisal third, with the results indicating that enamel thickness at the gingival third was 0.3 mm to 0.4 mm for incisor teeth. They argued that, because the enamel should be reduced by 0.5 mm in a veneer preparation, this would result in dentin being exposed at the gingival margin, or, alternatively, if the teeth are reduced less, an overcontoured restoration could result. There therefore would seem to be little alternative to preparation into dentin at the gingival margin.

There are no data giving details of the numbers of veneers placed year on year, but the featuring of porcelain veneers on "makeover" shows, particularly in the treatment of imbricated dentitions (so-called Instant Orthodontics), has increased public awareness of the technique and could be considered to have stimulated demand. However, preparations to "straighten" imbricated teeth will often involve dentin, and results from the present study suggest that preparation into dentin may have an adverse effect on veneer survival. In this regard, Calamia and Calamia⁴³ have expressed anxieties in respect of such deep preparations, stating "The key concept of preservation of enamel somehow has gone by the wayside or considered less important," adding "This may be a huge mistake," and, "Deeper preparation into dentin, a substrate with a much lower modulus of elasticity than porcelain, has provided a less rigid base or foundation for restoration placement than enamel."

Recent adverse publicity in the media with regard to porcelain laminate veneers has prompted criticism from within the dental profession, with Simonsen stating, in 2007,⁴⁴ "Where is the professional and public outrage at the troubling trends in the marketing and selling of 'cosmetic' dentistry that beseige our profession today? The code of primum non nocere (first do no harm) seems to have been cast aside in the headlong pursuit of outrageous overtreatment for financial gain by some." In this respect, it should be added that the Hippocratic Oath also states that "extreme remedies should be reserved for extreme diseases" and it could therefore be argued that a minor cosmetic defect which requires the cutting of (sometimes) a large number of teeth is not an extreme disease. This author therefore found it surprising that, in one of the included papers,²⁹ 30 patients were included in the study, with each needing 10 veneers. This may be considered to be coincidence or simply bad luck for such a number of patients to require such a large number of veneers. One positive factor, however, was the finding that the veneers were 100% successful, and it may be considered that the result was influenced by the authors' statement that all preparations were finished on enamel.

Porcelain veneers are different from most other restorations placed in dentistry insofar that the majority of veneers are *elective* restorations, generally placed in the absence of disease and only for the reason of esthetics. This may be driven by the patient or by the clinician. Because patients may be persuasive in pursuit of their esthetic demands, it is essential that the patient understands exactly what (s)he is letting her/himself in for, and the clinician has a responsibility to discuss the potential for success and the consequences of failure if adverse medicolegal circumstances are not to arise. In this regard, figures from Dental Protection Ltd in the United Kingdom indicate that the number of cases reported involving veneers increased two-fold in the years 2005 to 2010, and there was a strong upward trend in cases involving veneers which were reported to the regulatory authorities.⁴⁵

Risk factors for veneers could be considered to include (Lewis KJ, Dental Director, Dental Protection Ltd, London, personal communication, June 2009):

- 1 They are a complex treatment which therefore carries increased risk
- 2 Veneers are placed in patients who can afford them (and therefore know how to spell the word lawyer!)
- 3 The patient could be suffering from body dysmorphic disorder

It is therefore essential that the clinician fully understands the patient and understands why they are requesting veneers, and why they are requesting them "now." (Treat people, not teeth, would appear to be a concept to be recommended.) If a decision is made to proceed, then it is beholden on the clinician to obtain consent in writing from the patient, having provided them with full information on what the tooth preparation will involve (possibly by showing the patient the proposed preparation on a study cast) and what the chances of success might be. The patient must also be aware that sound enamel is being cut and that they will be entering a cycle of restorative dentistry which they cannot get off. The dentist, in turn, has to be fully cognizant of the limitations of the technique.

Calamia and Calamia⁴³ have suggested that success of the porcelain veneer technique involves the paying of great attention to detail of the following:

- 1 Planning the case
- 2 Conservative (enamel-saving) preparation of teeth
- 3 Proper selection of ceramics
- 4 Proper selection of the materials and methods of cementation
- 5 Proper finishing and polishing of the restorations

6 Proper planning for the continued maintenance of the restorations

Of these, the results of this study indicate that the most important is that the preparation must be conservative and kept in the enamel.

Finally, the question has been asked by Croll,46 "when did oral health become secondary to smile cosmetics?", adding the comment that the yellow pages in the United States do not feature advertisements such as "Dentistry for your health and wellbeing," but, rather, "Specialist in cosmetic dentistry" or "Hollywood smiles our specialty." It is this author's view that overemphasis on the cosmetic side of dentistry will ultimately result in the dental profession being downgraded from a profession to a trade or a business. The maintenance of overall oral health should be our goal, and although this may include esthetic procedures, they should not be of overriding importance. A reliance on the use of evidence from the literature will help prevent this happening, with the results of this study indicating that veneers should not be placed unless absolutely necessary because their survival rate is rarely 100%, and, if preparation into dentin is necessary for the desired esthetic effect, then other treatment, perhaps including orthodontics, must be considered.

CONCLUSION

A review of the literature has indicated that survival rates of porcelain laminate veneers are rarely 100% and there is reasonable evidence indicating that a veneer preparation into dentin adversely affects survival.

DISCLOSURE AND ACKNOWLEDGEMENT

Dr. Burke is a member of 3M ESPE Scientific Advisory Board but has no financial involvement in any dental company.

Thanks are due to Mr. Geoff Bateman, Consultant in Restorative Dentistry, Birmingham Dental Hospital, for his advice on selection of articles.

REFERENCES

- Buonocore MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. J Dent Res 1955;34:849–53.
- 2. Calamia JR. Indications for porcelain veneers. Etched porcelain veneers: a new treatment modality. N Y J Dent 1983;53:255–9.
- Horn H. A new lamination, porcelain bonded to enamel. N Y State Dent J 1983;49:401–3.
- 4. Pincus C. Building mouth personality. Paper presented to California Dental Association. 1937.
- Friedman MJ. Porcelain veneer restorations: a clinician's opinion about a disturbing trend. J Esthet Restor Dent 2001;13:318–26.
- Brunton PA, Richmond S, Wilson NHF. Variations in the depth of preparations for porcelain laminate veneers. Eur J Prosthodont Restor Dent 1997;5:89–92.
- Weinberg LA. Tooth preparation for porcelain laminates. N Y State Dent J 1989;55:25–8.
- Dunne SM, Millar BJ. A longitudinal study of the clinical performance of porcelain veneers. Br Dent J 1993;175:317–21.
- Nordbø H, Rygh-Thoresen N, Henaug T. Clinical performance of porcelain laminate veneers without incisal overlapping: 3-year results. J Dent 1994;22:342–5.
- Walls AWG. The use of adhesively retained all-porcelain veneers during management of fractured and worn anterior teeth. Part 2. Clinical results after 5 years of follow up. Br Dent J 1995;178:337–9.
- Pippin DJ, Mixson JM, Soldan-Els AP. Clinical evaluation of restored maxillary incisors: veneers vs. PFM crowns. J Am Dent Assoc 1995;126:1523–9.
- Shaini FJ, Shortall ACC, Marquis PM. Clinical performance of porcelain laminate veneers. Retrospective evaluation over a period of 6.5 years. J Oral Rehabil 1997;24:553–9.
- Peumans M, Van Meerbeck B, Lambrechts P. Five year clinical performance of porcelain veneers. Quintessence Int 1998;29:211–21.
- Friedman MJ. A 15-year review of porcelain veneer failure—a clinician's observations. Compend Contin Educ Dent 1998;19:625–35.
- Kihn PW, Barnes DM. The clinical longevity of porcelain veneers: a 48-month clinical evaluation. J Am Dent Assoc 1998;129:747–52.
- Meijering AC, Creugers NH, Roeters FJ, Mulder J. Survival of three types of veneer restorations in a clinical trial: a 2.5-year interim evaluation. J Dent 1998;26:563–8.
- Fradeani M. Six-year follow up with Empress veneers. Int J Periodont Restor Dent 1998;18:217–25.

- Kreulen CM, Creugers NHJ, Meijering AC. Meta-analysis of anterior veneer restorations in clinical studies. J Dent 1998;26:345–53.
- Dumfahrt H, Schaffer H. Porcelain laminate veneers. A retrospective evaluation after 1 to 10 years of service: part II: clinical results. Int J Prosthodont 2000;13:9–18.
- Aristidis GA, Dimitra B. Five-year clinical performance of porcelain laminate veneers. Quintessence Int 2002;33:185–9.
- 21. Peumans M, De Munck J, Fieuws S, et al. A prospective ten-year clinical trial of porcelain veneers. J Adhes Dent 2004;6:65–76.
- Smales RJ, Etemadi S. Long-term survival of porcelain laminate veneers using two preparation designs: a retrospective study. Int J Prosthodont 2004;17:323–6.
- Wiedhahn K, Kerschbaum T, Fasbinder DF. Clinical long-term results with 617 Cerec veneers: a nine year report. Int J Comput Dent 2005;8:233–46.
- Fradeani M, Redemagni M, Corrado M. Porcelain laminate veneers: 6- to 12-year clinical evaluation—a retrospective study. Int J Periodontics Restorative Dent 2005;25:9–17.
- Chen JH, Shi CX, Wang M, et al. Clinical evaluation of 546 tetracycline-stained teeth treated with porcelain laminate veneers. J Dent 2005;33:3–8.
- Murphy E, Ziada HM, Allen PF. Retrospective study on the performance of porcelain laminate veneers delivered by undergraduate dental students. Eur J Prosthodont Restor Dent 2005;13:38–43.
- Layton D, Walton T. An up to 16-year prospective study of 304 porcelain veneers. Int J Prosthodont 2007;20:389–96.
- 28. Guess PC, Stappert CF. Midterm results of a 5-year prospective clinical investigation of extended ceramic veneers. Dent Mater 2008;24:804–13.
- 29. Aykor A, Ozel E. Five year clinical evaluation of 300 teeth restored with porcelain laminate veneers using total-etch and a modified self-etch adhesive system. Oper Dent 2009;34:516–23.
- Cotert HS, Dundar M, Ozturk B. The effect of various preparation designs on the survival of porcelain laminate veneers. J Adhes Dent 2009;11:405–11.
- Burke FJT, Lucarotti PSK. Ten-year outcome of porcelain laminate veneers placed within the general dental services in England and Wales. J Dent 2009;37:31–8.
- Walls AWG. The use of adhesively retained all-porcelain veneers during the management of fractured and worn anterior teeth: part 1 clinical technique. Br Dent J 1995;178:332–6.
- Magne P, Versluis A, Douglas WH. Effect of luting composite shrinkage and thermal loads on the stress distribution in porcelain laminate veneers. J Prosthet Dent 1999;81:335–44.

- Clyde JS, Gilmour A. Porcelain veneers: a preliminary view. Br Dent J 1988;164:9–14.
- 35. Calamia JR. Clinical evaluation of etched porcelain veneers. Am J Dent 1989;2:9–15.
- Strassler HE, Nathanson D. Clinical evaluation of etched porcelain veneers over a period of 18 to 42 months. J Esthet Dent 1989;1:21–8.
- Rucker ML, Richter W, MacEntee M, Richardson A. Porcelain and resin veneers clinically evaluated: 2 year results. J Am Dent Assoc 1990;121:594–6.
- Karlsson S, Landahl I, Stegersjö G, Milleding P. A clinical evaluation of ceramic laminate veneers. Int J Prosthodont 1992;5:447–51.
- Barnes DM, Blank LW, Gingell JC, Latta MA. Clinical evaluation of castable ceramic veneers. J Esthet Dent 1992;4:Suppl:21–6.
- Peumans M, Van Meerbeck B, Lambrehts P, Vanherle G. Porcelain veneers: a review of the literature. J Dent 2000;28:163–7.
- 41. The glossary of prosthodontic terms. J Prosthet Dent 2005;94:63.
- 42. Ferrari M, Patroni S, Balleri P. Measurement of enamel thickness in relation to reduction for etched laminate

veneers. Int J Periodontics Restorative Dent 1992;23:407–13.

- Calamia JR, Calamia CS. Porcelain laminate veneers: reasons for 25 years of success. Dent Clin North Am 2007;51:399–417.
- Simonsen RJ. Commerce vs care: troubling trends in the ethics of esthetic dentistry. Dent Clin North Am 2007;51:281–7.
- 45. Riskwise UK. Veneers. Vol. 41. London: Dental Protection Ltd; 2001, pp. 1–4.
- 46. Croll TP. Dentistry... we have a problem. J Esthet Restor Dent 2003;15:201–2.

Reprint requests: F. J. Trevor Burke, DDS, MSc, MDS, MGDS, FDS RCS (Edin.), FDS RCS (Eng.), FFGDP (UK), FADM, Primary Dental Care Research Group, University of Birmingham, School of Dentistry, College of Medical and Dental Sciences, St. Chad's Queensway, Birmingham B4 6NN, UK; Tel.: 0044-0121-466-5476; email: f.j.t.burke@bham.ac.uk This article is accompanied by commentary, Survival Rates for Porcelain Laminate Veneers with Special Reference to the Effect of Preparation in Dentin: A Literature Review, Mark J. Friedman, DDS DOI 10.1111/j.1708-8240.2012.00518.x Copyright of Journal of Esthetic & Restorative Dentistry is the property of Wiley-Blackwell and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.