

Evidence-Based Learning Module Final Report

Veneers: full coverage or live with what you have –
What is best?

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1.0 Background and purpose

Cosmetic dentistry is a branch of dentistry that has not only gained profound attention but has become increasingly popular among dental practitioners and patients. Many procedures have been pioneered to provide patients with aesthetic dental treatments, from non-vital bleaching to placement of composite resins to all-ceramic and porcelain-fused to metal crowns. Among these various treatments are veneers, which are thin layers of aesthetic restorations made of acrylic, composite resin or porcelain that are shaped and designed to mimic the appearance of ideal dentition. The restorations are individually bonded to the facial surfaces of minimally prepared teeth in order to mask unaesthetic areas of a patient's dentition and to accomplish desirable aesthetic results. Veneers are some of the most commonly placed ceramic restorations in dental practices¹, and have been used as early on as 1938.² The development of materials such as porcelain and composite resins, and techniques such as acid etching and bonding, has contributed to the wide-spread use of veneers.

Of the numerous aesthetic restorations available, veneers have been particularly attractive due to the minimal tooth preparation that is required for their application. The advantage of conservative preparations is highly sought-after in comparison to other more invasive methods of treatment aimed at enhancing dental and orofacial aesthetics. Specifically, veneers are either indirect (fabricated in a laboratory setting and placed in the subsequent appointment) or direct (fabricated and placed at chair side) restorations. The material of choice for direct veneers is composite resin and is mainly indicated when teeth need to be restored due to caries accompanied by mild discoloration or malpositioning. Of the various restorative materials used to fabricate indirect veneers,

porcelain has been the oldest, most applied and researched material, and has been well-established in the correction of dental aesthetic problems.

Porcelain veneers are used for treating a variety of conditions associated with unaesthetic anterior teeth. These include tooth misalignment, congenital malformations, minor fractures, diastemas, acquired stains, as well as enamel defects.^{3,4,5} However, much controversy surrounds veneer restorations and their usage has been the source of some ethical dilemmas. Arguments for and against the use of veneers are focused on their clinical performance as judged using a wide range of criteria, including psychological effects, possible over-usage, cost effectiveness, and risks of developing unfavorable sequelae. Dental practitioners must consider these aspects as an integral part of their treatment modality. Numerous studies highlight the importance of the dentofacial region in overall aesthetics and provide practitioners with additional reason to become more familiar with veneer restorations.

Aside from recommendations for veneer placement within the professional setting, veneers have been advertised and advocated for independently by the media. As a result, it is crucial that clinicians be knowledgeable about current research so that they can address questions presented by the increasingly informed and inquisitive patient population. Although a considerable amount of literature and research has been generated, a review is in order for clinicians to make sense of this wealth of data. Such reviews would aid practitioners, as well as their patients, in deciding on the most appropriate treatment plans available. This report is intended to review current literature that will address, in particular, the use of porcelain veneers to correct dental aesthetic problems and to develop an evidence-based recommendation based on research available.

In addressing the question at hand, “Veneers: full coverage or live with what you have – what is best?”, the report will aim to determine whether the benefits of restoring with porcelain veneers outweigh the potential risks in the treatment of aesthetic problems.

2.0 Patient population

The patient population considered in this review is broad and includes all potential candidates for veneer restorations seeking treatment for aesthetic dental problems.

Aesthetic dental problems requiring veneer treatment are due to many factors, and are not bound by age, gender, or background. Research papers reviewed in this report include participants of both genders with permanent dentition and patient ages ranging from 15 to 73. However, it has been suggested that patient satisfaction with dental aesthetics is lower in younger patients⁶, and females have a tendency to be more concerned about their dental aesthetics⁷, which would make this report more pertinent to young patients and particularly to young female patients seeking aesthetic dental treatment.

3.0 Clinical problem

This report addresses aesthetic dental problems that warrant treatment as requested by the patient, and as determined by criteria set by the dentist and decisions made by the patient based on a presentation of treatment options and proper treatment plan discussions. Only those dentition that are suitable for veneer restorations are addressed in this report, independent of the number of teeth requiring aesthetic dental treatment. Those cases deemed unsuitable for treatment, including severely misaligned or discoloured teeth,

grossly damaged teeth lacking enough enamel for bonding, and dentition lacking adequate stability and functional harmony, were excluded.

Porcelain veneers are the focus of this evidence-based report. Clinical cases using composite resins and other materials for direct veneers were not included as the preliminary review of available literature revealed that porcelain has been the more extensively researched material and has been judged to have superior properties and clinical performance in comparison to composite resins.⁸ Furthermore, in addition to the increasing demand for porcelain veneers, it is more commonly chosen by both patients and dentists in the clinical setting.^{9,10}

Undoubtedly, clinical judgment is necessary to decide whether individual aesthetic problems are suitable for treatment with veneer restorations. However, there is disagreement as to what criteria should be used in making this decision. The present report aims to provide patients and clinicians with information that will facilitate decision-making in cases that fall within the aforementioned scope of problems treatable with porcelain veneers. Information regarding the clinical performance, psychological effects, functional effectiveness, and risk of unfavourable sequelae resulting from direct porcelain veneer restorations will be presented for this purpose.

4.0 Clinical flexibility

The current review will deal with the placement of porcelain veneer restorations in patients requiring aesthetic dental treatment of permanent dentition, and whose condition, expectations, and lifestyle make veneers a viable option. The findings of this report may not apply to those patients with unrealistic expectations, non-compliance with treatment

or follow-up, exceptionally poor oral hygiene, dental and oral conditions outside of this report's boundaries deeming the patient unsuitable for veneers, unusual lifestyles adversely affecting the dentition, malocclusions such as severe Class III, or inadequate motivation. Both clinical judgment and this report's contents may be used to facilitate a clinician's decision as to whether a patient satisfies the above standards.

5.0 Evidence for efficacy of porcelain veneers

5.1 Search strategy

The search for scientific literature was performed using two major databases: Medline and Pubmed. The following searches were conducted:

1. Medline:
 - a) "Dental veneer" yield = 2088
 - b) "Dental porcelain" yield = 6638
 - c) a or b yield = 7651
 - d) Limit c to "English" and "Human" yield = 3652
 - e) "Porcelain veneer" yield = 143
 - f) Limit e to "English" and "Human" yield = 101
 - g) d and f yield = 92
 - h) "Porcelain laminate veneer" yield = 42
 - i) Limit h to "English" and "Human" yield = 31
 - j) g or i yield = 120

2. Pubmed:

- a) “Porcelain veneers” yield = 1219
- b) Limit a to “Clinical trial” and “English” yield = 32

The results from both searches were combined. After accounting for the duplicates of search results, 137 research articles were compiled.

5.2 Inclusion/exclusion criteria

As discussed, porcelain veneers were decided as the primary focus of this report. Accordingly, keyword searches dealt principally with porcelain veneers (occasionally described as porcelain laminate veneers in the literature). Only studies conducted on human subjects and written in English were included in the search.

Following the initial search, the titles of 137 articles were reviewed and 27 publications were found to be closely relevant to the topic. Abstracts of these articles were reviewed more closely. Based on the consensus between group members, 10 articles were included for further review at the full-text and checklist level based on study design (i.e. clinical trials), relevance to the topic, and patient population (i.e. adult permanent dentition). Case reports, *in vitro* studies, and articles that primarily focused on comparisons between techniques and materials were beyond the scope of this study and were therefore excluded.

At the checklist level, studies that scored below 8.5 were excluded. While the low cut-off score may be a point of concern, limitations for studying the various aspects of porcelain veneer restorations must be identified. Study design issues such as introducing control groups and randomization would be difficult to carry out, primarily due to ethical concerns associated with placing veneers on teeth that do not require it. Thus, almost all

studies scored zero on questions regarding the controls and randomization on the checklist. The highest score given to a study was 10.5 and based on the overall trends after scoring all 10 articles, the score of 8.5 was considered to be a reasonable cut-off. At this level, five studies were chosen for evaluation in this report:

1. Aristidis GA, Dimitra B. Five-year clinical performance of porcelain laminate veneers. *Quintessence Int* 2002; 33(3):185-9.
2. Davis LG, Ashworth PD, Spriggs LS. Psychological effects of aesthetic dental treatment. *J Dent* 1998; 26(7):547-54.
3. Kihn PW, Barnes DM. The clinical longevity of porcelain veneers: a 48-month clinical evaluation. *J Am Dent Assoc* 1998; 129(6):747-52.
4. Layton D, Walton T. An up to 16-year prospective study of 304 porcelain veneers. *Int J Prosthodont* 2007; 20(4):389-96.
5. Peumans M, De Munck J, Fieuws S, Lambrechts P, Vanherle G, Van Meerbeek B. A prospective ten-year clinical trial of porcelain veneers. *J Adhes Dent* 2004; 6(1):65-76.

6.0 Summary of evidence

6.1 Outcome measures

Measures examined by the research and considered in this study include porcelain fracture, marginal integrity, aesthetics (colour match and surface roughness), periodontal health, tooth health (vitality and fracture), retention, reparability, and patient satisfaction. Porcelain veneers were placed for patients with dental aesthetic problems including discoloured, mal-proportioned, misaligned, eroded or fractured teeth, discoloured or unaesthetic existing restorations or veneers, diastemas, and/or surface enamel defects. Studies varied in duration, from 48 months to 16 years. Recall for these studies ranged

from 90% to 100%. Outcome measures used to define and evaluate these items varied between studies. Kihn and Barnes¹¹ utilized the modified Ryge criteria¹² (see appendix 1), whereas Layton and Walton² utilized a 6-field method without numerical scores, with the outcome categories: success, survival, repair, death, unknown, and failure. Aristidis and Dimitra¹³ and Peumans *et al.*³ each defined a unique evaluation system. However, while Peumans *et al.*³ opted for a score index with explicit criteria, Aristidis and Dimitra¹³ did not include numerical scores in their measures. Davis *et al.*¹⁴ assessed the psychological effects of veneer treatment rather than the physical characteristics of the veneers themselves and utilized three measures to evaluate patient satisfaction: the body-esteem index, repertory grid, and semi-structured interviews. The variability in the decision to include or exclude certain outcomes, combined with the absence of explicit scoring indices for some systems, weakens the conclusions that can be drawn from cross-study comparisons.

6.2 Overall success

The overall failure rate of veneers ranged from small to none in the four studies that measured the physical characteristics of veneers.^{2,3,11,13} In a 48-month study, no clinical failures were reported and all veneers remained clinically acceptable.¹¹ Five-year success rates were reported by three studies to be 98.4%¹³, 96%² and 92%³. At 10 years, Peumans *et al.*³ found that the number of clinically acceptable veneers fell significantly to 64%, while Layton and Walton² showed a much smaller drop to 93%. Longer term results were only presented in one study, which showed a further decrease to 91% at 12-13 years and 73% at 15-16 years. While these results imply that veneers have favourable short term prognoses with significantly higher risks of long term failure, consideration of the

standard error shows that this conclusion may not be accurate. Standard deviation increased from $\pm 2\%$ at 5 years to $\pm 13\%$ at 10 years in the Peumans *et al.*³ data, while Layton and Walton's² 10-year standard error only increased from $\pm 1\%$ to $\pm 2\%$. Therefore, the true 10-year survival is likely better approximated by the average in the latter study. Similarly, Layton and Walton's² 15-16 year survival rate had an error margin of 16%, due to the death of a patient and the resultant loss of five veneers to follow-up. Therefore, the evidence is too weak to allow the conclusion that veneer survival rates drop dramatically over the long term, although there is fair evidence to suggest its survival over a period of 10 years.

6.3 Porcelain fracture

Porcelain fracture was measured in all studies, with the exception of the psychological analytical research. In general, fractures were categorized as either clinically acceptable or clinically unacceptable. Acceptable fractures or unacceptable minor repairable fractures ranged from 3.8% at 48 months¹¹, 1.1%- 3% at 5 years^{3,13}, to 23% at 10 years³. These fractures were slight and of no clinical significance, occurring at the incisal edge^{3,11}, on facial, palatal or lingual surfaces³, and at margins¹³. These fractures were easily repaired using composite resin.

Unacceptable extensive fractures requiring replacement were not found at 48-months¹¹, and appeared only after 5 years for 0.6% (n=1) of the veneers¹³ and 7-8 years for 2% (n=2)³. While the single fractured veneer in Aristidis & Dimitra's study¹³ was replaced by a new veneer, two bulk-fractured veneers in Peumans *et al.*'s³ study were replaced by crowns. The 16-year data demonstrated the failure of 31% of veneers due to "mechanical complications"², although the authors did not specify the type or extent of

these complications. Nonetheless, porcelain fracture is likely included in this category, among other mechanical failures, although a direct comparison to other studies is impossible with the poorly elucidated data.

Although the incidence of porcelain fracture increases considerably with time *in vivo*, most of these fractures were of no clinical significance, and were easily repaired using composite resin. Only a small percentage of veneers experienced large bulk fractures that occurred after at least 5 years of being in service, which demonstrates the durability and reliability of porcelain veneers. Although Layton and Walton² reported a fairly high failure rate due to “mechanical complications”, they failed to explicitly define these complications. Thus a comparison of their data to the other studies would not yield reliable results.

6.4 Aesthetics

In studies which used colour match and surface roughness to evaluate aesthetics, perfect results were found after 4 (Alfa-rated and no difference with baseline), 5 and 10 years.^{3,11,13} Colour stability was observed in all restorations. Most patients were aesthetically satisfied, with a minority of patients (32%) rating the restorations only “acceptable” with a few minor aesthetic problems.³ However, Layton and Walton² reported that 31% of the veneers in the study failed due to aesthetics. However, they did not specify which aspect of aesthetics was compromised, and neglected to provide a score system or a set of criteria that categorized the veneer as a “failure.” Therefore, where aesthetics of a veneer were reliably and validly measured, the evidence strongly suggests that porcelain veneers have high long term aesthetic stability.

6.5 Marginal integrity

Marginal integrity was evaluated in all studies, using criteria which include marginal adaptation, discolouration, and recurrent caries. Only one study reported on post-operative sensitivity as a measure of marginal integrity¹¹, and demonstrated that it was not significantly different from baseline after 4 years.

Using the modified Ryge criteria, Kihn and Barnes¹¹ scored marginal adaptation of veneers as Alfa for 90% of the veneers and Bravo for 10%, at baseline. After 48 months, all margins were still clinically acceptable with 85% rated Alfa and 15% rated Bravo. Peumans *et al.*³ began with 100% “excellent” margins at baseline and found that after 5 years, 99% of the margins remained clinically acceptable, although only 14% remained “excellent”, while 54% show small clinically acceptable marginal defects at the cervical margin, and 63% at the palatal-incisal margin. Aristidis and Dimitra¹³ presented similar 5-year data with 99.4% of veneers remaining clinically acceptable, although they found that all of these veneers also remained “perfect”. At 10 years, only 78% of veneers were clinically acceptable with 4% still rated “excellent”, while small clinically acceptable marginal defects were found in 77% of cases at the cervical margin and in 78% at the palatal-incisal margin.³ Large unacceptable clinical marginal defects were the main reason for treatment failure in this study, and were present in 20% of veneers.³ The data for 15-16 years is unclear with respect to failure due to marginal defects, as this category was not considered separately and may have been incorporated under “mechanical failure”.² Although marginal adaptation accounts for the majority of veneer failures, almost all occur after a long duration in service and most veneers remain clinically acceptable for at least 10 years.

At 48 months, Kihn and Barnes¹¹ found that 2% of margins were rated “Bravo” for discolouration. At 5 years, while Aristidis and Dimitra¹³ found discolouration in only 1.1% of veneers due to staining of the luting cement, Peumans *et al.*³ reported 26% marginal discolouration. However, both groups found that the discolouration was almost unanimously clinically acceptable, with only 1 % unacceptable in the Peumans *et al.* study.³ At 10 years, Peumans *et al.* found acceptable discolouration in 79% with 33% of these rated “excellent”, although 19% were deemed clinically unacceptable with a higher percentage of occurrence at the cervical (15%) than the inciso-palatal (5%) margin.³ Overall, similar to results for marginal adaptation, veneers stand up well against discolouration early on, but become increasingly susceptible over a longer term *in situ*, especially if the margin is located at the cervical margin. Nonetheless, discolouration is generally deemed clinically acceptable, demonstrating the ability for veneers to maintain marginal colour stability.

At 48 months after placement, Kihn and Barnes¹¹ reported no secondary caries at the veneer margin, although 1.7% had slight interproximal decalcification. At 5 years, Aristidis and Dimitra¹³ found no secondary caries, although Peumans *et al.*³ found carious lesions in 0.3% of veneers. At 10 years, Peumans *et al.*³ found an 8% incidence of recurrent caries, with most lesions developing at porcelain-composite interfaces (7%) and one case at the cervical porcelain-tooth interface (1%). At 15-16 years, Layton & Walton² found recurrent caries in 6% of veneers, but did not specify the location or materials interface of caries occurrence. All studies suggest that recurrent caries is an uncommon complication of veneer treatment, even over the long term. However, caries risk appears to be considerably higher for veneers with margins terminating on existing composite

restorations. Although this is a common observation among restorations in general, further research is needed to investigate the impact of veneer margin placement on caries risk.

6.6 Retention

Retention of veneers was perfect for all veneers with no restorations lost after the duration of the studies for up to 10 years.^{3,11,13} However, at 16 years, Layton and Walton² reported that only 87.5% of veneers were retained. Nonetheless, the majority of veneers demonstrate strong resistance to debonding over periods as long as 16 years.

6.7 Periodontal health

Periodontal health was examined by 3 studies. At 48 months *in situ*, Kihn and Barnes¹¹ observed no significant difference in gingival health and plaque index scores between margins rated Alfa versus Bravo using the modified Ryge criteria, although absolute scores were better for Alfa-rated veneers. No support failure was discovered after 5 years by Aristidis and Dimitra¹³, but 12.5% support failure was described by Layton and Walton² after an observation period of up to 16 years. However, since Layton and Walton² neglected to define the criteria for “support failure,” the results cannot be reliably compared to other studies. Thus, evidence shows that veneers have virtually no adverse effects on periodontal health at least over the short term. However, longer term data is needed to determine whether the increasing rate of marginal defects has effects on the health of supporting tissues.

6.8 Tooth health

Studies conducted by Peumans *et al.*³, Aristidis and Dimitra¹³ reported no fracture of veneered teeth, although Layton and Walton² cited 6% of treatment failures as due to tooth fracture over a 16-year period. With respect to pulp vitality, after 4 years, Kihn and Barnes¹¹ observed no tooth sensitivity or adverse reactions. After 5 years, Aristidis and Dimitra¹³ rated tooth vitality as “perfect.” Peumans *et al.*³, however, observed pulpal irritation in 2 veneers after 3 years, both of which had pre-existing deep interproximal composite fillings. At 10 years, one veneer with a large composite filling and caries recurrence was also found to be radiographically non-vital. All 3 teeth (4%) required endodontic treatment, and during treatment, one tooth fractured and necessitated a crown restoration. Layton and Walton² did not report any loss of vitality over the 16-year study period. The evidence suggests that damage to veneered teeth, such as fracture or loss of vitality, is a rare occurrence and is only significant in cases where deep existing restorations are present.

6.9 Patient satisfaction

Patient satisfaction was considered by Peumans *et al.*³, Aristidis and Dimitra¹³ and was the focus of the study by Davis, Ashworth and Spriggs¹⁴. Overall, patient acceptance was good. Of the few that were not completely satisfied, minor aesthetic problems were the basis of complaints.^{3,13} Using 3 measures, body-esteem index, repertory grid and semi-structured interviews, Davis, Ashworth and Spriggs¹⁴, evaluated patient satisfaction and fulfillment of expectations after treatment with porcelain veneers. No personality differences were recognized between the controls (who did not have dental appearance problems) and the treatment group, according to the 16PF personality measure. Pre-

treatment, patients were identified to be self-conscious about their appearance and most reported adopting “defensive” postures and agreed that their teeth significantly influenced their perception of self and social interactions with others. Treatment patients were described to be dissatisfied with their appearance, had low self-esteem and shared a desire for “normality”. Desire for “normalization” was a clear aspect in patient motivation for treatment and expectations, which were high but largely realistic. The focus of expectations was identified as being on the perception of “self” and “changes in self”. Post treatment, all patients demonstrated a change in a positive direction on the body-esteem scale. As well, the Repertory Grid Analysis found a significant positive shift in patient ratings of self toward ideal self in the treatment group with respect to having a “healthy” and “clean” appearance, and feeling “at ease with others” ($p < 0.05$). No significant shifts were observed in the control group, which had both negative (41%) and positive (59%) changes on the body-esteem scale. Post-treatment reactions were largely positive, with the majority feeling more “normal” and “natural”, with greater confidence, happiness and more smiling as major descriptors. Two neutral responses were received from the treatment group in which the patient described themselves as feeling “different”. Nonetheless, at the 6-month follow-up, equally if not more positive reactions were received with patients feeling “more comfortable” and “more normal”. Patients reported positive changes in self-perception and behaviour, and linked these personal changes to improved social relations. At this recall appointment, marginal integrity, colour and appearance of veneers were still rated as satisfactory.

Davis *et al.*¹⁴ provide extensive insight into the profound psychological effects that veneer treatment has on individuals who are insecure about the appearance of their

teeth. This study is the only controlled trial in the review, and as such offers the strongest study design and the highest level of evidence available. Although patient satisfaction is addressed by two other studies in this review, the measure largely reflects the absence of obvious physical flaws on the veneer, rather than aesthetic improvement as perceived by the patient. Thus, patient satisfaction is likely the most reliably and validly measured outcome of all those discussed in this review. The substantial psychological and sociological benefit of using dental veneers to improve dental appearance and, in turn, self-confidence is compelling evidence for the positive impact conferred by this treatment.

7.0 Summary of findings and recommendations

7.1 Assessment of technology

Based on the finding of this report, a technology assessment table was constructed. However, due to the nature of the intervention, some general considerations should be noted. As mentioned previously, it was not feasible to have controls when assessing the clinical performance of porcelain veneers. Therefore, placing the veneer restoration is compared to not having the restoration or “no veneer” in the technology assessment table. Furthermore, the performance of the veneer is compared to the tooth before the veneer is placed. Because porcelain veneers are mainly placed to correct the esthetics, performance of veneers were assessed based on their ability to address the patients’ esthetic concerns.

Technology assessment table

Compared to “no veneer” the test intervention costs	Compared to “no veneer” the test intervention works		
	Better	The same	Worse
Less			
The same			
More	√		

7.2 Evidence-based recommendations

Based on the five studies reviewed, the evidence suggests that porcelain veneers are a successful form of minimally invasive aesthetic dental treatment. Success is based on the absence of porcelain fracture, desirable aesthetics, marginal integrity, retention, periodontal health, tooth health, and patient satisfaction. Evidence on clinical longevity suggests the half-life of porcelain veneers to be greater than ten years when following the criteria established by these research studies. Patients treated with porcelain veneers for aesthetic reasons were generally satisfied with the treatment and presented with improved self-esteem and a sensation of feeling “normal”. Moreover, most of the porcelain veneers that failed were easy to repair by composite resin or required replacement at worst. In summary, problems associated with porcelain veneer restorations rarely necessitate more invasive treatment.

Overall, based on the findings of this report, there is fair evidence (CTFPHC grading = B) to support the use of lab-fabricated porcelain bonded veneers as a minimally invasive procedure to treat aesthetic problems such as discoloration, mild malformations, and/or slight misalignment. However, this success was only demonstrated when careful pre-treatment prognosis and patient selection was considered.

7.3 Limitations of current research

The current literature on porcelain veneers suffers from several shortcomings, including unreliability of long term data, lack of standardized criteria in study design, and lack of randomization and controls. The data provided by the studies in this review are reliable for short term studies; however, longer term studies either neglected some key clinical outcomes, or suffered from a relatively large loss to follow-up (although still less than 20%). Studies also applied different criteria for patient selection, procedures and methods, and outcome measures, thereby creating possible confounding variables and preventing cross-study comparisons. Finally, all studies considered in this review failed to incorporate randomization into the study design and, with the exception of the Davis *et al.*¹⁴ paper, also failed to control for treatment interventions. However, since it is unethical to place veneers randomly on participants, and exact *in vivo* conditions are difficult to replicate between control and experimental groups, randomized controlled clinical trials may not be feasible in studying veneers. Even so, Davis *et al.*'s controlled clinical trial¹⁴ sets an example for the plausibility of a better study design, albeit at the expense of narrowing the study's scope to a single clinical outcome.

7.4 Future recommendations

Future research should investigate methods to improve marginal adaptation of porcelain veneers, as this was demonstrated to be the primary reason for treatment failure. Feilzer *et al.*¹⁵ notes that this loss of marginal integrity is largely due to the polymerization shrinkage of the adhesive bonding agent used to attach the veneer to the tooth. Thus, the interface between porcelain, adhesive, and tooth must be more extensively studied in

order to create long-lasting, effective veneers. Future studies should also establish and employ standardized criteria for patient selection, materials and tooth preparation methods, as well as indices and scores for important clinical outcomes. Standardization would improve the validity of cross-study comparisons, as well as eliminate confounding variables. To measure important clinical outcomes, we recommend the use of the modified Ryge criteria,¹² which were employed by Kihn & Barnes.¹¹ This set of criteria encompasses virtually all important clinical results and offers an explicit, reproducible scoring system to rate each outcome. However, in order to standardize patient selection, materials, and tooth preparation methods, new criteria would have to be established, tested, and adopted by future research groups.

8.0 Evidence Tables

9.0 References

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9.2 Studies excluded

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10.0 Appendices

Appendix 1: Modified Ryge Criteria¹⁴

Characteristic	Rating			
	Alpha	Bravo	Charlie	Delta
Color match	Matches shade tab in color/shade	Mismatches shade tab in color/shade by less than one shade tab gradation	Mismatches shade tab in color/shade by one shade tab gradation or more	N/A
Marginal adaptation	No visible evidence of crevice along the margin that the explorer will penetrate	Visible evidence of a crevice along the margin that the explorer will penetrate	Explorer penetrates crevice, reaching dentin, or base is exposed	Restoration is mobile, fractured or missing
Cavosurface marginal discoloration	No discoloration anywhere on the margin between the restoration and the tooth structure	Discoloration present, but has not penetrated along the margin in a pulpal direction	Discoloration has penetrated along the margin in a pulpal direction	N/A
Secondary Caries	No caries as evidenced by softness, opacity or etch at the margin of the restoration	Evidence of caries at margin of the restoration	N/A	N/A
Postoperative sensitivity	No postoperative sensitivity	Postoperative sensitivity	N/A	N/A

Appendix 2: List of excluded articles and reasons for exclusion

Article(s)	Reason(s) for exclusion
Chen <i>et al.</i> 2005 ¹	Inconsistencies in data; loss to follow-up not accounted for
Dunne and Millar 1993 ²	A retrospective study
Peumans <i>et al.</i> 2004 ³	Exact study encompassed within a 10-year prospective study which was included
Shaini <i>et al.</i> 1997 ⁴	A retrospective study
Walls 1995 ⁵	Poor study design based on checklist cut-off