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Retrospective Study on the Performance of Porcelain Laminate Veneers Delivered by Undergraduate Dental Students

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Abstract - *The aim of this study was to retrospectively evaluate the clinical performance of porcelain laminate veneer restorations delivered by undergraduate students at the Department of Restorative Dentistry, University Dental School and Hospital Cork and to analyze the factors that influence their prognosis and their effect on periodontal health. Patients who had veneers fitted over a period of 5 yrs. were recalled for evaluation. The recall protocol took the form of a questionnaire and a full clinical examination of the teeth involved and contra lateral control teeth. In all, 29 patients with 62 porcelain veneers were examined; only 2 of which were in the mandible. 77 % of patients had veneers fitted due to discolouration, 13% in order to alter the shape or size of teeth and 10% due to palatal erosion. On the date of recall 89% of veneers had never debonded or fractured, 6% had to be rebonded since the date of insertion and 5% presented with a fracture. From this study it appears that porcelain laminate veneers are successful in the treatment of discoloured and irregular configured anterior teeth. It shows that undergraduate students can deliver satisfactory veneer restorations.*

KEY WORDS: Porcelain laminate veneer; Undergraduate; Retrospective

INTRODUCTION

Avoiding eye contact, covering ones mouth with one's hand, or tensing the oral musculature when speaking or smiling, are some attempts which are often made by individuals to conceal the appearance of unaesthetic anterior teeth. Facial beauty is particularly valued in our society and any disfigurement in the oral region may lead to low self-esteem or a lack of self-confidence[1].

A veneer is a labial facing that is generally and mostly used to cover the surfaces of anterior discoloured teeth. They have gained favour not only for their excellent appearance, but also for their minimally destructive tooth preparation, reduced need for anaesthetic administration during operative procedure and versatility during function.

The improvements in the physical properties of porcelain in the last century have rendered it the material of choice for the construction of these veneers[2–5].

The porcelain laminate veneer may be used to restore teeth compromised by vital or non-vital discolouration, tetracycline discolouration, enamel hypoplasia, fluorosis and irregular configuration. Their advantages include improved aesthetics, colour and morphological stability and tissue acceptability. Resin composite veneers, unlike porcelain veneers still suffer from a limited longevity, as they remain susceptible to discolouration, wear and marginal fracture. Clinical studies show that porcelain veneers are stronger, more durable and have superior aesthetics than resin composite veneers[2–5].

While full coverage crowns may address or be a choice for similar aesthetic problems, however, the removal of sound tooth tissue for retentive purposes alone is unnecessary[6,7]. Furthermore veneers result in less gingival inflammation than porcelain fused to metal crowns[8].

Short and long terms studies have evaluated the success of porcelain veneers. The long-term success in the Dunne and Miller and the Dumfahrt and Schaffer studies (97% at 5yrs and 91% at 10yrs) are indications that porcelain veneers are the most durable, conservative aesthetic restoration[9,10]. In one study, American dentist considered veneers to be more aesthetic than crowns[11]; however, European dentists may or may not give the same response.

In our literature search, we did not find any studies that reported the performance of veneers fitted by undergraduate students. The objectives of this study were to determine the current status of this treatment modality, to evaluate the clinical performance of veneer restorations fitted by undergraduate students at the Department of Restorative Dentistry, University Dental School and Hospital, Cork and to analyze the factors that influence their prognosis and their effect on periodontal health.

METHOD

Fifty eight patients who have had veneer restorations provided by undergraduate students in the Cork University Dental School and Hospital over a period of 5 years, i.e. from 1996 to 2001 were recalled for evaluation. The exclusion criteria included patients at risk of Infective Endocarditis, on anticoagulant therapy or those who had any bleeding disorder. A protocol was submitted for ethical approval and was approved by the Cork Teaching Clinical Research Ethics Committee.

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The recall protocol took the form of a questionnaire, which collected relevant information about the patient (age, sex etc). An assessment form was designed to collect data regarding the reasons for treatment and the location of the fitted veneers, whether the veneer failed/debonded, the possible reasons for failure and the details of rebonding. A Visual Analogue Scale was also used to evaluate patients' satisfaction with the overall treatment and appearance and these have been used reliably in other studies[12].

The clinical examination involved the recording of veneer adaptation, margin locations, percentage of remaining tooth structure on the veneered teeth, the incisal edge design of the veneered teeth (feathered or included), rating of aesthetics, integrity of the veneer abutments, occlusal relationship of the patient where relevant, moisture control procedure used when the veneer was fitted, the bonding procedure used and the presence of primary or secondary caries on the veneered tooth.

The periodontal examination included recording of the plaque index, gingival index, bleeding on probing, periodontal pocket measurement around the veneer/s and gingival recession measurements. In all cases contra-lateral tooth/teeth were similarly examined as a control. A protocol was established to allow the consistent choice of alternate control teeth when the contra-lateral teeth were missing, crowned or heavily restored with a restoration that extended to the labial tissues.

The author (EM) was calibrated in a pilot study and the co-author (HZ) formed the standard for assessment and after further examination and consultation the study was initiated.

The following periodontal indices were examined on the abutment and control. The Plaque Index of Silness and Loe (1964)13 was used and graded as follows:

0 = No Plaque
1 = Film of Plaque visible only on removal on the probe or by disclosing
2 = Moderate accumulation of plaque, which can be seen by the naked eye
3 = Heavy accumulation of soft material filling the niche between the gingival margin and the tooth surface i.e. the interdental region is filled with debris.

The Gingival Index described by Loe and Silness (1963)[14] was used and graded as follows:

0 = Normal gingiva
1 = Mild inflammation, slight change in colour, slight oedema, no bleeding on probing
2 = Moderate inflammation, redness, oedema, and glazing, bleeding on probing
3 = Severe inflammation, marked redness and oedema, ulceration. Tendency to spontaneous bleeding.

Bleeding on Probing was adjusted to scores 0 and 1 (dichotomous) indicating the presence or absence of bleeding as it is generally accepted that the gingival inflammation should be estimated by gingival bleeding[15,16].

The pocket depth was measured from the crest of the gingival margin to the base of the pocket. The measurements were made with a calibrated periodontal probe graduated in millimeters.

The presence or absence of recession was recorded using a similar graduated probe. The measurements were made from the cementoenamel junction to the crest of the gingival margin. If the gingival crest was apical to the CEJ a positive recording was noted and if the CEJ was apical to the crest of the gingival margin a negative recording was noted in mms.

Data analysis

The data for veneer and control sites (mesio-labial, mid–labial and disto-labial sites) were cross tabulated and analysed using Chi Square tests adjusted using the Fisher's Exact method when cells contained counts of less than 5. The variables analysed in this way were the scores for Plaque Index, Gingival Index and Bleeding on Probing. Recession scores were almost exactly the same for both veneer and control sites, and thus were not analysed statistically. The *p*-value for statistical significance was 0.05.

The sex and age and satisfaction with veneers were also cross tabulated and analysed using Chi Square tests adjusted using the Fisher's Exact method

RESULTS

The responders to the recall were 29 out of the 58 who were invited to attend. Non-responders included mainly patients who changed their address (mainly university students) or those who repeatedly missed appointments.

In all, 62 porcelain-laminate veneers were examined clinically in 29 patients, 19 were female (65%) and 10 were male (35%). Of the 62 veneers, only 2, 3% were placed in the mandible, 60, 97% were placed in the maxilla. 56, 90% of the veneers were on the labial surface and 6, 10% were on the palatal surface.

Discolouration was the main reason why patients had the veneers placed and 48 (77%) were placed to disguise discolouration. Eighteen (29%) of the veneers were constructed due to tetracycline staining, 16 (25%) were due to vital discolouration and 14 (23%) were due to non-vital discolouration. Eight veneers (13%) were placed to alter the shape and size of the teeth and 6 (10%) were placed due to palatal erosion.

Using the visual analogue scale, 18 (62%) patients rated their overall satisfaction with treatment and appearance of the veneer between 90–100%, 4 (14%) patients between 80–89%, a further 5 (17%) between 70–79% and only 2 (7%) patients between 60–64% (*Figure 1*). Using the same visual analogue scale, the sex distribution related to patient satisfaction was as follows; 7 (42%) males had a satisfaction of more than 90% and 3 (10%) males had a satisfaction of less than 90%. Eleven females (38%) showed a satisfaction of more than 90% and 8 (27%) females showed a satisfaction of less than 90% (*Table 1*).

The age relationship to satisfaction was as follows; at the age range 20–39 years old there was 6 (21%) patients who reported a satisfaction of more than 90% and similarly 6 (21%) patients reported a satisfaction of less than 90%. At the age range 40–69 years, 13 (45%) patients

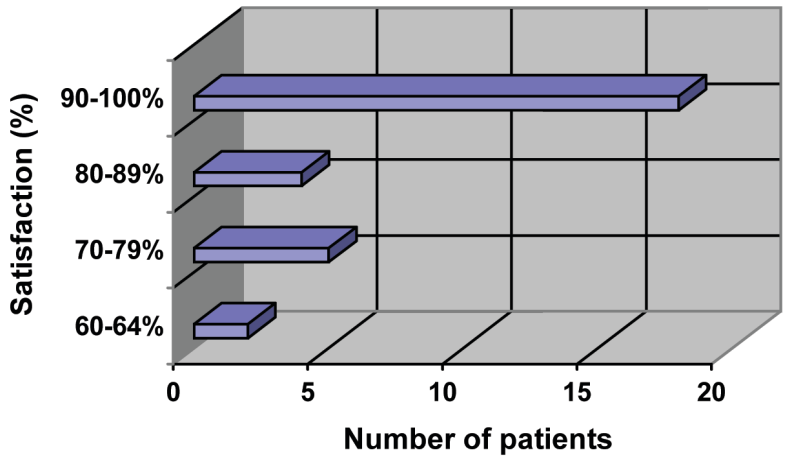

Figure 1. *Patients' satisfaction*

Table 1. *Patients rating of satisfaction with veneers, by gender*

Satisfaction VAS	*Males*	*Females*
>90%	7	3
<90%	11	8
p-value	Chi-square (Fisher's exact) test, p=0.53	

Table 2. *Patients rating of satisfaction with veneers, by age*

Satisfaction VAS	*20–39 years*	*40–69 years*
>90%	6	6
<90%	13	5
p-value	Chi-square (Fisher's exact) test, p=0.14	

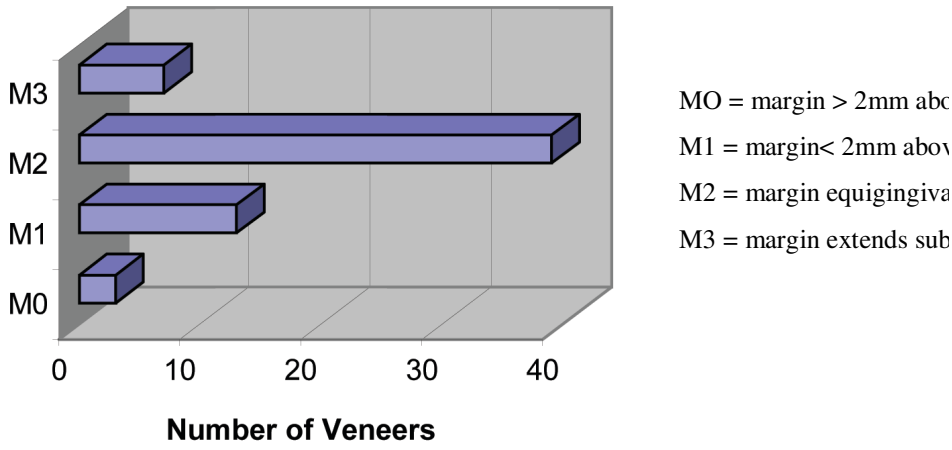

Figure 2. *Margin location*

showed a satisfaction of more than 90% and 4 (13%) patients showed a satisfaction of less than 90% (*Table 2*).

The questionnaire also revealed that, 90% (26) were prepared to repeat the treatment if necessary and 10% (3) were not prepared to repeat this type the treatment.

On the date of clinical examination, 59 (95%) veneered teeth were problem-free, 4 (6%) of these, however, had a single time debond/rebond since the original date of insertion.

Three (5%) of the overall veneer restorations presented with some degree of fracture and 6 (9%) had preexisting inter-proximal composite restorations and all were still in service.

Regarding the incisal edge preparation, only two types were used, (a) feathered preparation (73%) and (b) the overlapping incisal edge preparation (27%).

The gingival margins of 89% of the veneers were placed supra or equigingivally to allow for cleansable gingival margins, 11% were placed subgingivally (*Figure 2*).

In evaluation of veneer marginal adaptation, 95% of the veneers were rated satisfactory since all margins were closed (the margins of the veneer were continuous with the margins of the preparation), 3% showed a minor void or defect around the margin and 2% needed to be replaced due to a major defect i.e.; fracture of the veneer. 97% of the patients reported that the veneer abutment remained non-problematic and indeed no caries was detected on the veneered teeth.

The clinical techniques used for moisture control were reported to be rubber dam in 62% of the veneers, cotton wool roll in 37% and in the remainder (1%) it was not specified in the patients' records.

All 62 veneers were etched with hydrofluoric acid in the laboratory to increase the bond strength of the luting composite to the veneer and silane-coupling agent was

Table 3. *Plaque around veneered and control teeth*

Plaque Index	*Mesio-labial*		*Mid-labial*		*Disto-labial*	
	Veneer	*Control*	*Veneer*	*Control*	*Veneer*	*Control*
0	52	49	51	49	53	51
1	5	4	9	3	4	3
2	5	2	2	4	5	5
3	0	7	0	6	0	3
p-value	Chi-square (Fisher's exact) test, p=0.089		Chi-square (Fisher's exact) test, p=0.09		Chi-square (Fisher's exact) test, p=0.084	

Table 4. *Gingival inflammation around veneered control teeth*

Gingival index	*Mesio-labial*		*Mid-labial*		*Disto-labial*	
	Veneer	*Control*	*Veneer*	*Control*	*Veneer*	*Control*
0	54	54	54	55	54	55
1	0	7	0	6	0	6
2	8	1	8	1	8	1
3	0	0	0	0	0	0
p-value	Chi-square (Fisher's exact) test, p=0.09		Chi-square (Fisher's exact) test, p=0.09		Chi-square (Fisher's exact) test, p=0.09	

Table 5. *Bleeding on probing around veneered and control teeth*

Bleeding on probing	*Mesio-labial*		*Mid-labial*		*Disto-labial*	
	Veneer	*Control*	*Veneer*	*Control*	*Veneer*	*Control*
No	52	47	51	47	52	47
Yes	10	14	11	14	10	14
p-value	Chi-square (Fisher's exact) test, p=0.085		Chi-square (Fisher's exact) test, p=0.085		Chi-square (Fisher's exact) test, p=0.085	

also used. Data of the bonding system used was not clear in all the patients' records and hence the bonding systems used in this study were not evaluated.

Periodontal evaluation

Periodontal evaluation showed no significant increase in plaque detected around the veneered teeth as compared to the control teeth (*Table 3*).

There was no significant difference in the plaque index of veneered and control teeth. The plaque index of score 3 was significantly higher on the control teeth than the veneers where no scores of 3 were recorded.

There was absence of inflammation around the majority of both veneered (87%) and control teeth (*Table 4*). There was an increased presence of inflammation on some of the control teeth when compared to the veneered teeth. Eight of the veneered teeth showed a score 2 out of the overall sample and neither the veneered teeth nor the controls scored 3 on the gingival inflammation index.

Fifty-two (84%) veneer teeth showed no bleeding on probing while 10, 16% showed bleeding on gentle probing on the mesio-labial and disto-labial. Fifty-one (82%) veneered teeth showed bleeding on probing while 11, 18% did bleed on probing around the mid-labial of the restorations (*Table 5*). The pocket probing depth did not increase with the exception of one veneer abutment that showed an increased probing depth. There was also recession around some veneers, with 3 (5%) veneered teeth showing some degree of recession at the time of examination.

DISCUSSION

Physical attractiveness, particularly facial beauty is an important factor in an individual's life. The importance of the face as a means of self-identification and self- presentation suggests that any "disfigurement" may lead to a lack of self-confidence and a low self-esteem1. As a result of the importance of appearance one might hear some of these comments:

"She never smiles in photographs"

"Oh, the guy with the yellow teeth"

The psychological and emotional consequence of patients' perception of an "unattractive smile" is a relatively small research area in dentistry[1].

In this study 97% of the patients expressed high satisfaction (above 70%) with the appearance, comfort and treatment. This result compared well to previous studies[8,10], e.g.; in Dumfahrt and Schaffer10 study, 99% of the patients rated the aesthetic result as excellent.

This study highlights, from a patient's point of view, that a porcelain veneer is an ideal restoration when the tooth needs to be restored conservatively for aesthetic reasons. The authors agree therefore with the report by Davis *et al.* that minimal dental treatment can have a profound effect on the patient's self-confidence[1].

The overall patient satisfaction correlated well with the patients' willingness to repeat the treatment if required where 90% of the patients said that they would repeat the treatment if it was necessary, as they found the final result most satisfactory. Only 10% said that they would

not repeat this type of treatment if required; however, they did not report any dissatisfaction with the treatment. The reasons were, in one patient abutment sensitivity, which was related to the fact that the teeth had to be prepared more than once due to failure of previously constructed veneers. Another patient sighted as the reason that the veneers were over-contoured and the third patient wouldn't repeat the treatment as they reported that gingival bleeding was now more frequent than before the veneers were placed. However, the gingival margins of this particular veneer were 1mm supra-gingival and the bleeding on probing was also evident on the control and other teeth i.e.: the patient had plaque induced gingivitis which was generalized, not just related to the veneered tooth.

On the date of recall only 5% of the veneers presented with some degree of fracture, 2% of these were unsatisfactory and required replacement.

Six percent of the veneers had to be rebonded on one occasion since their original date of insertion but on the date of recall presented with no identifiable problem and should therefore in the authors' opinion be considered as successful. The remaining 89% remained in situ without any evidence of debonding or fracture.

The results of this study correlated well with the results of a detailed meta-analysis, which revealed a pooled cumulative survival ratio of 92% after 3 years for porcelain veneers[17]. However, it is slightly lower than the survival probability in Dumfahrt and Schaffers' longitudinal study, which was reported to be 97% at 5 years and 91% at 10 years[10]. This may be due to several factors in this study; the smaller sample size, the veneers being constructed by undergraduate students and the retrospective nature of this study in comparison to Dumfahrt and Schaffers' study, which was a prospective study[10].

Another limitation of this retrospective studies is the high number of non-responders is thought to be due to the majority of the non-responders being university students. The location of the hospital in close proximity to the University campus and the most of these patients were university students who completed their studies and moved to other addresses, possibly outside the Cork area.

Regarding the incisal edge preparation there are three main types namely, intra-enamel preparation, the overlapping incisal edge preparation and the feathered incisal preparation[2]. Students at the Cork University Dental School and Hospital used the latter two only, with the majority being of the feathered design (73%). The effect of incisal edge preparation on porcelain veneer fracture resistance could not be confirmed in this study.

Close examination of the veneered teeth that failed showed a remaining intact tooth structure of approximately 60% with the remainder of the tooth structure filled with composite resin. In the successful veneered teeth, 9% had pre-existing interproximal composite restoration, however, more than 60% of intact tooth structure was present while the remainder of the veneers showed no evidence of composite restorations. This concurs with the findings of Dunne and Miller where some of the failures were related to reduced amount of tooth structure for bonding due to the presence pre-existing composite restorations[9].

The results of this study confirm that veneered teeth are not more susceptible to tooth decay since none presented with carious lesions as compared to control non-veneered teeth.

The use of subgingival margins was not preferred by undergraduate students in this study and indeed 89% of the veneers were placed supra or equigingival to allow for cleansable gingival margins and only 11% were placed subgingivally.

The use of subgingival margins was found to be justifiable in 1% of the cases and the reason being the cosmetic constraints of a high smile line, however, the patients' overall oral hygiene has to be taken in consideration when making a decision to the use of supra or subgingival margin.

Subgingival margins were also used (10%) where tooth surface loss (palatal erosion) resulted in short clinical crowns and the need to cover the full palatal surface to provide an increased surface area for bonding was necessary.

This study also assessed the periodontal health of veneered teeth and compared these to contralateral control teeth. There was no statistically significant difference between the veneered and control teeth in the Plaque, Gingival indices and Bleeding and probing. The majority of the veneered and control teeth scored 0 in the Plaque index (*Table 3*). There is a limitation to the use of plaque index around veneered teeth, as there is generally less plaque accumulation on glazed surfaces[18].

The sample size was not large enough to provide adequate power necessary to conduct multivariate analysis necessary to determine whether there was a relationship between margin level, edge preparation plaque accumulation, inflammation and success and failure. Also a cause and related effect association cannot be ascertained form a retrospective study and the evaluation of such effect would require a randomized controlled clinical trial, which although more significant and effective, it is costly and would not provide outcomes for nearly two decades. It is therefore reasonable to accept outcomes form retrospective studies, with the understanding of their limitations, as they provide useful information about important clinical issues and can suggest areas in need of further research[19].

It is not usually possible in a retrospective study to identify if the recession has occurred following veneer restoration or before restoration.

The complete absence of inflammation around 87% of the veneered teeth is a satisfactory finding and highlights the importance of placing the veneer margins supragingivally.

The veneered teeth did not show significant increase in bleeding on probing as compared to the controls. Pocket probing depth also seemed to be within the normal parameters of gingival health, except for one veneer (1.6%), which showed an increase in pocket probing depth. This increase, however, was related to a generalized state of periodontal disease rather than isolated pockets related to the veneered tooth.

CONCLUSION

From this study, it appears that porcelain veneers are successful in the treatment of discoloured and irregular configured anterior teeth. Veneer restorations do not adversely affect the gingival health or impede plaque control measure. It also shows that under appropriate supervision, undergraduate students can deliver satisfactory veneers.

ADDRESS FOR CORRESPONDENCE

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