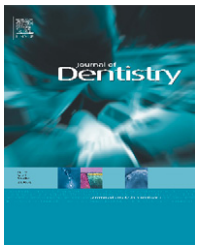
Available online at www.sciencedirect.com

SciVerse ScienceDirect

journal homepage: www.intl.elsevierhealth.com/journals/jden



Shear bond strength of porcelain laminate veneers to enamel, dentine and enamel–dentine complex bonded with different adhesive luting systems

Elif Öztürk [a,*], *Şükran Bolay* [b], *Reinhard Hickel* [c], *Nicoleta Ilie* [c]

[a] *University of Kocaeli, Faculty of Dentistry, Department of Restorative Dentistry, Yuvacik/Basiskele, Kocaeli, Turkey*
[b] *Hacettepe University, Faculty of Dentistry, Department of Restorative Dentistry, Sihhiye-06100, Ankara, Turkey*
[c] *Ludwig-Maximilians-University, School of Dentistry, Department of Restorative Dentistry, Goethestrasse 70, 80336 Munich, Germany*

ARTICLE INFO

Article history:
Received 23 November 2011
Received in revised form
3 April 2012
Accepted 4 April 2012

Keywords:
Porcelain laminate veneers
Dentine exposure
Adhesives

ABSTRACT

Objectives: The aim of this study was to evaluate the shear bond strength of porcelain laminate veneers to 3 different surfaces by means of enamel, dentine, and enamel–dentine complex.

Methods: One hundred thirty-five extracted human maxillary central teeth were used, and the teeth were randomly divided into 9 groups ($n = 15$). The teeth were prepared with 3 different levels for bonding surfaces of enamel (E), dentine (D), and enamel–dentine complex (E–D). Porcelain discs (IPS e.max Press, Ivoclar Vivadent) of 2 mm in thickness and 4 mm in diameter were luted to the tooth surfaces by using 2 light-curing (RelyX Veneer [RV], 3M ESPE; Variolink Veneer [VV], Ivoclar Vivadent) and a dual-curing (Variolink II [V2], Ivoclar Vivadent) adhesive systems according to the manufacturers' instructions. Shear bond strength test was performed in a universal testing machine at 0.5 mm/min until bonding failure. Failure modes were determined under a stereomicroscope, and fracture surfaces were evaluated with a scanning electron microscope. The data were statistically analysed (SPSS 17.0) ($p = 0.05$).

Results: Group RV-D exhibited the lowest bond strength value (5.42 ± 6.6 MPa). There was statistically no difference among RV-D, V2-D (13.78 ± 8.8 MPa) and VV-D (13.84 ± 6.2 MPa) groups ($p > 0.05$). Group VV-E exhibited the highest bond strength value (24.76 ± 8.8 MPa).

Conclusions: The type of tooth structure affected the shear bond strength of the porcelain laminate veneers to the 3 different types of tooth structures (enamel, dentine, and enamel–dentine complex).

Clinical significance: When dentine exposure is necessary during preparation, enough sound enamel must be protected as much as possible to maintain a good bonding; to obtain maximum bond strength, preparation margins should be on sound enamel.

1. Introduction

The porcelain laminate veneer technique bonds a thin porcelain laminate to the tooth surface with dental adhesives and resin cements in order to restore discoloured, worn, fractured, malformed, or slightly malpositioned anterior teeth.[1] For the longevity of the porcelain laminate veneers, a vital importance is attributed to the strength and durability of the adhesion complex formed between the 3 different

* *Corresponding author*. Tel.: +90 2623442222.
E-mail address: dtelifoz@gmail.com (E. Öztürk).
0300-5712/$ – see front matter
http://dx.doi.org/10.1016/j.jdent.2012.04.005

components: the tooth surface, the resin cement, and the porcelain surface.[1,2] Besides, many factors influence the long-term success of the porcelain laminate veneers, such as structure of the tooth surface, preparation depth, type and thickness of the porcelain, type of the resin cement and dental adhesive, tooth morphology, and functional and parafunctional activities.[1,3] Regarding preparation depth, enamel reduction, depending on location usually 0.3–0.7 mm, is necessary to remove the aprismatic and hypermineralized enamel top surface, which can be resistant to acid etching.[4,5]

It is reported that preparation should be completely in enamel to maintain an optimal bond with the porcelain laminate veneers and to decrease the stresses in the porcelain.[4,6] Therefore, preparation technique becomes more important for the longevity of the porcelain laminate veneers because high failure rates of these restorations have been attributed to the large exposed dentine surfaces.[7] However, to the knowledge of the authors, no *in vitro* study has reported the effect of dentine exposure on the bond strength of the porcelain laminate veneers in the dental literature.

Preparation for porcelain laminate veneers should be made meticulously to maintain the preparation completely in enamel.[6,8] However, exposure of considerable amounts of dentine is usually inevitable during the preparation, especially along the cervical and proximal areas.[9,10]

Although improved new adhesives are developed, the bond strength of porcelain to enamel is still superior as compared to the bond strength of porcelain to dentine.[11,12] Problems associated with bonding to dentine are more complicated to resolve than those associated with bonding to enamel because of the characteristics of the dentine substrates, which include lower inorganic content, tubular structure and variations in this structure, and the presence of outward intratubular fluid movement.[13,14]

Adhesive systems also play an important role in the long-term outcome of porcelain laminate veneers.[15,16] To maintain optimal bonding between porcelain and the tooth structure, an optimal curing of the resin cement is necessary.[1] Light-curing resin cement is generally preferred by dentists for cementation of porcelain laminate veneers due to their colour stability and longer working time as compared to dual- or chemical-curing resin cements.[15,17]

Although clinical trials are the most suitable tools to evaluate the efficacy of the adhesive systems, long-term clinical trials are difficult to perform because of the time and rapid developments and changes in the adhesive systems. Therefore, laboratory studies are still largely used to predict the clinical behaviour of dental materials.[18] The laboratory tests most widely used to examine the bond strengths of the adhesive systems to dental hard tissues are shear and tensile bond strength tests.[19]

The aims of this study were as follows: (i) to assess whether the shear bond strength of the porcelain veneers to dentine and to enamel–dentine complex, which is obtained from dentine exposure during preparation, is comparable with the shear bond strength of the porcelain veneers to enamel; (ii) to evaluate whether light-curing adhesive systems perform as well as dual-curing adhesive systems by measuring the shear bond strength between the porcelain and tooth surface. The null hypotheses were as follows: (i) there is no difference in the shear bond strength of the porcelain laminate veneers to enamel, dentine, and enamel–dentine complex cemented with 3 different resin cements; (ii) the type of the adhesive system does not affect shear bond strength values; (iii) the type of the adhesion surface of the prepared tooth does not affect shear bond strength values.

2. Materials and methods

The protocol of this study plan was approved by the Ethics Committee of Hacettepe University (Approval Number: FON 07/27-42, 13.09.2007). One hundred thirty-five noncarious human maxillary central teeth extracted within the last 6 months were used in this study. Two light-curing adhesive systems – Variolink Veneer (Ivoclar Vivadent, Schaan, Liechtenstein) and RelyX Veneer (3M ESPE, Seefeld, Germany) – a dual-curing adhesive system – Variolink II (Ivoclar Vivadent, Schaan, Liechtenstein) – and lithium disilicate glass-porcelain – IPS e.max Press (Ivoclar Vivadent, Schaan, Liechtenstein) – were selected for this study. The descriptions of the adhesives and the porcelain included in this study are summarized in Table 1.

2.1. *Sample preparation technique*

After removal of dental plaque, calculus, and periodontal fibres, the teeth were stored in distilled water during the experiment. The teeth were randomly divided into 3 groups according to the prepared tooth surface ($n = 45$). All of the teeth were mounted in acrylic resin blocks to provide better control during tooth preparation.

2.1.1. *Preparation of enamel*

Facial surfaces of the teeth were initially prepared by placing depth-orientation grooves (0.5 mm in depth) with a depth preparation bur (Diatech, Coltène/Whaledent, AG, Switzerland). The preparation surfaces were painted with a pen, which was insoluble in water. Then, the specimens were prepared without exceeding the depth-orientation grooves to provide flat enamel surface area, approximately 5 mm in diameter, for luting the porcelain discs to the middle third of the facial surface by grinding with silicon carbide abrasive papers of grit sizes of 100, 400, and 600 (Leco® VP 100, Leco Instrumente GmbH, Germany). Preparations were continued until the colour was removed from the middle third of the painted facial surface. In total, 45 teeth were included for the enamel preparation.

2.1.2. *Preparation of dentine*

The facial surfaces of the specimens were prepared until a flat area (approximately 5 mm in diameter) was provided only in the dentine in the middle third of the teeth by grinding with silicon carbide abrasive papers of grits 100, 400, and 600 (Leco® VP 100, Leco Instrumente GmbH, Germany). In total, 45 teeth were included for the dentine preparation.

2.1.3. *Preparation of enamel–dentine complex*

Enamel preparations were continued with the controlled preparations by grinding with silicon carbide abrasive papers