FRACTURE STRENGTH OF VENEER CONTACT LENS

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ABSTRACT

The no prep technique to ceramic veneer have some advantages, one of the most important is the preservation of tooth structure. **Purpose:** Evaluate fracture resistance in bovine teeth, of ceramic veneer in different thickness (0,3 to 1,0mm). **Methods:** 60 teeth were selected for this study. Forty fifth ceramic veneer were made for each tooth, variating the thickness in: G1 – 0,7mm; G2 – 0,5mm; G3 – 0,3mm and G4 – 1,0mm (control group). Flexural strength test was carried out after 24h of luting. The results were analysed by ANOVA and HSD of Tukey. **Results:** the results showed that was no statistic difference between the groups (G1- 297.2200; G2 - 294.5467; G3 - 291.9380 and G4 -290.0733). **Conclusion:** The ceramic veneer thickness didn't have influence in the final flexural strength.

KEYWORDS: Ceramic. Dental Veneers. Esthetics.
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INTRODUCTION

Ceramic veneer is an alternative to aesthetic dental treatment.[1-6] The clinical success of this treatment its possible due of adhesion procedures accomplished in tooth structure and ceramic, including etching, adhesive and silane application.[7-11]

The adhesive technique allows conservative prep following the Dentistry trend.[12-14] The prep accomplished to ceramic veneer can be restricted to enamel or no prep,[15-18] representing one fourth to half of ceramic total crown prep.[19]

The no prep technique to ceramic veneer it's usually sought by the patients. There are some advantages about the no prep technique as: less anxious; tooth structure preservation; no anesthesia needs and according to the literature, it is a reversible treatment.[20,21] On the other hand, there are some disadvantages as: possibility of over configuration; the necessity to involve more teeth; limited translucence; margins prep not visible to technician and occlusion changes.[20,12]

There are some cases report showing no prep to ceramic veneer treatment, varying the ceramic thickness in 0.3 to 0.7mm.[12, 22-24] However, the literature relate that the main cause of ceramic veneer failure is by mechanical reason, [25] like ceramic fracture.[6,26] Still, the scientific embasement about ultra-thin ceramic veneer needs more grounding.

For this reason, the purpose of this study was evaluated the fracture strength of different thickness of lithium disilicate ceramic in bovine teeth.

METHODS

The ceramic selected for this study was lithium disilicate - IPS e.max Press (Ivoclar Vivadent, Schaan, Liechenstein). Sixty bovine incisors with similar dimensions was, the teeth were randomly distributed in 4 groups (n=15): G1- ceramic veneer with 0.7mm thickness; G2 – ceramic veneer with 0.5mm thickness; G3 – ceramic veneer with 0.3mm thickness and G4 – ceramic veneer with 1mm thickness. Each tooth was included in acrylic resin to facilitate handling. The teeth were sustained 24h in distilled water at 37°C.[27]

Standardized ceramic veneer was fabricated with IPS e.max Press (Ivoclar, Vivadent) following the thickness of each experimental groups. The ceramic veneer polishing was carried by abrasive rubber (MasterCeram, Eurodental, Brasil).

The ceramic veneer thickness was measured with a digital pachymeter (Mitutoyo Corporation, Tokyo, Japan) in three points with a precision of 0,01mm.

After all, the ineer surface of the ceramic was etched with 10% hydrofluorid acid (Dentsply) for 20s, removed with air/water spray for 1min, followed by fosforic acid 37% (Condac, FGM, Brazil) for 1min. the surface was air dry with air spray during 30s, followed by silane application (Mono Bond Plus, Ivoclar Vivadent). The teeth surface was treated with fosforic acid 37% for 30s, followed by 60s of air/water spray and dry. Both surfaces, inner of ceramic veneer and teeth surface received an adhesive coat (Tetric N Bond, Ivoclar Vivadent), before light cure, the luting cement was applied in the ceramic veneer (Variolin II, Ivoclar Vivadent). The restorations luted using digital pressure, the excess was removed and photopolimerized (Olsen) 60s in labial and lingual surfaces. The margins were polished with abrasive rubber (Astropol, Ivoclar Vivadent). The specimens were stored in artificial saliva at 36°C during 48h after test.

The specimens were accomplished in an Instron universal testing machine (4444, Instron, USA). The load was applied perpendicular at lingual surface 2mm from the incisor edge. A stainless steel point was applied with 1mm/min crosshead speed, according to ISO recommendation (ISO/TS 11405/2003), until fracture. The fracture load was measured in Newton (N).

The fracture specimens were analyzed visually and with photography (Nikon D60 an 105mm macro lens, at 15 cm distance; f32 and vel 1s). Both way was analyzed using a transiluminator (Microlux, Addent).

Fracture classification adapted from Bergoli (2014)[28]: type I – adhesive failure in veneer; type II – ceramic failure without crown fracture; type III – crown fracture; type IV – fracture passive to be repaired above enamel-cement junction; type V – catastrophic fracture below enamel-cement junction.

The data were analyzed statistically by using SPSS 12 (SPSS Inc., Chicago, IL, USA). ANOVA was applied to analyze the normal distribution of groups. The Tukey HSD test was used to verify which groups had differences between them. The significance level was fixed in $\rho<0.05$.

RESULTS

The groups presented normal distribution therefore the means could be compared by ANOVA one way ($\alpha=0,05$). The multiple comparison test HSD Tukey was used to verify differences between the means.

The tables show the fracture resistance values of experimental groups.

The was no statistical difference between experimental groups G1 – 0.7mm; G2 – 0.5mm; G3 – 0.3mm and G4 – control. The ceramic veneer thickness had not influenced the fracture resistance of this study. Table 3 shows the fracture classification in each group. There was no difference in the fracture patterns found in the experimental groups.

DISCUSSION

The interesting in aesthetic treatment with contact lens had increased. This leads the need for a better compression about the relation teethe/restoration in thin thickness to obtain more scientific datas.[29]

The present study used a methodology to evaluate fracture strength that is already widespread in literature.[30-35] The strength was applied in the buccal face to evaluate the strength in Newtons in the palate face.[36] The data obtained with this methodology vary according to the type of substrate used, human or bovine teeth.[33-35,37] Once the methodology used in this study evaluate the ceramic veneer bonded to bovine teeth it is not possible to compare the results with others paper, once there is no longer paper using bovine teeth.

In the present study the results of fracture strength showed no significant difference between the experimental groups, that means, that the thickness of the ceramic veneer 'contact lens' do not influence the fracture strength.

These finding is in contrast with Ge's (2014)[38] study, were the thickness of the enamel and the ceramic veneer has influence in the fracture strength. The explanation for this difference may lie in the methodology, such as the different substrate, bovine x human teeth, distinct luting technique, geometry of the prep (no prep x flat surface) and ceramic thickness.

Another important fact to analyze is the fracture pattern. [39] In this study the authors followed BERGOLI et al. (28) classification.[28] The catastrophic failure was prevalent (80%) and occurred beneath the periodontal ligament simulation, agreeing with BERGOLI et al.[28], who found 62%. It is important to emphasize that in Bergoli's study the teeth was prepared to receive the ceramic veneer, and in the present study the authors followed the no prep technique.

It can be concluded that the thickness evaluated in this study didn't influence in the fracture pattern and in the fractur strength as showed by the control group (G4). Although the strength in this paper was applied from palatine to buccal face the prevalent failure pattern fracture was the same as in the studies that use the force coming from buccal face. Which leads to conclude that the veneer didn't influenced the fracture pattern as well as in the force incidence.

Still the bovine teeth are well known in the literature as an alternative to human teeth, due to the resemblance to the human enamel[40], there are morphologic and structural differences that have to be considered.[37] In the present study evaluated the influence of the ceramic veneer after luting. As the veneer was luted in the same type of substrate (bovine teeth, with similar size), no bias was created in this research.

The high bonding to human enamel allows the great longevity to ceramic veneer.[3,6,11,41] As no prep was performed on the bovine teeth place the ceramic veneer, there was no prior loss in the integrity of the teeth.[42] That means, the teeth remained intact, not influencing the results of fracture resistance due to the possible loss of dental structure (enamel).

Ceramic bonding to dental substrate is important to have clinical longevity.[43,44] Its know that the ceramic thickness associated to the thin layer of luting agent are the best combination to avoid failures during the restoration clinical performance.[45] In this study an expert dental clinician was selected to do all the ceramic luting, fact that contributes to obtain suitable clinic results.[46] All luting was performed manually, without any device to approach the clinical situation. Regarding the ceramic veneer, they were made using all the buccal face size of the bovine teeth, following the anatomic convexity. Naturally, the force distribution on the convex surface its more complicated the in a flat surface. Previous studies have shown that the increase of ceramic thickness raises the values of fracture strength,[38,47] fact that can be explained by the different thickness applied in these studies. In the present paper the method used thickness with little difference between them: 0,7 to 0,3mm. All facts argued above can explain the divergence in the obtained results. It can also attribute the fact that the restoration in the buccal face was bigger, influencing the resistance values, that means, the greater the area of the tooth covered by the ceramic, the greater the need for a material with a superior flexural strength.[25]

Ultimately, its well known that the aesthetic and the patient satisfaction are real and important daily basis in clinic.[48] The clinical procedures, like teeth prep or no prep, luting, finishing and polishing, are key factors to succeed in ceramic restoration.[49] Worth noting that the treatment in different area and the correct case planning are important for successful treatment. Nowadays there is a big trend towards the ceramic 'contact lens'. However, there are others minimally invasive restorative techniques like composite resin.[50] Its important that the clinician be aware about the advantages and disadvantages about the techniques to apply the suitable for each case.[15] Burke (2009),[51] approach a test that he called 'daughter test'. This test is the question that leads the clinician if he really would indicate the ceramic veneers, with prep or no prep, in his most loved ones. If the answer is positive, proceed with treatment.

It is worth mentioning that clinical follow-up and further studies are essential to assist in the understanding of the tooth/restoration complex, when using ultrathin ceramic veneer without wearing out the dental structure.

CONCLUSION

It can be concluded that the thickness of the tested ceramic (0.7mm; 0.5mm; and 0.3mm) didn't influenced the fracture resistance of restoration, as well as did not influence the fracture pattern found in restored bovine teeth.

REFERENCES

[1] Calamia JR. Etched porcelain facial veneers: a new treatment modality based on scientific and clinical evidence. N Y J Dent 1983;53:255-9.

[2] Horn HR. Porcelain laminate veneers bonded to etched enamel. Dent Clin N Am 1983;27:671-84.

[3] Layton D, Walton T. An up to 16-year prospective study of 304 porcelain veneers. Int J Prosthodont 2007;20:389-96.

[4] 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.

[5] Burke FJT. Survival rates for porcelain laminate veneers with special reference to the effect of preparation in dentin: a literature review. J Esthet Restor Dent 2012;24:257-65.

[6] Beier US, Kapferer I, Burtscher D, Dumfahrt H. Clinical performance of porcelain laminate veneers for up to 20 years. Int J Prosthodont 2012;25:79-85.

[7] Addison O, Marquis PM, Fleming GJP. The impact of hydrofluoric acid surface treatments on the performance of a porcelain laminate restorative material. Dent Mater 2007;23:461-8.

[8] Roulet JF, Soderholm KJ, Longmate J. Effects of treatment and storage conditions on ceramic/composite bond strength. J Dent Res 1995;74:381-7.

[9] Calamia JR. Etched porcelain veneers: the current state of the art. Quintessence Int 1985;16:5-12.

[10] Calamia JR, Calamia CS. Porcelain laminate veneers: reasons for 25 years of success. Dent Clin N Am 2007;51:399-417.

[11] Peumans M, Van Meerbeek B, Lambrechts P, Vanherle G. Porcelain veneers: a review of the literature. J Dent 2000;28:163-77.

[12] Notarantonio A. Porcelain laminate veneers: restorative management. Compend Contin Educ Dent 2011;32:54-8.

[13] Alencar MS, Araújo DF, Maenosono RM, Ishikiriama BL, Francischone CE, Ishikiriama SK. Reestablishment of esthetics with minimum thickness veneers: A one-year follow-up case report. Quintessence Int 2014;45:593-7.

[14] Gresnigt M, Ozcan M, Kalk W. Esthetic rehabilitation of worn anterior teeth with thin porcelain laminate veneers. Eur J Esthet Dent 2011;6:298-313.

[15] Magne P, Hanna J, Magne M. The case for moderate "guided prep" indirect porcelain veneers in the anterior dentition. The pendulum of porcelain veneer preparations: from almost no-prep to over-prep to no- prep. Eur J Esthet Dent 2013;8:376-88.

[16] Cherukara GP, Seymour KG, Samarawickrama DY, Zou L. A study into the variations in the labial reduction of teeth prepared to receive porcelain veneers--a comparison of three clinical techniques. Brit Dent J. 2002;192:401-4.

[17] Brunton PA, Richmond S, Wilson NH. Variations in the depth of preparations for porcelain laminate veneers. Eur J Prosthod Rest Dent 1997;5:89-92.

[18] Atsu SS, Aka PS, Kucukesmen HC, Kilicarslan MA, Atakan C. Age- related changes in tooth enamel as measured by electron microscopy: implications for porcelain laminate veneers. J Prosthet Dent 2005;94:336-41.

[19] Edelhoff D, Sorensen JA. Tooth structure removal associated with various preparation designs for anterior teeth. J Prosthet Dent 2002;87:503-9.

[20] Christensen GJ. Thick or thin veneers? J Am Dent Assoc 2008;139:1541-3.

[21] Radz GM. Minimum thickness anterior porcelain restorations. Dent Clin N Am 2011;55:353-70.

[22] Schmitter M, Seydler B B. Minimally invasive lithium disilicate ceramic veneers fabricated using chairside CAD/CAM: a clinical report. J Prosthet Dent 2012;107:71-4.

[23] Kacker MD, Yarovesky U, Jadali L. Ultra-thin veneers: beautiful and natural. Dent Today 2011;30:102, 4-5.

[24] Shuman I. Simplified restorative correction of the dentition using contact lens-thin porcelain veneers: a report of three cases. Dent Today 2006;25:88-92.

[25] Li Z, Yang Z, Zuo L, Meng Y. A three-dimensional finite element study on anterior laminate veneers with different incisal preparations. J Prosthet Dent. 2014 Aug;112(2):325-33.

[26] Gurel G, Sesma N, Calamita MA, Coachman C, Morimoto S. Influence of enamel preservation on failure rates of porcelain laminate veneers. Int J Periodontics Restorative Dent 2013;33:31-9.

[27] Soderholm KJ, Mukherjee R, Longmate J. Filler leachability of composites stored in distilled water or artificial saliva. J Dental Res 1996;75:1692-9.

[28] Bergoli C, Meira J, Valandro L, Bottino M. Survival Rate, Load to Fracture, and Finite Element Analysis of

Incisors and Canines Restored With Ceramic Veneers Having Varied Preparation Design. Oper Dent 2014; INPRESS.

[29] Okida RC, Filho AJV, Barao VAR, Santos DMD, Goiato MC. The use of fragments of thin veneers as a restorative therapy for anterior teeth disharmony: A case report with 3 years of follow-up. J Contemp Dent Pract 2012;13:416-20.

[30] Abdulkhayum A, Munjal S, Babaji P, Chaurasia VR, Munjal S, Lau H et al. In-vitro evaluation of fracture strength recovery of reattached anterior fractured tooth fragment using different re-attachment techniques. J Clin Diagn Res 2014;8:208-11.

[31] Sharmin DD, Thomas E. Evaluation of the effect of storage medium on fragment reattachment. Dent Traumatol 2013;29:99-102.

[32] Capp CI, Roda MI, Tamaki R, Castanho GM, Camargo MA, de Cara AA. Reattachment of rehydrated dental fragment using two techniques. Dent Traumatol 2009;25:95-9.

[33] Bruschi-Alonso RC, Alonso RCB, Correr GM, Alves MC, Lewgoy HR, Sinhoreti MAC et al. Reattachment of anterior fractured teeth: effect of materials and techniques on impact strength. Dent Traumatol 2010;26:315-22.

[34] Yilmaz Y, Guler C, Sahin H, Eyuboglu O. Evaluation of tooth-fragment reattachment: a clinical and laboratory study. Dent Traumatol 2010;26:308-14.

[35] Stellini E, Stomaci D, Zuccon A, Bressan E, Ferro R, Petrone N et al. Tooth fragment reattachment through the use of a nanofilled composite resin. Eur J Paediatr Dent 2010;11:77-81.

[36] Korioth TW, Waldron TW, Versluis A, Schulte JK. Forces and moments generated at the dental incisors during forceful biting in humans. J Biomech 1997;30:631-3.

[37] Yassen GH, Platt JA, Hara AT. Bovine teeth as substitute for human teeth in dental research: a review of literature. J Oral Sci 2011;53:273-82.

[38] Ge C, Green CC, Sederstrom D, McLaren EA, White SN. Effect of porcelain and enamel thickness on porcelain veneer failure loads in vitro. J Prosthet Dent 2014; AHEAD OF PRINT.

[39] Kelly JR, Campbell SD, Bowen HK. Fracture-surface analysis of dental ceramics. J Prosthet Dent 1989;62:536-41.

[40] Schmidlin PR, Zehnder M, Zimmermann MA, Zimmermann J, Roos M, Roulet JF. Sealing smooth enamel surfaces with a newly devised adhesive patch: a radiochemical in vitro analysis. Dent Mater 2005;21:545-50.

[41] Layton DM, Clarke M. A systematic review and meta-analysis of the survival of non-feldspathic porcelain veneers over 5 and 10 years. Int J Prosthodont 2013;26:111-24.

[42] Schmidt KK, Chiayabutr Y, Phillips KM, Kois JC. Influence of preparation design and existing condition of tooth structure on load to failure of ceramic laminate veneers. J Prosthet Dent 2011;105:374-82.

[43] Perillo L, Sorrentino R, Apicella D, Quaranta A, Gherlone E, Zarone F et al. Nonlinear visco-elastic finite element analysis of porcelain veneers: a submodelling approach to strain and stress distributions in adhesive and resin cement. J Adhesive Dent 2010;12:403-13.

[44] Vargas MA, Bergeron C, Diaz-Arnold A. Cementing all-ceramic restorations: recommendations for success. J Am Dent Assoc 2011;142:20S-4S.

[45] 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.

[46] Adebayo OA, Burrow MF, Tyas MJ. Bond strength test: role of operator skill. Aust Dent J 2008;53:145-50.

[47] Lin T-M, Liu P-R, Ramp LC, Essig ME, Givan DA, Pan Y-H. Fracture resistance and marginal discrepancy of porcelain laminate veneers influenced by preparation design and restorative material in vitro. J Dent 2012;40:202-9.

[48] Soares PV, Spini PHR, Spini PH, Carvalho VF, Souza PG, Gonzaga RCdQ et al. Esthetic rehabilitation with laminated ceramic veneers reinforced by lithium disilicate. Quintessence Int 2014;45:129-33.

[49] D'Arcangelo C, De Angelis F, Vadini M, D'Amario M. Clinical evaluation on porcelain laminate veneers bonded with light-cured composite: results up to 7 years. Clin Oral Investig 2012;16:1071-9.

[50] Baratieri LN, Araujo E, Monteiro S. Color in natural teeth and direct resin composite restorations: essential aspects. Eur J Esthet Dent 2007;2:172-86.

[51] Burke FJT, Kelleher MGD. The "daughter test" in elective esthetic dentistry. J Esthet Restor Dent 2009;21:143-6.