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Evaluation of crosshead speed influence on shear bond strength test

Avaliação da influência da velocidade no ensaio de resistência ao cisalhamento

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ABSTRACT

The objective of this study was to evaluate the influence of different speeds using the piston device in the shear bond strength. 48 cylinders of composed resin had been confectioned (Solidex),and were divided randomly in four groups (n=12). The specimens were adapted to the device for the shear bond strenth test and were taken to an universal testing machine with a load cell of 1000 Kg. The test were carried through with four different speeds: group A: 0.5; group B: 1.0; group C: 1.5 and group D: 2.0 mm/min. The mean and standard deviations, in Kgf, were: A - 66,31 (10,24); B - 64,53 (20,40); C - 75,23 (11,84) and D - 66,62 (13,81). The data were submitted to ANOVA (p = 0.13). The results indicated that it did not have statistical significant difference between the groups A, B, C and D concluding that the speed in this type of test, with this device, can be varied without modify results.

KEYWORDS

Shear Strength; Materials Testing; Composed resin.

RESUMO

O objetivo do presente estudo foi avaliar a influência de diferentes velocidades usando o dispositivo pistão para o ensaio de cisalhamento. Foram confeccionados 48 cilindros em resina composta microhíbrida (Solidex), divididos aleatoriamente em quatro grupos (n = 12). As amostras foram adaptadas ao dispositivo para o ensaio de cisalhamento e levadas a uma máquina de ensaios universal com uma célula de carga de 1000 Kg. Os ensaios foram realizados com quatro velocidades diferentes: grupo A: 0,5 mm/min; grupo B 1,0 mm/min; grupo C: 1,5 mm/min e grupo D 2,0 mm/min. Os valores médios e desvios padrão obtidos, em Kgf, foram: grupo A: 66,31 ± 10,24; grupo B: 64,53 ± 20,40; grupo C: 75,23 ± 11,84 e grupo D: 66,62 ± 13,81. Os dados foram submetidos ao teste ANOVA (p = 0,13). Os resultados indicaram que não houve diferença estatisticamente significante entre os grupos A, B, C e D concluindo que se pode variar a velocidade neste tipo de ensaio, utilizando o dispositivo pistão, sem que os resultados fossem alterados.

PALAVRAS-CHAVE

Resistência ao Cisalhamento; Teste de Materiais; Resina composta.

INTRODUCTION

Dental technological advancements have led to launch many materials in dental market. *In vitro* tests are the gold standard for such advancements in selecting and using of dental materials. Among the most common laboratorial mechanical tests are the bond strength [1] and shear bond strength [2] tests.

The shear bond strength test has been introduced as an alternative to bond strength test [3]. However, the great variability of results has suggested the hypothesis of lack of technique standardization [4,5], making difficult the correct interpretation and the comparison with other researches, which can generate false conclusions [6,7]. Among the variables subject to influence on the results, the literature has cited the crosshead speed of the testing machine [8,9].

The speed at which the sample is submitted to load up to its rupture is an essential factor for laboratorial mechanical test [10]. However, although crosshead speed is not very discussed and the speed standardization is of extreme importance for study comparison, the literature has reported many values adopted for such speed [11]. Most of studies employing mechanical tests has used between 0.5 and 2.0 mm/min; ISO – TR 11405 guideline [12] recommends the use between 0.45 and 1.05 mm/min.

Low speed offers the capture of more reliable data [13], while high sped could develop abnormal stresses during the mechanical test leading to cohesive fracture [14].

Considering the control of the methodological variables for the reliability of scientific researches, this study aimed to evaluate the influence of the crosshead speed on shear bond strength test through using a device suitable for this test type.

MATERIAL AND METHODS

Forty-eight cylinders were constructed with microhybrid resin composite (Solidex – Shofu), which were randomly divided into four groups (n = 12).

The cylindrical samples were obtained with the aid of a Teflon device, measuring nine millimeters; with the tip with smallest diameter (4 mm) measuring eight millimeters of length and that with the highest diameter (5 mm) measuring one millimeter of length (figure 1).

The resin composite was inserted by increments of two millimeters of thickness. The material was light-cured with the aid of a light-curing unit (Solidilite). The last layer was light-cured for three min.

After the proof in a device suitable for shear bond strength test (figure 2a and 2b), the cylinders were submitted to mechanical test in universal testing machine EMIC DL 1000 (Emic São José dos Pinhais, PR), with load cell of 1000 Kg linked to a computer to record the values in Mega Pascal (Mpa).

The tests were conducted at four different speeds: group A: 0.5 mm/min; group B: 1.0 mm/min; group C: 1.5 mm/min and group D: 2.0 mm/min.

Data were submitted to statistical analysis by applying one-way ANOVA.

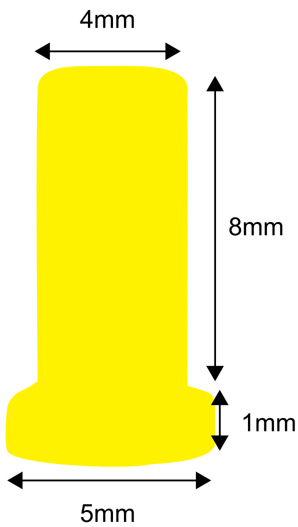

Figure 1 - Resin composite cylinder.

Figure 2a - Device used in the shear bond strength test. (A) internal piece and (B) external piece.

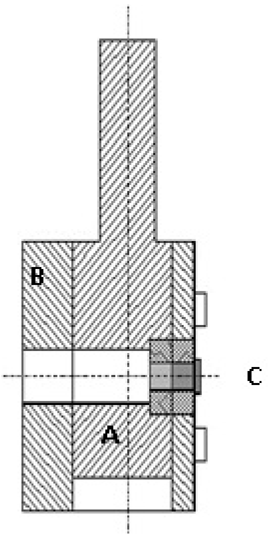

Figure 2b - Schematic drawing of the sample (C) placed inside the device. A and B corresponds to the lateral sections of the device.

RESULTS

The obtained mean and standard deviation values are seen in table 1. Data were submitted to ANOVA (p = 0.13) (table 2). The results showed no statistically significant differences among groups.

Table 1 - Mean and standard deviation values (Kgf)

Groups	Mean ± Standard-deviation
A	66.31 ± 10.24
B	64.53 ± 20.40
C	75.23 ± 11.84
D	66.62 ± 13.81

Table 2 - Result of one-way ANOVA for the experimental conditions

Effect	GL	SQ	QM	F	P
Factor	3	1252	417	1.98	0.13
Error	44	9255	210		
Total	47	10507			

DISCUSSION

The polymers are viscoelastic materials sensible to loading speed [15]. In order to explain their behavior inside oral cavity considering the masticatory cycle, one single speed to conduct the laboratorial mechanical test would be inadequate for achieving a correct analysis.

The microhybrid resin composite Solidex – Shofu was chosen for this study because it has been used in prosthetic elements for posterior teeth, where a great variation of masticatory efforts and speeds may occur. In previous studies, the interval used for speed values has been from 0.5 to 12.7 mm/min, which can make difficult the comparisons among studies on the same subject [16].

The statistical tests applied on the results obtained in this present study agreed with those found by Hara et al. [14] who studied the speed influence on bond strength of resin composite to dentin through shear bond strength test, without statistically significant differences among the four groups studied (group A:0.50; group B: 0.75; group C: 1.00; and group D: 5.00 mm/min). Reis et al. [17] studied the speed influence on bond strength of resin to dentin through microtensile test and did not find statistically significant differences among the studied groups (0.1; 0.5; 1.0; 2.0 and 4.0 mm/min). Musanje et al. [16] analyzed the speed effect on flexural tests when studying the mechanical properties of some resin composite and also did not find the speed influence on the obtained results.

Despite of the large number of studies published, preferably to verify the bonding quality than to verify the conditions under which the study should be conducted, further discussion on crosshead speed still should be necessary [7].

Other factors, such as photopolymerization, could affect the values obtained in the mechanical test. Each test aims to quantify a given property, so that the tests are complementary to each other [8]. Shear bond strength test was used in this present study because it is a simple test largely employed [2].

The crosshead speed used for a given mechanical test needs to be carefully analyzed.

Although no interference on the results of this present study was observed, there is a tendency towards reducing the bond strength by increasing the crosshead speed, as demonstrated by the study of Farret et al. [18], however, without statistical significant differences among subgroups.

CONCLUSION

During the shear bond strength test, by using one of the many existing devices for this purpose, it was possible to vary the crosshead speed of the load cell on the sample in a universal testing machine, without altering the results.

REFERENCES

1. Callister Jr WD. Ciência e Engenharia de Materiais: Uma Introdução. 5ª. ed. Rio de Janeiro: LTC; 2002.
2. Pashley DH, Sano H, Ciucchi B, Yoshiyama M, Carvalho RM. Adhesion testing of dentin agents: a review. Dent Mat. 1995;11:17-25
3. Van Meerbeek B, Peumans M, Poitevin A, Mine A, Van End A, Neves A, De Munk J. Relationship between bond-strength tests and clinical outcomes. Dent Mater. 2010 Feb;26(2):e100-21. doi: 10.1016/j.dental.2009.11.148.
4. Li N, Nikaido T, Takagaki T, Sadr A, Makishi P, Chen J, et al.. The role of functional monomers in bonding to enamel: acid-base resistant zone and bonding performance. J Dent. 2010 Sep;38(9):722-30. doi: 10.1016/j.jdent.2010.05.015.
5. Wang H, Shimada Y, Tagami J. Effect of fluoride in phosphate buffersolution on bonding to artificially carious enamel. Dent Mater J. 2007 Sep;26(5):722-7.
6. Itinoche MK, Kimpara ET, Bottino MA, Neiser MP and Oyafuso DK. Study of the shear bond strength between metal alloys and composite materials for aesthetic veneer:ceromer and polyglass. Pós Grad Rev. 1999;2(2):70-8.
7. Van Noort R, Howard IC, Cardew G. A critique of bond strength measurement. J Dent. 1989 Apr;17(2):61-7.
8. Estrela, C. Metodologia científica. São Paulo: Artes Médicas; 2001.
9. Miyazaki M, Oshida Y, Iwasaki K, Onose H, Moore BK. Influence of bonding area and crosshead speed on dentin bond. J Dent Res. 1999;78:312.
10. Abreu CW, Santos JF, Passos SP, Michida SM, Takahashi FE, Bottino MA. The influence of cutting speed and cutting initiation location in specimen preparation for the microtensile bond strength test. J Adhes Dent. 2011;13 (3):221-6.
11. Al-Salehi SK, Burke FJT. Methods used in dentin bonding tests: An analysis of 50 investigations on bond strength. Quintessence Int. 1997 Nov;28(11):717-23.
12. International Organization for Standardization. ISO TR 11405. Guidance on testing of adhesion to tooth structure. 1994.
13. Usanmaz A, Latifoglu MA, Dogan A, Akkas N, Yetmez M. Mechanical properties of soft liner-poly(methylmethacrylate) – based denture material. J Appl Polym Sci. 2002;85:467-74.
14. Hara AT, Pimenta LAF and Rodrigues Junior AL. Influence of cross-head speed on resin-dentin shear bond strength. Dent Mater. 2001 Mar;17(2):165-9.
15. Ward IM. Mechanical Properties of Solid Polymers, 2nd. NewYork John Wiley & Sons;1983.
16. Musanje L, Darvell BW. Effects of strain rate and temperature on the mechanical properties of resin composites. Dent Mater. 2004;20(8):750-65.
17. Reis A, de Oliveira Bauer JR, Loguercio AD. Influence of crosshead speed on resin-dentin microtensile bond strength. J Adhes Dent. 2004;6(4):275-8.
18. Farret MM, Gonçalves TS, Lima SEM, Lima EM, Menezes LM. Oshima HMS, et al. Influência de variáveis metodológicas na resistência de união ao cisalhamento. Dental Press J Orthod. 2010;15(1):80-8.

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