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ORIGINAL ARTICLE

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Bond strength of resin cements to novel materials to intracanal posts applications

Resistência de união de cimentos resinosos a novos materiais para pinos intrarradiculares

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ABSTRACT

Objective: Evaluate the bond strength of resin cements to new materials for application in intraradicular posts. **Material and Methods:** Five materials were evaluated: fiberglass, PET, polyethylene, polyacetal and PTFE. Two commercial resin cements (Rely X U200 and Rely X Arc) were applied on the test specimens of the materials (9x3mm) and the bonding was evaluated through the shear bond strength test, where the chisel operated with a load of 1kN and a velocity of 0.5mm/min at the cement/material interface. The data were analyzed by the Shapiro-Wilk test, followed by the two-way analysis of variance, performed with the Bonferroni post-test (α=0.05). **Results:** The glass fiber was statistically different from all evaluated materials ($p<0.05$). There was no statistically significant difference between the other materials ($p>0.05$). Comparing the two cements, a statistical difference was found between Rely X U200 and Arc only for the glass fiber ($p=0$). **Conclusion:** PET, polyethylene, polyacetal and PTFE exhibited reduced bond strength compared to the glass fiber.

KEYWORDS

Resin cement; PET polymer; Polytetrafluoroethylene.

RESUMO

Objetivo: Avaliar a resistência de união de cimentos resinosos a novos materiais para aplicação em pinos intrarradiculares. Material e método: Foram avaliados cinco materiais: fibra de vidro, PET, polietileno, poliacetal e PTFE. Dois cimentos resinosos comerciais (Rely X U200 e Rely X Arc) foram aplicados sobre os corpos de prova dos materias (9x3mm) e a resistência de união foi avaliada através do teste de cisalhamento, onde o cinzel atuou com carga de 1kN e velocidade de 0,5mm/min na interface cimento/material. Verificada a normalidade dos dados através do teste Shapiro-Wilk, foi realizada a análise de variância de dois fatores com pós-teste de Bonferroni (α=0,05). Resultados: a fibra de vidro foi diferente estatisticamtente de todos os materiais avaliados ($p<0,05$). Os demais materiais não apresentaram diferença estatiscamente significante entre si ($p>0,05$). Comparando-se os dois cimentos, foi encontrada diferença estatística entre o Rely X U200 e Arc apenas para a fibra de vidro ($p=0$). Conclusão: PET, polietileno, poliacetal e PTFE apresentaram resistência de união reduzida comparando-se à fibra de vidro.

PALAVRAS-CHAVE

Cimentos de resina; Polietilenotereftalatos; Politetrafluoretileno.

INTRODUCTION

The use of intraradicular posts is the main retention method used in coronal restorative material for endodontically treated teeth with pronounced coronal destruction. [1,2] Traditionally, metal posts were used for intraradicular retention and had high survival rates after 10 years. [3] Notwithstanding, due to the high modulus of elasticity of the metal compared to dentin, which increases the risk of root fracture and catastrophic failure, [4] fiberglass posts were introduced as an alternative. [1]

Prefabricated intraradicular fiber posts have been suggested as a promising restorative material due to their favorable aesthetics, biocompatibility, reduced treatment time and modulus of elasticity, which is similar to dentin. [5, 6, 7] Due to their modulus of elasticity, these posts promote better stress distribution along the root axis. [8] Consequently, fiberglass and carbon posts are widely used in oral rehabilitation. [9, 10, 11] However, a failure rate of up to 7% is still reported for treatments using these intracanal retainers [12] and no differences have been found in the incidence of root fractures between the use of these retainers and metal posts. [7] Thus, new materials that reduce these problems are highly desirable for this application.

Poly (ethylene terephthalate), known by the acronym PET and commercially known as DACRON®, available since the 1970s, is widely applied in the medical field, representing the material most used for vascular substitutes in cardiovascular surgery [13,14], due to its good postoperative performance and biocompatibility. [15] PET is a semi-crystalline transparent thermoplastic polymer material, which has become popular in dentistry due to its aesthetics and ductility. It is used for making orthodontic aligners, vacuum formed retainers, night protectors, temporomandibular joint splints, bleaching plates, etc. [16-18]

Polyethylene, widely applied in Dentistry and commonly used in prosthetic components and as reinforcing fibers, is the most durable reinforcing fiber available. This material consists of aligned polymer chains with low density and good impact resistance. Because of its white color, it can be used in aesthetic dental applications. [19,20]

Polyacetal is a semi-crystalline thermoplastic material, which is applied in several areas such as in the automobile, medical, dental, electronic, electrical areas, and other areas. In dentistry, due to its mechanical properties, biocompatibility, and favorable esthetics, it is applied in removable partial dentures, making it a good alternative for a removable partial prosthesis with chromium-cobalt alloys. [21]

Polytetrafluoroethylene (PTFE), commonly known by the trade name Teflon, is a polymeric material that has common uses outside of dentistry. Its applications include integration in kitchen appliances and building materials, as well as computer circuits and components. [22] In dentistry, it has been used for tissue-guided regeneration, coating instruments to improve the handling properties and matrices. [22-24]

Currently, resin cements are the most used materials to attach posts to the dentin of the root canal. However, in vivo and in vitro studies have shown that loss of retention is the predominant mode of failure in fiber posts after restorations [25,26].

The evolution and innovation of dental materials is recommended to provide technical facilitation and/or to improve chemical, physical and mechanical properties, bringing them closer to the values presented by the dental structures. In the case of the intraradicular posts, specifically, modulus of elasticity, to promote homogeneity in the dissipation of forces between the structures and prevent fractures and localized stress overload, suggesting long-term rehabilitation durability.

With this objective, the present study evaluated the bond strength of five materials (PET, polyethylene, polyacetal, PTFE and fiberglass) in resin cements commonly used in dental practice, as a future recommended application in intraradicular posts using the shear bond strength test.

MATERIALS AND METHODS

Five materials were used: PET, fiberglass, polyacetal, polyethylene, and PTFE and two commercial resin cements: RelyX U200 and RelyX Arc (3M ESPE, St. Paul, MN, USA).

Test specimens (n=5) from each material were prepared in the dimensions of 9 x 3 mm. The specimens were included in PVC rings with auto-polymerized acrylic resin (Clássico ®, Art. Clássico, São Paulo, SP) so that one of the faces was exposed and centered in the ring (Figure 1).

The cements were provided and handled according to the manufacturer's instructions. A 2mm x 2mm plastic matrix was insulated with Vaseline, positioned in the center of the exposed face and filled with cement with a metal spatula in small portions, which was photopolymerized according to the manufacturer's instruction for 20 seconds. Subsequently, the plastic matrix was removed (Figure 2).

For the evaluation of the bond strength between the materials and the cements, the specimens were submitted to the shear strength test, performed in a universal testing machine (EMIC DL 2000, São José dos Pinhais, Paraná, Brazil), with a 1kN load cell and velocity of 0.5mm/min, where the chisel was positioned at the material/cement interface. The shear strength values were recorded in MPa.

After verifying the data through the Shapiro-Wilk test, the two-way analysis of variance with Bonferroni post-test was performed ($\alpha = 0.05$).

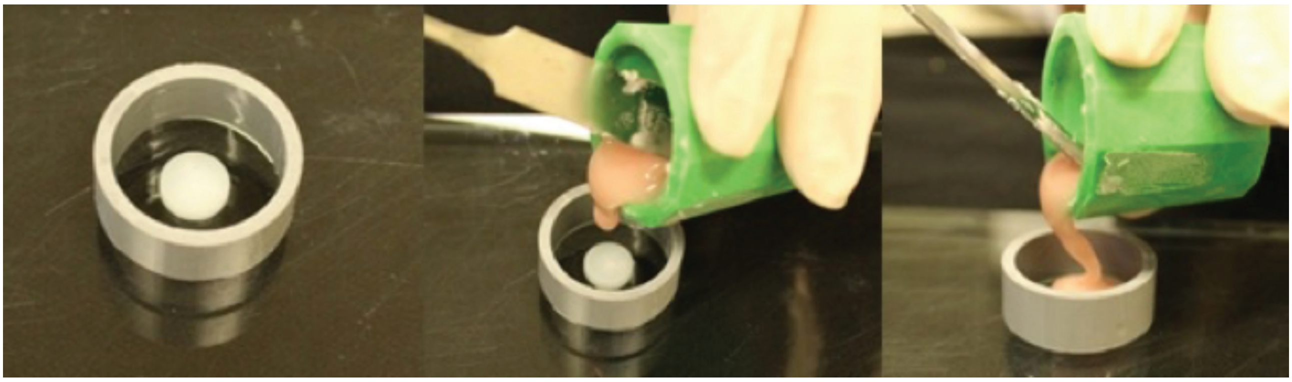

Figure 1 - Inclusion of test specimens to PVC matrix with auto-polymerized acrylic resin.

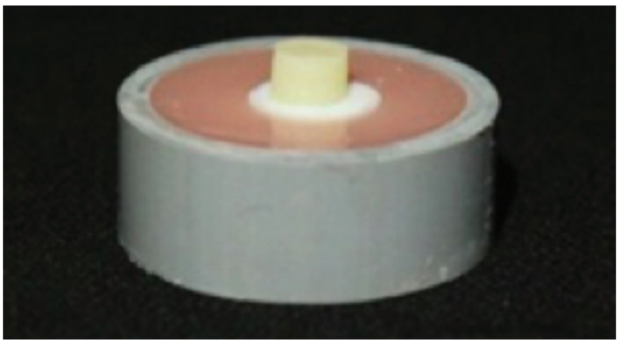

Figure 2 - The test specimen included in acrylic resin with photopolymerized cement.

RESULTS

The values of the bond strength of the different materials evaluate are expose in table 1. The intermaterial evaluation of the RelyX U200 cement showed that only the fiberglass material was statistically different from all the other materials evaluated ($p < 0.05$). In the RelyX Arc cement evaluation, the materials did not exhibit the statistically significant difference between them ($p > 0.05$).

In the evaluation between the cements, the fiberglass exhibited the statistical difference between the Rely X U200 and Arc (p = 0).

Table 3 - General description of the sample and comparison of the right (RM) and left (LM) measurements

Material	Cement	
	RelyX U200	RelyX Arc
PET	1.46 (0.66) Aa	1.38 (0.97) Aa
Fiberglass	7.41 (3.23) Ba	2.47 (0.68) Ab
Polyacetal	2.05 (0.71) Aa	0.95 (0.72) Aa
Polyethylene	1.22 (0.39) Aa	1.25 (0.61) Aa
PTFE	0.73 (0.51) Aa	0.46 (0.25) Aa

AB Equal capital letters indicate statistical similarities in the column.
ab Equal lowercase letters indicate statistical similarities in the line

DISCUSSION

Fiberglass posts have been extensively used in oral rehabilitation, bringing improved resistance and dissipation of intracanal forces compared to metallic posts. Problems such as restoration retentions in these materials were overcome with the use of resin cements. [27] The clinical success of this alternative treatment has been mainly attributed to the modulus of elasticity of fiberglass posts, which is closer to the dentin structure module than to metal pins [28].

The modulus of elasticity represents the flexibility of the material, where high values indicate a hard material and low values, a flexible material. [29] Diameter, type of fiber and material can influence the property of prefabricated fiber posts. [30] Thus, the modulus of elasticity is related to the stress transmitted to the root, which is one of the most important factors in the fracture mechanism. [31]

Restored teeth with prefabricated metal posts or molten metal cores have high fracture strength values [32]. However, their failure mode causes irreversible fractures and dental loss. This can be explained by the modulus of elasticity of these posts, which have higher modulus of elasticity than the fiber posts and generate high-stress concentration in the remaining root structure. [33] Although the fiberglass has a modulus of elasticity closer to the root dentin than to the metal one, [4,8] which would reduce root fracture cases when comparing these two materials, there is no difference in the incidence of this problem. [7]

Modulus of elasticity discrepancy is a source of stress concentrations, notwithstanding the smaller modulus of elasticity of the fiberglass, and the pins of this material do not contribute to better stress distribution in the tooth root, increasing the risk of root fracture. [34]

In this study, the four new materials evaluated, PET, PTFE, polyacetal, and polyethylene, exhibited lower bond strength values than the fiberglass group for the RelyX U200 cement, commonly used as intraradicular retainers in clinical procedures. For the Relyx ARC cement, no statistics differences were found among the groups evaluated. [1,5-7,9-11,27] However, clinically speaking, a reduced incidence of catastrophic failures, which does not allow replacing the restoration, may be more important than the survival rate of the restoration. [7]

The human dentin exhibits a modulus of elasticity of 19.3 GPa [35], while for fiberglass it is 41.87 GPa [36]. For the new materials evaluated, the elastic modulus values for PTFE are 1.46 GPa [37], 1.16 GPa for polyacetal [38], 0.74 Gpa for polyethylene [39] and 2.7 Gpa for PET. [40] Notwithstanding the low values, which can be altered considering that the final product in the form of pins has threads and roughness, which increase the bonding surface of the cement, these values are closer to the ones found for the dentin than for the fiberglass.

Thus, despite the lower bond strength values, the greater proximity of the modulus of elasticity values of the new materials to those found for human dentin could bring more favorable results to restorations that require intraradicular retainers, since there would be a decrease in cases of root fracture.

CONCLUSION

The evaluated materials, PET, PTFE, polyethylene, and polyacetal, showed reduced bond strength when compared to fiberglass. However, their modulus of elasticity is closer to that of the dentin.

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