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ORIGINAL ARTICLE

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Evaluating the shear bond strength and remineralization effect of calcium silicate-based and conventional self-adhesive resin cements to caries-affected dentin

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Abstract

Objective: Given the importance of preserving caries-affected dentin (CAD) in conservative dentistry, the shear bond strength (SBS) of different resin cements to CAD has been investigated. Here, we aimed to compare the SBS and remineralizing effect of a calcium silicate (TheraCem) and conventional self-adhesive cement (Panavia SA) on the SBS of CAD.

Materials and Methods: Forty-eight extracted third molars (24 sound and 24 CAD) were used. In each group, 12 teeth were prepared for bonding to TheraCem or Panavia SA. After removal of the enamel and caries, resin composite cylinders were luted on the prepared dentin. After 28 days of storage in the artificial saliva, SBS was measured and the failure mode analysis was investigated. The images of fractured sections were analyzed using scanning electron microscopy and energy-dispersive X-ray to evaluate the Ca/P weight ratio.

Results: SBS of CAD and sound dentin was not different when cemented with TheraCem (9.56 ± 4.51 vs. 9.17 ± 2.76, p = .806), but the CAD showed significantly lower SBS to Panavia SA (9.4 ± 2.36 vs. 7.39 ± 2.18, p = .015). The Ca/P ratio in CAD was significantly higher when bonded to both TheraCem and Panavia-SA than that of the controls (p = .001); however, this ratio was not different for those bonded to TheraCem compared to Panavia SA.

Conclusions: Based on our results, TheraCem as a calcium silicate cement shows better SBS to attach the restoration to CAD as compared to Panavia SA. Obliteration and mineralization of the dentinal tubules in TheraCem were also higher than in Panavia SA. However, their ability to improve the amount of the Ca/P ratio in CAD was similar.

KEYWORDS

calcium silicate, caries affected dentin, remineralization, self-adhesive resin cement, shear bond strength

In this study, the mixed failure mode was predominant in all groups. The cohesive failure was only recorded for sound dentin bonded to TheraCem, which may be related to the low resistance of the tested material itself rather than its true bond strength to the dentin (Bonifácio et al., 2012; Choi et al., 2006). Also, it may be related to numerous porosities in the structure of the material, which may act as stress points (Hoshika et al., 2015). In addition, the most adhesive failure was found for CAD bonded to Panavia SA. Adhesive failures in CAD may be related to several factors like the presence of collagen fibrils partially denatured by bacterial acids and/or metalloproteinases (Kuboki et al., 1977; Pashley et al., 2004) and an incomplete infiltration of the luting agent into the demineralized dentin that is commonly related to these failures (Hashimoto et al., 2002).

Here, we noticed that despite the finding that the Ca/P weight ratio was higher in the CAD group bonded to both TheraCem and Panavia SA compared to unbonded CAD, there was no significant difference between the two types of cement. It is well known that calcium silicate cements, under a wet condition, can release calcium and form apatite crystals. They can also form calcium hydroxide, which is a highly alkaline material and, hence, may cause degradation of the exposed demineralized collagen (Camilleri, 2014; Chen et al., 2018; Huang et al., 2020). Although calcium silicate cements may deliver the minerals to the demineralized dentin and may increase its hardness, it is shown that they cannot induce intrafibrillar remineralization and recovery of a sound modulus of elasticity (Schwendicke et al., 2019). The observed peaks of ions other than calcium and phosphate may be related to the main component of the cement, also the mineral content dissolved by the functional acidic monomer, and the filler particles released from the cement itself (AL-Kataan and Ali 2021).

It should be noticed that our study, as an in-vitro study, had some limitations. As the SBS test must be performed on various specimens, the variability among the test groups could not be avoidable. Thus, the next studies are suggested using the microtensile test, which allows multiple specimens of carious and sound dentin obtained from the same tooth to ensure an accurate comparison. Furthermore, having a longer storage time and performing hardness and XRD tests would be beneficial for the evaluation of CAD after cementation by Ca silicate cements.

5 | CONCLUSION

Based on our findings, it is concluded that TheraCem, as a calcium silicate cement, shows better SBS to attach the restoration to CAD as compared to Panavia SA. Obliteration and mineralization of the dentinal tubules in TheraCem were also higher than in Panavia SA. However, their ability to improve the amount of the Ca/P ratio in CAD is similar. Based on our findings, it may be suggested that calcium silicate cement has a remineralization effect in addition to improving bonding strength to CAD.

AUTHOR CONTRIBUTIONS

All authors contributed to the conception, design, data acquisition and interpretation, and statistical analysis, drafted, and critically revised the manuscript. All authors gave their final approval and agree to be accountable for all aspects of the work.

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CONFLICT OF INTEREST

There is no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

This study was approved by the Research Ethics Committee of Shiraz University of Medical Sciences (Ethical Approval Number: IR.SUMS.-DENTAL.REC.1399.191) and conforms with the declaration of Helsinki and follows the protection of human subjects' guidelines. From all participants, informed written consent was taken.

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REFERENCES

AL-Kataan, Z. A., & AL-Naimi, A. M. (2021). Accumulative calcium ion release & EDX analysis from new generation self–adhesive resin cement. *Advances in Health Sciences Research*, *38*, 164–169. https://doi.org/10.2991/ahsr.k.211012.027

Alrahlah, A. (2018). Diametral tensile strength, flexural strength, and surface microhardness of bioactive bulk fill restorative. *The Journal of Contemporary Dental Practice*, *19*(1), 13–19. https://doi.org/10.5005/jp-journals-10024-2205

Bonifácio, C. C., Shimaoka, A. M., de Andrade, A. P., Raggio, D. P., van Amerongen, W. E., & de Carvalho, R. C. R. (2012). Micromechanical bond strength tests for the assessment of the adhesion of GIC to dentine. *Acta Odontologica Scandinavica*, *70*(6), 555–563. https://doi.org/10.3109/00016357.2011.640280

Camilleri, J. (2014). Hydration characteristics of biodentine and theracal used as pulp capping materials. *Dental Materials*, *30*(7), 709–715. https://doi.org/10.1016/j.dental.2014.03.012

Chen, L., Yang, J., Wang, J. R., & Suh, B. I. (2018). Physical and biological properties of a newly developed calcium silicate-based self-adhesive cement. *American Journal of Dentistry*, *31*(2), 86–90.

Choi, K., Oshida, Y., Platt, J. A., Cochran, M. A., Matis, B. A., & Yi, K. (2006). Microtensile bond strength of glass ionomer cements to artificially created carious dentin. *Operative Dentistry*, *31*(5), 590–597. https://doi.org/10.2341/05-108

Czarnecka, B., Deręgowska-Nosowicz, P., Limanowska-Shaw, H., & Nicholson, J. W. (2007). Shear bond strengths of glass-ionomer cements to sound and to prepared carious dentine. *Journal of Materials Science: Materials in Medicine*, *18*(5), 845–849.