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RESEARCH ARTICLE

Comparative Analysis of the Compressive Strength of Glass Ionomer and Alkasite Restorative Materials over Tricalcium Silicate

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ABSTRACT

This study's objective was to compare compressive strength of two restorative materials, glass ionomer (EQUIA forte) and alkasite (Cention N), when used over tricalcium silicate (Biodentine) as a pulp capping material. An in vitro study was conducted using 30 extracted premolars without caries, restorations od resorption. Standardized Class I cavities were prepared, lined with 1 mm layer of Biodentine, and restored with the two materials mentioned before. Samples underwent mechanical testing using a universal testing machine. Compressive strength was calculated, and results were analyzed using Student's t-test. No statistically significant difference was observed between the compressive strength of glass ionomer (mean: 17.56 MPa) and alkasite (mean: 13.88 MPa) restorations ($p = 0.3304$). Stereomicroscopy revealed adhesive failure in the alkasite group and better dentin adhesion in the glass ionomer group, as well as higher punctual values. Both restorative materials demonstrated comparable compressive strength when used over tri calcium silicate. The findings support their interchangeable use, with selection potentially guided by clinical preference, availability, and cost.

Keywords: Alkasite, compressive strength, glass ionomer, restorative materials.

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1. Introduction

The modern focus of pediatric dentistry has as a main challenge to induce remineralization of carious dentine, to protect and preserve pulp vitality, avoiding postoperative symptoms like sensibility, pain, swelling or internal or external. For this reason, it is important to assure that the dental restoration has marginal sealing and an adequate union between the restoration material and the pulp covering agent [1]. Success depends on the materials biocompatibility and its capacity to prevent bacterial microleaks, due to an inadequate distribution of mechanical tensions from chewing beyond adhered material to the dental piece. To avoid all that, it's important, to reduce microfiltration, to enhance compression resistance, and to avoid fracturing of the restorative material [2].

Compressive strength refers to a material's ability to resist crushing forces, crucial for materials like restorative fillings and core build-up materials that withstand chewing forces. Compressive strength tests simulate masticatory forces and are used to evaluate the performance of dental materials. It is also evaluated to observe clinical yield and measure adhesion values between dental tissue and the restoration, adhesion or coating material, since any issues with them compromises the treatment's success [3]. The reported average compressive strength a natural healthy is ca 305 MPa [4], the restorative work made on it needs to aim to emulate that same mechanical abilities.

The search for the best material for dental restoration is an ongoing task throughout the research community. The protection of pulp requires a dental material with biocompatibility, bioactivity, adequate physical and mechanical properties, which are essential for repairing the dentin.

Among restorative materials used in modern dentistry are glass ionomer EQUIA Forte (Gc Dental. Tokyo, Japan) and Alkasite Cention N (Ivoclar Vivadent, Schaan, Liechtenstein). Glass ionomer and alkasite are materials used widely in dental restoration practices. The evaluation of

the differences and the similarities between them, have been studied focusing on different aspects such as strength [5], micro leaking [6], ionic release for remineralization treatment [7] even as a comparison in the interaction with cement for pulp covering [8], color stability [9], ion release [10], bacterial adhesion [11], among other parameters. As a whole, there are different research results that shows that alkasite is better in some areas and glass ionomer is better in others. However, on regards of the mechanical differences, there are reports of alkasite being mechanically superior than glass ionomer in fraction toughness and flexural strength [12] and there are others that reported no significant difference among them [13].

These restorative materials have been known to be used directly over the dentine in the cavity plane, and in absence of a pulp covering material, showing good adherence. There are pulp covering materials that are commonly used in combination of the restoration materials previously mentioned, such as calcium silicate (CS), calcium enriched mixture (CEM) cement, mineral trioxide aggregate (MTA) or tricalcium silicate commonly called Biodentine (BD) [14]. However, there's been studies showing better mechanical resistance in glass ionomer over tricalcium silicate (BD) than MTA or CEM cement [15]. This has been attributed to the fact that BD is a bioactive and bio interactive material with the ability to release ions and form calcium phosphate deposits. In pulp coating, BD is a better alternative over MTA because it exhibits better properties such as low porosity, less absorption, and water solubility, such as high resistance to shearing and to compression [16].

Due to similar effects and ongoing research on them, all these materials have been used in the general practice with different preferences and perspectives depending on a number of factors. The objective of this research is to evaluate the differences between glass ionomer and alkasite's compression resistance, when it's used as a final restoration material over tricalcium silicate.

2. Materials and Methods

An in vitro study was carried out on 30 first and second premolars previously extracted for clinical reasons and donated for research by patients that met the inclusion criteria: no carious lesions, no restorations and no radicular reabsorption. The samples were sanitized using chloramine (0.5% v/v) and stored in distilled water. Class I cavities were performed in each specimen with an occlusal surface ca. 4 mm long (mesial to distal), 2.5 mm wide (vestibular to lingual palatine and 3 mm deep) using a high-speed hand piece (Fig. 1A). All the measures were confirmed with a digital Vernier (HUSKY®).

After that, a 1 mm Biodentine® (Septodont, Saint-Maur-des-Fossés, France) layer was applied (Fig. 1B), then the specimens were separated into two groups and used different restoration material: alkasite Cention® N (Ivoclar Vivadent, Schaan, Liechtenstein) as group A and glass ionomer EQUIA® Forte (Gc Dental. Tokyo, Japan) resin as group B.

The specimens were subjected to a compression test (The Universal Test Machine Shimadzu Corporation© model AG-lC 100kN) until fracture (Fig. 1C), and then, analyzed using a stereomicroscope. The compression resistance, statistical analysis was carried out in GraphPad Prism 9.4.1, using t-Student statistical trial.

The specimens were analyzed under a stereoscopic microscope (Mitutoyo © MSM-414L Series 377, Binocular-377 972[a], Sakado, Japan) to observe force vs. displacement curve till the fracture (cohesive, adhesive or mixed) between the restoration material and the indirect pulp covering otherwise considered compression strength.

Upon results, the statistical analysis was carried out using GraphPad Prism software, and a Student's t-test among the groups (A and B) to explore significance difference.

3. Findings/Results

Both groups were evaluated once the restoration was complete. The compression resistance values in each group

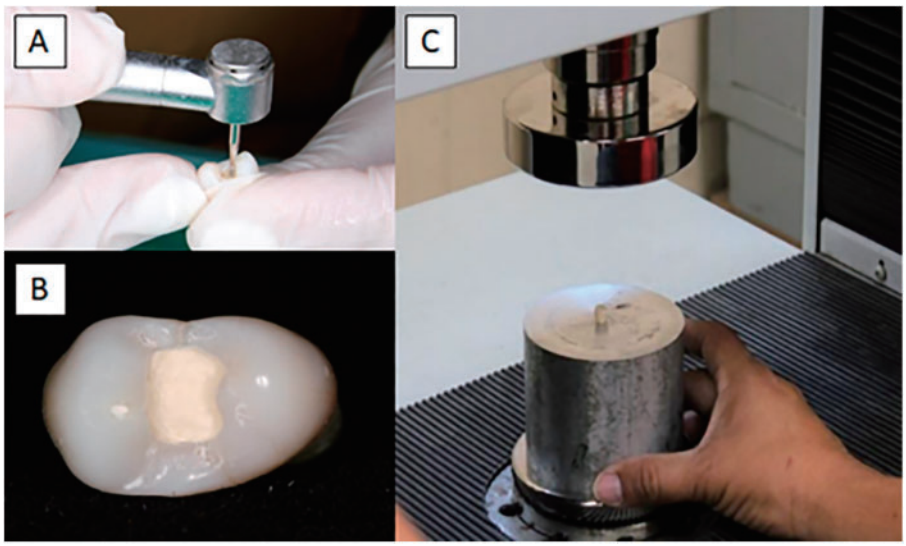

Fig. 1. Specimen repair (A), Restored specimen with tricalcium silicate (B), Specimen mechanical test until fracture (C).

TABLE I: Compression Strength Values of Restorative Materials

Restoration material N = 30	Median (MPa)	Min value (MPa)	Max value (MPa)	Mean (MPa)	P value
Group A N = 15	10.11	3.05	32.45	13.88	p = 0.3304
Group B N = 15	17.86	4.03	34.18	17.65	

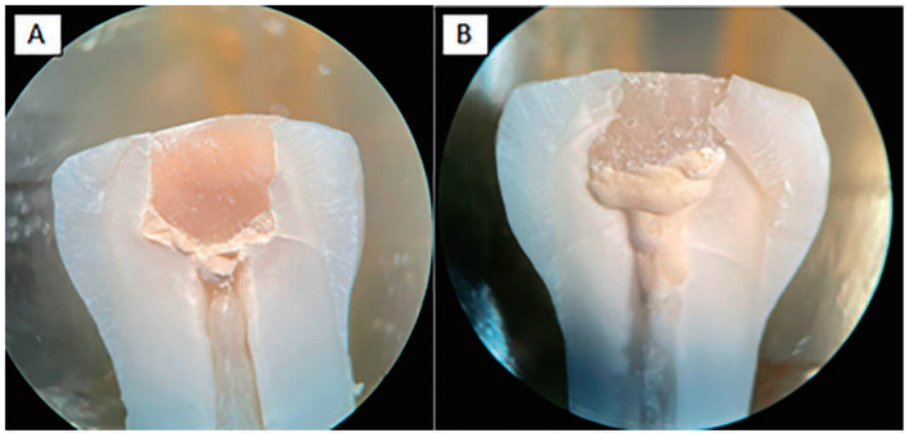

Fig. 2. Stereoscope images of a sample specimen in each group: (A) Group A specimen after fracture, (B) Group B specimen after fracture.

showed in Table I. The comparative strength values of the two restorative materials were statistically compared and did not exhibit significant difference (p = 0.3304).

A representative sample was observed with the stereoscope, in both cases adhesive fractures were observed as depicted in Fig. 2. In group A, alkasite material presented an adhesive fracture, in which the material was completely separated leaving the tricalcium silicate cement exposed, in comparison to group B, which exhibited good dentine adhesion, even after the fracture.

4. Discussion

The bond strength between the restorative material union of the pulp capping material has a crucial role in the crown sealing, and there for pulp therapy success. The right union between the restoring material and the pulp covering material also distributes the superficial mechanical tensions onto the dentine. For this reason, this study was used to evaluate the compressive resistance among the restoration materials and the pulp cover ones.

Although, as it was mentioned before, the literature shows diverse results among the comparison of alkasite and glass ionomer, this research showed that the mean exhibited by glass ionomer specimens was higher than alkasite's (13.88 vs. 17.65 MPa). However, there was not a lot of difference in the maximum compression strength a given specimen could withstand (32.48 vs. 34.18 MPa), and there was no significant difference observed when taken as a group. This can be interpreted as a non-difference in the compression resistance between the materials and therefore no difference in the efficient use of one material over the other. An important observation is wide the range in values, 3.05 to 32.48 for group A and 4.03 MPa to 34.18 MPa for group B, this can be attributed to the biological nature of the sample and the fact that the premolars belonged to different patients, and the patient's history, nutrition, genetics, to mention some of the factor related, can impact dental organ strength and in consequence the success of the restoration treatment [17].

The only observable difference in the obturation in the material after the mechanical test was that the glass ionomer's fracture (group B) exhibited good dentine adhesion, compared to the alkasite that presented adhesive fracture, meaning that the material was detached from the dentine in most specimens, leaving only the tricalcium silicate cement behind, this suggest superior bonding under the conditions tested. This is attributed to the lack of adhesive used in the experiment to give the material equality of conditions and methodology, further study is needed to assure if the glass ionomer adheres to the dentine in comparison to alkasite.

The fact that both material resistances did not exhibit significant mechanical difference, can provide the practitioner the choice to decide among the according to clinical preference, availability do to geographic location and price. It has been observed that Cention® alkasite is more cost effective than EQUIA Forte® glass ionomer, for which this result can contribute to a more cost effective and clinical efficient choice.

5. Conclusion

The mechanical comparison between Cetion N (alkasite) and EQUIA Forte (glass ionomer) over Biodentine (tricalcium silicate) as pulp covering material, showed no significant difference, suggesting they can be used interchangeably with similar results. Both materials are suitable for use in vital pulp therapy, though, glass ionomer may offer improved dentin adhesion and greater punctual values. Further studies are recommended to explore

additional performance metrics such as longevity, wear resistance, shear resistance, and bonding durability.

Conflict of Interest

The authors declare that they do not have any conflict of interest.

References

[1] Al-Nerabieah Z, AlKhouli M, Dashash M. Navigating the complexities of molar incisor hypomineralization: challenges and strategies in pediatric dentistry. *Int J Dent*. 2025;2025(1):9329492.

[2] Cho K, Rajan G, Farrar P, Prentice L, Prusty BG. Dental resin composites: a review on materials to product realizations. *Compos B Eng*. 2022;230:109495.

[3] Ronald L, Sakaguchi, Powers JM. Chapter 12-replicating materials—impression and casting. In *Craig's Restorative Dental Materials*, 13th ed. Sakaguchi RL, Powers JM, Eds. Saint Louis: Mosby, 2012, pp. 277–325

[4] Willems G, Lambrechts P, Braem M, Vanherle G. Composite resins in the 21st century. *Quintessence Int*. 1993;24(9):641–58.

[5] Ozaslan S, Celiksoz O, Tepe H, Tavas B, Yaman BC. A comparative study of the repair bond strength of new self-adhesive restorative materials with a resin composite material. *Cureus*. 2023;15(8):e44309.

[6] Bharath MJ, Sahadev CK, Sagar R, Guria A. Comparative evaluation of microleakage in alkasite and glass-hybrid restorative system: an in-vitro. *Int J Res*. 2019;7:199–205.

[7] Di Lauro A, Di Duca F, Montuori P, Dal Piva AM, Tribst JP, Borges AL. Fluoride and calcium release from alkasite and glass ionomer restorative dental materials: in vitro study. *J Funct Biomater*. 2023;14(2):109.

[8] Abdelkafy H, Salem NA, Marzouk RM, Eldehna AM. Interfacial assessment of cention forte vs. equia forte and two forms of calcium silicate cements at two time intervals. *Br Dent J Open*. 2024;10(1):68.

[9] Çapan BŞ, Birant S. Effect of pediatric drugs on the color stability of dental restorative materials currently used in pediatric dentistry. *J Aust Ceram Soc*. 2024;60(2):601–8.

[10] Llancari-Alonzo P, Alvítez-Temoche D, Ladera-Castañeda M, Castro-Ramirez L, López-Gurreonero C, Cayo-Rojas C. Fluoride release and flexural strength of four ion-releasing restorative materials: an in vitro comparative study. *J Clin Exp Dent*. 2024;16(10):e1207–16.

[11] Dey P, Suprabha BS, Suman E, Natarajan S, Shenoy R, Rao A. Comparative evaluation of surface roughness and bacterial adhesion on two bioactive cements: an in-vitro study. *BMC Oral Health*. 2024;24(1):1278.

[12] Battula MS, Kaushik M, Mehra N, Raj V. A comparative evaluation of fracture toughness, flexural strength, and acid buffer capability of a bulk-fill alkasite with high-strength glass-ionomer cement: an: in vitro: study. *Dent Res J*. 2022;19(1):90.

[13] Birant S, Özcan H, Koruyucu M, Seymen F. Assesment of the compressive strength of the current restorative materials. *Pediatr Dent J*. 2021;31(1):80–85.

[14] Xavier MT, Costa AL, Caramelo FJ, Palma PJ, Ramos JC. Evaluation of the interfaces between restorative and regenerative biomaterials used in vital pulp therapy. *Materials*. 2021;14(17):50–55.

[15] Jahromi M, Roozbeh R, Zarean P, Zarean P, Broujeni P. In vitro comparison of shear bond strength of a flowable composite resin and a single-component glass-ionomer to three different pulp-capping agents. *Dent Med Probl*. 2019;56:239–44.

[16] Al-Sherbiny IM, Farid MH, Abu-Seida AM, Motawea IT, Bastawy HA. Chemico-physical and mechanical evaluation of three calcium silicate-based pulp capping materials. *Saudi Dent J*. 2021;33(4):207–14.

[17] Santos MJ, Zare E, McDermott P, Santos Junior GC. Multifactorial contributors to the longevity of dental restorations: an integrated review of related factors. *Dent J*. 2024;12(9):291.