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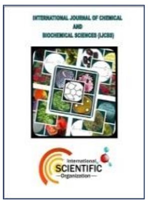

Comparative assessment of microleakage and compressive strength of four types of restorative materials

Mohammad Aleemuddin[1], Ruchi Garg[2,*], Ishita Kapur[3], Priyankka I[4], Sumeet Agarwal[5], Saidath K[6], Mehak[7], Prashant Babaji[8]

[1]*Department of Conservative Dentistry and EndodonticsYenepoya (Deemed to be university) Yenepoya Dental College, Mangalore, Karnataka, India.*
[2]*Department of Public Health Dentistry, Swami Devi Dyal Hospital and Dental College, Barwala, Panchkula, Haryana, India.*
[3]*Department of Conservative Dentistry and Endodontics, Maharishi Markandeshwar College of Dental Sciences & Research, Maharishi Markandeshwar (Deemed to be University) Ambala, Haryana, India.*
[4]*Department of Pediatric and Preventive dentistry, Chettinad dental college and hospital, Kelambakkam, Chennai, Tamilnadu, India.*
[5]*Department of Prosthodontics, Crown & Bridge and Implantology, Bharati Vidyapeeth (Deemed to be) Dental college and hospital, Navi Mumbai.*
[6]*Department of Orthodontics and Dentofacial Orthopedics, Nitte (Deemed to be university) AB Shetty Memorial Institute of Dental Sciences (ABSMIDS) Mangalore, Karnataka, India.*
[7]*Department of Conservative Dentistry and Endodontics, Swami Devi Dyal Hospital and Dental College, Barwala, Panchkula, Haryana, India.*
[8]*Department of Pediatric Dentistry, Sharavathi Dental College, Shivamogga, Karnataka, India.*

Abstract

Reduced microleakage and resistance to masticatory forces (compressive and flexural) determine how long restoration materials last. The current research was done to assess the compressive strength and microleakage of conventional GIC, Cention N, ormocer, and Ceram-x.For the assessment of microleakage, Class V cavities were done on forty human premolar teeth and categarised into 4 groups with 10 samples in each as; Group A (GC Fuji II), Group B (Cention N -IvoclarVivadent, Liechtenstein), and Group C (ormocer -Voco, Cuxhaven, Germany) and group D- Ceram-x were restored in relation to the manufacturer's directions. The samples went through a thermocycling process and a dye penetration test. At a magnification of 40, the sections were made and examined under stereomicroscope. 40 cylindrical specimens with a 5 mm 5 mm measurement that were divided into four study groups, each with ten samples of the restorative material, were created for the compressive strength evaluation. Then compressive strength for all samples was evaluated using the Universal Testing Machine.The data were analyzed statistically. The microleakage was found maximum with ormocer subsequently Ceram-x, cention N and GC Fuji II. The compressive strength was found to be maximum for Cention N subsequently Ceram-x, ormocer, and GC Fuji.The sealing ability was maximum in GC Fuji, Cention N, Ceram-x, and ormocer while the compressive strength was highest for Cention N subsequently Ceram-x, ormocer, and GC Fuji II.

Keywords: Ceram-x, compressive strength, Ceram-x, ormocer, GIC, microleakage

Full length article **Corresponding Author*, e-mail:drruchigarg640@gmail.com

1. Introduction

One of the most frequent causes of tooth structure loss is dental caries, which affects the shape and function of the affected tooth. Various restorative materials can be used to repair teeth damaged by dental caries. Dental practises offer a variety of direct filling materials, including amalgam, glass ionomer cement (GIC), and aesthetic composite. The ability of the restorative materials to withstand masticatory forces (compressive and flexural) and exhibit less microleakage determines how long they will last. The success of the restoration depends on the marginal seal [1]. Preventing microleakage is one of the most crucial requirements for restoration success [2]. Since its creation by Wilson and Kent in the early 1970s, glass ionomer cement (GIC) has been successfully used as a dental restorative material. GICs' poor mechanical characteristics, such as brittleness, low strength, and toughness, are one of their main drawbacks [3]. Newer glass ionomer cements have developed as a result of the failure of older glass ionomer cements to achieve adequate hardness, have high abrasion resistance and resistance to fracture [1,2]. The amount of stress necessary to cause a material to deform in any way is known as a material's compressive strength. It is calculated by multiplying the highest load by the specimen's initial cross-sectional area. Numerous posterior aesthetic restorative materials have been developed as a result of the requirement for good compressive strength with minimal microleakage [2]. The term "organically modified ceramics" is abbreviated as "Ormocers." Silicones, organic polymers, and ceramic glasses make up the material's fundamental building blocks [4]. The nanotechnology era, which is currently being heavily utilised to produce restorative materials with enhanced aesthetics, adhesion, and mechanical properties, is the new era. One of the most recent developments is the Ceramx nanocomposite, a light-curable, radiopaque restorative material that can be used to restore both permanent and baby teeth [2]. A brand-new tooth-colored aesthetic material is called Centon. It is a member of a subclass of composite materials. It has GIC and amalgam-like characteristics [5]. An "alkasite" restorative material called Cention N was first introduced in 2016 [6]. Alkasite is a new class of filling material that is similar to composite or organic rubber materials and is essentially a division of the composite material class. This new category makes use of an alkaline filler that can release ions that can neutralise acids [7]. It can be used as a bulk replacement material because it is a dual-cured material. When the powder and liquid are packaged separately and combined before use, Cention N is radiopaque and releases calcium, fluoride, and hydroxide ions [1,6]. High flexural strength characterises Centon-N. During acid attacks, increased hydroxide ion release from alkaline filler will control pH. It shares characteristics with GIC and amalgam [1].

The present *in vitro* study evaluated the marginal leakage and compressive strength of convetional GIC, Ormocer, Cention N and Ceram-x in Class V restorations.

2. Materials and methods

Forty freshly extracted, caries-free maxillary and mandibular premolars were included for the evaluation of microleakage. All of the research samples were cleaned and stored in thymol crystal solutions until further use. The study samples were classified into 4 equal groups by chance, each with ten samples. On the buccal crown portion of each tooth, a Class V cavity was prepared and filled using each of the chosen restorative materials: Group A (GC Fuji II), Group B (Cention N - Ivoclar Vivadent, Liechtenstein), and Group C (ormocer restorative - Admira Fusion x-tra (Voco, Cuxhaven, Germany) and Group D- Ceram-x.

The samples were then put through 1500 cycles of thermocycling, with a 30 second interval between each temperature bath between 12 and 60 degrees Celsius. Following thermocycling, all tooth surfaces received two coats of nail polish, with the exception of a 1-mm area around the restoration, and the root apices received a seal of yellow sticky wax. The teeth were next submerged in 2% methylene blue dye for 24 hours in a water bath. The samples were divided in half buccolingually along their long axis starting at the midpoint mesiodistally, and examined under stereomicroscope at a magnification of 40. The scoring criteria provided by Prabhakar et al. [8] were used to determine the degree of marginal leakage.

- 0 = No dye penetration

- 1 = Only enamel is affected by dye penetration between the restoration and tooth.

- 2 = Dye penetration into the enamel and dentin between the restoration and the tooth

- 3 = Dye penetration into the pulp chamber between the restoration and the tooth.

In specially made split cylindrical moulds with a 5 mm 5 mm size, forty cylindrical specimens were created, with ten samples in each group, for the evaluation of compressive strength. In accordance to manufacturer's suggestion, each restorative substance was placed inside. All materials were dried and set before being removed from the split cylindrical mould and kept in distilled water for 24 hours.

The Universal Testing Machine was then used to test each specimen's compressive strength under a 20 kN load, at a crosshead speed of 1 mm/s, at a 90° angle, until failure was evident visually or audibly. The formula: [9] was used to determine the compressive strength in megapascals for each study sample.

$CS = Load/\pi r2$

where CS = compressive strength; load is expressed in Newton (N); $\pi = 3.14$; r = half the diameter of mold.

Using SPSS software version 23.0, SPSS Inc., Chicago, IL, USA, the obtained data were statistically analysed using ANOVA, Paired t-test, and post-hoc Tukey's test with P > 0.05.

3. Results and Discussions

Analysis of variance for microleakage was used to perform a statistical correlation with the mean value scores of all four study groups, and it was discovered to be significant statistically (P 0.05) [Table 1]. Using a paired t-test, the intergroup comparison of all four groups revealed a highly considerable discrepancy among Groups A and B (P 0.01), but no difference between Groups A and C, A and D, or C and D (P > 0.05). Microleakage scores between Groups B and C and B with D showed a statistically considerable discrepancy (P 0.05) [Table 2]. Microleakage was found to be lowest with GC Fuji II and highest with ormocer showing, followed by Ceramx, cention N, and Ceramx.

The mean value scores of all four study groups were obtained for the compressive strength results, statistical analysis was performed using analysis of variance, and a highly significant correlation was found (P 0.01) [Table 3]. Using the post-hoc Tukey's test for the intergroup comparison, the findings revealed an insignificant discrepancy between Groups A and B (P > 0.05), but a highly significant correlation between Groups A and C, A and D, and B (P 0.01) [Table 4].

Table 1: Average microleakage scores among groups

Group	Mean+_SD	p
GC Fuji II- Group A	1.24±0.456	0.02
Ormocer -Group B	2.18±0.345	
Ceram-x- Group C	1.53±0.654	
Cention N- Group D	1.39±1.063	

Table 2: Intergroup comparison for microleakage

Group comparison	t	p
GC Fuji II vs ormocer	3.685	0.001*
GC Fuji II vs Ceram-x	1.032	0.246**
GC Fuji II vs Cention N	0.163	0.902**
Ormocer vs Ceram-x	1.784	0.051*
Ormocer vs Cention N	2.365	0.001*
Ceram-x vs Cention N	0.527	0.425**

*P<0.01 is highly significant; **P>0.05 is insignificant

Table 3: Compressive bond strength (MPa).

Group	Mean ± SD
GC Fuji II	153.15 ±1.12
ormocer	172.13 ± 1.16
Ceram-x	194.32 ± 1.02
Cention N	221.73 ± 1.34

One-way analysis of variance(ANOVA)

Table 4: Inter group comparison of dentin compressive bond strength among groups

Group comparison	Mean	Std. error	p
GC Fuji II vs ormocer	-18.98	0.421	0.153
GC Fuji II vs Ceram-x	-41.17	0.421	0.001
GC Fuji II vs Cention N	-68.58	0.421	0.001
Ormocer vs Ceram-x	-22.19	0.421	0.01
Ormocer vs Cention N	-49.6	0.421	0.001
Ceram-x vs Cention N	-27.73	0.421	0.01

With the highest score for Cention N, followed by Ceramx, ormocer, and GC Fuji, the compressive strength was found to be highly considerable (P 0.01).For posterior load-bearing restorations, a modern dentist has access to a wide range of direct filling materials, including contemporary bulk fill composites and silver amalgam. The performance is currently the main source of concern [10]. The choice of material for tooth restoration depends on the material's strength and the region of application so that it can withstand intraoral forces during functional and parafunctional movements of the jaw. Under occlusal load, materials with low compressive strength relative to the tooth will fracture the restoration [11].In present study cention N showed lower microleakage and highest compressive strength.Thermocycling was used in the current study to replicate the variations in intraoral temperature [2].In order to prevent dye from penetrating the restoration through invisible cracks, regions without enamel or cementum, etc., two coats of nail polish were applied, leaving a 1 mm wide margin all around the restoration. Dye penetration tests were used to assess the restorative material's durability because they are thought to still be widely used to assess microleakage [6].The methylene blue dye was chosen due to its low molecular weight and small particle size, which can easily facilitate its diffusion [12].

Ishaq et al. assessed the microleakage of three different restorative materials with various chemical structures in order to identify which material has the best ability to seal. They found that, Better sealing ability in Ormocer. They observed least microleakge with ormocer [5].Glass hybrid restorative system, Zirconomer improved, and Cention N were all compared for microleakage, and Dhivya et al. came to the conclusion that Zirconomer improved showed less microleakage than Cention N and Equiaforte cements [6].According to Sujith et al.'s assessment of the mechanical and microleakage characteristics of Cention-N in comparison to glass ionomer cement (GIC) and composite restorative materials, Cention-N had the least mean microleakage [1].Naz et al. assessed and contrasted the compressive strength, microleakage, and GIC type IX, Zirconomer Improved, and Cention N. As a result of its good compressive strength and minimal microleakage, they came to the conclusion that Cention N can be suggested as a permanent restorative material [13]. Zirconomer and Cention N, two glass-containing restorative materials, were evaluated for microleakage and dentin shear bond strength by Kumari and Singh, and their results were contrasted with those of a traditional glass ionomer cement (GIC) (GC Fuji II). They observed that Cention N consistently outperformed both Zirconomer and the traditional GIC (GC Fuji II) [3]. Glass ionomer cement type II (GIC II), GIC IX, and Cention N were evaluated by Pathak et al. for their compressive strength, diametral tensile strength, and shear bond strength on primary teeth. When it comes to the restoration of deciduous teeth, Cention N (Ivoclar) is a good substitute for GIC II and GIC IX due to its high mechanical strength [10]. According to Naz et al., shear bond strength of alkasite (cention N) demonstrated significantly higher values than GIC, whereas alkasite and nano-hybrid composite showed no considerably difference [14]. Mazumdar et al found that CN showed minimum microleakage compared to AA and GICs [7].Jain et al found lowest lowest microleakage with bioactive restorative material compared to ormocer, and conventional glass ionomer cement [4].

Composite, Cention-N can be utilized for restoration in place of GIC Type II because it has a much higher compressive strength [11].Because UDMA particles, which are less elastic and give the monomer matrix stiffness, are present in Cention N, the study found that its compressive strength is the highest. Stability and increased mechanical strength are guaranteed by UDMA [13].According to theory, the presence of isofiller in cention N's low elasticity modulus acts as a stress reliever for shrinkage, thereby lowering microleakage and polymerization shrinkage [3].The only difference between Cention N (Ivoclar) and GIC may be that Cention N (Ivoclar) exhibits a high polymer network density and high degree of polymerization over the entire depth of the restoration due to the special use of crosslinking methacrylate monomers in combination with a stable and efficient selfcure initiator [10].Further studies are needed to validate the results.

4. Conclusions

While the compressive strength was highest for Cention N, followed by Ceramx, ormocer, and GC Fuji, the sealing ability was highest in GC Fuji, Cention N, Ceramx, and ormocer.

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