

Comparative Evaluation of Shear Bond Strength of Cention N with Other Aesthetic Restorative Materials to Dentin: An in Vitro Study

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Abstract

Aim: To evaluate the shear bond strength of Cention N and recent tooth-colored restorative materials to dentin.

Materials and Methods: Flat dentinal surface was prepared from 40 caries free, extracted human permanent molars and were mounted in acrylic rings. These were randomly divided into four groups—Group A: Ketac-Molar, Group B: Zirconomer Improved, Group C: Cention N, & Group D: GC Fuji II LC (RMGIC). These restorative materials were applied on dentinal surface of all the specimens using Teflon molds. The mounted samples were stored in distilled water for 24 hours and thermocycled. They were then subjected to shear bond strength test using universal testing machine. Data was analyzed using a one-way analysis of variance (ANOVA) and Tukey's post-hoc tests.

Results: Cention N exhibited highest mean Shear Bond strength (7.0487 ± 0.42 MPa). Ketac-Molar and Zirconomer Improved were comparable in their bond strength values (3.2157 ± 0.37 , & 3.4644 ± 1.18 MPa), but depicted lower bond strength when compared to RM GIC (5.468 ± 1.75 MPa).

Conclusion: Cention N restorative material showed better bonding potential to dentin as compared to RMGIC, Zirconomer Improved and Ketac-Molar.

Keywords: *Zirconomer, Cention N, Shear bond strength*

I. INTRODUCTION

Various restorative materials have been used to preserve the lost tooth structure and maintain form, function and aesthetics. They substitute the biological, functional, and esthetic harmony of the remaining tooth structure. The foundation for aesthetics in the sequence is laid by position, contour, texture, and color.¹ Glass ionomer cement (GIC) was the earliest aesthetic restorative material introduced by Wilson and Kent in 1972.² GIC bonds directly to teeth and has re-mineralizing effect because of fluoride content. Since GIC lack sufficient hardness, fracture resistance and low abrasion resistance, newer conventional GIC, Ketac-Molar has been developed with improved mechanical properties.³ To overcome the problems of moisture sensitivity and inferior mechanical properties associated with conventional glass ionomer cements, resin modification of glass-ionomer cement was designed to achieve desirable physical properties similar to those of composite resins, while maintaining the basic characteristics of the conventional glass-ionomer cement.⁴ This goal was achieved by incorporating water-soluble resin monomers into an aqueous solution of polyacrylic acid. In this way the system undergoes polymerization of the resin monomer while the acid-base reaction proceeds at the same time.⁵ A new class of restorative glass ionomer that provides the strength and durability of amalgam is evolved as a recent posterior restorative material called Zirconomer Improved. The inclusion of Zirconia fillers in glass component of Zirconomer Improved reinforces the structural integrity of restoration and imparts superior mechanical properties in posterior load-bearing areas.⁶ Cention N is an alkasite restorative which is a new category of filling material, like Compomer or Ormocer and is essentially a subgroup of composite resin. It is a dual-cured restorative material. (Self-curing resin based restorative material with light curing option).⁷ The clinical success of the new restorative materials depends upon a good adhesion with the dentinal surface to withstand various dislodging forces acting within the oral cavity. The purpose of the present in-vitro study was to evaluate and compare the shear bond strength of a conventional restorative glass-ionomer (Ketac-Molar), a zirconia reinforced glass ionomer (Zirconomer Improved), a resin modified glass ionomer (GC Fuji II LC), and a resin filling material (Cention N) to dentin.

II. MATERIALS AND METHODS

A total number of forty caries free, extracted human permanent molars, were selected for the study and they were thoroughly cleaned and stored in normal saline at room temperature. The teeth then were embedded in self-cure acrylic resin and depth holes measuring 1.5 mm were made in the deepest part of central fossa of each tooth with the

help of a round diamond bur. This is done to standardize the depth of dentin as it also affects dentin bond strength. Occlusal surfaces were made flat with a diamond disc until a clean dentinal surface is exposed. The prepared dentin surfaces were then polished with 600 grit wet silicon carbide paper. Then they were randomly divided into four groups of 10 teeth each based on the restorative material used as follows:

GROUP A: KETAC - MOLAR

GROUP B: ZIRCONOMER IMPROVED

GROUP C: CENTION N

GROUP D: GC FUJIII LC(RMGIC)

Group A (Ketac-Molar): The Occlusal Dentin was conditioned with polyacrylic acid for 10 sec, washed off with water for 10 sec and blotted dry with the help of cotton pellets. Conventional GIC was mixed according to the manufacturer's directions, and transferred to teflon molds of dimensions 3.5 mm width and 2.5 mm height placed on the surface of prepared tooth and condensed properly with stainless steel condenser. Positive pressure was applied with a mylar strip for 4-5 min until the material has set (Figure 1).

Group B (Zirconomer Improved): Here, Zirconomer Improved GIC was mixed and placed in a manner similar to Group A. Samples of Group A and B are protected with GC Fuji varnish (Figure 2).

Group C (Cention N): The Occlusal Dentin was etched with 37% ortho phosphoric acid for 15 sec rinsed for 10 sec with water and blotted dry with the help of cotton pellets. Bonding agent was applied on to the surface and light cured for 10 sec, then powder and liquid was mixed according to the manufacturer's directions and transferred to Teflon molds placed onto prepared tooth and condensed properly (Figure 3).

Group D (RMGIC): The Occlusal Dentin was conditioned with 20% polyacrylic acid for 10 sec rinsed with water for 10 sec and blotted dry. Then the restorative material was mixed and applied to the tooth surface and light cured for 20 sec. Then the surface of the set cement was protected by application of GC Fuji varnish (Figure 4).



Figure 1: Group A (Ketac-Molar)



Figure 2: Group B (Zirconomer Improved)



Figure 3: Group C (Cention N)



Figure 4: Group D (RMGIC)

EVALUATION OF SHEAR BOND STRENGTH: All the 40 samples were stored in distilled water at room temperature for 24 hours and subjected to thermocycling for 2000 cycles between 5°C and 55°C with a dwell time of 30s. The samples were then subjected to shear bond strength testing in a universal testing machine (UTM) at a cross head speed of 0.5 mm/min, calculated as ratio of MAXIMUM LOAD RECORDED AT FAILURE IN NEWTONS to SURFACE AREA of bonded cylinders in mm².⁸ The data collected

was tabulated accordingly and was subjected to statistical analysis. Mean and standard deviations were calculated for each group and analysed using a one-way analysis of variance (ANOVA). Post hoc Tukeys test was used to identify differences between the groups.

III. RESULTS

ANOVA showed a significant difference in mean shear bond strength at $p < 0.05$. Cention N showed maximum mean shear bond strength (7.0487 MPa) and Ketac-Molar showed minimum mean values amongst all the groups (Table 1). Ketac-Molar and Zirconomer Improved were comparable in their bond strength values (3.2157 & 3.4644 MPa), but depicted lower bond strength when compared to GC FUJIII LC (5.4638 MPa).

Table 1: Comparison of the shear bond strength in terms of {Mean (SD)} all the different materials using ANOVA test

Materials	N	Mean	Std. Deviation	F value	p value
Ketac-Molar	10	3.2157	0.37880	27.212	<0.001**
Zirconomer	10	3.4644	1.18453		
Cention N	10	7.0487	0.42744		
GC FUJIII LC	10	5.4638	1.75158		
Total	40	4.7982	1.90200		

($p < 0.05$ – significant*, $p < 0.001$ – Highly significant**)

IV. DISCUSSION

Bond strength values are gross methods for determining the efficacy of bonding restorative materials to dentin. A restored tooth transfers stress differently from an intact tooth. Any force on the restoration creates compression,⁹ tension or shear along the tooth restoration interface, which contributes to a complex stress distribution; a combination of compressive, tensile and shear stresses. Since mastication is one of the indentation processes, basically similar to the shearing phenomenon, the true nature of the material's adhesiveness at the interface is shown by the shear bond strength. Shear bond strength depends on bond type (micromechanical, ion exchanging) and type of restorative materials (Robert et al, 2001). The Mean Shear Bond strength values obtained in this study is: Cention N > GC FUJIII LC > Zirconomer > Ketac-Molar. Higher shear bond strength implies better bonding of material (Cention N) to tooth. In the present study, bond strength of Ketac-Molar obtained was 3.2157 Mpa. It exhibited the least bond strength since this material relies on chemical bond (weak bond) and polyacrylic acid used for dentin conditioning acts as a mild etching agent¹⁰ which removes the smear layer but does not remove smear plugs from the dentinal tubule.

The mean bond strength of Zircomer Improved obtained was 3.466 Mpa which is not statistically significant, but higher than Ketac-Molar. Because of reinforcement with nano zirconia fillers, it exhibited stronger shear bond strength-thus improving mechanical properties. The mean shear bond strengths obtained from resinmodified glass ionomer restorative materials is 5.46 Mpa, which is greater than conventional GIC (3.2157). The results of the present study were in accordance with Almaummar et al¹¹ and Suryakumari et al who evaluated shear bond strength of conventional GIC, RMGIC, and composite restorative materials and concluded that the resin modified glass-ionomer shows higher shear bond strength than conventional glass-ionomer in permanent dentition. The higher values are due to presence of light activated resin component (HEMA) with its superior wetting ability.¹² Conditioning of the dentin surface with polyacrylic acid results in removal of smear layer from surface and intertubular plugs and demineralizes the surface dentin. The HEMA of hybrid ionomers penetrates the network of exposed collagen resulting in small layer of micromechanical retention at the interface. The adsorption of a thin strong polymer layer on dentin in glass ionomers was observed, which may be faster with light curing materials and also exchange of ions between the glass ionomers and dentin at their interface.¹³ The improved adhesion values may also be due to the acid base reaction slowness, which makes the poly-acid available for longer periods of time, resulting in higher bond strength. Compared to RMGIC, the higher bond strength values obtained for Cention N (7.047 Mpa) could be explained by etching of dentin resulting in demineralized dentin with a collagen network penetrated by the bonding agent, hybrid layer formation to form a microchemical bond. Cention N is a tooth-coloured, basic filling material for direct restorations. It is self-curing with optional additional light-curing. It is available in the tooth shade A2. The powder consists of various glass fillers, initiators and pigments. Liquid-consists of four different dimethacrylates, monomers and initiators. Urethane dimethacrylate (UDMA) the main component of the monomer matrix, and has no hydroxyl side groups, i.e., its hydrophobic and low water absorption rates. Tricyclodecan-dimethanol dimethacrylate (DCP) low viscosity, difunctional monomer which initiates hand mixing of Cention N. Tetramethyl-xylene-diurethane dimethacrylate (Aromatic aliphatic-UDMA) – partly aromatic urethane dimethacrylate is a hydrophobic, high-viscosity cross-linker combining the beneficial properties of aliphatic (low tendency to discolour) and aromatic (stiffness) diisocyanates. Polyethylene glycol 400 dimethacrylate (PEG-400 DMA) - enhances the Cention N flowability.¹⁴ Polymerization technology in Cention N: Self-cure mechanism – liquid portion of Cention N has hydroperoxide and the filler in the powder is coated with the other initiator components. Instead of conventional benzoyl peroxide, Hydroperoxide imparts greater temperature-resistance i.e. it is less sensitive to heat, which is an important factor regarding storage stability.

Thiocarbamide rather than amine often increases the product's color stability, as a material's color stability decreases with increasing amine content. Light curing (dual curing) mechanism for optional light curing, it has photo initiator Ivocerin and an initiator of acyl phosphine oxide. Ivocerin, a dibenzoyl germanium derivative¹⁵ is an amine free initiator. In a study by Mazumdar et al, Cention N was also found to have a better bond strength as compared to Nano hybrid composite.¹⁶ The results of the present

study were in accordance with Nidhi Agarwal et al¹⁷ who comparatively evaluated microleakage and shear bond strength of Cention N, Nano- filled composite, and Ketac-Molar in primary molar teeth and concluded that Cention N has least microleakage and highest shear bond strength when compared to Nano- filled composite and Ketac-Molar and can be recommended for use in primary dentition.

Limitations: The results of the present in vitro study, cannot be extrapolated directly to the clinical situations. It can be expected that if a restorative material shows a lower bond strength under optimal laboratory test conditions, it is very possible that it may not be successfully maintained in the oral cavity, so additional retention criteria are considered when clinically applied.

V. CONCLUSION

Within the limitations of the study, Cention N exhibited highest shear bond strength and is statistically significant in comparison to Ketac-Molar.

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