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Evaluation of Microshear Bond Strength of Chitosan Modified Gic

[1]A. Karthick, [2]M. Kavitha, [2]S.C. Loganathan and [1]D. Malarvizhi

[1]Department of Conservative Dentistry and Endodontics,
Sree Balaji Dental College, Bharath University, Chennai, India
[2]Tamilnadu Government Dental College, Chennai, India

Abstract: Objective: The aim of this study is to evaluate micro-shear bond strength of Chitosan-modified glass ionomer cement (10 v/v% and 50 v/v%) in comparison to conventional glass ionomer restorative cement. Methods: Conventional Glass Ionomer Cement (GIC) was modified by adding Chitosan. For microshear bond strength, 30 dentin discs were prepared from ten freshly extracted molar teeth and embedded in 1*1cm acrylic blocks. GIC cylinder of dimension 0.7*1mm was prepared over dentin discs. Microshear bond strength test was done using wire and loop method by subjecting specimens until fracture in Instron Universal testing machine. Results: Mean microshear bond strength of 10 v/v% Chitosan modified glass ionomer restorative material was greater than 50 v/v% Chitosan modified GIC and the conventional GIC. Significance: Microshear bond strength of Chitosan modified glass ionomer cement is significantly greater than conventional glass ionomer cement.

Key words: Glass Ionomer Cement · Chitosan · Microshear Bond Strength

INTRODUCTION

Glass-ionomer cement (GIC) has been successfully applied as dental restoratives for over 35 years since its invention by Wilson and Kent. Brittleness, low tensile and flexural strengths have limited the current conventional GIC's use only at certain low stress-bearing sites such as Class III and Class V cavities [1]. Glass ionomer cement has been modified from their time of development to improve their physical properties and to facilitate application.

Chitosan, a natural linear bio-polyaminosaccharide, is a hydrolyzed (deacetylated) derivative of chitin. Chitin is the principal component of the protective cuticles of crustaceans and in cell walls of some fungi and insects' cuticles. Structurally, Chitosan possesses reactive amino group, reactive primary and secondary hydroxyl groups at C2, C3 and C6 positions respectively [2] and has rigid crystalline structure through inter and intra molecular hydrogen bonding. Chitosan is a weak base, insoluble in water and organic solvents, but soluble in dilute aqueous acidic solution (pH < 6.5) [3]. In dentistry it has been used for edentulous ridge augmentation [4], for improving hemostasis [5], enhancement of new bone formation [6], for increasing the secretion of saliva [7], as a tool for guided bone regeneration [8] and for improved wound healing [9].

Previous studies on Chitosan modified GIC have evaluated fluoride release, flexural strength and pH [10]. But there are no studies to evaluate the chemical adhesion of chitosan modified GIC with the tooth structure. Therefore the objective of this study was to evaluate micro-shear bond strength of Chitosan-modified glass ionomer cement (10 v/v% and 50 v/v%) in comparison to Conventional glass ionomer restorative cement. The null hypothesis that addition of chitosan does not improve the bond strength of conventional glass ionomer cement to dentin.

MATERIALS AND METHODS

Chitosan powder (Sigma Alrich, Manopolise, USA) and Fuji II GIC (GC dental Industrial Corporation, Tokyo, Japan) were used in this study.

Corresponding Author: Karthick Arumugam, Reader, Department of Conservative Dentistry and Endodontics Sree Balaji Dental College& Hospital, Bharath University Pallikaranai, Chennai, India. Tel: +91 9884718819.

Preparation of Chitosan modified GIC 0.3N acetic acid was used as a solvent for chitosan [11]. 1.8 ml of glacial acetic acid was made up to 100 ml with distilled water in a 100 ml standard flask to get 0.3N acetic acid. 20 mg and 100 mg of Chitosan were weighed separately and dissolved in 0.3 N acetic acid and made up to 100 ml with the same acetic acid in a 100 ml standard flask to get 0.2mg / ml and 1mg / ml Chitosan Solution respectively. 0.1ml of 0.2mg/ml of Chitosan solution was added to 0.9ml of GIC liquid and 0.5 ml of 1mg/ml Chitosan solution was added to 0.5ml of GIC liquid to get 10 v/v% and 50 v/v% Chitosan modified glass ionomer solution respectively.

Group I: Conventional glass ionomer cement

Group II: 10 v/v% Chitosan modified glass ionomer cement

Group III: 50 v/v% Chitosan modified glass ionomer cement

Microshear Bond Strength: Ten recently extracted human first molars due to periodontal reasons, which were free of caries, restorations, cracks, fractures or other structural defects were collected, cleaned with ultrasonic scaler, disinfected with 10% formalin and stored in distilled water until t he start of the procedure. The occlusal enamel was removed and flat 2mm thickness of coronal mid dentin were prepared from each tooth by using Isomet saw (Isomet-model 650, S o uth Bay technology, Sun Clemente, CA, USA) at slow speed with water coolant. 30 specimens of dimension 5*5mm were prepared and embedded into 1 * 1 cm acrylic blocks and divided into three groups of ten specimens each. Prefabricated PTFE mould (0.7mm internal diameter and 1 mm thickness) was placed over the dentin specimens and GIC build up done. The bonded specimens were immersed in the water at 37°C for 24 hours, thermocycled for 500 x cycle in 5°C and 55°C water bath with dwell time of 30 seconds in each bath. Each specimen with acrylic mould was attached to jig of Universal testing machine. Shear force applied by Lloyd's Universal testing machine until fracture at a cross head speed of 1mm/min. Results of microshear bond strength test was statistically analyzed using One Way ANOVA followed by STUDENT NEUMAN KEUL test.

RESULTS

Table shows the mean Micro-Shear bond strength and statistical comparison between the groups I, II and III.

Groups	Mean ± SD (MPa)	P value
Group I	2.417 ± 0.195 [a]	<0.001*
Group II	6.565 ± 0.221 [b]	
Group III	3.455 ± 0.303 [c]	

Note: Different alphabets denotes significance at 1% interval.
*** denotes significance at 5% interval**

Mean Micro-Shear bond strength value of Group II is **171.6%** more than Group I

Mean Micro-Shear bond strength value of Group III is **42.95%** more than Group I

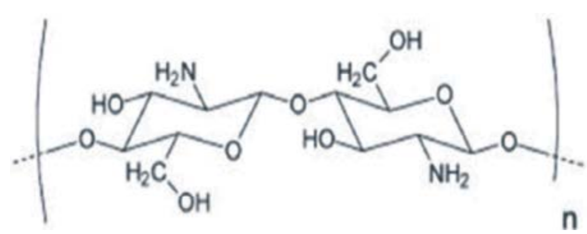
Micro-Shear bond strength between the Groups I, II and III showed they were statistically significant (p< 0.001)

Results of Micro-Shear bond strength: **Group II > Group III > Group I**.

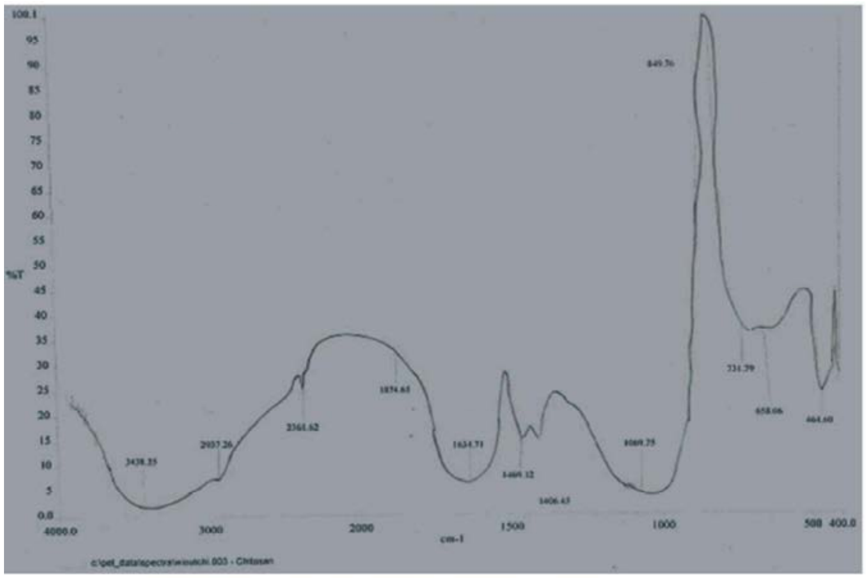
DISCUSSION

Glass ionomer cement is useful in treatment of patients with coronal and radicular dentin involvement. Reliable bond to dentin is due to hydrophilic nature of GIC [12]. An important property of this cement is its unique chemical adhesion to enamel and dentin. Due to its lack of wear resistance and fracture toughness [13], research efforts were made to reinforce GIC. Some of the efforts include formation of different kinds of self cured GIC, water hardening versions, amino-acid residue modified GIC and so on.

Chemical structure of Chitosan

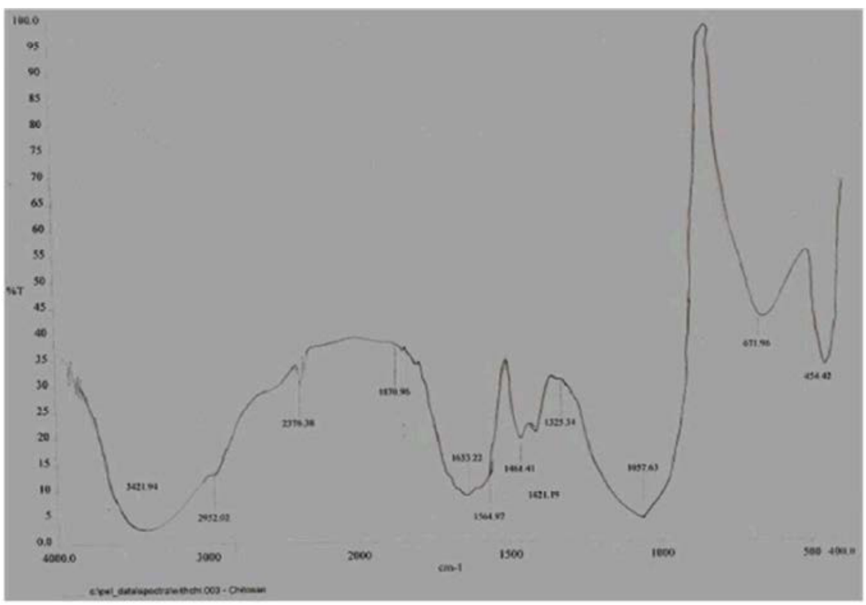


Chitosan carries a positive charge due to easy availability of the free amino group and so reacts with surfaces/polymers with negative charge, providing possibilities for covalent and ionic modifications, thereby allowing improvement of properties.



IR SPECTRUM OF GIC BEFORE ADDING CHITOSAN.

Fig. 1: IR Spectrum Of Gic Before Adding Chitosan.

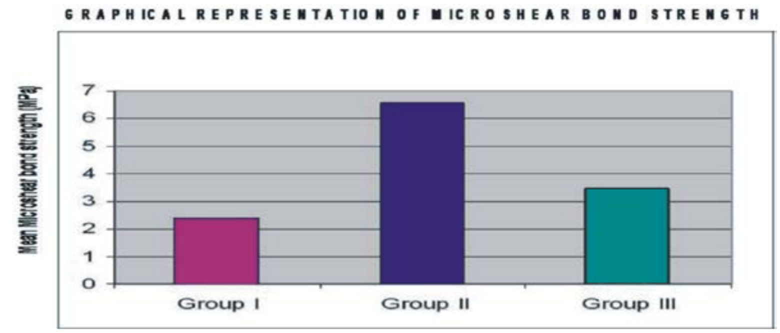


IR SPECTRUM OF GIC AFTER ADDING CHITOSAN.

Fig. 2: IR Spectrum Of Gic After Adding Chitosan

Due to its high biocompatibility and hydrophilicity [10], Chitosan has been added to GIC. In this study, Chitosan was added to GIC liquid because volume/volume (v/v) proportioning was used [10]. An Infra Red Spectroscopic study was carried out to determine the setting reaction between the Chitosan and conventional glass ionomer cement (Figure 1 & 2). It reveals that the reaction has taken place between the amino (-NH2) group of Chitosan and the functional group [OH group and C= O group] of GIC.

In Microshear bond test, specimen production is better controlled as it uses known diameter micro-bore tubing [14]. Compared to blade method, wire loop method is easier, versatile and useful in assessing bond strength between mineralized tissue and GIC [15].



Graph1: Graphical representation of MICROSHEAR BOND STRENGTH

Results showed that ranking in descending order, 10 v/v% Chitosan had the highest microshear bond strength followed by 50 v/v% Chitosan and the conventional glass ionomer cement.

Since Chitosan possess hydroxyl and acetamide groups, they bind to hydroxyl group of powder particles and carboxylic groups of polyacrylic acid by hydrogen bonding. This interaction reduces interfacial tension among GIC components thereby improving mechanical performance. But with increasing Chitosan concentration, Chitosan molecules segregate and interact with one another rather than with GIC components resulting in poor mechanical performance.

Though there are different classes of fluoride releasing materials, their properties need to be improved significantly before considering them as universal restorative materials. Although a single material would be desirable, compromises may be necessary when selecting materials.

CONCLUSION

Microshear bond strength of 10v/v% Chitosan modified glass ionomer cement is significantly greater than conventional glass ionomer cement.

Clinical Significance: It is hoped that the laboratory measurements of Micro-Shear bond strength may aid the interpretation of future studies of the clinical performance of Chitosan modified GICs.

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