

# Evaluation of Push-out Bond Strength of a Resin Sealer to Dentin after a Final Flush of Three Irrigants

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## ABSTRACT

**Aim:** To evaluate the push-out bond strength of resin-based sealer to root dentin after a final flush of three different irrigants.

**Materials and methods:** Thirty extracted human mandibular premolars were sectioned 4 mm below the cement–enamel junction and 60 horizontal disks of 2 mm from middle one-third of the root were prepared. The disks were immersed in 3% sodium hypochlorite for 1 minute, and after drying the disks, they were finally flushed with the following irrigants: group I—Chitosan solution, group II—*Morinda citrifolia* juice (MCJ), and group III—ethylenediaminetetraacetic acid (EDTA). The disks were filled with AH Plus sealer, and after 7 days, the disks were subjected to push-out bond strength using a universal testing machine.

**Results:** EDTA had the highest push-out bond strength followed by MCJ and then chitosan.

**Conclusion:** Chitosan and MCJ can be used as alternative irrigants as a final flush during the cleaning and shaping of the root canals.

**Clinical significance:** EDTA, chitosan solution, and MCJ are efficient in smear layer removal which thereby increases better sealer penetration and prevents the dislocation of obturating materials.

**Keywords:** Bond strength, Irrigants, Smear layer.

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## INTRODUCTION

Microflora within the pulp canal space can be reduced through chemomechanical procedures. The canal preparation generates an indeterminate smear layer on the dentin, which enhances colonization of microorganisms and also hinders the effect of irrigants and medicaments.<sup>1</sup> It also impedes with the sealer bonding and penetration, thus compromising the seal post obturation.<sup>2</sup>

Eliminating the smear layer is of utmost importance. Various chemical irrigants are used during chemomechanical preparation to disinfect the pulp space and to remove smear layer. It has been studied that the interlocking of the sealer into the tubular dentin after the elimination of smear layer enhances displacement of obturating materials.<sup>3</sup> The increased bond strength of a sealer from radicular dentin through micro-mechanical retention or frictional resistance is beneficial to maintain the integrity of the dentin–sealer interface.

Ethylenediaminetetraacetic acid (EDTA) is the most extensively used chelator. It acts on the inorganic portion of root canal dentin. It reacts with calcium ions of dentine resulting in calcium chelation, further decalcifying the dentine at approximate depths of 20 to 30 micron within 5 minutes.<sup>4</sup> However, various ill effects of EDTA such as dentin erosion, which depends on the concentration and duration of application and damages the periapical area, is a matter of concern. Hence, the requirement of a biocompatible agent as a chelator is the need of the hour.

Chitosan, a natural polysaccharide obtained from the deacetylation of chitin which is found in crab and shrimp shells, has many applications due to its benefits such as biocompatibility, biodegradability, and bioadhesion.<sup>5</sup> It also shows a remarkable chelating capacity for different metal ions because of its acidic pH. The antifungal effect of a 2% chitosan gel containing 0.1% chlorhexidine against *Candida albicans* has been demonstrated, and its addition to calcium hydroxide paste as an intracanal

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medication has been proved to promote prolonged calcium ion release.<sup>6,7</sup>

*Morinda citrifolia* is a medicinal plant used for over 2,000 years by Polynesians. Commercially called as Noni, the fruit contains polysaccharides, scopoletin, vitamins, and minerals. It contains antibacterial compound L-asperuloside with alizarin. It has many therapeutic effects such as antimicrobial and anti-inflammatory and is an immune enhancer.<sup>8</sup>

Previous studies have reported the efficacy of chitosan and *M. citrifolia* juice (MCJ) for the elimination of the smear layer only. There is a lack of literature on the elimination of smear layer and push-bond strength of AH Plus sealer to dentin after a final rinse of chitosan and MCJ.

Hence, this study aims to evaluate and compare the push-out bond strength of AH Plus sealer to dentin after a final flush with 0.2% chitosan, 6% MCJ, and 17% EDTA.

## MATERIALS AND METHODS

### Irrigant Preparation

#### Chitosan Solution Preparation<sup>9</sup>

- To prepare 0.2% chitosan solution, 0.2 g of chitosan (Panvo Organics Limited, India) was diluted in 100 mL of 1% acetic acid, and the solution was stirred with a magnetic stirrer continuously for 2 hours.

#### Morinda citrifolia Juice Preparation

- To prepare 6% MCJ solution, 6 mL of commercial 100% MCJ (DIVINE NONI Nutraceuticals product) was diluted with 96 mL of distilled water.

Thirty extracted human permanent mandibular premolars were stored in 0.1% thymol solution. Teeth were then sectioned transversally 4 mm below the cement–enamel junction to provide sixty 2-mm-thick dentin disks from the middle one-third of the roots that were then mounted in acrylic resin. The canal space of each disk was prepared using a Gates Glidden drill no. 2 (Mani). Dentin disks were immersed in 1 mL of 3% sodium hypochlorite for 1 minute to simulate the irrigation during root canal preparation and then, per the test irrigants, the disks were randomly divided into three experimental groups ( $n = 20$ ) as follows:

- Group I ( $n = 20$ ): 1 mL of 0.2% chitosan solution for 1 minute,
- Group II ( $n = 20$ ): 1 mL of 6% MCJ for 1 minute, and
- Group III ( $n = 20$ ): 1 mL of 17% EDTA solution (CANALARGE; AMMDENT) for 1 minute.

After dentin treatment, standardized pulp spaces were dried with paper points and filled with AH Plus sealer. Specimens were incubated at 37°C in a humidifier for 7 days.

#### Push-out Test

The sealer was loaded with a 2-mm-diameter cylindrical stainless-steel plunger. Loading was performed on a universal testing machine (TUE-C-400; Fine Spavy Associates & Engineers Pvt. Ltd) at a speed of 1.2 mm/minute until debonding occurred (Fig. 1).

The bond strength value in megapascals (MPa) was computed by dividing the maximum load needed to dislodge the sealer by the interfacial area.



**Fig. 1:** Loading of the sealer with a 2-mm-diameter cylindrical stainless-steel plunger. Loading was performed on a universal testing machine

Push-out bond strength (MPa) = maximum load at which dislodgement is seen in surface area.

### STATISTICAL ANALYSIS

Data obtained were analyzed statistically using one-way analysis of variance test to compare the mean bond strength of all the three groups. The intergroup comparison was done using the *post hoc* test (SPSS Software, Version 13.0, Chicago, IL).

### RESULTS

The result showed a statistically significant ( $p$  value < 0.001) difference between all the three groups.

Comparison of mean push-out bond strength of three groups are as follows: EDTA showed significantly highest push-out bond strength than MCJ and chitosan solution ( $p$  value < 0.001). The statistical ranking of push-out bond strength values is as follows: EDTA with mean push-out bond strength of 17.07 MPa, MCJ with 15.08 MPa, and chitosan solution with 12.12 MPa (Fig. 2).

For the intergroup comparison *post hoc* analysis was done ( $p$  value 0.000) (Table 1).

Group I—Chitosan solution was significantly different from groups II and III.

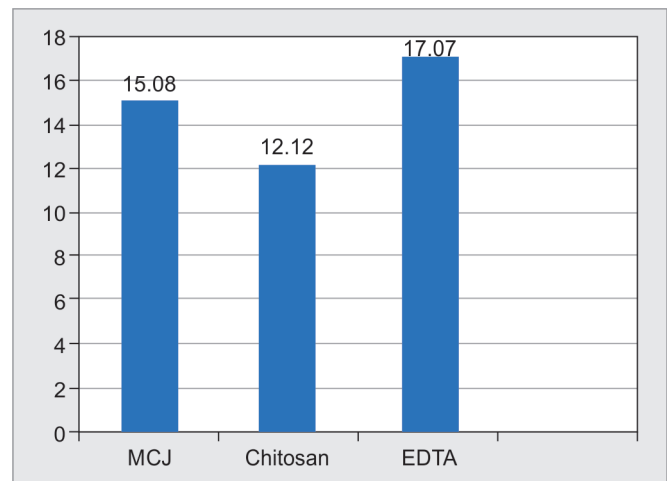
Group II—*M. citrifolia* juice was significantly different from groups I and III.

Group III—EDTA was significantly different from groups I and II.

### DISCUSSION

EDTA is the most frequently used chelating agent. In the present study, 17% EDTA effectively removed the smear layer that allowed the penetration of the sealer into the open dentinal tubules, hence creating an efficient microretention. Various studies have been done on smear layer removal efficacy with different chelating agents and irrigants. The results of this study with respect to EDTA are similar to the study done by Verma et al.<sup>10</sup> Madhusudhana et al. reported that there was no statistically significant difference between Chitosan and EDTA in the elimination of the smear layer.<sup>9</sup> A study proved that 0.2% Chitosan, 15% EDTA, and 10% citric had similar smear layer removal patterns.<sup>4</sup>

A study reported that 1 mL of 17% EDTA when used for 1 minute eliminates smear layer effectively. Application of EDTA for more



**Fig. 2:** Mean push-out strength values of EDTA, MCJ, and chitosan

**Table 1:** Intergroup comparison of EDTA, MCJ, and chitosan (*post hoc* analysis)

Multiple comparisons						
Dependent variable: mean						
Bonferroni						
(I) Group	(J) Group	Mean difference (I-J)	Std. error	p value	95% confidence interval	
MCH	Chitosan	2.9643333*	0.4798976	0.000	1.792831	4.135835
	EDTA	-1.9866667*	0.4798976	0.000	-3.158169	-0.815165
Chitosan	MCH	-2.9643333*	0.4798976	0.000	-4.135835	-1.792831
	EDTA	-4.9510000*	0.4798976	0.000	-6.122502	-3.779498
EDTA	MCH	1.9866667*	0.4798976	0.000	0.815165	3.158169
	Chitosan	4.9510000*	0.4798976	0.000	3.779498	6.122502

\*The mean difference is significant at the 0.05 level

than 1 minute or the quantity greater than 1 mL led to the erosion of the root dentin. So, in the current study, 1 mL of 17% EDTA was used for 1 minute.<sup>11</sup> To avoid the bias among all the experimental groups, 1 mL of the final irrigant was used for 1 minute was used.<sup>9</sup>

Earlier studies have proven 6% MCJ and 0.2% of chitosan have similar chelating action as 17% EDTA. Hence, these specific concentrations were considered in this study.<sup>9</sup> Sayin et al. reported that when EDTA was used alone or combination with sodium hypochlorite, it significantly decreased the microhardness of root dentin.<sup>12</sup> Use of EDTA for 1 minute effectively removes dentinal debris, but when applied for 10 minutes erodes the root dentin. The erosion is because of an extensive opening and broadening of the dentinal tubule. Hence, the application of EDTA longer than 1 minute is not advised.<sup>13</sup> Thus, to overcome the ill effects of EDTA, more biocompatible irrigants need to be studied.

*Morinda citrifolia* has been studied in endodontics as an irrigant and intracanal medicament. A study by Madhusudan et al. proved that MCJ group performed better than the chitosan solution group in eliminating the smear layer. *M. citrifolia* juice acquires antibacterial properties and also contains organic acids such as caproic, caprylic, and ursolic acids. The chelating property of MCJ could be due to the presence of these organic acids.<sup>9</sup> Studies have reported 6% MCJ as an effective chelator without any adverse influence on microhardness property of root dentin compared to EDTA.<sup>14</sup> In this study, MCJ was as effective as EDTA to eliminate the smear layer and has a better push-out bond strength.

Chitosan has an effect on the inorganic portion of the smear layer for its elimination from the root dentin. Chitosan is hydrophilic in nature, which helps it to get adsorbed into the root dentin. Chitosan possess a great number of free hydroxyl and amino groups that make it cationic in nature.<sup>15</sup> This in return is responsible for the ionic interaction between the dentin calcium ions and the chelator. In an acidic medium, the amino groups present in the polymer are protonated which results in the attraction of other molecules for adsorption to root dentin, which then penetrates deeper in the dentinal tubules.<sup>16,17</sup> Atomic absorption spectrophotometry with flame analysis was done using of 0.2% chitosan solution which showed no significant difference compared to 15% EDTA. If both solutions have a similar chelating effect, then the less concentrated solution should be preferred for use.<sup>4</sup> In the present study, chitosan was as effective as EDTA and MCJ in elimination of the smear layer, but there was a statistical difference in push-out bond strength.

The ability of the sealer to penetrate into the tubular dentin and thereby adapting the obturating material to the canal walls is much

more improved after the removal of the smear layer. AH Plus is an epoxy resin-based root canal sealer. It provides good mechanical properties, high radio opacity, adequate biocompatible properties, mild polymerization shrinkage, low solubility, and microretention to root dentin.<sup>10</sup>

Results of this study showed that EDTA had the highest push-out bond strength when compared to MCJ and chitosan solution. Future studies should be carried out using different concentrations of irrigants at different time intervals and their effect *in vivo*.

## CONCLUSION

Within the limits of the study, it can be concluded that chitosan solution and *M. citrifolia* can be used as herbal alternative irrigants as final flush during the cleaning and shaping of the root canals. It is seen that they are effective, less toxic, and more biocompatible than the traditionally used irrigants.

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