

**Original Article**

# Remineralization Efficacy of Gum Arabic Varnish Vs Fluoride Varnish and CPP-ACPF Varnish in Initial Carious Lesions Over 6 Months Follow Up: A Randomized Controlled Clinical Trial

Ahmed Hesham Samaha <sup>a</sup>, Rawda Hesham Abd ElAziz <sup>b</sup>, Rasha Raafat Hassan <sup>b</sup>

<sup>a</sup>Conservative Dentistry Department , Faculty of Dentistry, Cairo University, Egypt, New- Mansoura University (NMU)

<sup>b</sup>Conservative Dentistry Department, Faculty of Dentistry, Cairo University, Egypt.

**Email:** ahmed.hesham@dentistry.cu.edu.eg

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## ABSTRACT

**Objective:** To evaluate the remineralizing efficacy of Gum Arabic varnish clinically

**Materials and Methods:** A total of 90 teeth with initial carious lesions in 42 participants randomly assigned into 3 equal groups, group 1 (G1) received laboratory made Gum Arabic varnish, group 2 (G2) received casein phosphopeptide amorphous calcium phosphate fluoride (CPP-ACPF) varnish (MI Varnish) and group 3 (G3) received 5% sodium fluoride (NaF) varnish (Profluorid Varnish), Remineralization efficacy and caries lesion activity were evaluated at baseline (T0), 1 month (T1), 3 months (T2) and 6 months (T3) with 2 blinded assessors using DIAGNOdent and Nyvad criteria score.

**Results:** According to the DIAGNOdent scores, intergroup comparisons between all materials have shown no statistically significant difference within follow up periods; baseline and 1 month respectively ( $P = 0.713$  and  $P = 0.184$ ), unlike at 3 and 6 months ( $P < 0.0001$ ). Intragroup comparison within Gum Arabic showed no statistically significant difference between follow up periods ( $P = 0.079$ ) unlike MI Varnish and Profluorid varnish ( $P < 0.0001$ ), while the Nyvad criteria intergroup comparisons between all materials showed no statistically significant difference at baseline ( $P = 1.0000$ ), unlike at 1, 3 and 6 months ( $P < 0.0001$ ,  $P = 0.0045$  and  $P = 0.0139$ ) respectively.

**Conclusion:** Although Gum Arabic Varnish helped in arresting 85% of the active initial carious lesions, it didn't produce effective remineralization to the lesions at 6 months follow up. Both MI Varnish and Profluorid Varnish showed similar remineralization potential and were able to arrest all the active initial carious lesions.

**Keywords:** Gum Arabic, Remineralization, Initial carious lesions, fluoride varnish, randomized clinical trial

## 1. INTRODUCTION

White-spot lesions represent the initial stage of caries lesions which results from demineralization of the enamel surface. Clinically, these lesions are considered to be active when their surfaces have lost luster and become porous. At this early stage, the development of caries can be reversed, avoiding further destruction of dental hard tissue and the need for invasive treatment. In this context, the use of remineralization agents has been a focus of interest for researchers [1].

The remineralization of early carious lesions is enhanced with fluoride by adsorbing onto the partially dissolved crystal lattice, attracting phosphate and calcium ions, and forming fluorapatite crystals [2]. Although fluoride varnish is the gold standard remineralizing agent, it creates only top-bottom surface mineralization limited to the outer surface of the enamel [3]. Furthermore, excessive fluoride usage has the potential to cause dental fluorosis, discoloration, and gastrointestinal problems. By using new remineralization systems that are capable of restoring lesion subsurface structure would significantly reduce the need for traditional restorations while preserving tooth structure [4].

Casein phosphopeptide-amorphous calcium phosphate (CPP-ACP) is a milk-derived peptide that binds to amorphous calcium phosphate nanoparticles. The peptide residues ensure supply of bioavailable calcium and phosphate ions for subsurface remineralization by stabilizing the amorphous calcium phosphate phase and inhibiting its premature crystallization in the oral cavity. According to studies, CPP-ACP nanoclusters attach to enamel,

plaque, and pellicle preventing bacterial adherence to the tooth, forming fluoridated CPP-ACFP complexes, and acting as a PH buffer against acid attack. [5]. CPP-ACP improved remineralization of enamel subsurface lesions (bottom up remineralization) compared to fluoride alone products, which induced surface-only remineralization. [6]. However, some patients reported their allergy to milk and milk derivatives making the general use of CPP-ACP for these patients not accepted.

Gum Arabic (Acacia Senegal) is an excretion derived from the stems and roots of Acacia Senegal and other African Acacia species. It is mainly composed of high molecular weight polysaccharides, as well as high amounts of calcium, magnesium, and potassium salts, all of which have the ability to enhance tooth remineralization. Gum Arabic's calcium ion concentration may substitute calcium ions isolated from hydroxyapatite crystals while preventing further demineralization of tooth enamel. [7]. Gum Arabic also includes cyanogenic glycosides and a variety of antimicrobial enzymes such as (oxidases, peroxidases, and pectinases). [8]. Due to the presence of high concentrations of calcium ions in Gum Arabic, it could be used as a remineralizing agent as mentioned by a recent review [4] to help tooth enamel remineralization. Natural remineralizing agents can be more acceptable to the population than fluoride-based remineralizing systems. To determine if these new remineralizing techniques provide any added benefit over classic fluoride remineralization, well-designed randomized controlled trials are required. [4].

The null hypothesis would be that there is no difference in the remineralization efficacy between Gum Arabic varnish and fluoride varnish or CPP-ACP with fluoride based varnish on initially carious lesions

## 2. MATERIAL & METHODS

### 2.1. Gum Arabic (Acacia Senegal) varnish (laboratory prepared)

The varnish was prepared in the National Research Centre. The Gum Arabic Powder was dispersed in double distilled water (DW) with a concentration of 10 mg/ml using a magnetic stirrer bar under ambient temperature this concentration was recommended because when compared to lesser concentrations, this concentration inhibits the cell adhesion of both *Streptococcus mutans* and *Streptococcus*

*sobrinus* to tooth surfaces [8], after preparation, the varnish was stored in single-use form then the varnish was sterilized using steam autoclave.

### 2.2. Profluorid Varnish (VOCO America Inc.)

5% NaF varnish, 1 ml of VOCO Profluorid varnish contains 50 mg of sodium fluoride [9].

### 2.3. MI Varnish (GC America Inc.)

MI Varnish consists of (10% w/v CPP-ACP, 5% sodium fluoride), a bioavailable varnish containing calcium, phosphate and fluoride. All materials are shown in **Table (1)**

**Table (1):** Materials used, composition, lot number and manufacturer.

Material	Composition	Lot number	Manufacturer
Gum Arabic (Acacia Senegal) Varnish	10 mg/ml Gum Arabic in double distilled water		Laboratory prepared
Profluorid Varnish	5% NaF varnish	1846758	VOCO America Inc
MI Varnish	CPP-ACP 10% w/v, sodium fluoride 5%	2101051	GC America Inc.

### 2.4. Study design:

This three-armed, parallel-design, and randomized clinical trial study was conducted in the clinic of Conservative Dentistry Department, Faculty of Dentistry, Cairo University, Egypt, after the approval of the Ethics Committee in the Faculty of Dentistry

- Cairo University (Ref.1/7/20), and The protocol of the current study was registered in ([www.clinicaltrials.gov/](http://www.clinicaltrials.gov/)) database, with unique identification number NCT04422860 .The procedure and the aim of the study were explained to the participants and each of them signed informed consent.

## 2.5. Sample size calculation:

Based on a study Du et al. [10] the predicted sample size was 75 subjects to be able to reject the null hypothesis that the population means of the experimental and control groups were equal with probability (power) 0.8. Sample size was increased by 20 % to compensate for dropouts with a total of 90 subjects (i.e.30 per group).

## 2.6. Study setting and participants:

A total of 90 teeth with initial carious lesions in 42 participants with one or two lesions were randomly assigned into 3 equal groups (n=14 patients), group 1 received laboratory made Gum Arabic varnish, group 2 received MI Varnish and group 3 received 5% Profluorid Varnish, Remineralization efficacy and caries lesion activity was evaluated at baseline (T0) and after 1 month (T1),3 months (T2) and 6 months (T3) with 2 blinded assessors using DIAGNOdent and Nyvad criteria score. Randomization was done using simple randomization by another contributor who is not involved anymore in the trial through generating numbers from 1:42 into three columns according to interventions/comparator assessment methods. The allocation sequence was generated using ([www.randomization.com](http://www.randomization.com)).The randomization list was secured and away to ensure no tampering with the random list. Each participant chose a random number from an opaque sealed envelope.

### Clinical examination of initial carious lesions:

After taking the full medical and dental history, the clinical

examination of labial surfaces with active initial lesion was done to evaluate the color texture and light reflection. The inspection was carried out under direct illumination with a dental chair light using a dryness test that involved gentle drying for 5 second [11]. To avoid intra examiner errors, all subjects were examined by the same examiner. Patients were selected according to inclusion and exclusion, patients with non-cavitated initial carious lesions with score 1 or 2 according to The International Caries Detection and Assessment System (ICDAS) caries diagnostic criteria were included in the study and the diagnosis was confirmed by the using of DIAGNOdent as the early demineralization of the smooth surface scores are (8–15).

## 2.7. DIAGNOdent calibration

The DIAGNOdent calibration in compliance with the manufacturer's instructions.

- a) The CAL key was pressed (The calibration symbol appears).
- b) Once hearing the signal, the probe was placed vertically on calibration disk.
- c) When the tone stops, this means that the calibration is over.

## 2.8. Remineralizing material application

### 2.8.1. Teeth preparation:

Teeth with initial carious lesions were polished with a fluoride-free prophylaxis paste. Excess saliva was removed using an air syringe and high volume suction.

### 2.8.2. Gum Arabic Varnish application

Using a disposable bond brush, the varnish was painted on the selected surface.

**2.8.3. Profluorid Varnish application**

the varnish was applied on the clean surface according to manufacturer instructions, the surface to be treated was covered with a thin film using the brush applicator then the area was allowed to become wet to ensure the setting of the varnish.

**2.8.4. MI Varnish application**

The varnish was applied on the clean surface according to manufacturer instructions, the foil cover of the MI Varnish unit dosage bottle was removed and MI Varnish was stirred with the disposable brush before application, then the surface to be treated was covered with a thin film using a disposable bond brush then the

area was allowed to become wet to ensure the setting of the varnish.

All the patients of the 3 groups were given the same instructions to avoid brushing or flossing and to avoid hard and sticky food or products that may contain alcohol (oral rinses, beverages, etc.) for the next 4 hours after application.

**2.9.Outcomes:**

**2.9.1. Primary outcome: Remineralization efficacy**

The measurements were recorded at baseline 1 month, 3 months and 6 months' follow-up periods. DIAGNOdent calibration was performed based on manufacturing information as mentioned before. The tip of the probe was positioned on the lesion and rotated around its vertical axis until the highest value was found and a peak reading was recorded [12].

Scores are shown in **Table (2)**

**Table (2): DIAGNOdent scores according to manufacturer information**

Caries site	Healthy tooth structure score	Demineralization beginning score	Strong demineralization score
Caries of smooth surface	0-7	8-15	>16

**2.9.2. Secondary outcome: Caries lesion activity assessment**

The surface texture and topography of the carious lesions are used to detect

lesion activity. The diagnostic criteria cover the entire caries spectrum, from clinically sound surfaces to non-cavitated and microcavitated caries lesions in enamel to frank cavitation into the dentine. [13]. Scores are shown in **Table (3)**

The DIAGNOdent score and the Nyvad criteria score were checked by the outcome assessors at baseline and at

follow up period who were blinded to the participants' randomization allocation.

**Table (3):** Description of the Nyvad criteria for caries lesion activity and severity assessment [13].

Score	Category	Criteria
1	<b>Active caries (Intact surface)</b>	Enamel has whitish or yellowish opaque surface that has lost its shine; When the tip of the probe is gently moved over the surface, it feels rough; it is frequently covered with plaque. There is no clinically evident deficiency of tooth substance.  Smooth surface caries that is frequently present towards the gingival margin Fissure/pit: preserved fissure morphology; lesion spreading along the fissure's walls.
4	<b>Inactive caries (Intact surface)</b>	The surface of enamel is whitish, brownish or black.  Enamel may be shiny and feels hard and smooth when the tip of the probe is moved gently across the surface, no clinically detectable loss of substance.  Smooth surface: caries lesion typically located at some distance from the gingival margin.

### 3.Statistical analysis:

Data were analyzed using Medcalc software, version 19 for windows (MedCalc Software Ltd, Ostend, Belgium). Data was explored for normality using Kolmogorov Smirnov test and Shapiro Wilk test. Continuous data showed normal distribution and were described using mean and standard deviation. Intergroup comparison between continuous data was performed using one-way ANOVA, while intragroup comparison was performed using repeated measures ANOVA. Two-way ANOVA was used to test interaction of variables followed by tukey post-hoc test. Categorical data was described as frequency and percentage, comparisons between categorical variables were performed using the chi square test. A

value less than or equal to 0.05 was considered statistically significant and all tests were two tailed.

### 3. RESULTS

#### 3.1.Demographic data

This study was conducted on 90 teeth with initial carious lesions in 42 participants that were randomly allocated to the interventions and the control arms (n=30). After 6 months 39 participants having 85 teeth completed the follow-up with 92.8% retention rate. Twenty-two females (52.4%) and twenty males (47.6%) participated in the current clinical trial, there was no statistically significant difference between all groups regarding the gender distribution among groups (P = 0.100). Mean age

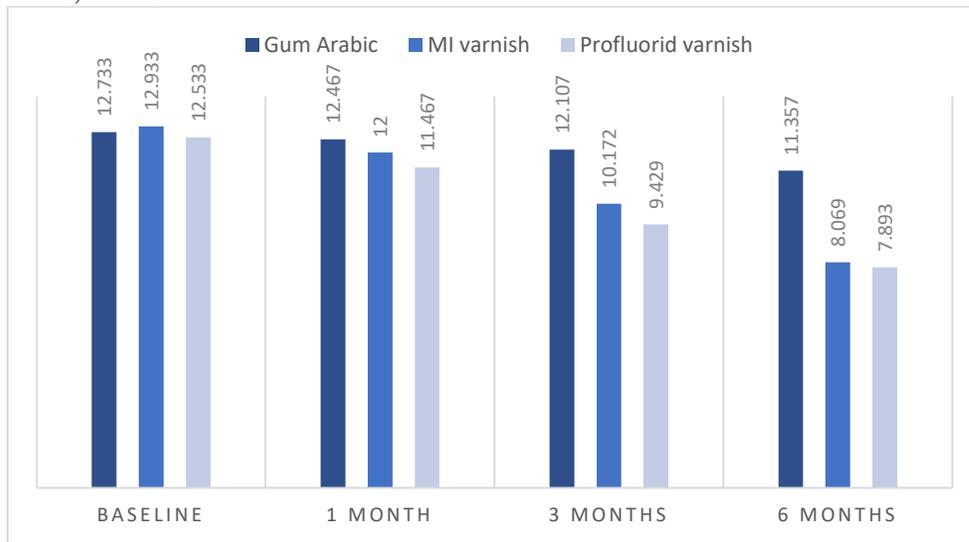
of the participants in the current trial was  $27.5 \pm 5.5$  years there was no statistically significant difference among all groups regarding age ( $P = 0.550$ ).

**3.2.DIAGNOdent score:**

**3.2.1. Effect of material and follow-up on DIAGNOdent score:**

Intergroup comparison between all materials showed no statistically significant difference within follow up periods; baseline and 1 month

respectively ( $P = 0.713$  and  $P = 0.184$ ), while at 3 and 6 months' intergroup comparison revealed statistically significant difference ( $P < 0.0001$ ). Intragroup comparison within Gum Arabic has shown no statistically significant difference between follow up periods ( $P = 0.079$ ), MI Varnish and Profluorid varnish have shown statistically significant difference between different follow-up periods ( $P < 0.0001$ ). **Table (4) and Figure (1)**



**Figure (1):** Bar chart showing effect of material on DIAGNOdent score at each follow-up.

**Table (4):** Mean and standard deviation of DIAGNOdent score of all materials at each follow-up:

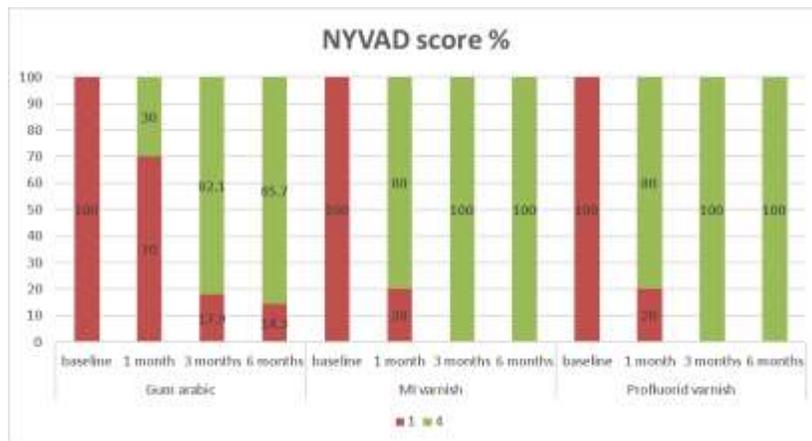
Intervention	Gum Arabic		MI Varnish		Profluorid varnish		P value
	Mean	SD	Mean	SD	Mean	SD	
Baseline	12.733 <sup>A,a</sup>	2.067	12.933 <sup>A,a</sup>	1.639	12.533 <sup>A,a</sup>	1.907	0.713 NS
1 month	12.467 <sup>A,a</sup>	2.255	12.03 <sup>A,a</sup>	1.838	11.467 <sup>A,a</sup>	2.145	0.184 NS
3 months	12.107 <sup>A,a</sup>	1.950	10.172 <sup>B,b</sup>	1.794	9.429 <sup>B,b</sup>	1.913	<0.0001*
6 months	11.357 <sup>A,a</sup>	2.112	8.069 <sup>C,b</sup>	1.646	7.893 <sup>C,b</sup>	1.853	<0.0001*
P value	0.079 NS		<0.0001*		<0.0001*		

Means that do not share a letter (upper-case letters vertically and lower-case letters horizontally) are significantly different, \* corresponds to statistically significant difference, NS corresponds to no significance

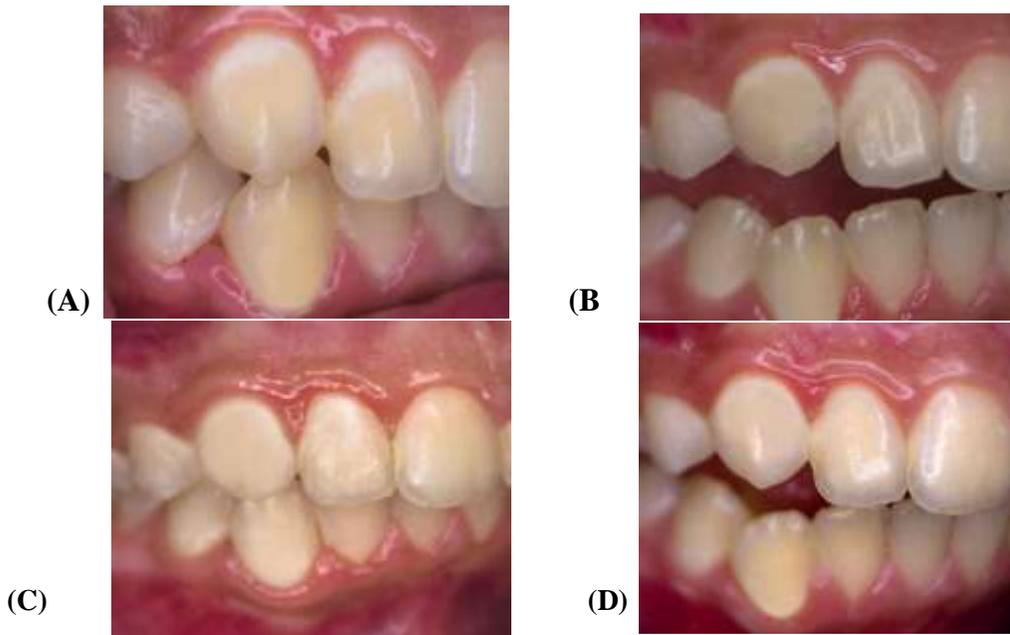
**3.3. Nyvad criteria:**

Intergroup comparisons between all materials have shown no statistically significant difference at baseline ( $P = 1.0000$ ), while there was statistically significant difference at 1, 3 and 6 months ( $P < 0.0001$ ,  $P = 0.0045$  and  $P = 0.0139$ ) between all materials. Intragroup comparison within Gum Arabic varnish, MI Varnish and Profluorid varnish have shown statistically significant difference between different follow-up periods ( $P < 0.0001$ )

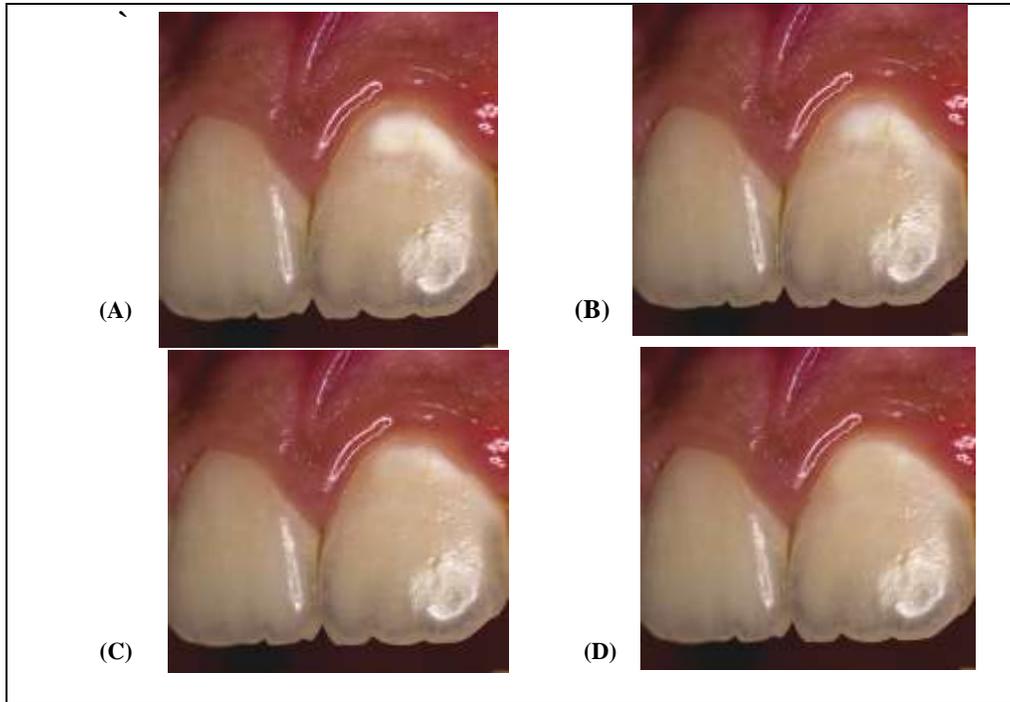
Regarding clinical significance, there was 9 times more risk for carious lesions to remain active for Gum Arabic when compared to Profluorid varnish after 6 months ( $RR = 9$  (95% CI 0.5072 to 159.7044;  $P = 0.1343$ )). There was no risk for carious lesions to remain active for MI Varnish when compared to Profluorid varnish after 6 months ( $RR = 0.9667$  (95% CI 0.01983 to 47.1214;  $P = 0.9864$ )). **Figure (2-5).**



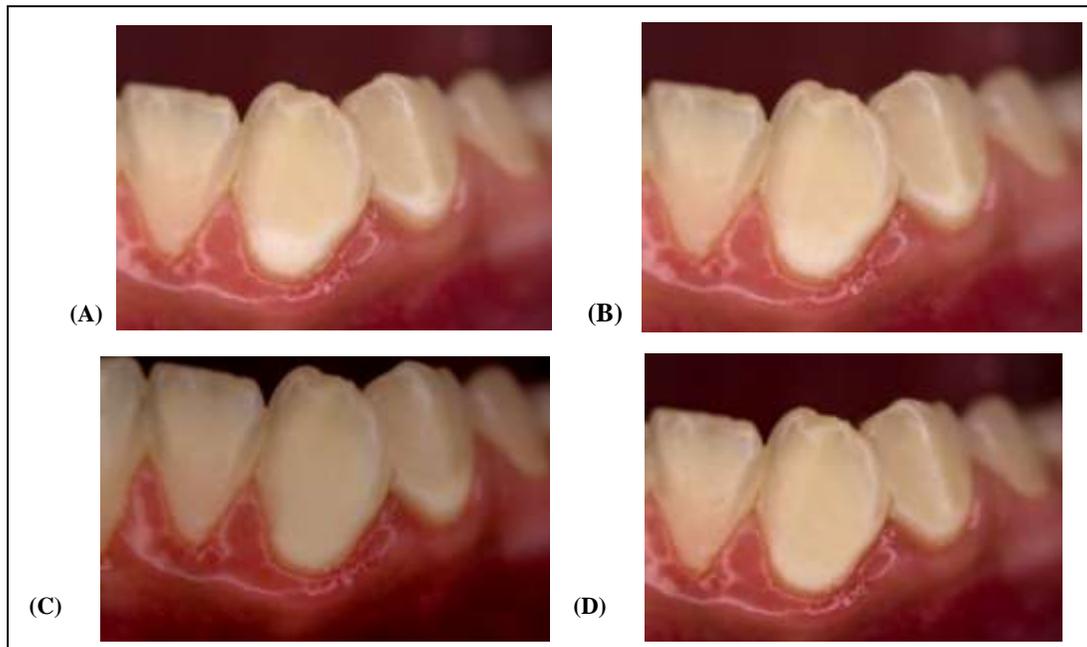
**Figure (2):** Bar chart showing percentage of each Nyvad score within each follow-up period for all materials.



**Figure (3):** Nyvad score within Gum Arabic varnish group at different follow-up periods. A. T0 (baseline), B. T1 (1 month), C. T2 (3 months) & D. T3 (6 months)



**Figure (4):** Nyvad score within Profluorid Varnish group at different follow-up periods A.T0 (baseline), B. T1 (1 month), C. T2 (3 months) & D. T3 (6 months)



**Figure (5):** Nyvad score within MI Varnish group at different follow-up periods. A. T0 (baseline), B. T1 (1 month), C. T2 (3 months) & D. T3 (6 months)

#### 4. DISCUSSION

Enamel demineralization is the early stage of enamel caries, there is subsurface demineralization behind

intact enamel surface. Light is reflected differently from demineralized enamel surfaces than from sound enamel, resulting in a chalky white appearance

[14]. These white spots lesions (WSLs) should be controlled in a multifactorial manner, the most important strategy is to prevent demineralization and biofilm formation, as well as to apply techniques for lesion remineralization [4].

A review of literature by Roopa et al. [15] reported that, this opaque WSLs are softer than the surrounding sound enamel clinically and slowly becomes more white with air drying. It is critical to distinguish between incipient and arrested lesions. Incipient lesions are active lesions that progress under acid attack, whereas arrested lesions do not.

Gum Arabic is a natural substance that has been demonstrated to decrease acid-dependent demineralization and promote remineralization in environments free of fluoride. [4]. In the current study the varnish form was chosen over different forms because it acts as a reservoir of Gum Arabic and can remain on tooth surfaces for longer time. [5].

The gold standard in WSLs treatment is the fluoride varnish according to many systematic reviews [16], [17], [18] and [19]. Variety of fluoride forms e.g., (Mouthwashes, gels, toothpastes and varnishes) have all been reported to be effective in the treatment of WSLs; however, professionally applied varnishes have the unique benefit of eliminating the requirement for patient compliance, in this double blinded clinical trial, the varnish form was selected because it has higher quantities of fluoride than daily toothpaste and mouth rinse. Apart from reducing clinical chair time, it may remain on tooth surfaces for many hours following application [5].

CPP-ACP which is a milk-derived nano complex that can maintain higher calcium

and phosphate concentrations in an amorphous state even higher calcium and phosphate concentrations than milk and can be considered a salivary biomimetic due to their many similarities to salivary inhibitor statherin [20]. CPP-ACP has a greater ability to remineralize enamel subsurface lesions than fluoride alone products, which mainly remineralize the surface only of the enamel [6]. It has been proven that CPP-ACP in the presence of fluoride has the ability to induce the production of fluorapatite-like crystals deep within the subsurface lesion [21]. MI Varnish (10% w/v CPP-ACP, 5% sodium fluoride) was chosen in the current study as another intervention to test the efficacy of the biomimetic remineralizing agent.

The DIAGNOdent device was used in this study to investigate the remineralizing effect since it is a more objective and accurate tool for identifying initial carious lesions than visual inspection [12], DIAGNOdent enamel depth assessments in smooth surface caries exhibited adequate sensitivity (75%) and high specificity (96%) when compared to quantitative light produced fluorescence (QLF). DIAGNOdent results may be affected by calculus or plaque and stains that are irrelevant problems patients or clinicians [22], one of the drawbacks of the DIAGNOdent that it can only determine the depth of lesions; however, it is unable to assess the amount of lesion areas, as a result the optimal technique for assessing the WSLs is to combine the use of technology-based methodologies with visual examination [23]. Moreover, in this study, caries lesion activity assessment was evaluated using The Nyvad criteria which is a caries classification system based on tactile and visual assessment for detecting the activity and severity of caries lesion [13].

For practically comparable sensitivity levels, the Nyvad criteria had significantly higher specificity than the ICDAS, [24]. The correct use of this visual- tactile criteria provides an easier, more economical and fast method that allows the diagnosis and the treatment decision [25].

In the current study DIAGNOdent scores within the Gum Arabic varnish group at different follow up periods showed non statistically significant different at follow-up periods, this could be due to the composition of the Gum Arabic which is mainly high molecular weight polysaccharides [7], these high molecular weight polysaccharides take a longer periods to diffuse into the lesion subsurface, this result was contradicting with Paramita et al. [7], that studied the effect of Gum Arabic (Acacia Senegal) topical gel application on demineralized enamel hardness and the findings indicated that after soaking in a demineralization solution, the enamel hardness value was decreased; However, after applying the Gum Arabic gel, the enamel hardness value improved. This is contradicting with our results and this could be due to different application forms and different concentration 20 mg/ml that was used.

Moreover, intragroup comparison within Gum Arabic group with Nyvad criteria score showed statistically significant difference between different follow-up periods, Gum Arabic was able to arrest 30% after one month, 82% after 3 months and 85% of the active lesions by the end of the follow up periods, this is could be due to enhancing the oral health as a result of the oral hygiene measures given to the patient, another explanation that only surface remineralization might

have occurred. It is also possible that this was due to the protective surface coatings developed on the enamel surface in the form of a polymer layer, which may decrease the erosive impact of acid exposure on enamel surfaces. the development of this coating was explained by Beyer et al. [26], that studied that the polymers of Gum Arabic (GA), the polymer layer formation is induced by the adsorption of Gum Arabic's polymers on enamel's hydroxyapatite surface, the glucuronic acid is one of Gum Arabic's polymers that may interact with hydroxyapatite nanoparticles through electrostatic interaction and the formation of hydrogen bonds with calcium ions on the enamel surface. Moreover, the hydrogen bonds formed between polymer molecules provide a coating layer that protects the enamel surface from the erosive effects of the acid.

The great decrease in DIAGNOdent scores for the Profluorid intragroup comparison indicating enhanced remineralization of the initial lesions over different follow up periods, this could be as a result of the transient reservoir of concentrated fluoride ions that can infiltrate into the hydroxyapatite crystals when it contacts with the enamel surface. The substitution of free fluoride ions for hydroxide ions reduces the volume of

apatitic crystals, enhances their stability, and decreases their solubility [5]. These results are in line with Singh et al. [23], who studied the remineralization effect of fluoride toothpaste alone and in combination with fluoride varnish and CPP-ACP plus crème by DIAGNOdent at baseline as well as after 1, 3, and 6 months of usage. The results showed that at different follow-up periods 2 times daily usage of fluoride toothpaste showed no significant impact on WSLs remineralization, while for six months the use of fluoride varnish and fluoride toothpaste twice a day significantly reduced the severity of WSLs.

The decrease in DIAGNOdent readings for the active initial carious lesions in MI Varnish group over follow up periods showed its remineralization potential, this could be attributed to the formation of stable amorphous calcium fluoride phosphate as a consequence of a reservoir of fluoride ions slowly released and interacted with carbonated hydroxyapatite crystals over time, resulting in deeper penetration and the formation of fluoro-hydroxyapatite crystals, the incorporation of fluoride into plaque is enhanced when CPP-ACP is added, which promotes enamel remineralization even more. When CPP-ACP and fluoride are combined (ACFP), they could have a synergistic and improved effect on enamel remineralization [21], this synergistic effect was explained by Singh et al. [23], when plaque bacteria create acids, the CPP-bound ACP buffers the plaque's pH by dissociating to calcium and phosphate ions. When fluorides are present, the increased calcium and phosphate ions in plaque counteract any pH drop, preventing enamel demineralization, nano-complexes formed of CPP-ACFP which break down when the pH

decreases, causes the release of calcium ions, phosphate ions, and some neutral species, which then penetrate within the subsurface lesion generating fluorapatite. Similar results were reported by Heshmat et al. [27], which reported that CPP-ACFP has a clinically beneficial impact on plaque pH but has no effect on salivary pH.

The intergroup comparison between Profluorid varnish and MI Varnish groups regarding the DIGNOdent readings showed no significant difference between the two groups over the different follow up periods indicating that both materials have the same remineralization efficacy, these results were contradicting with Llena et al. [28], that evaluated the remineralization effect of formulations of the casein phosphopeptide (CPP) to fluoride varnish on enamel WSLs. The results showed that according to the DIAGNOdent readings CPP-ACFP is more effective at remineralizing smooth-surface WSLs than fluoride varnish.

For the Profluorid varnish DIAGNOdent findings were parallel to a study by Du et al. [10], that demonstrated the efficacy of fluoride varnish (5% sodium fluoride) in reversing WSLs, the results showed that WSLs were successfully reversed by the application of fluoride varnish and recommended that it should be included as a routine caries prevention treatment. The explanation for this result is that the varnish has high fluoride concentration than toothpastes and mouth rinses and after application to tooth surfaces, the varnish may remain on the teeth for many hours and release a sufficient quantity of fluoride ion to maintain fluoridation of the surface. Also, the results of the current trial were confirmed with systematic review and meta-analysis by Alrebdi et al. [29], that

evaluated the efficacy of 5% sodium fluoride varnish on the WSLs, results of this systematic review showed that three of the four trials included in this review found that using fluoride varnish improved WSLs remineralization significantly

The Nyvad criteria showed that both MI Varnish and Profluorid were able to arrest 80% of the active initial carious lesions after 1 month and 100% after 3 months, the results showed that there would be no risk for carious lesions to remain active for MI Varnish when compared to Profluorid varnish after 6 months, the current Nyvad results for Profluorid are parallel to results reported by Restrepo et al. [25] that evaluated the efficacy of fluoride varnish in the treatment of active WSLs, Nyvad criteria were used to evaluate the caries assessment, the results of study showed that by the end of the follow-up, 70.58 % of WSLs were classified as inactive with intact surface (NY, score 4) and 29.42 % as active with intact surface (NY, score 1). There was no significant difference among the groups at the end of the study, the fluoride varnish promoted faster remineralization than comparator.

The results of the current study were also confirmed in a systematic review that investigated the effectiveness of CPP-ACP and CPP-ACPF in the prevention and remineralization of WSLs. They included randomized clinical trials that assessed the efficacy of CPP-ACP and CPP-ACPF against placebo and other therapies. The authors found that both CPP-ACP and CPP-ACPF can improve remineralization or reduce the occurrence of WSLs [30].

The null hypothesis was rejected as the fluoride varnish and CPP-ACP

fluoride based varnish proved to have a higher remineralization efficacy when compared to laboratory prepared Gum Arabic varnish.

## 5. CONCLUSION

Under the limitation of the study; it could be concluded that Although Gum Arabic Varnish helped in arresting 85% of the active initial carious lesions, it didn't produce effective remineralization to the lesions at 6 months follow up. Both CPP-ACPF varnish and fluoride varnish showed similar remineralization potential a superior to Gum Arabic Varnish and were able to arrest all the active lesions. The application of fluoride varnish or CPP-ACPF varnish could be helpful in decreasing the incidence of new lesions and preventing further demineralization and enhanced the remineralization of the exciting initial carious lesions.

## 6. RECOMMENDATIONS

Further clinical studies with longer follow up are needed to prove the efficacy of Gum Arabic varnish and also the improvement of aesthetic appearance of the initial carious lesions. Further trials with different concentrations of Gum Arabic could be postulated to prove its remineralization potential.

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