Effect of two application protocols of two remineralizing agents on the shear bond strength of resin composite to artificially caries affected dentin.

Thesis Submitted to Operative Dentistry Department, Faculty of Dentistry, Ain Shams University in partial fulfillment of the requirements of Master degree in operative dentistry.

BY

Hajar Adel Sayed Abdelaal

B.D.S
Faculty of Dentistry,
Ain Shams University, 2011

2018

Dr. Omaima Hassan Ghallab

Professor of operative dentistry department

Faculty of Dentistry,

Ain Shams University

Dr. Mohammed Nasser Mohammed Anwar

Lecturer of operative dentistry

Faculty of Dentistry,

Ain Shams University

First, I would like to express my greatest gratitude to the Almighty **ALLAH,** the one and only**,** who has given me the opportunity, strength, courage and blessing to pursue this work.

I am greatly honored to express my deepest gratitude to, **Dr: Omaima Hassan Ghallab,** professor of operative dentistry department, Faculty of Dentistry, Ain Shams University for her continuous encouragement, humanity, patience, time, endless support and guidance.

I would like to express my sincere thanks and deep gratitude to **Dr. Mohammed Nasser Mohammed Anwar,** Lecturer of operative dentistry, Faculty of dentistry Ain Shams University, for his valuable unlimited guidance, and mentor attitude. I benefited greatly from his experience and knowledge throughout the research work.

I wish to dedicate to this work to

To my mother who always inspires me with her love and prayers

To my father who taught me that hard work is the essential for a successful life.

To my sisters and brothers, without their love, and encouragement, this thesis would not have been possible.

To my lovely friends especially Dr. Passant Sonosy, Dr. Marwah Tahtawy, Dr. Menah Ahmad and Dr. Nesma Ahmad and Dr. Doaa Farag for their help and support

List of tables……...…… I

List of figures……...……..III

Introduction…….……...1

Review of literature…….....3

Aim of the study…….…….....48

Materials and methods…….……...…..49

Results…….……..…...……64

Discussion…….…….……76

Summary and Conclusions…….…….....93

References……..…..……...96

Arabic summary……..…….

List of tables

Table number	Title	page
Table (1)	Materials, composition, manufacturer, and lot number.	49, 50
Table (2)	The levels of the study	52
Table (3)	Interactions between variables of the study for shear bond strength test.	53
Table (4)	Interaction between variables of the study for the microhardness test	53
Table (5)	One way ANOVA for the effect of the variables interaction, (time and type of remineralizing agent) on the shear bond strength of resin composite to an artificial CAD	64
Table (6)	Means and Standard Deviations values for the effect of the periods of application of two remineralizing agents on the shear bond strength of resin composite applied to an artificially CAD.	65
Table (7)	T-test of the effect of remineralizing agents for the same time period and the effect of time periods for the same remineralizing agent on the shear bond strength of resin composite to artificially CAD	65

Table number	Title	Page
Table (8)	One way ANOVA for the effect of the variables interaction, (time and type of remineralizing agent) on the micro hardness of an artificial CAD.	67
Table (9)	Mean and standard deviation values for the effect of the periods of application of two remineralizing agents on the micro hardness of CAD.	68
Table (10)	T-test of the effect of remineralizing agents for the same time period and the effect of time period for the same remineralizing agent on the microhardness of CAD.	68

List of figures

Figure	Title	Page
Figure (1)	Diagram for specimens grouping.	51
Figure (2)	(a): Prepared dentin specimen. (b): dentin specimen in PVC mold. (c): finished dentin Specimen.	55
Figure (3)	a): 2×2mm polyethylene tubule, b): application of adhesive resin on the flat dentin, c): poly ethylene tube placed on flat dentine surface specimen to serve as a mold for resin composite d): Scrapping of excess adhesive resin bond.	58
Figure (4)	a): resin composite microtubule was attached to the dentin surface. (b): final composite specimen.	59
Figure (5)	a) Shear bond strength testing machine. b) chisel attachment.	60
Figure (6)	Digital Vicker hardness tester	61
Figure (7)	Environmental Scanning Electron Microscope	62
Figure (8)	citric acid, PH=4.5	63
Figure (9)	Remin Pro^{R} (Voco-Germany)	63
Figure (10)	MI-paste Plus^{TM} (GC-Japan)	63

Figure	Title	Page
Figure (11)	Single bond^{TM} Universal adhesive	63
Figure (12)	FiltekTM Z250 XT (Nano-hybrid composite)	63
Figure (13)	Bar chart for the effect of the period of application (7 days or 14 days) of two remineralizing agents (Remin Pro and MI paste plus) on the shear bond strength of resin composite applied to an artificially caries affected dentin, positive and negative controls	66
Figure (14)	Bar chart for the effect of the period of application (7 days or 14 days) of two remineralizing agents (Remin Pro and MI paste plus) on the micro hardness of an artificially caries affected dentin, positive and negative controls	69
Figure (15)	ESEM micrograph of non-treated dentin surface, (2500X).	70
Figure (16)	ESEM micrograph of CAD surface was treated by 10% of citric acid showed opened dentinal tubules, (5000X).	70
Figure (17)	ESEM micrograph of CAD surface was treated with MI paste plus for 7 days showed precipitation of minerals on the dentin surface with partial narrowing of dentinal tubules (arrows), (10000).	71

Figure	Title	Page
Figure (18)	ESEM micrograph of CAD surface treated with Remin Pro for 7 days showed precipitation of minerals and formation of mineral globule (arrows), (10000X).	71
Figure (19)	ESEM micrograph of CAD surface was treated with MI paste plus for 14days showed intense precipitation of minerals (arrows), (5000X).	72
Figure (20)	ESEM of CAD surface was treated with Remin Pro for 14 days. It showed partial occlusion of dentinal tubules and formation of globules of mineral (arrows), (10000X).	72
Figure (21)	ESEM micrograph of resin CAD interface showed few resin tags (arrows), (1200X).	73
Figure (22)	ESEM micrograph of resin non-treated dentin interface showed Continuous hybrid layer and resin tags (arrows), (1200X).	73
Figure (23)	ESEM micrograph of resin CAD interface that was remineralized by MI paste plus for 7 days showed a) continuous hybrid layer and resin tags, (1200X). b) partially occlusion of dentinal tubules (arrows), (2400X).	74
Figure (24)	ESEM micrograph of resin CAD interface that was remineralized by Remin Pro for 7 days showed resin tags (arrows), (1200X).	74

Figure	Title	Page
Figure (25)	ESEM micrograph of resin CAD interface that was remineralized by MI paste plus for 14 days showed partially occlusion of dentinal tubules (arrow), (600X).	75
Figure (26)	ESEM micrograph of resin CAD interface that was remineralized by Remin Pro for 14 days showed partially occlusion of dentinal tubules (arrow), (1200X).	75

Caries affected dentin (CAD) is a structure of dentin that is affected by acids, but not contaminated by bacteria. It differs in its chemical, mechanical, biological and physical properties from the intact dentin. Its inter-tubular dentin is porous, has low mineral contents, and low surface energy. CAD has a low micro-hardness value, low cohesive strength, in addition to thick smear layer and high intrinsic wetness. All these factors may have a dramatic effect on the bond strength of the composite restoration to CAD, **(Vaseenon et al., 2011)** [138]**.** The response of CAD to the adhesive system is different from that of the normal dentin. In CAD, etching increases the depth of demineralization leaving unprotected, exposed collagen fibrils which are not totally infiltrated by resin. Matrix metalloproteinase disintegrates these unprotected collagen fibrils, leading to decrease in the durability of the resin-dentin bond, which further decreases the life of bonding restoration. All the previous factors lead to an urgent for improving the quality of the CAD layer in order to overcome the lowering of the bond strength, (**Banasal et al., 2014)** [8].

The adhesion of the tooth structure is one of the influencing factors that are required for the clinical success of esthetic restoration. It decreases the marginal leakage, prevents secondary caries, improves the marginal seal, and enhances the mechanical retention of esthetic restoration. So, the treatment of CAD layer through remineralization is very important to improve its bond strength and restore the decrease in the mineral content, (**Vaseenon, et al., 2011)** [138]. Many types of research were carried out to remineralize the CAD layer by using external remineralizing agents or by

applying an adhesive system or a temporary filling that contains a remineralizing agent, (**Kamozaki et al., 2015)** [55]**.**

Today, companies compete to produce remneralizing agents which release Ca, $PO_{4,}$ and fluoride in order to enhance the remineralization of tooth structure and treat the early dental carious lesions. Casein phosphopeptide stabilizes amorphous calcium phosphate (CPP-ACP) (Recaldent), allowing the stabilization of high concentrations of calcium and phosphate ions with fluoride at the tooth surface, thus enhancing remineralization. Another new product is known as Remin Pro (VOCO, Germany) which is supplied as a remineralizing tooth paste that contains hydroxyapatite, fluoride, and xylitol. Fluoride and hydroxyapatite can be effective in hypersensitivity treatment, decreasing the demineralization process, and stimulating remineralization. Xylitol acts as an antibacterial agent, **(Kamash et al., 2013)** [55] and (**Voco et al., 2010)** [140].

There is no suffecient data in the literature about the effect of Reminpro and MI paste plus on the bond strength and the microhardness of the CAD and also whether the time of application has a synergistic effect on their action or has no significant effect. Therefore, it is necessary to investigate the effect of these remineralizing agents (MI paste plus and Remin Pro), the duration of application, and the application techniques on the bond strength of CAD to the composite resin restoration.

Caries Affected dentin (CAD):

Dental caries is a cyclic process, including demineralization and remineralization that occurs alternatively depending on the condition of the oral environment. The demineralization process occurs in the two steps. First, the cariogenic bacteria metabolize the carbohydrates, leading to organic acid production that can attack the tooth surface. Second, the organic acid disintegrates the mineral crystal causing calcium and phosphate ions release into the oral cavity. The demineralization process is delayed by remineralization which can prevent the occurrence of a cavity. Natural Remineralization is a repairing process in which there is a mineral ion retaking to the decalcified or demineralized region. It includes the precipitation of the ions of calcium and phosphate that are found in saliva. In the presence of fluoride in the tooth surface the precipitated minerals go deeper into the surfaces, and then into the subsurface, leading to the regrowth of the hydroxyappetite from the remnants of the preexisting crystal. The substitution of hydroxyl ions by fluoride ions in hydroxyapatite results in the formation of fluoroapatite (FAP) crystal that is identified by the formula (Ca_5 (PO_4) 3F), **(Featherstone, 2008)** [34] and **(Pitts et al., 2016)** [97].

Dentin caries was classified into two different layers, caries-infected dentin (CID) and caries-affected dentin (CAD). CID is a superficial layer where there is a disintegration of the mineral matrix or crystal. This layer is full of pathogenic bacteria and bacterial by-products. Due to the high