ORIGINAL RESEARCH

Comparative evaluation of tensile bond strength of seventh generation dentin bonding agent on teeth of different age groups – An Invitro Study

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ABSTRACT

Introduction: Aesthetic restorations on tooth surface involve the use of composites to enhance the smile of a patient. Dentin bonding agents play a vital role in improving the bond strength between the composite and the tooth surface. The evolution of several generation of bonding agents reduced the need for extensive tooth preparation and simplified the bonding mechanism. It reduced the rate of failure of adhesive system and improved the success of composite laminate veneer restorations.

Objective: To compare the bond strength of seventh-generation bonding agent with dentin of different age groups.

Methods: Non-carious intact 55 teeth were grouped into five; Group A-16 to 20 years, Group B-21 to 30 years, Group C- 31 to 40 years, Group D- 41 to 50 years, Group E- 51 to 60 years. They were mounted on acrylic blocks and occlusal surface was prepared by sectioning it perpendicular to the long axis of the tooth. Composite build-up with seventh generation bonding agent was adapted and cured on the prepared occlusal surface. After thermocycling, the specimens sere tested using a universal testing machine to calculate the microtensile bond strength.

Results: The highest mean value was exhibited among Group E the highest (34.8182 ± 7.74362), and the mean value of group A; the lowest (21.1818 ± 5.23103) among all tested groups. ANOVA test was used to check the microtensile bond strength among groups and TUKEY POSTHOC was used to compare the tensile strength between groups.

Conclusion: The dentin of old age group demonstrated the highest bond strength.

Keywords: Bonding agent, Composites, Dentin, Adhesion

INTRODUCTION

Composite laminate veneers are bonded to the dentin in most clinical scenario, which is a structure of hydrated biological composite and made up of approximately 70 percent of inorganic material, 18 percent of organic material, and 12 percent of water. It includes the peritubular and intertubular matrices, that are mineralized; the dentinal tubules with odontoblast

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process and the organic material in the peri-odontoblastic space. The predentine, which is unmineralized, lines the pulpal side of the dentine. These structural units are distributed based on their stage of development[1]. The changes related to age are gradual enlargement of intratubular mineral deposits and peritubular dentin resulting in narrowing or complete obliteration of dentinal tubules[2]. Moreover, mineralization is increased in the mature teeth and the organic content such as mucopolysaccharides is altered. At restorative procedures, the change in morphology and composition of permanent teeth in elderly patients may affect the acid etching and resin infiltration in bonded esthetic restorations[3].

An etchant, 37 per cent of phosphoric acid is used to remove a layer of enamel accompanied by a selective dissolution of hydroxyapatite crystals found in prismatic and inter-prismatic enamel. Etching increases the energy, surface area and microscopic roughness of the enamel to facilitate the bonding agent to infiltrate by capillary penetration. Etching and rinsing are accompanied by micro and mechanical tags that are responsible for the micromechanical interlocking of the bonding agent to effectively protect the esthetic restoration margins and avoid the deterioration of the bonding agent[4].

Dentin bonding agents are resin monomers composed of hydrophilic and hydrophobic groups. Hydrophilic groups increase the wettability to the dental hard tissues and the hydrophobic group allows copolymerization and interaction with the composite restorative material, creating a hybrid layer. A hybrid layer is the inter-diffused resin dentin zone which helps in micromechanical retention of the composite restoration. Through the years, various several generations of bonding agents have evolved and it has been used to improve the bond strength between the restorative material and the tooth surface. The seventh-generation bonding agent is a self-etch adhesive which includes etchant and bonding agent in a single container to eliminate the need for two-step self-etching system. These bonding agents have water incorporated in their formulations which tend to hydrolyse and chemically break down the molecules. The shear bond strength of the seventh-generation bonding agent is 25 MPa and claims to withstand the occlusal forces to prevent fracture of the restoration thereby enhancing the longevity of the restoration[5].

The aim of our study was to evaluate the tensile bond strength of the seventh-generation bonding agent to human dentin of varied age using a universal testing machine. The null hypothesis states that there are no changes in bonding mechanism among varied age groups while using a 7^{th}-generation bonding agent.

MATERIALS AND METHODS

55 non-carious intact and completely erupted, freshly extracted third molars were collected from human participants aged between 16 to 60 years and disinfected in 0.5% thymol for 24 hours and stored in distilled water for one week as it done in the previous study by Gianni et al[4]. Carious, fractured, hypoplastic and partially erupted teeth were excluded from the study. The samples were divided into five groups of each 11 samples based on the age of the patient; Group A-16 to 20 years, Group B-21 to 30 years, Group C-31 to 40 years, Group D- 41 to 50 years, Group E- 51 to 60 years.

The specimens were prepared by sectioning the occlusal surface of the enamel perpendicularly to the long axis of the tooth using a low-speed diamond saw under copious water to expose areas of mid-coronal dentin. The sectioned dentin surfaces were wet-polished with 600-grit silicon carbide paper and the samples were ultrasonically treated for 180 secondsto remove the hard tissue debris. The samples were dried and the exposed dentin surfaces were etched for 20 seconds using 37% Orthophosphoric acid, rinsed for 20 seconds with water and air-dried. The seventh-generation universal bonding agent (Tetric N Bond Universal, Ivoclar Vivadent) was applied in a single coat over the etched dentin surface using the

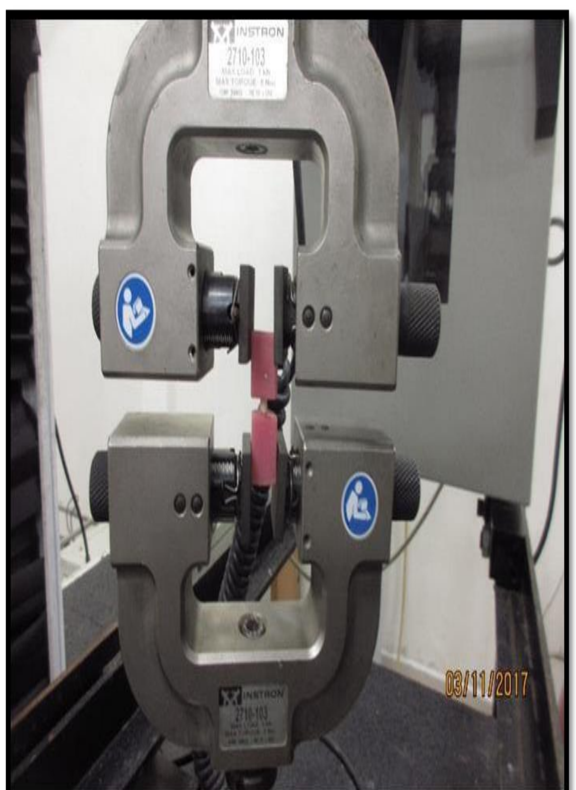

FIG:1-TESTING OF MICROTENSILE BOND STRENGTH

FIGURE:2-FRACTURED SPECIMENS

applicator micro brushes, air dried and cured with a light cure composite unit (Cu100A) for 20 seconds. Tetric N Ceram (Ivoclor Vivadent, Liechtenstein) was incrementally applied to build up a 5-mm veneer and each increment was light cured for 40s with a light-curing unit (Cu 100A). The finishing and polishing of the specimens were done using a super snap kit (Shofu, Kyoto, Japan). The specimens were then stored in water at 37˚c for 24 hours and were sectioned mesiodistally into thin sections with approximately 1 mm in thickness along the long axis of the tooth, using a low-speed diamond disc (Addler) under water. Each specimen was further vertically sectioned buccolingually by 1mm in thickness. Prior to mounting in acrylic blocks, the samples were subjected to `thermocycling for 1000 cycles in a cyclic chamber, stored in distilled water maintained at 5° C and 55° C with a dwell time in each bath for 30s to prevent adverse consequences due to different coefficients of thermal expansion between the tooth and the composite. The transfer time was 5–10 seconds. An impression of the sectioned specimen measuring 1x1x1cm was made to fabricate a positive replica using self-cure acrylic (DPI) resin. Both the sectioned specimen and the positive replica were fixed together using cyanoacrylate glue to test for tensile strength failure by universal testing machine at a crosshead speed of a 0.5mm/min. (Fig:1) (Instron3382 Germany). The load at failure divided by the cross-sectional area at the site of fracture (Fig:2) for each specimen was used to calculate the microtensile bond strength in MPa. The data were statistically analyzed by one-way ANOVA and individual bond strength values were correlated with the tooth age by linear regression.

RESULTS

Table1 shows the microtensile bond strength data of the five groups (Group A; 16- 20, Group B; 21-30 years, Group C; 31- 40 years, Group D; 41-50 years, Group E; 51- 60 years). Table 2 shows the descriptive statistics of the data, the mean value of group E; the highest (34.8182 ± 7.74362), and the mean value of group A; the lowest (21.1818 ± 5.23103) among all tested groups. Figure 9 shows the progressive increase in mean microtensile bonds strength from Group 1 to Group5.

(Group1<Group2≤Group3≤Group4≤Group5).

The ANOVA test was done to compare the mean values among the groups. The results of ANOVA show statistically significant values for comparison of mean microtensile bond strength among the 5 groups ($p<0.05$). The TUKEY POSTHOC test was done to compare the mean values between 2 groups which shows statistically significant values only when the values of Group 1 was compared to the other groups ($p<0.05$)

DISCUSSION

The null hypothesis was rejected and dentinal changes due to aging had an influence on the bond strength. There have been variations over the past 45 years in dentin bonding systems; application, chemistry, technique, mechanism and effectiveness[6]. The evolution of bonding agents has increased as the demand for bonded esthetic restorations has continued to increase. But, the altered dentinal morphology and composition of elderly may affect the results of acid etching or infiltration of resin monomer [7]. Tetric N-Bond Universal, a single component light-cured 7th generation adhesive for direct and indirect bonding procedures[8]. It is a combination of monomers of hydrophilic (hydroxyethyl methacrylate/HEMA), hydrophobic (decandioldimethacrylate/D3MA) and intermediate (bis-GMA) nature that allows to reliably bridge the gap between the hydrophilic tooth substrate and the hydrophobic resin restorative, under a variety of surface conditions[9]. The low levels of acidic monomer are "mild-etching" adhesives with a pH between the range 2.5 – 3.0 and the self-etch mode will infiltrate into dentin-producing high-quality interfacial morphology[10]. Hence 7th generation Universal bonding agent was used due to the comparable bond strength in different bonding conditions.

In our study, the samples were stored for a week since Santana et al stated that research using micro tensile bond strength to dentine testing should use tooth storage for no longer than 1 month and that the storage times of 7 and 30 days produced no significant difference in μTBS[11]. A bonding area of 1mm square was used to assess the micro tensile bond strength of Tetric N Bond Universal. The micro tensile test

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measures the bond strength and the modulus of elasticity of the mineralized and demineralized dentin more effectively than the other macro methods[12].
It is observed that the micro tensile bond strength values were higher with older subjects (Group E 51-60 years). The probable reason for this could be the incorporation acid etching procedure prior bonding. The possible explanation for achieving higher tensile bond strength values can be explained by the inherent properties of dentine[13]. Dentinal tissue is rich in
-oxygen and water that prevent and hamper the bonding mechanism. (Nakabayashi 1991) In aged dentin, the tubules and the peri-tubular dentine are calcified and hence indirectly reduce the moisture content of the dentin. Hence moisture as a deterring factor of dentin bonding is absent in ageing dentin[14].

Nakajima, et al. also showed much higher bond strength values to dentin of old molars (45-69 years) than to young molars (17-25 years). On the contrary, several authors have proved that the age or depth of dentin, adhesion to glass ionomer and different bonding systems did not show as great an influence on bond strengths with the newer type of bonding systems[15]. Our study also demonstrated that groups B, C, D, E demonstrated the maximum tensile bond strength when compared to group A which was statistically significant. There was a progressive increase in the mean micro tensile bond strength values from groups B through E with no statistically significant difference between the groups, proving that age related dentinal changes play a vital role in adhesive properties[16].

Table 1: The microtensile bond strength values obtained from the study for groups I to V.

Sample No	MICROTENSILE BOND STRENGTH (MPa)				
	Group I 16 TO 20 YEARS	Group II 21 TO 30 YEARS	Group III 31 TO 40 YEARS	Group IV 41 TO 50 YEARS	Group V 51 TO 60 YEARS
1	28	20	38	42	26
2	14	41	23	30	43
3	16	21	35	20	29
4	25	37	26	39	41
5	24	23	34	27	42
6	18	28	32	38	38
7	23	25	25	29	37
8	17	39	33	37	29
9	26	30	27	23	31
10	15	27	32	41	22
11	27	42	22	31	45

Table 2 Descriptives

Tensile Bond Strength in MPa

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
16 to 21 years	11	21.1818	5.23103	1.57721	17.6676	24.6961	14.00	28.00
22 to 30 years	11	29.7273	5.33087	1.60732	26.1459	33.3086	22.00	38.00
31 to 40 years	11	30.2727	8.13746	2.45354	24.8059	35.7395	20.00	42.00
41 to 50 years	11	32.4545	7.43456	2.24161	27.4599	37.4492	20.00	42.00
51 to 63 years	11	34.8182	7.74362	2.33479	29.6159	40.0204	22.00	45.00
Total	55	29.6909	8.10321	1.09264	27.5003	31.8815	14.00	45.00

LIMITATIONS OF THE STUDY

Further next upsurge is to traverse and explore the resin infiltration into dentinal tubules, analyse the resin-dentin interface and to probe the modes of failure using Scanning Electron Microscopy.

CLINICAL IMPLICATIONS

Thus, the inference from the study is the seventh-generation bonding resulted in better adhesion among the oldest age group. It resulted in reduction in the failure rate of the restoration and also improved the bond between the restoration and the dentin interface which ultimately increased the success of the restoration.

CONCLUSION

It is concluded that the tensile bond strength increases with age and among the five tested groups; the youngest age group demonstrated the lowest tensile bond strength values and the oldest age group demonstrated the highest tensile bond strength values.

CONFLICT OF INTEREST

There is no conflict of interest among the authors.

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