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Effect Of Different Surface Treatment And Different Wire On Composite Wire Bond Strength

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Abstract

Dental trauma has become a frequent emergency in children and adults alike. Dental splinting after traumatic tooth injury is needed to stabilize subluxated. Luxated, avulsed and root fractured teeth. The current study was undertaken to evaluate the suitable method of enhancing the wire-composite bond strength of dental splints using different wire surface treatments. The results of the study indicated that sandblasting the positions of stainless steel wires embedded in composite resin enhanced the strength of the wire-composite bond for both the types of the composite material i.e. light activated and chemical activated.

INTRODUCTION

Splinting therapy may be applied with bonded external appliances, intracoronal appliances or indirect caste restorations to connect multiple teeth together with the goal of improving bond stability. Unstable teeth may be due to a lack of periodontal support from bone loss, a lack of support from tooth loss, or the need to splint abutment teeth to support pontics. Dental splinting after traumatic tooth injury is needed to stabilize subluxated, luxated avulsed and root fractured teeth[1]. Rigid dental splinting has been the treatment of choice until the 1970's which were based on the principles of bone fracture immobilization in which total immobility improves healing without callus formation[1]. Indications for splinting are mobility of teeth that is increasing or impairs patients comfort, migration of teeth, or prosthetics where multiple abutments are necessary. Before considering splitting the etiology of the instability must be identified[2]. Most of the failures of this wire-composite splint occur at the wire composite resin interface. Different methods of increasing the bond strength between composites and metals were through mechanical retention methods like roughing of metal surface, undercuts, microretention methods like tinplating, sand blasting and electrolytic etching and chemical adhesion though the use of metal bonding agents[3,4,5]. Thin flexible wires have been recommended for wire composite splint[6]. Two types of composite materials have bee advocated for the wire composite splint[7]. This study was to evaluate the suitable method of enhancing the wire composite bond strengths of dental splints using round (0.12”) and rectangular wire (0.17” x 0.28”) surface treatments.

MATERIAL AND METHODS

The study sample consisted of 150 maxillary incisors (extracted teeth) from the oral and maxillofacial surgery Govt. Dental College Postgraduate Institute of Medical College, Rohtak (Haryana) embedded in acrylic blocks (Dentsply) in test groups of 15 samples each. The test groups were different wire surface treatments like sand blasting and metal primer, sandblasting only, metal primer only and no surface treatment. Two different types of composite materials such as light activated (Gluma) and chemically activated composite material (Rely-9-bond) were tested on 0.12” round and 0.17”x0.28” rectangular wires for the different wire surface treatments. Before bonding, the facial surface was cleaned with distilled water to remove debris and dried with absorber paper. The apical 1/3rd of the roots were sliced with a diamond disc (AVCO). The mounting of the teeth was done using a split rectangular steel box and tooth was stabilized with self care acrylic resin (Dentsply). The tooth surface was covered with adhesive tape expect for bonding site (4.5mm). This was done to have a uniform etching and bonding area for all the test samples. To consistently place the wire within the composite resin, a standard splint acrylic template was made. The template had a round well of 4.5mm diameter and 1.5mm depth with uniform 12.5mm of composite bonding surface area.

A slot for the wire extended from the end of the wall to end of the template. The length of slot was 8cm and width of the slot was 2mm more than the diameter of each of the test wire. The well ensured approximately 2mm of composite over the wire, placing the wire as close to the tooth surface as possible while still surrounding it with the composite resin. The test sample was placed on a flat surface along with the aligning which aligned as well as stabilized the bonding template over teeth surface. Acid etching and bonding procedure for both the test composite resins were done following manufacturer's instructions. The wires were sand blasted with 75 microns aluminum oxide at pressure of 100 psi for 10 seconds, resulting in 8mm of the wire etched to a dull finish. The alloy primer was applied directly to the wire surface with a brush for 10 seconds and dried for 10 seconds. The wires were immediately bonded to the composite resin. The cured samples were placed in distilled water, stored in an incubator at 37°C for 48 hours and then thermocycled between 4°C and 60°C for 100 cycles with a time in each thermal both of one minute[8]. After thermocycling, the samples were further returned to the incubator for storage before testing 24 hours later. Testing of samples was done with a Leyods universal testing machine at a cross head speed of 3mm per minute. The test samples were placed in the lower jaw of machine and the wire was pulled along its long axis by the testing machine until the wire was fully dislodged from the composite resin. The force needed to dislodged the wire was recorded (converted into Mpa by using surface area of wires).

The entire data collected was subjected to statistical an analysis by using computer software package SPSS.

OBSERVATIONS AND RESULTS

Figure 1

Table 1: Mean Bond Strength Of The 0.12" (Round) Wire-Composite Interface

Sr. No.	Surface Treatments	Chemically (Mpa) activated Mean±SD	Light activated Mean±SD
1	Sandblasting	289.32±0.38	212.03± 0.22
2	Metal Primer only	32.89±0.36	26.89±0.26
3	Sandblasting and Metal Primer	253.12±0.32	214.23±0.23
4	No Surface Treatment	11.62±0.42	9.63±0.24

Figure 2

Table 2: Mean Bond Strength Of The 0.17" X 0.028" Wire-Composite Interface

Sr. No.	Surface Treatments	Light activated Mean±SD	Chemically activated Mean±SD
1	Sandblasting	277.35±0.38	193.45±0.23
2	Sandblasting and Metal Primer	242.12±0.46	25.43±0.27
3	Metal Primer only	29.42±0.26	18.57±0.22
4	No Surface Treatment	10.62±0.29	8.52±0.21

$P<0.05$

Different surface treatments of wires in both light activated and chemically cured composite resin were significantly different from each other ($p<0.05$) with higher values for sand blasting followed by sand blasting and metal primer, metal primer only and no surface treatment. We obtained the lowest value. Further '+' test revealed that all the surface treatments of light activated composite resin for all the different types of wires had higher wire composite strength than chemically activated composite material.

DISCUSSION

Occasionally the dentist may have the opportunity to reattach the fragment of a fractured tooth using resin and bonding techniques. This procedure is atraumatic and seems to be ideal method of restoring the fractured crown. Dentoalveolar injuries like avulsion and luxation require splinting for stabilization of the displaced teeth. Thin flexible wires have been recommended for the wire composite splint[6]. Different surface treatment has been tested on metals to enhance the bond strength of the composite to methods[4,5]. Studies have proven that sandblasting enhanced the bond strength between composite resin and metals by at least three hundred percent[9]. Claims have also been made that adhesion promoters (Metal primers) can also increase the metal composite bond strength[5]. With both, light and chemically activated, sand blasting of round, rectangular stainless steel wires provided the strongest wire composite surface. The bond strengths of 289.32 mpa (0.12" round) and 277.35mpa (0.17x0.28" rectangular wire) was significantly higher than other surface treatment. The observed values were comparable with studies on resin to metal bonding where similar results have been obtained[3].

Oesterle[9] reported that bond strength for sand blasted 0.030" round wire (246.1mpa) which were significantly higher than control wires (10.1). Surprisingly the application of metal primer to sand blasted wire actually decreased the bond strength of the joint (246.10mpa) when compared with only sandblasted wires (268.45 mpa). This might be due to the metal primer marking the microretention effects of sandblasting, thereby significantly lowering the bond strength. Studies on bonded retainers have reported of lower bond strength for the wire composite interface on using a combination of sand blasting and metal primer (213.5mpa) when compared with sandblasting alone (246.1mpa)[9]. Use of metal primer alone on the wire resulted in an increase in the wire-composite interface bond straight (32.89mpa) when compared with no surface treatment (11.62mpa). Previous studies on composite to metal bonding, mediated by metal adhesive promoters have indicated that the bond strength obtained with metal primers (Fusion, primet, ABC Bond) were generally not high[5].

Metal primer alone and no surface treatment had significantly lower wire composite interface bond strengths when compared with sandblasting. It give that micromechanical retention provided by sand blasting significantly enhanced the wire composite interface bond strength when compared with chemical adhesion techniques like the use of metal primers. Student's ‘t' test revealed that all the wire surface treatments of light activated composite resin had higher wire composite interface bond strength than chemically activated composite material in 0.012” and 0.017” x 0.028” wires. This might be related to light activated composite resin's mechanical properties, particularly tensile strength and fracture toughness.

CONCLUSION

Sand blasting the portions of the wires embedded in composite resin enhanced the strength of wire composite bond for both types of composite materials. Light activated composite resin had higher wire composite material.

Thus, when using composite material for the wire composite splint, it is desirable that some surface treatment of the wires should be done to enhance the wire composite bond strength.

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