The effect of waterlase laser and herbal alternative, green tea and Salvadora Persica (Siwak) extract on push-out bond strength

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ABSTRACT

Background: The bond strength of root canal sealers to dentin was important for maintaining the integrity of the seal in root canal filling in both static and dynamic situations. In a static situation, it should eliminate any space that allowed the percolation of fluids between the filling and the wall while in a dynamic situation; it was needed to resist dislodgement of the filling during subsequent manipulation.

Materials and Methods: Forty mandibular premolars were selected for this study. All canals were instrumented using ProTaper rotary instruments. Instrumentation was done with copious irrigation of 5.25% sodium hypochlorite. Roots were randomly divided into four groups according to the type of cleaning and method of root canal irrigation (ten teeth for each group): Group A. The root canals were irrigated with 5 ml of 17% of EDTA for 1 minute and 5 ml of 5.25% NaOCl. Group B. Cleaning with waterlase laser. Group C. The root canals were irrigated with 5 ml of 5mg/ml of siwak (Salvadora persica) extract for one minute. Group D. The root canals were irrigated with 5 ml of 5% of green tea (camellia sinensis) extract for one minute. All groups were rinsed with distilled water and then obturated with cold lateral condensation technique and i Root sp sealer (Bioceramic sealer, the roots then stored in moist environment at 37°C for one week. Three horizontal sections were prepared at a thickness of 1 mm ±0.1 in the apical, middle and coronal parts of each root. The test specimens were subjected to the push-out test method using a Universal Test Machine that carried 1-mm, 0.5- mm and 0.3-mm plungers for coronal, middle and apical specimens, respectively. The loading speed was 0.5 mm/ min. The computer showed the higher bond force before dislodgment of the filling material. These forces were divided by the surface area to obtain the bond strength in MPa.

Results: In all groups the mean value of push-out strength was greatest in apical area and least in coronal area and the middle area was in between, except in Waterlase the middle area showed the least mean push-out strength.

Conclusion: Herbal extracts used in this study (Siwak and green tea) can be used safely as an intra-canal irrigant for smear layer removal with efficiency that is comparable with conventional synthetic materials (EDTA) and more complicated methods (Waterlase).

Key words: Waterlase, Siwak, Green tea, push out test. (J Bagh Coll Dentistry 2014; 26(2):1-6).

INTRODUCTION

The bond strength of root canal sealers to dentin was important for maintaining the integrity of the seal in root canal filling in both static and dynamic situations. In a static situation, it should eliminate any space that allowed the percolation of fluids between the filling and the wall while in a dynamic situation; it was needed to resist dislodgement of the filling during subsequent manipulation [(1)].

The physical properties necessary for this function include adaptation and adhesion of the filling material to the root canal wall, because gutta-percha does not directly bond to the dentin surface and ideally, the sealer should be capable of producing a bond between core material and dentin wall [(2)].

Cleaning of both the root canal and the dentinal tubule system, as well as proper filling of the canal, are essential procedures for the success of root canal treatment. Even when treatment is adequate, failure may occur within the canal. Thus, disinfection and shaping of the canal with a combination of chemical agents and endodontic instruments play an important role in the success of endodontic therapy [(3-5)].

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Sodium hypochlorite (NaOCl) has been widely used as an irrigant since its introduction in endodontics by Walker in 1936. Sodium hypochlorite solutions require careful handling and several factors are associated with its safety concerns. The main disadvantages of sodium hypochlorite are unpleasant taste, high toxicity, corrosive to instruments, inability to remove smear layer and reduction in elastic modulus and flexural strength of dentin [(6,7)].

Herbal or natural products have been used in dental and medical practice for thousands of years and have become even more popular today due to their high antimicrobial activity, biocompatibility, anti-inflammatory and anti-oxidant properties [(8)].

Green tea made solely from the leaves of camellia sinensis and the antimicrobial activity is due to inhibition of bacterial enzyme gyrase by binding to ATP B sub unit. Green tea exhibits antibacterial activity on E-faecalis plaknotic cells. It is also found to be a good chelating agent [(9-10)].

Salvadora persica (Miswak, Siwak) was chewing sticks contain trimethyl amine, salvadorime chloride and fluoride in large amounts. Fifteen percent alcoholic extracts of it has maximum antimicrobial action. It can be used as a substitute for sodium hypochlorite and chlorhexidine as root canal irrigant [(11- 13)].

The remaining of smear layer after rotary or hand instrumentation not only contains infected tissue, but can seal infection within dentinal tubules. Scanning Electron Microscopy shows how treatment with Waterlase Radial Firing Tips (RFT) leaves canal walls free of smear layer, and opens dental tubules, allowing YSGG laser energy to penetrate and destroy bacteria.

This study is conduct to compare the effect of newer method waterlase laser to remove smear layer and usage of herbal extracts, green tea and Salvadora persica (siwak), as irrigation solution with standardized method 17%EDTA on push strength of bioceramic sealer.

MATERIALS AND METHODS

Sample preparation

Forty freshly extracted mandibular premolars with straight single roots and close apices were used in this study. After extraction, all teeth were stored in 0.1% thymol solution at room temperature, root surfaces were verified any defects and cracks.

The length of root was determined by digital calliper and marker to 14 mm and by using diamond disk the root sectioned perpendicular to its long axis to provide straight line access for canal preparation and filling procedure**.** The pulpal tissue was removed by using barbed broach and copious amount irrigation of 5.25% NaOCl. The exact location of apical foramen and potency of canals were verified by insertion of No.15 K file into canal until it was visualised at apical foramen. The working length was established by subtracting 1mm from this measurement.

The root canal was flooded with 5.25%NaOCl and instrumented by protaper rotary system (SX_F3) at speed 500rpm and 1 N/C torque.

Sample grouping

The roots were randomly divided into four groups (n=10) according to type of cleaning and method of root canal irrigation.

Group A. The root canals were irrigated with 5 ml of 17% of EDTA for 1 minute and 5 ml of 5.25% NaOCl followed by 5ml distilled water.

Group B. Cleaning with waterlase laser.

First step use RFT2 to clean apical and coronal 2/3 partially. After place the tip into hand piece select setting, fill the canal with sterile solution and then insert RFT2 in root canal 1mm short of the apex. Activate laser and start moving the tip coronally at approximately 1mm/S and maintain in contact with the side surface of canal wall coronal and apical movement, repeat this manner twice to ensure canal has been cleaned.

The second step use RFT3 to clean the coronal 2/3. Adjust the tip to about 9 mm and clean in the same manner of first step.

Group C. The root canals were irrigated with 5 ml of 5mg/ml of siwak **(Salvadora persica)** extract for one minute followed by 5 ml distilled water.

Group D. The root canals were irrigated with 5 ml of 5% of green tea **(camellia sinensis)** extract for one minute followed by 5 ml distilled water.

Salvadora Persica (miswak or siwak) preparation

Sticks of siwak *(S. persica)* were incubated at 37°C for 24 hrs. Each stick was cut with sharp knife to small pieces then ground with food grinder into very fine powder**,** 250 gm of *S. persica* powder was taken and put in a beaker to which one litter of sterilized distilled water was added. T he liquid was left to boil at 100°C for 15 minutes in closed container. After bench cooling, the liquid was filtered using filter paper (No.1), and solution left to dry in an incubator at 37°C for 24 hrs, to allow complete evaporation of water and obtain powder of miswak. The powder was collected and kept in tightly closed glass container and kept in refrigerator until use [(14)].

Camellia sinensis (green tea) preparation

Five grams of the selected dry green teas leaf, steeped for 1.5- 2 minutes in 100 ml of distilled water. The coolest brewing temperature was below 70˚C.The mixture was purified to obtain the 5% concentration solution of green tea [(15)].

After irrigation all samples were obturated by cold gutta percha (lateral condensation technique) and I root sp sealer (Bioceramic sealer). The canal of each root was dried with paper point size F3. The master cone of gutta percha size 30 was adjusted to working length with tug back. After remove the syringe cap, attached an intra canal tip securely. The flexible intra canal tip can be bent to facilitate access. Insert the tip of the syringe into deepest part of root canal, gently and smoothly dispense I root sp sealer into the apex of root canal by compressing the barrel of the syringe and continue filling the root canal while withdrawing the intra canal tip and then the master gutta percha cone was inserted to correct position. The previously checked finger spreader size 20 was inserted between master cone and the canal wall used firm pressure to within (1-2mm) from working length.

When spreader no inter more than 2mm, access gutta percha was removed with heated instrument to level 1mm higher than the coronal end of the root and vertically condensed with root

canal plugger so gutta percha was obturated the entire canal up to canal terminus.

The gutta-percha was removed at 1 mm below the orifice, and the canal orifice was sealed with glass ionomer cement to serve as a barrier to the ingress of fluids. All obturated roots of all groups were wrapped in saline moistened gauze in closed plastic vial allowing the sealer to set for 7 days at 37°C in an incubator [16,17].

After the storage period, the roots were embedded in clear orthodontic resin. Metal mould (length 70mm, width 60mm and height 30mm) containing three cylindrical moulds of (diameter 12 mm * height 25mm) were loaded with freshly prepared acrylic. With the aid of dental surveyor the roots would be centrally located within the acrylic blocks and ensure that the sectioning would be perpendicular to the long axis of the roots, the metal mould loaded with the freshly prepared acrylic, the rod of the surveyor with the root fixed on its face was pushed into the acrylic paste with gentle pressure to allow the complete embedding of the root into the acrylic and to allow the escape of the excess material [18]

The material was allowed to cure under cooled water 20°C, which was necessary to compensate for the anticipated rise in the temperature of the samples subsequent to the exothermic curing reaction of the cold cure resin. The acrylic moulds were allowed to cure completely for at least 30 min as recommended by the manufacturers.

After complete curing of the acrylic mould, the metal mould was open. The excess acrylic was cut off using diamond disk. The roots were horizontally cut with flow of cold water (19-25°C) to minimize smearing. To get three sections of 1mm in thickness coronal, middle and apical, the cuts were made at 1,5,8 mm from coronal reference point respectively.

Push-out test was performed by applying a compressive load to the apical aspect of each slice via a cylindrical plunger mounted on Tinius-Olsen Universal Testing Machine managed by computer software.

Samples were examined under the Nikon metallurgical microscope (magnification 50X) and pictures of both sides of each section are taken with digital camera which was connected with microscope, and measurements calculated using LUCIA G software analysis program. The diameter of both apical and coronal side of the section at each level was obtained from which the radius was calculated.

The obturated area of the section at each level was measured from the apical side to determine the size of punch pin. Three different sizes of punch pins were used; (1 mm, 0.7mm, and 0.3mm) diameter for the coronal, middle and apical slices respectively. The punch pins should provide almost complete coverage over the main cone without touching the canal wall and sealer [16,19].

Each section was placed on perforated metal base designed by the researcher; the diameter of holes about 3mm to provide clearance for the obturating material when it dislodged from the tooth slice.

The sections were placed above the metal base with its apical direction upward and the coronal direction downwards because the load should be applied to the apical aspect of the root section and in an apical–coronal direction. The root filling in each section subjected to loading using a universal testing machine.

Loading was performed on microcomputer electrical control universal testing machine (WDW50) at a speed of 0.5 mm / min in an apical-coronal direction until the first dislodgment of obturating material and a sudden drop along the load deflection. The punch was positioned so that only contacts the core filling material and avoided contact with the sealer and root canal walls [16].

The maximum failure load was recorded in Newton (N) and was used to calculate the push-out bond strength in megapascals (MPa) according to the following formula [8]:

Push-out bond strength (MPa) = Maximum load (N)/ Adhesive area of root canal filling (mm^2)

The adhesion (bonding) surface area of each section was calculated as: $(\pi r1 + \pi r2)*L$.

L was calculated as $\sqrt{(r1 \quad r2)^2 \mid h\hat{}2}$

π = 3.14; r1 = coronal radius, in mm; r2 = apical radius, in mm; h = thickness of section in mm, L = adhesion area.

RESULTS AND DISCUSSION

A predominant trend in modern dentistry has been to search for biocompatible agents, especially those to be used in direct contact with tissues. Accordingly there was growing interest in the use of medicinal plants for therapeutic application. In endodontics because of the cytotoxic reactions of the most of the commercial intra-canal medicaments used and their inability to eliminate bacteria from dentinal tubules, and the complexity and high cost of some techniques like laser, trend of recent medicine attends to use biologic medication extracted from natural plants [21].

Increased adhesion depends on the area of contact, which can be increased by using de-

mineralizing agents. Ethylene diaminetetraacetic acid (EDTA) solution in different concentrations is able to remove the smear layer and expose a large number of dentinal tubules [22].

Comparison of different groups

Table 1 showed the descriptive statistics and groups' difference at each level. At the coronal and apical thirds, ANOVA test showed non-significant differences among the groups. This may indicate that all the groups had the ability to remove smear layer in a comparable values. However at the middle third, there was significant difference between groups and LSD test (table 2) showed that Waterlase laser showed significant difference when compared with herbal extract (green tea and siwak) and 17%EDTA groups. Although Er,Cr:YSGG laser had proven to have the ability of smear layer removal at power of 1.25 watts, it may lead to melting and closure of dentinal tubules which result in reduction of surface area to which Bioceramic sealer may adhere. This might be the reason that Waterlase showed less values of push-out strength [23].

These results come in agreement with study done by Scoop et al. [23] who used SEM to evaluate the effect of Er,Cr:YSGG laser on morphological changes in root canal wall and showed that it had the ability to remove smear layer effectively. Also these results are in line with another study done by Balto et al. [24] on the effect of *Salvadora persica* (siwak) extract on intra-canal smear layer removal and they exhibited that at concentration of 5 mg/ml it was as effective as 17% EDTA in removing smear layer at coronal third.

Table 1: Descriptive statistics and groups differences

Levels	Groups	Descriptive Statistics		Groups differences (ANOVA)	
		Mean	S.D.	F-test	P-value
Coronal	EDTA	3.97	0.16	1.83	0.16 (NS)
	Waterlase laser	4.49	0.73		
	Siwak	4.06	0.30		
	Green tea	4.22	0.71		
Middle	EDTA	4.49	0.33	3.07	0.04 (S)
	Waterlase laser	3.98	0.42		
	Siwak	4.55	0.58		
	Green tea	4.62	0.70		
Apical	EDTA	4.89	0.60	0.07	0.98 (NS)
	Waterlase laser	4.86	0.74		
	Siwak	4.96	0.66		
	Green tea	4.84	0.53		

Table 2: LSD test after ANOVA

Levels	Groups		Mean Difference	P-value
Middle	EDTA	Waterlase laser	0.51	0.037 (S)
		Siwak	-0.06	0.794 (NS)
		Green tea	-0.13	0.583 (NS)
	Waterlase laser	Siwak	-0.57	0.020 (S)
		Green tea	-0.64	0.010 (HS)
	Siwak	Green tea	-0.07	0.772 (NS)

NS: non-significant, S: significant, HS: highly significant

Comparison of different levels

Table 3 showed the descriptive statistics and levels' difference at each group. ANOVA test showed significant differences among different levels within EDTA, Waterlase and siwak. However LSD test (table 4) showed that within EDTA group the difference was significant between all the three areas (coronal, middle and apical), and within Waterlase group the difference only was significant between middle and apical areas, while siwak showed significant difference between coronal and apical areas only. However in all groups the mean push-out strength value was greatest in apical area and least in coronal area and the middle area was in between, except in Waterlase the middle area showed the least mean push-out strength.

These results are attributed to both the type of smear layer removing method and the obturation itself. The cold lateral condensation technique usually produces better obturation apically than middle and coronally because of the matching

between the cross-section of master cone and the instrumented canal. While at the middle and coronal levels, the quality of obturation is totally dependent on the lateral condensation which is less reliable. However during irrigation the needle was inserted into apical area, so that the irrigating solution was more fresh and stronger apically than middle and coronal areas. Hence more effective smear layer removal was in apical area than middle and coronal areas.

In Waterlase, the middle area showed the least mean push-out strength value. This may be due to ledges and zips formation during irradiation of the canal with Er,Cr:YSGG laser that may have adverse effect on the quality of obturation of middle area which result in reduced push-out strength [25].

These results coincided with Scoop et al. [23] whom also stated that smear layer was removed more efficiently from apical than middle and coronal areas. However the result disagreed with Khademi and Feizianfard [26] whom results showed that the middle third of root canal was cleaner of smear layer than coronal third, and the apical third showed the greatest amount of smear layer.

As conclusion; herbal extracts used in this study (Siwak and green tea) can be used safely as intra-canal irrigant for smear layer removal with efficiency that is comparable with conventional synthetic materials (EDTA) and more complicated methods (Waterlase).

Table 3: Descriptive statistics and levels differences

Groups	Levels	Descriptive Statistics		Levels differences (ANOVA)	
		Mean	S.D.	F-test	P-value
EDTA	Coronal	3.97	0.16	12.86	0.000 (HS)
	Middle	4.49	0.33		
	Apical	4.89	0.60		
Waterlase Laser	Coronal	4.49	0.73	4.66	0.02 (S)
	Middle	3.98	0.42		
	Apical	4.86	0.74		
Siwak	Coronal	4.06	0.30	7.01	0.004 (HS)
	Middle	4.55	0.58		
	Apical	4.96	0.66		
Green tea	Coronal	4.22	0.71	2.31	0.12 (NS)
	Middle	4.62	0.70		
	Apical	4.84	0.53		

Table 4: LSD test after ANOVA

Groups	Levels		Mean Difference	P-value
EDTA	Coronal	Middle	-0.52	0.008 (HS)
		Apical	-0.92	0.000 (HS)
	Middle	Apical	-0.40	0.036 (S)
Waterlase Laser	Coronal	Middle	0.52	0.085 (NS)
		Apical	-0.36	0.222 (NS)
	Middle	Apical	-0.88	0.005 (HS)
Siwak	Coronal	Middle	-0.49	0.052 (NS)
		Apical	-0.90	0.001 (HS)
	Middle	Apical	-0.41	0.1 (NS)

NS: non-significant, S: significant, HS: highly significant

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