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EFFECT OF DIFFERENT INTRACANAL MEDICATIONS ON THE PUSH-OUT BOND STRENGTH OF A BIOCERAMIC SEALER TO RADICULAR DENTIN

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ABSTRACT

Aim Appraise the impact of three intracanal medications on the push-out bond strength of a bioceramic sealer to radicular dentin.

Methodology Forty maxillary cental incisors were collected, decoronated, and chemo-mechanical preparation was carried out using ProTaper Next files. According to the intracanal medications, teeth were equally separated into four groups ; Group 1: bioceramic intracanal medicament (Bio-C Temp), Group 2: Glycyrrhizin, Group 3: Calcium hydroxide (CH), and Group 4: without use of intracanal medications (control). Intracanal medicaments were eliminated after one week and all samples were filled using gutta-percha lateral compaction technique and a Bioceramic sealer (Bio-C). After one week of incubation, push-out bond strength was measured at three root levels. The collected data were statistically analyzed and compared using one-way analysis of variance (ANOVA) and Tukey test ($P \leq 0.05$).

Results at all root levels, group 3 using CH medication showed statistically significant lower results than all other tested groups. Control group showed higher values followed by bioceramic and Glycyrrhizin intracanal medicaments groups without statistical significant differences . In all groups, coronal root levels recorded higher values than other levels with statistical significant difference with apical level only.

Conclusions push-out bond strength of Bio-C bioceramic sealer to radicular dentin was negatively affected by prior application of CH. However, bioceramic (Bio-C Temp) and Glycyrrhizin intracanal medications did not have negative impact.

KEYWORDS bioceramic intracanal medicament, bioceramic sealer, Calcium hydroxide, Glycyrrhizin.

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INTRODUCTION

Root canal disinfection is the most crucial element of endodontic therapy which influence the success of the treatment. Despite the fact that irrigation and instrumentation have advanced significantly, intracanal medicaments are still required to fully eradicate bacteria and stop their recolonization upon canal walls[1].

Calcium hydroxide(CH) is the most widespread medicament due to its potency against majority of intracanal infections[2]. However, it may not be able to eradicate *Enterococcus faecalis* and *Candida albicans*[3]. In addition, its complicated distribution through the canal[4,5],and its complete removal is intericate[6]. As a result, ongoing research is being done on alternative medicaments.

Bioceramic compounds has recently opened up advanced avenues for enhancement of root canal disinfection[7,8]. Intracanal bioceramic dressing Bio-C Temp (Angelus, Londrina, Brazil) composed of calcium silicate, calcium tungstate and titanium oxide radiopacifiers, calcium aluminate, calcium oxide, and base resin. It is specifically used as an intracanal dressing for retreatment, pulp necrosis, and exudate cases. It combine both antimicrobial action and bioactivity[9]. In addition, its high alkalinity (pH = 12), high radiopacity and low solubility permit the extended time of contact between the medication and canal walls, and gradual release of hydroxyl (OH-) and Ca2+ ions. Therefore, the environment become unsuitable for bacterial growth[9].

Seeking for more biocomptability and efficacy, herbals were used as intracanal medicaments. Herbals have avariety of biological effects as antibacterial, antifungal, antiviral, antiprotozoal and anti inflammatory actions which were documented in researches[10,11]. Glycyrrhiza glabra or liquorice is one of herbs that has been utilized in phytomedicine for 4000 years[12]. Its effectiveness against *Enterococcus faecalis* and biocomptability were documented in different researches[13,14].

The main factor to prevent root canal infection via coronal or apical leakage is to establish a strong contact between root canal wall and filling[15,16]. The main chemical constituents of sealers are; zinc oxide eugenol, calcium hydroxide, glass ionomer, silicone, resin, and bioceramics. Bioceramic sealers possess excellent biological and physical properties [16-17]. Bio-C sealer (Angelus, Londrina, Parana, Brazil) is a ready-to-use bioceramic sealer containing calcium aluminate, calcium silicates, calcium oxide, iron oxide, zirconium oxide, silicon dioxide and a dispersing agent. It has biocompatibility, bioactive nature[18], high PH, optimal flow values, and radioopacity as the manufacturer claims.

An appropriate method to evaluate the attachement a sealer to the canal wall and the core material is dislodgement resistance, also called, push-out bond strength[19]. It has been recommended in numerous investigations[20-22] because it is easy to explain and can provide an actual assessment of the bond strength[23].

It is necessary to clean out the intracanal dressing in advance to filling, which is technically challenging[24], as its remnants can affect sealers features[25-28] which in turn affect treatment outcomes. Based on this point of view, the purpose of the present study was to check the impact of medications remnants on the quality of root filling.The null hypothesis was that medications will have negative impact on sealer bond strength.

MATERIALS AND METHODS

Ethical consideration

This study was approved by the Research Ethics Committee of the Faculty of Dentistry, Tanta University. The purpose of the present study was explained to the patients and informed consents was obtained.

Sample size

The sample size was determined using power calculations (G Power version 3.1.9.; Franz Faul, University of Kiel, Kiel, Germany).

Sample selection and preparation

The inclusion criteria of this study included human maxillary central incisors extracted due to periodontal diseases.They have fully developed roots with closed apices. All freshly extracted teeth were gathered from the outpatients of Oral Surgery Department, Faculty of Dentistry, Tanta University clinic.Tap water was used to rinse the teeth as soon as they were extracted, and they were then subsequently submerged and cleaned for an hour in 2.5% Sodium hypochlorite (NaOCL) solution[29] (Clorox Co, 10th of Ramadan, Egypt).

If there was any calculus or remnant soft tissue still attached to the extracted teeth, it was removed using sharp hand scalers.The teeth were kept in distilled water nearly within two to three months following extraction until use[30]. To exclude any teeth having cracks, fractures, cavities, or resorption, the teeth were inspected under 2.5x magnification loupes and were digitally radiographed using digital intraoral sensor (Dr.Suni plus Digital Intraoral Sensor, Suni Medical Imaging, Inc.,Sanjose, USA). A safe-sided diamond disc (Komet, Brasseler, Lemgo, Germany) fixed to a straight handpiece under water cooling was used to decoronate teeth and to obtain a root length of 16±1 mm.

K-file #10 (Dentsply/Maillefer, Ballaigues, Switzerland) was used to calculate the working length. After insertion inside the root canal, the file was moved forward until it emerged from the apex. The file's working length was determined by taking this measurement and subtracting 1 mm. Root canals were instrumented using ProTaper Next files (Dentsply/Maillefer, Ballaigues, Switzerland) up to master apical file X4 (40/0.06), at 300 rpm rotational speed and 2 NCM torque values using a 20:1 gear reduction hand piece driven by an endodontic motor (E-CONNECT, Changzhou City, China). Each file was utilized in a circumferential brushing motion inside the root canal. Following each file, to irrigate the canals with a standardized volume of 3 mL of freshly prepared 2.5% NaOCl solution, a 27-gauge side-vented needle was used. Finally, the canals were flushed with 5 mL of 17% Ethylenediaminetetraacetic acid (EDTA)(Adam Dent, Egypt) for 1 minute followed by 5 mL normal saline solution (Ultimate Pharma, Egypt) as a final irrigation[31]. Absorbent paper points (Dentsply/ Maillefer, Ballaigues, Switzerland) were used to dry the canals.

Study groups

Based on the intracanal medication used, ten randomly selected teeth were set to one of four tested groups. Group 1: bioceramic intracanal medicament (Bio-C Temp)(Angelus, Londrina, Brazil), Group 2: Glycyrrhizin (TargetMol, Wellesley Hills, Massachusetts, USA), Group 3: Calcium hydroxide (CH)(Prevest, Jammu, India), and Group 4: no intracanal medications as a control. An independent trained investigator not involved in the study handled the randomization and concealment process. Random sequence generation was achieved using a computer random allocation program and concealed from the operator using the sequentially numbered opaque sealed envelope (SNOSE) technique. Then a closed envelope containing the instructions to use either Bio-C intracanal medication, Glycyrrhizin,CH or no medication was selected.

Application of intracanal medications

In group 1; Bio-C Temp intracanal medicament was applied using the ready-to-use syringe and needle system. Group 2; Glycyrrhizin gel was despinsed into the canals using a plastic syringe. Group 3; CH powder was mixed with distilled water in 1:1 ratio until thick creamy consistency was obtained, and then applied into root canals using

lentulo spiral(Mani, INC, Japan). The coronary opening in all samples was sealed with temporary filling (Cavit, ESPE, Seefeld, Germany). Then, samples were incubated in an oven (37°C, 100% relative humidity) for one week.

Removal of intracanal medications

Temporary filling was removed and removal of intracanal dressing was done using 5 mL of 2.5% NaOCl and a K-type file which was moved against root canal walls. Then, 3mL of 17% EDTA solution was used for 3 minutes. After medicaments removal, 5 mL normal saline solution was used and canals were dried.

Push-out test

All root canals were filled using gutta-percha lateral condensation technique and a Bio-C bioceramic sealer (Angelus, Londrina, Parana, Brazil), sealed with temporary filling and incubated for one week at 37°C and 100% relative humidity to allow complete sealer setting. Roots were embeded vertically in chemical cured acrylic resin blocks. Blocks were sectioned using a slow-speed, water-cooled diamond disc (Komet; Brasseler, Lemgo, Germany) to produce ~2 mm thick section from each root level. Loading was applied using a 1 mm, 0.7 mm, and 0.5 mm diameter stainless steel cylindrical plungers to match the diameter of three root canal levels. The plungers were contacting filling only and mounted on the upper member of universal testing machine (Lloyd Instruments Ltd, Fareham, UK) in apical to coronal direction. The force was applied at a cross head speed of 1 mm/min until bond failure occurred.

The bond strength at failure was calculated in megapascals (MPa) using the following formula[32]:

Push-out bondstrength (MPa) = F/A

F = maximum load (Newton)

A (adhesion surface area in mm2) = $\pi h (r1+r2)$

Where, π is the constant 3.14; $r1$, apical radius; $r2$, coronal one; and h is the thickness of the slice.

Statistical analysis

Statistical Package for Social Sciences software (SPSS for Windows desktop version 20.0; SPSS In. Chicago, IL, USA) was used. Analysis was done using one-way ANOVA and Tukey test ($P \leq 0.05$).

RESULTS

Mean± SD of bond strength values of different groups at three root levels and their statistical analysis are shown in Table 1. Relative to intracanal medication, at all root levels, it was found that Bio-C Temp (group 1) had higher bond strength values than Glycyrrhizin (group 2) but without statistically significant differences between each other and in comparison to the control group which received no medication. However, CH (group 3) had significantly lower values than other tested groups.

In comparing the root thirds in all groups, the coronal level had insignificantly higher values when compared with the middle level. Values for the apical level were significantly lower than those of the coronal and middle levels ($p < 0.05$) except in group 3 where no significant difference was found between apical and middle levels.

TABLE (1) Mean± SD of push-out bond strength values of different groups at different root levels and their statistical analysis

Groups \ Root levels	Coronal	Middle	Apical	P value
Group1	5.442^{Aa}±0.496	4.864^{Aa}±0.436	3.215^{Ab}±0.649	0.0001
Group 2	5.417^{Aa}±0.438	4.831^{Aa}±0.802	3.203^{Ab}±0.444	0.0001
Group 3	3.609^{Ba}±0.800	3.005^{Bab}±0.784	2.293^{Bb}±0.362	0.0008
Group 4	5.758^{Aa}±1.074	5.515^{Aa}±1.079	3.639^{Ab}±0.903	0.0001
P value	0.0001	0.0001	0.0003	

Different superscripted capital letters in each column are significantly different at P≤ 0.05 using Tukey test.
Different superscripted small letters in each row are significantly different at P≤ 0.05 using Tukey test.

DISCUSSION

Obturation material must have good adhesion to dentin to, increase tooth fracture resistance and decrease treatment failure possibility[33]. Intracanal medications are mainly used to assist the action of chemo-mechanical preparation in eliminating the remaining microorganisms. However, it was found that they have either positive or negative impact on root filling bond strength[34]. So, this study was done to determine the impact of intracanal medications on the push-out bond strength of a bioceramic sealer.

Calcium hydroxide (CH) was tested in this study as it is the traditional dressing strongly favored in the literature[35]. CH was used in a powder form to exclude any effect of the other additives used in ready-to-use paste forms. Due to its excellent properties; antimicrobial action, bioactivity, high alkalinity, and low solubility[9], intracanal bioceramic dressing Bio-C Temp was tested. Glycyrrhizin intracanal medicament was tested as its effective antibacterial action, anti-inflammatory properties and biocompatibility which were proved by previous studies[14,36,37].

All crowns were removed to standardize a root length of 16±1 mm to obtain specimens with comparable dimensions. Removal of intracanal dressing was done using 5 mL of 2.5% NaOCl followed by 3mL of 17% EDTA solution for 3 minutes as EDTA has the ability to chelate CH residues and thus facilitate its removal [38,39]. Gutta-percha lateral condensation technique was used to ensure comparable thickness of the sealer.Varied methods have been documented to evaluate the adhesion of a dental material to dentin. However, push-out test is a reliable, and practical method [40,41] even at low levels[42] .So , it was the test of choice in this study.

The lowest values were observed in CH group. This may be due to remnants of CH medication on root canal walls, acting as physical barrier between the root dentin and endodontic sealer[43,44]. These remnants chemically react with sealer and reduce its flow, working time, film thickness[45], and penetration into dentinal tubules[46], which in turn decrease the bond strength[47]. This was in agreement with different studies[27,44,35,48]. However, this was in disagreement with different studies who stated that CH improved the dislocation resistance of calcium silicate based sealers [31,49,50,51].This inconsistency may be due to differently used sealers and different methodologies for CH removal.

This study results showed higher values in group 1 (Bio-C Temp). This can be explained, as stated by Escobar et al.,[48] as Bio-C Temp showed physical chemical interaction with the bioceramic sealer which provided an increase in bond strength. This was in agreement with Alshamrani et al.[52]. However, this was not supported by Almohareb et al.,[53] who found that Bio-C Temp intracanal medicament decreased the bond strength of both Bio-C Repair and MTA. This may be due to using different materials other than Bio C bioceramic sealer. In addition, Glycyrrhizin intracanal medication group showed higher values than CH. This may be due to its acidic nature that may enhance sealer penetration into dentinal tubules and therby increasing the sealer bond strength[54].

Considering the root levels, higher values were observed in the coronal level, followed by the middle level, and the apical level, in all tested groups. This was found in previous researches [55, 56,57-61] as the morphological structure of the dentin with high number of large diameter dentinal in the coronal and middle regions, which increase sealers adhesion to dentinal walls [61-63]. In addition, the smaller volume of medications in these thirds, which provided greater interaction between filling material and dentin as proved by Escobar et al.,[48]

CONCLUSIONS

- Medications based on bioceramic compounds or Glycyrrhizin had favorable impact on bond strength of Bio-C bioceramic sealer to radicular dentin.
- CH medication had negative impact on bond strength of Bio-C bioceramic sealer to radicular dentin.

RECOMMENDATIONS

- Further studies to assess the interaction between medications based on bioceramic compounds or Glycyrrhizin and different root canal sealers
- Future studies studing the microhardness, bond strength, and cytotoxicity could consider extended application times of Bio-C Temp and Glycyrrhizin to determine their the long-term effects

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