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Effect of Blood Contamination on Some Properties of a Tricalcium Silicate Based Root End Filling Material (In Vitro Study)

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ABSTRACT:

This study aimed to evaluate the effect of blood contamination on the push-out bond strength of Biodentine when used as retrograde filling material. Extracted single rooted human teeth were prepared and resected. Retrograde cavities were created and filled with Biodentine prepared according to the manufacturer's instructions. Teeth were divided into 2 groups according to the liquid in which the retro-filling was allowed to set. Group A was inserted in deionized water for control and group B in blood. Push-out bond strength testing was performed. Results showed a negative effect of blood contamination on the bond strength values of Biodentine retro-filling.

Introduction:

When non-surgical treatment modalities are proved to be unsuccessful or if they are contraindicated to begin with, surgical therapy is approached in order to save the tooth. The procedure generally consists of exposing the apical diseased area, resection of the root end, retrograde cavity preparation and insertion of the root end filling material [(1)] .

Several materials have been proposed as root end filling materials. According to Gartner and Dorn [(2)], a material used to seal the root-end cavities is considered to be ideal if it is able to prevent microorganisms and their byproducts from leaking into the periapical tissues. The material has to be non-carcinogenic, non-toxic, dimensionally

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stable and biocompatible with tissue fluids as well. Its sealing ability should not be affected by the presence of moisture.

Bioceramics [3], which are specially designed ceramics used for replacement of body parts that are lost or diseased, were proposed as a very promising material to be used in retrograde cavities. The first generation of bioceramics used in endodontics was MTA [3]. It is a tri-calcium silicate-based cement which explains its sealing ability and biocompatibility. However, it suffered a number of drawbacks such as long setting time and difficult handling properties allowing new materials to be developed claiming the ability to overcome these flaws. Biodentine (Septodont, France), is a pure tricalcium silicate-based cement that was marketed as dentin substitute. Several investigations have previously reported its successful use for retrograde filling [4]. During clinical application, exposure of root end filling material to blood might affect its setting reaction. This might negatively affect the biological and physical properties of the material. Therefore, conducting a study to evaluate the effect of blood contamination on Biodentine when used as a retro-filling material was thought to be of value.

Materials and methods:

Forty extracted single rooted human maxillary sound teeth with no signs of internal or external resorption were used. Whole fresh human blood was collected from the Clinical Pathology Department at El-Demerdash Hospital Ain shams university. Endodontic access cavities were prepared in all teeth, canals were cleaned and shaped using M-Pro rotary files till size 25 taper 0.06, irrigated with sodium hypochlorite solution of 2.5% concentration, dried and obturated. Root end resection was done for all teeth by cutting 3 mm from the apical part of the root perpendicular to the long axis of the tooth using high speed diamond stone and root end cavities were prepared in all teeth under dental operating microscope, using ultrasonic diamond coated retrograde tip. Cavities were standardized to the same dimensions of 3 mm in depth and 1 mm in diameter.

All teeth (n=40) were divided randomly into 2 main groups according to the liquid in which the setting of the retrograde filling material will take place (n=20). Group A inserted in deionized water for control and group B in blood (Figure 1). Biodentine was mixed according to the manufacturer's instructions, transferred to the retro-cavities using MTA carrier and then condensed by a micro-condenser using gentle pressure to ensure complete filling of the cavities to the level of the resection. Shortly after insertion (4-5 minutes) and before the initial setting of the material was complete, all teeth were inserted into the Eppendorf tubes containing either the blood or the deionized water.

Teeth were left in their tubes in an incubator adjusted at 37 degrees Celsius for over 45 minutes then removed from the blood, washed with saline, and a precision cutting machine was used to cut transversely slices from the mid-root perpendicular to the long axis of the tooth thus forming dentin discs 2 mm in thickness with the set material in the form of cylinders in its core (Figure 2). Push-out test was performed for all discs using a universal testing machine at a crosshead speed of 1 mm/min in an apical to coronal direction parallel to the long axis of the disc (Figure 3). A cylindrical attachment of 0.7 mm in diameter was used to provide a clearance space of at least 0.2 mm from the borders of the dentinal wall ensuring contact only with the material to be tested. The maximum load applied to dislodge the retro-filling material was recorded in Newtons. The push out bond strength in Mega Pascals was then calculated. Statistical analysis for intergroup comparison between the blood contaminated group and the non-contaminated control group was performed using two sample t-test to determine the effect of blood on bond strength.

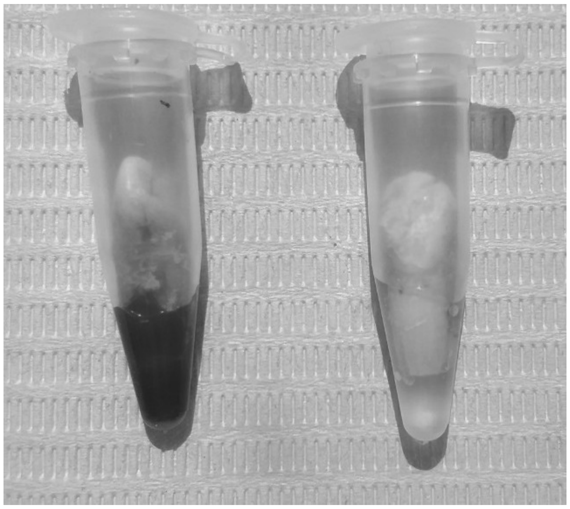


Figure 1: Eppendorf tubes containing either blood or deionized water.

Figure 2: A dentin disc with set Biodentine in its center

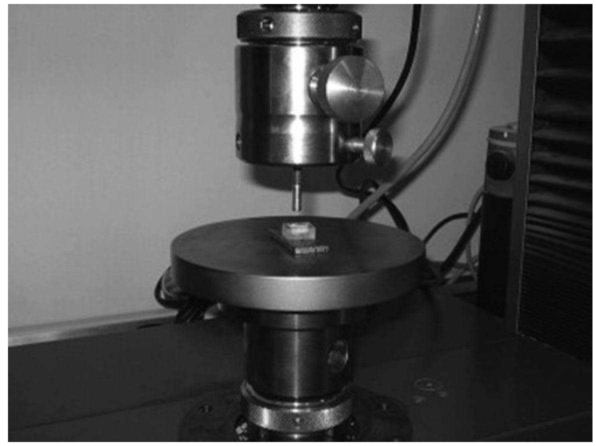
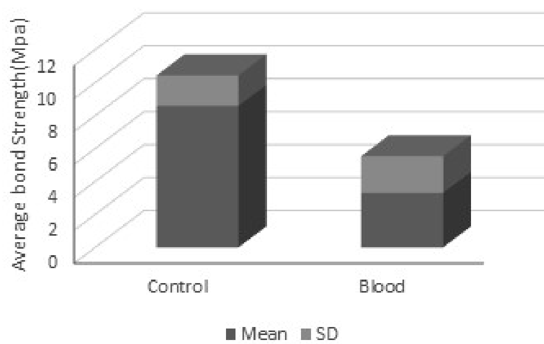


Figure 3: Universal testing machine

Results:

Blood contaminated samples showed lower push-out bond strength mean value (8.581.86±) than non-contaminated samples (3.29±2.24). This difference was found to be statistically significant (P<0.001) (Figure 4).



Discussion:

Some of the most interesting properties of tricalcium silicate based bioceramics are apatite deposition in contact with tissue fluids, remineralization and stimulation of bone healing [5,6]. Properties that qualified such a material to be used successfully as a retrograde filling material. Although setting of Biodentine is not affected by body fluids, ideally, a retro-filling material should not be subjected to any kind of contamination throughout its placement and setting in order to avoid any possible deterioration in its biological or mechanical properties[7,8].

Clinically, it could be considered utterly difficult, if not impossible, to achieve such an environment. In the present study, a hemorrhagic situation was simulated in contaminated samples by inserting the tooth with the retro-filling material before complete setting in blood contained in Eppendorf tubes[9]. Multiple methods can be used for assessment of bond strength of filling materials to canal walls such as pull-out[10,11], push-out [12,13] and micro-tensile tests [14]. However, it was reported that pull-out and micro-tensile test methods are not suitable for Biodentine[15]. Micro-tensile method was demonstrated to have increased rate of premature failure as well as large data variability as reported by Goracci et al [16]. In the current study, push-out method was used because of its decreased premature failures and its ability to provide uniform stress distribution [16,17]. Blood contamination had a significant negative effect on the push-out bond strength of Biodentine retro-filling to radicular apical dentin. These results were consistent with the results demonstrated by Akcay et al.[15] who also used Biodentine as a retrograde filling material. They attributed the reduction in bond strength to blood interference with complete hydration and therefore setting of the material, based on the surface differences observed in the blood contaminated group. On the other hand, Agrawal et al. [18] showed no significant effect of blood contamination on bond strength values of Biodentine. He used Biodentine as a repair for furcal perforations and not as root end filling. Results were attributed to the short setting time of Biodentine.

Conclusions and recommendations:

- Under the circumstances of this study, it can be concluded that blood contamination during setting of Biodentine had a negative effect on its dislocation resistance.
- Blood contamination during placement of Biodentine retro-filling should be avoided.
- Further investigations of the effect of blood contamination on other calcium silicate materials are needed.

Investigation of different methods efficiency in blood control during retro-filling material insertion.

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