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Analysis of Marginal Gap between Dentin and Biodentine on Irrigation with 3% Sodium Hypochlorite - An In Vitro study

Research Article

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Abstract

Introduction: The furcation perforations should immediately be repaired with an endodontic material in order to minimize the bacterial contamination and the irritation of periodontal tissues during the usage of endodontic irrigants.
Aim: The purpose of this in-vitro study is to analyse the marginal gap between dentin and biodentine following treatment with 3% sodium hypochlorite(NaOCl) and saline solutions.
Materials and Methods: Nine human mandibular premolar teeth were longitudinally sectioned. Wells of 1 mm width and depth were created in the thickest portion in cervical 1/3rd of the section. Biodentine was incrementally placed and condensed in the sample. The 18 samples were wrapped in wet gauze for 10 minutes and divided into 2 subgroups (n = 9) to be immersed into saline (Group A) and 3% sodium hypochlorite (Group B) for 10 minutes. After incubation for 48 hours, the samples were examined under a stereomicroscope to determine the marginal gap formed between dentin and biodentine interface.
Result: Marginal gaps were seen in samples immersed in 3% sodium hypochlorite(NaOCl) and saline solution but the difference was not statistically significant.($p<0.05$)
Conclusion: Within the limitations of this study it was found, there was no significant difference in marginal gap formed at the interface due to exposure to saline solution or 3% sodium hypochlorite(NaOCl).

Keywords: Furcal Perforation; Marginal Gap; Biodentine; Sodium Hypochlorite; Saline Solution.

Introduction

Perforation can be defined as a mechanical or pathologic communication between the root canal system and the external tooth surface [1]. Iatrogenic perforations must be filled with restorative materials to prevent bacterial leakage between the root canal system and the periodontium. Sealing the communication pathways between the root canal system and the periradicular tissues, has been done with a variety of materials [2, 3]. Several materials like reinforced zinc oxide eugenol, amalgam, super EBA, calcium hydroxide, composite resins, glass ionomer, MTA, bioaggregate, biodentine, platelet rich plasma (PRP), platelet rich fibrin (PRF) and others, have been applied for repairing furcation perforation, but none of them meet the criteria for an ideal repair material.[2] [3, 4] MTA is one of the most widely used root repair materials because of its good biocompatibility, marginal adaptation, bacterial leakage, and low cytotoxicity. However, it has some disadvantages, including a long setting time (3 h), difficult applicability, and high cost [2-4].

Biodentine (Septodont Ltd., Saint Maur des Fausses, France) is a recent inorganic restorative commercial cement based on tricalcium silicate (Ca_3SiO_5) that is marketed as a "bioactive dentine substitute." As compared to other tricalcium silicate cements including mineral trioxide aggregate (MTA) and Bioaggregate, the material is said to have better physical and biological properties. [5] Tricalcium silicate, calcium carbonate, zirconium oxide, and a water-based liquid containing calcium chloride as a setting ac-

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celerator and water-reducing agent make up this high-purity calcium silicate–based dental material. Because of its good sealing efficiency, high compressive strength, fast setting time,[6, 7] biocompatibility, bioactivity, and bio-mineralization properties, biodentine is recommended for use as a dentin replacement under resin composite restorations and as an endodontic repair material.

The furcation perforations should immediately be repaired with an endodontic material in order to minimize the bacterial contamination and the irritation of periodontal tissues because of the usage of endodontic irrigants [8]. Following perforation repair, endodontic treatment should be continued using different irrigants like saline, 2% chlorhexidine gluconate (CHX) and sodium hypochlorite (NaOCl) solutions to disinfect the root canal system. (Yan et al. 2006) This invariably leads to contact between the irrigant and the repair material, thus affecting its properties. However, there is no information about the marginal gap created between biodentine and dentine following use of irrigants. Hence, the purpose of this in-vitro study is to analyse the marginal gap between dentin and biodentine following treatment with 3% sodium hypochlorite(NaOCl) and saline.

The null hypothesis states that there is no difference in marginal gap between dentin and biodentine on irrigation with sodium hypochlorite and saline in an Invitro environment. The alternate hypothesis is that there is a difference in marginal gap between dentin and biodentine on irrigation with sodium hypochlorite and saline in an Invitro environment.

Previously our team has a rich experience in working on various research projects across multiple disciplines [9-23] Now the growing trend in this area motivated us to pursue this project.

Materials And Methods

Freshly extracted single-rooted human mandibular premolar teeth were used. The crowns of all teeth were removed and they were longitudinally sectioned in a buccolingual direction using a low speed diamond saw under constant water cooling. Apical end of the root was cut. Wells with a diameter and depth of 1mm were prepared in the thickest part of the dentin in cervical 3rd.

The Biodentine capsule was gently tapped on a hard surface to loosen the powder, then opened and placed on the white capsule holder. Then 5 drops of the liquid were poured into the capsule. The capsule was closed and placed on a mixing device (amalgamator) at a speed of 4000 rotations/min for 30 s. Biodentine was incrementally placed into the prepared spaces of the dentin by the special MTA carrier and compacted with a suitable size plugger and condensed. Excess material was trimmed from the surface of the samples with a scalpel. Subsequently, the samples were wrapped in wet gauze, placed in an incubator, and allowed to set for 10 minutes at 370C with 100% humidity.

Immediately after incubation, the sectioned samples were randomly divided into two groups, which comprises 9 samples in each group. Samples were immersed in saline solution (Group A) (n=9) or 3% sodium hypochlorite(NaOCl)(Group B) (n=9). After 10 minutes of immersion, all samples were removed from the test solutions, rinsed with distilled water, and allowed to set for 48 hours at 370C with 100% humidity in an incubator.

The samples were labelled and observed under the stereo-microscope (Olympus SZ-40, Olympus, Tokyo, Japan) with a magnification up to 20x. The perimeter of each cavity was divided into three sections and the presence of any gap between the dentin surface and biodentine in each section was analyzed.

Data were tabulated and the mean and standard deviation values were calculated. Using Independent- Samples Mann-Whitney U Test, statistical significant differences were calculated.

Results And Discussion

Table 1 depicts the values for marginal gap found between dentin and biodentine following immersion in saline solution and 3%sodium hypochlorite. Marginal gap was seen in both, that is the samples immersed in saline solution and those immersed in 3% sodium hypochlorite. Although more marginal gaps were seen in samples immersed in 3% sodium hypochlorite (NaOCl), the difference was not statistically significant.($p<0.05$) Hence, the null hypothesis was retained.

Perforation in the furcations of posterior teeth are the most common perforations, which negatively impact the prognosis of the affected teeth. [24] An suitable furcal perforation repair material should be used to reduce inflammation and improve the periodontal ligament (PDL) attachment. Due to their strong biocompatibility and ability to cause calcium-phosphate precipitation at the interface to the periodontal tissue with high consistency of the material-dentin interface, calcium silicate cements are the materials of choice for treating the furcation perforation.[25]

One of the most significant conditions for furcation perforation repair is a three-dimensional hermetic seal. This seal is the result of the cement's marginal adaptation, adhesion, solubility, and volume changes. As a result, the size of the gap between the dentin and the repair material, as well as the amount of fluid leakage, are quantitative indicators of the material's sealing capacity.[26]

On completion of repair of the furcal perforation, the success of the endodontic therapy depends on proper cleaning, shaping and obturation of the canals. These repair materials come into contact with irrigants during the cleaning and shaping of the canals, which can adversely affect their properties.

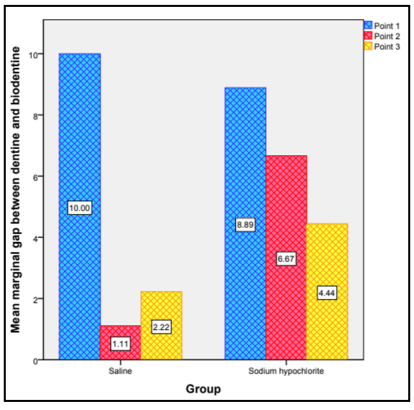
There are several studies on the gap size formed by regular MTA products as root-end filling materials, but no information on marginal gap as furcal perforation repair materials. There aren't many researchers investigating the properties and clinical applications of new calcium silicate-based materials like Biodentine, and we couldn't find any studies examining gap formation between dentin and biodentine after irrigants were applied in cases of furcal perforation repair. Presence of gap in the dentin-biodentine interface following root canal treatment will allow for microleakage and thus provide scope for bacterial passage. This will affect the overall success of the endodontic treatment. Hence, this study focused on evaluating formation of gap at the dentin-biodentine interface following usage of root canal irrigants such as saline solution and 3% sodium hypochlorite (NaOCl).

In this study, a marginal gap was seen at the material-dentin

Table 1. Marginal gap measured in each sample at 3 different points.

Sample No.	Group A(saline)	Group B (3% sodium hypochlorite)
1.1	30µ0	0
1.2	0	0
1.3	20µm	0
2.1	0	40µm
2.2	0	30µm
2.3	0	20µm
3.1	0	40µm
3.2	0	20µm
3.3	0	20µm
4.1	30µm	0
4.2	0	0
4.3	0	0
5.1	0	0
5.2	0	0
5.3	0	0
6.1	0	0
6.2	0	0
6.3	0	0
7.1	30µm	0
7.2	10µm	0
7.3	0	0
8.1	0	0
8.2	0	10µm
8.3	0	0
9.1	0	0
9.2	0	0
9.3	0	0

Figure 1. Mean marginal gap between dentin and Biodentine, measured at three different points on the specimen, after immersion in saline and 3% sodium hypochlorite respectively.



interface on immersion of samples in saline and 3% sodium hypochlorite(NaOCl) solution in a few samples. Although more gaps were seen in samples immersed in 3% sodium hypochlorite (NaOCl) solution,on statistical analysis, it was found that there was no significant difference in the gap formed in either of the samples immersed in saline solution or 3% sodium hypochlorite (NaOCl) solution. This outcome may be due to smaller sample size in the current study. More studies including larger sample size and comparing multiple irrigants are needed.

The uptake of calcium and silicon ions into dentin causes the development of a tag-like structure, according to the findings of Han and Okiji [6]. Despite the altered surface morphology, Biodentine performed admirably well even after exposure to 3.5% NaOCl, 2 %CHX, and saline solutions in the study by Guneser et al. [27]

The effects of various root canal irrigants on the perforation repair material are investigated in this report, which is the first of its kind. Following furcal root perforation, the site is prepared and

restored with appropriate material based on the clinical condition, and root canal cleaning, shaping, and obturation are undertaken. The repair material inevitably comes into contact with the root canal irrigants during the cleaning and shaping of the root canal. As a result, it's crucial to study if any gaps are created at the interface that could allow microleakage and bacterial entry, as this can affect endodontic treatment success.

Apart from the above stated advantages of the study, there were a few limitations. Firstly, despite using a clinical model to replicate furcal perforation, an in vitro environment cannot simulate clinical situations in all aspects. Thus, the results of this study should be considered with caution and further studies should be conducted with increased sample size, various concentrations, multiple root canal irrigants, different time periods and mode of assessments of the marginal gap formed at the interface.

Conclusion

Within the limitations of this study it was found, there was a marginal gap formed at the interface due to exposure to saline solution or 3% sodium hypochlorite (NaOCl). But the results comparing marginal gaps formed between dentin and biodentine comparing samples immersed in saline solution and 3% sodium hypochlorite (NaOCl) were statistically insignificant. Further studies are required to warranty these results.

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