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# EVALUATION OF SEALING ABILITY OF BIODENTINE AS APICAL PLUG ON SIMULATED IMMATURE PERMANENT TEETH – AN INVITRO STUDY

Dental Science

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## ABSTRACT

Management of open apex was traditionally by Calcium hydroxide [$Ca(OH)_2$]. Recently, alternatives like biodentine has gained importance. **Aim:** This study was done to compare the sealing ability of 2mm Vs 5mm of biodentine as apical plug. **Materials and methods**: 30 mandibular premolars were decoronated and the apices were removed up to 2mm. Canals were instrumented and the specimens were divided into 3 groups – Group A- Control-(Untreated), Group B-2mm and Group C–5mm biodentine apical plug respectively. Group B and C were then obturated and the coronal access were sealed with composite resin. The samples were then immersed in 1% methylene blue for 72 hours. Then, samples were split longitudinally and prepared for stereomicroscopic evaluation. Statistical analysis of data was done using One-way ANOVA. **Results:** There was a significant difference in the sealing ability of 5mm when compared to 2mm of Biodentine. **Conclusion:** Greater thickness of Biodentin has better sealing ability.

## KEYWORDS

Apical plug, Apexification, Biodentine, Calcium hydroxide, Open apex

## INTRODUCTION

Caries or trauma can lead to necrosis of pulp which in turn causes cessation of root closure before maturation of root.(Shabahang, 2013) Endodontic management of non-vital immature permanent teeth with open apices was traditionally carried out using $Ca(OH)_2$ for apexification procedures by inducing a calcific bridge.(Andreasen, Farik, & Munksgaard, 2002; Pawar, Pawar, Hegde, & Kokate, 2013) Other alternatives gained attention due to the weakening of root dentin caused by long term use of $Ca(OH)_2$ which makes the tooth susceptible to fracture. (Damle, Bhattal, & Loomba, 2012) Promising alternatives that were recently developed are calcium silicate based materials such as Mineral trioxide aggregate and Biodentine. (Refaei, Jahromi, & Moughari, 2020) These root end repair materials have claimed to stimulate bio mineralization. They have high biocompatibility and possess superior sealing ability.(Refaei et al., 2020)

Biodentine is a new calcium silicate-based restorative cement with dentin-like mechanical properties. Biodentine consists of powder and liquid. The powder mainly contains tricalcium and dicalcium silicate (3CaO SiO2 and 2CaO SiO2), which is the main component of Portland cement, as well as calcium carbonate (CaCO3) and zirconium oxide. The liquid consists of calcium chloride (CaCl2 2H2O) solution with an admixture of polycarboxylate.(Grech, Mallia, & Camilleri, 2013; Zanini, Sautier, Berdal, & Simon, 2012) Biodentine has a good sealing ability and has shown favourable biologic response as a pulp capping agent. It also has good mechanical properties; its setting time is 12 minutes and does not cause discoloration (Nikfarjam et al., 2016)(Tran et al., 2012) . Studies have shown that reduction of apical plug significantly increases microleakage.(Tran et al., 2012) However, there are few studies using varying thickness of Biodentine as an apical barrier for the purpose of outcome comparison. Hence the purpose of this study is to compare the sealing ability of two different thickness of Biodentine as apical plug using Stereomicroscope.

## METHODOLOGY

30 freshly extracted human mandibular single rooted premolars extracted for orthodontic or periodontal reasons were used in this study. Teeth were cleaned from attachment, debris and calculus. The apices were removed by cutting with a diamond disc under water coolant - 2mm from the apical root end in an attempt to standardize the working length of all specimens to 15± 1 mm and to simulate a tooth with open apex. After this, the samples were instrumented up to Protaper #F3 under constant irrigation. The samples were then randomly divided into 3 groups of 10 sample each.

| Group | Sample size | Apical plug |
|---|---|---|
| Group A | 10 | Untreated(Control) |
| Group B | 10 | 2mm Biodentine apical plug |
| Group C | 10 | 5mm Biodentine apical plug. |

Group B and C were further obturated with theromoplasticized Guttapercha and zinc oxide eugenol sealer. The coronal access were sealed with composite resin to avoid coronal leakage. Following this, the samples were stored at 37º C in 100% humidity for 24 hours. After this, the external root surfaces were covered with 3 coats of nail polish, except for an area 2mm around root apex, then the teeth were immersed in 1% methylene blue for 72 hours. The samples were prepared by sectioning the root canal using a diamond disc to make longitudinal grooves on the buccal and lingual surfaces of all the roots without penetration of the canal. A chisel was used (to avoid disturbing the canal morphology) to split them into two halves to view the depth of penetration under stereomicroscope.

Images were taken under stereomicroscope at 10X magnification. ***(Figure 1)*** Data were collected by measuring the depth of dye penetration of each sample. ***(Table 1)*** Statistical analysis was carried out using SPSS software version 20. One-way ANOVA test was used for intergroup comparisons. ***(Table 2)***

*Figure 1* ***Group A- Control*** ***Group B- 2mm apical plug*** ***Group C- 5mm apical plug***

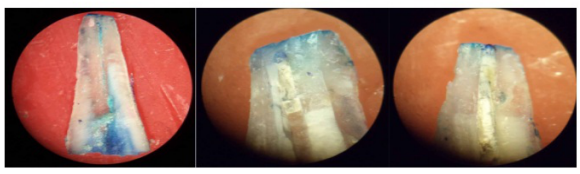

***Table 1 Depth of penetration (µm)***

| Sample | Group A | Group B | Group C |
|---|---|---|---|
| 1 | 12440 | 3964 | 2454 |
| 2 | 13210 | 3626 | 2077 |
| 3 | 12761 | 4618 | 2461 |
| 4 | 13110 | 3737 | 3073 |
| 5 | 12987 | 4348 | 2396 |
| 6 | 12663 | 4407 | 2937 |
| 7 | 12767 | 4425 | 2328 |
| 8 | 13279 | 4461 | 2958 |
| 9 | 13812 | 4425 | 3033 |
| 10 | 12889 | 3043 | 2792 |

***Table 2 Mean, Standard deviation, Mean Difference and P value comparison***

| S.no | Groups | Mean ± SD | Inter group Comparison | Mean Difference | P value | Significance |
|---|---|---|---|---|---|---|
| 1 | A | 12991± 386.40 | A B | -10340.9 -1454.5 | 0.00 | Significant |
| 2 | B | 4150 ± 500.83 | A C | -8886.4 1454.5 | 0.00 | Significant |
| 3 | C | 2650 ± 384.59 | B C | 8886.4 10340.9 | 0.01 | Significant |

## RESULT

There was significant difference among the three tested groups. There was greater depth of penetration in the control group due to absence of apical seal. Comparing Group B and C showed that the depth of penetration was least in Group C which had thicker apical plug than Group B.

## DISCUSSION

Success of root canal therapy depends on a good access cavity preparation, through cleaning and shaping and providing a three dimensional seal of root canal.(Tabrizizade et al., 2014) Completion of root formation provides an apical barrier against which the obturating material can be condensed. Incomplete root formation can occur due to caries or trauma to an immature permanent tooth, leading to necrosis of pulp thus causing cessation of root end closure.(Pawar et al., 2013) Proper apical seal is achieved when the root maturation is completed wherein the apical foramen is narrow aiding in three dimensional sealing of root canal.(Mohebbi, 2015)

The ideal root-end filling materials should prevent leakage of microorganisms and their products into the surrounding tissues.–(chong & pitt ford, 2005) Traditionally, the treatment of choice in such cases was $Ca(OH)_2$ apexification. Several studies showed that the long term use of $Ca(OH)_2$ leads to weakening of root dentin (over 18 months).(Andreasen et al., 2002) Recently, alternatives to $Ca(OH)_2$ such as calcium silicate cements have drawn the attention. Calcium silicate cements like Biodentine and MTA are widely used these days due to their high levels of biocompatibility and good sealing ability.(Nikfarjam et al., 2016; Zanini et al., 2012)

In this study, methylene blue dye was used for evaluation of dye penetration because it is less expensive and easy to manipulate. It also has high degree of staining and a molecular weight lower than that of bacterial toxins.(Kontakiotis, Georgopoulou, & Morfis, 2001).

In our study 5mm thickness of Biodentine showed less dye penetration than 2mm thickness of Biodentine. This is similar to a studies conducted by Torabinejad *et al* in which microleakage of three different thicknesses of MTA ( 1 mm, 2 mm, and 3 mm ) filled as a root-end filling material was compared and which concluded that the microleakage in the 3-mm and 2-mm root-end cavities was less than at 1-mm depth.(Torabinejad & Parirokh, 2010) and another study conducted by Adel et al in which varying thickness of apical plug was compared and concluded that reducing the thickness of apical plug significantly increased the microleakage.(Adel et al., 2012)This could be because the higher thickness of Biodentine has greater mineral content from which the anhydrous material dissolves and causes more crystallisation of hydrates forming a larger segment of interlocking mass which decreases microleakage. (Roberts, Toth, Berzins, & Charlton, 2008)

## CONCLUSION

Hence, from the results of this study it was concluded that there was a significant difference in the sealing ability of 5mm of Biodentine when compared to 2mm of Biodentine as apical plug. The thickness of apical plug was inversely proportional to the depth of penetration. Further studies with other calcium silicate based materials, greater thickness of Biodentine apical plug and in vivo studies will aid in establishing the results of the current study.

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