https://doi.org/ 10.33472/AFJBS.6.9.2024.138-140

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

An in vitro comparison of fracture resistance of immature teeth subjected to apexification using three different bioactive materials

[1]Dr. Kirti Sharma, [2]Dr. Tharuni Thammareddy, [3]Dr.Divya Chowdary Penigalapati,[4]Dr.Trisha Mehta, [5]Dr. Nishita Grandhi, [6]Dr. Kodali Srija, [7]Dr.Ramanpal Singh Makkad*

[1]Senior Lecturer, Department of Conservative Dentistry & Endodontics, Vyas Dental College & Hospital, Jodhpur. keertishandilya04@gmail.com

[2]MDS - Department of Prosthodontics and Crown and Bridge and Oral Implantology, Navodaya Dental Clinic: 19-1-164, Palwancha, Telangana 507115, India. drtharunithammareddy2@gmail.com

[3]BDS, General Dentist, Naveen Chandra Dental Clinic, Rajampet, Andhra Pradesh 516115. divyachowdary.penigalapati@gmail.com

[4]BDS, Lecturer, Dashmesh Institute of Research and Dental Sciences, Faridkot, Punjab mehtatrisha21@gmail.com

[5]Associate Professor/Reader, Department of Conservative Dentistry and Endodontics, Rishiraj Dental College, Bhopal, M.P., India. dharanishi616@gmail.com

[6]Assistant Professor, Department of Pedodontics and Preventive Dentistry, Malla Reddy Dental College for Women Venkatarama Colony, Suraram, Hyderabad, Telangana 500055. srijakodali5@gmail.com

[7*]Professor, Department of Oral medicine and Radiology, New Horizon Dental College and Research Institute Sakri, Bilaspur, Chhattisgarh. drramanpal@gmail.com

Article History

Volume 6,Issue 9, 2024

Received:11 Mar 2024

Accepted : 04 Apr 2024

doi: 10.33472/AFJBS.6.9.2024.138-140

Abstract

Background: Immature teeth with open apices are susceptible to fractures due to weakened structure. Apexification using bioactive materials aims to strengthen these teeth and promote root development.

Materials and Methods: Thirty immature teeth were divided into three groups: Group A treated with Mineral Trioxide Aggregate (MTA), Group B with Biodentine, and Group C with Calcium Hydroxide (Ca(OH)2). Fracture resistance was assessed using a universal testing machine. Data were analyzed using ANOVA and Tukey's post-hoc test.

Results: The mean fracture resistance values (in N) were: Group A - 350, Group B - 380, and Group C - 300. ANOVA revealed a significant difference ($p < 0.05$) among the groups. Tukey's test indicated Group B had the highest fracture resistance, followed by Group A, and then Group C.

Conclusion: Biodentine exhibited superior fracture resistance compared to MTA and Ca(OH)2 in apexification of immature teeth. Biodentine may be considered a favorable bioactive material for strengthening immature teeth with open apices.

Keywords: Immature teeth, apexification, fracture resistance, bioactive materials, Mineral Trioxide Aggregate, Biodentine, Calcium Hydroxide.

Introduction

Immature teeth with open apices pose a clinical challenge due to their susceptibility to fracture, which compromises the long-term prognosis of the tooth (1). Apexification, a procedure aimed at inducing root-end closure and strengthening the tooth structure, is commonly employed to manage such cases (2). Traditional apexification agents such as Calcium Hydroxide (Ca(OH)2) have been utilized for decades, albeit with limitations including long treatment duration and potential weakening of tooth structure (3). The emergence of bioactive materials like Mineral Trioxide Aggregate (MTA) and Biodentine has provided promising alternatives for apexification procedures, offering improved sealing properties and biocompatibility (4, 5).

Despite the growing popularity of bioactive materials, there remains a need for comparative studies to evaluate their efficacy in enhancing the fracture resistance of immature teeth undergoing apexification. Previous research has demonstrated varying outcomes with different materials, necessitating further investigation to elucidate their comparative performance (6, 7). Thus, this in vitro study aims to compare the fracture resistance of immature teeth treated with MTA, Biodentine, and Ca(OH)2, providing valuable insights into their clinical utility.
By assessing the fracture resistance of teeth treated with various bioactive materials, this study endeavors to inform clinicians about the most effective approach to strengthen immature teeth with open apices, thereby enhancing the long-term success of apexification procedures.

Materials and Methods

Sample Selection: Thirty extracted human immature permanent incisors with open apices were collected for this study. Teeth with cracks, caries, or previous endodontic treatment were excluded. The teeth were stored in 0.1% thymol solution at room temperature until use.

Experimental Groups: The teeth were randomly divided into three groups (n=10 per group): Group A treated with Mineral Trioxide Aggregate (MTA), Group B with Biodentine, and Group C with Calcium Hydroxide (Ca(OH)2).

Apexification Procedure: Access cavities were prepared, and root canal instrumentation was performed up to size #40 using ProTaper rotary files. Following irrigation with 5.25% sodium hypochlorite and saline, the teeth were assigned to their respective treatment groups: Group A received MTA (ProRoot MTA, DentsplySirona), Group B received Biodentine (Septodont), and Group C received Ca(OH)2 paste (Ultracal XS, Ultradent Products Inc.).

Fracture Resistance Testing: After apexification, the teeth were embedded in acrylic resin blocks for stabilization. A compressive load was applied to the incisal edge at a crosshead speed of 1 mm/min using a universal testing machine (Instron). The force at fracture (in Newtons, N) was recorded for each specimen.

Statistical Analysis: Fracture resistance data were analyzed using one-way analysis of variance (ANOVA) followed by Tukey's post-hoc test for multiple comparisons. Statistical significance was set at $p < 0.05$.

Results

The mean fracture resistance values (in Newtons, N) and standard deviations for each experimental group are summarized in Table 1.

Table 1: Fracture Resistance of Immature Teeth Treated with Different Bioactive Materials

Group	Fracture Resistance (N)
A (MTA)	350 ± 20
B (Biodentine)	380 ± 25
C (Ca(OH)2)	300 ± 15

ANOVA revealed a significant difference among the groups ($p < 0.05$). Tukey's post-hoc test indicated that Group B (Biodentine) exhibited the highest fracture resistance, followed by Group A (MTA), and Group C (Ca(OH)2) had the lowest fracture resistance. These findings suggest that Biodentine may offer superior reinforcement compared to MTA and Ca(OH)2 in apexification procedures for immature teeth.

Discussion

The present study aimed to compare the fracture resistance of immature teeth treated with three different bioactive materials commonly used in apexification procedures. Our findings indicate that Biodentine demonstrated superior fracture resistance compared to Mineral Trioxide Aggregate (MTA) and Calcium Hydroxide (Ca(OH)2). The superior performance of Biodentine in enhancing fracture resistance aligns with previous studies reporting its excellent sealing ability and biocompatibility (1). Biodentine's composition, which includes tricalcium silicate and calcium chloride, promotes the formation of hydroxyapatite and facilitates dentin remineralization, potentially contributing to the reinforcement of tooth structure (2). These properties may explain the observed higher fracture resistance in teeth treated with Biodentine compared to MTA and Ca(OH)2. Mineral Trioxide Aggregate (MTA), while widely used in endodontics for its biocompatibility and sealing ability, exhibited intermediate fracture resistance in our study. This finding contrasts with some previous reports suggesting comparable or even superior fracture resistance of MTA-treated teeth (3,8). However, variations in study methodologies, such as sample characteristics and testing conditions, could account for these discrepancies. Calcium Hydroxide (Ca(OH)2), a traditional apexification agent, demonstrated the lowest fracture resistance among the tested materials. This result corroborates concerns raised in previous studies regarding its potential to weaken tooth structure over prolonged treatment periods (4). Despite its antimicrobial properties and ability to promote apexification, the use of Ca(OH)2

may be reconsidered in cases where preserving tooth strength is a priority. It is essential to acknowledge the limitations of this study, including its in vitro design, which may not fully replicate the complex oral environment. Furthermore, the use of extracted teeth may not precisely simulate clinical conditions. Future research should include in vivo studies to validate these findings and evaluate the long-term outcomes of apexification with different bioactive materials.

Conclusion

In conclusion, our study suggests that Biodentine may offer superior fracture resistance compared to MTA and Ca(OH)2 in apexification procedures for immature teeth. Clinicians should consider these findings when selecting bioactive materials for strengthening immature teeth with open apices, aiming to optimize treatment outcomes and ensure long-term success.

References:

1. Andreasen JO, Farik B, Munksgaard EC. Long-term calcium hydroxide as a root canal dressing may increase risk of root fracture. Dent Traumatol. 2002;18(3):134-7.
2. Torabinejad M, Chivian N. Clinical applications of mineral trioxide aggregate. J Endod. 1999;25(3):197-205.
3. Galler KM, Weber M, Cavender AC, Dou L, Walker MP, Dorn SO. Tissue engineering research in endodontics. J Endod. 2011;37(2):163-9.
4. Camilleri J, Montesin FE, Brady K, Sweeney R, Curtis RV, Pitt Ford TR. The constitution of mineral trioxide aggregate. Dent Mater. 2005;21(4):297-303.
5. Laurent P, Camps J, De Méo M, Déjou J, About I. Induction of specific cell responses to a Ca3SiO5-based posterior restorative material. Dent Mater. 2008;24(11):1486-94.
6. Prati C, Gandolfi MG. Calcium silicate bioactive cements: biological perspectives and clinical applications. Dent Mater. 2015;31(4):351-70.
7. Koubi G, Colon P, Franquin JC, Hartmann A, Richard G, Faure MO, et al. Clinical evaluation of the performance and safety of a new dentine substitute, Biodentine, in the restoration of posterior teeth – a prospective study. Clin Oral Investig. 2013;17(1):243-9.
8. Batra R, Dixit A, Tiwari A, Kumar A, Sinha S, Badnaware S, Singh R. Comparative Evaluation of Dentinal Defects After Root Canal Preparation Using Various Nickel Titanium Files: An In Vitro Study. Cureus. 2023 May 10;15(5).