Case Report
https://doi.org/10.36377/ET-0114

Apexification of traumatized anterior teeth with blunderbuss canals using MTA putty and collagen membrane: A case report

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Abstract
INTRODUCTION. Trauma to developing permanent teeth can disrupt root formation, leading to open apices and weakened tooth structure.
AIM. This report details the non-surgical management of an 8-year-old male with blunderbuss canals in anterior teeth using mineral trioxide aggregate (MTA) putty and a resorbable collagen membrane to support apical barrier formation and healing.
MATERIALS AND METHODS. Non-surgical apexification was performed using MTA putty as the primary apical barrier material, supplemented by a resorbable collagen membrane to aid in barrier formation and periapical healing.
RESULTS. Over 12 months, clinical and radiographic follow-ups showed successful healing with no periapical pathology.

Keywords: immature teeth, blunderbuss canal, apexification, MTA putty, collagen membrane

Article info: received – 14.05.2025; revised – 06.07.2025; accepted – 20.07.2025

Conflict of interest: The authors report no conflict of interest.

Acknowledgements: There are no funding and individual acknowledgments to declare.

For citation: Singhania R., Kalra G., Hasan S.F., Nangia T., Srivastava M., Prasadh N L., Shah S., Puri N. Apexification of traumatized anterior teeth with blunderbuss canals using MTA putty and collagen membrane: A case report. *Endodontics Today.* 2025;23(3):417–422. https://doi.org/10.36377/ET-0114

Апексификация травмированных передних зубов с каналами BLUNDERBUSS с использованием MTA PUTTY и коллагеновой мембраны: отчет о случае

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Резюме
ВВЕДЕНИЕ. Травма формирующихся постоянных зубов может нарушать формирование корней, приводя к несформированным верхушкам (открытым апексам) и ослабленной структуре зуба.
ЦЕЛЬ. В данном клиническом случае представлен нехирургический подход к лечению 8-летнего мальчика с воронкообразными каналами во фронтальных зубах с применением минерального триоксидного агрегата (МТА) в виде пасты и рассасывающейся коллагеновой мембраны для формирования апикального барьера и стимулирования заживления.
МАТЕРИАЛЫ И МЕТОДЫ. Была проведена нехирургическая апексификация с использованием пасты МТА в качестве основного материала для апикального барьера, а также дополнительным применением рассасывающейся коллагеновой мембраны для поддержания барьера и заживления периапикальной области.
РЕЗУЛЬТАТЫ. В течение 12 месяцев клинического и рентгенологического наблюдения отмечалось успешное заживление без признаков периапикальной патологии.

Ключевые слова: незрелые зубы, воронкообразный канал, апексификация, паста МТА, коллагеновая мембрана

Информация о статье: поступила – 14.05.2025; исправлена – 06.07.2025; принята – 20.07.2025

Конфликт интересов: авторы сообщают об отсутствии конфликта интересов.

Благодарности: финансирование и индивидуальные благодарности для декларирования отсутствуют.

Для цитирования: Сингхания Р., Калра Г., Хасан С.Ф., Нангия Т., Шривастава М., Прасад Н Л., Шах С., Пури Н. Апексификация травмированных передних зубов с каналами BLUNDERBUSS с использованием MTA PUTTY и коллагеновой мембраны: отчет о случае. *Эндодонтия Today.* 2025;23(3):417–422. https://doi.org/10.36377/ET-0114

INTRODUCTION

Dental trauma is a common concern in young children and a leading cause of pulpal non-vitality in immature permanent incisors. Evidence shows that 13.80% to 15.10% of individuals experience trauma to permanent anterior teeth, highlighting the need for preventive strategies and early intervention [1]. Such injuries can damage the periodontium, alveolar bone, and pulp's neurovascular supply, potentially leading to pulp necrosis and long-term complications [2].

A major consequence of necrosis in immature teeth is arrested root development, resulting in open apices, blunderbuss canals, a compromised crown-to-root ratio, and thin, fragile dentinal walls, complicating conventional endodontic treatment [3]. In such cases, achieving proper cleaning, debridement, and root canal sealing becomes challenging, increasing the risk of extrusion of filling materials into periapical tissues, which can hinder healing. To prevent this, an apical calcific barrier is necessary to facilitate proper root canal filling and strengthen weakened root structures [3; 4].

Various materials have been used for apical barrier formation in apexification procedure, including calcium hydroxide, tricalcium phosphate, and osteogenic proteins, with calcium hydroxide being the gold standard [5; 6]. However, the European Academy of Paediatric Dentistry (EAPD) and Americam Association of Endodontists (AAE) recommended alternative approaches to calcium hydroxide apexification for immature necrotic teeth, favoring regenerative approaches because of its unpredictable outcomes and longer appointment time[1] [3]. In recent years, biocompatible materials like Mineral Trioxide Aggregate (MTA) and Biodentin have become increasingly preferred. MTA, a tricalcium silicate-based powder, has demonstrated excellent sealing ability, promotes the formation of mineralized tissue, improves treatment outcomes, and reduces the number of required appointments [7].

In cases involving blunderbuss canals with wide, funnel-shaped open apices, there is a heightened risk of material extrusion beyond the apex, particularly when using calcium silicate-based sealers and cements even though MTA-based apical closure has shown favorable results [8]. Despite their biocompatibility, the unintended extrusion of these materials may affect the healing of periapical lesions. Research indicates that hemostatic collagen membranes can serve as effective apical barriers, minimizing extrusion and promoting more accurate MTA placement [8; 9].

This case report presents the successful endodontic management of a traumatized immature tooth using the MTA apexification procedure with a collagen membrane as an apical barrier.

[1] American Association of Endodontists. Clinical considerations for a regenerative procedure. Revised 2021 May 18. Available at: https://www.aae.org/specialty/wp-content/uploads/sites/2/2021/08/ClinicalConsiderationsApprovedByREC062921.pdf (accessed: 27.06.2025).

CASE PRESENTATION

A 11-year-old male patient presented to the Department of Pediatric and Preventive Dentistry in the month of March, 2024 with a chief complaint of pain in the upper front tooth region for the past two days. The pain was mild to moderate, continuous, localized, and aggravated during mastication. The patient reported a history of dental trauma six months ago, which resulted in a fractured and loose tooth. Splinting was performed at a nearby dental clinic. No relevant medical history was noted.

Clinical examination revealed fracture including the enamel, dentin and pulp in relation to tooth 21 (Fig 1, *A*). The tooth was unresponsive to both electric and thermal pulp sensibility tests. Diagnostic intraoral periapical radiograph (IOPAR) and CBCT were advised. CBCT revealed a radiolucency involving the enamel, dental and pulp and a large blunderbuss canal with an open apex, accompanied by a periapical lesion (Fig. 1, *B*). Based on these findings, a diagnosis of Ellis class IV fracture with open apex and symptomatic periapical abscess involving tooth 21 was established.

The treatment plan was explained to the parents, and after thorough discussion and informed consent, it was decided to proceed with MTA apexification in conjunction with a resorbable collagen membrane placement given the presence of a blunderbuss canal with an open apex followed by esthetic rehabilition of the tooth.

The access cavity for tooth 21 was prepared using an Endo Access bur and an Endo Z bur under rubber dam isolation. The working length was established with an apex locator (Woodpecker AI motor, Guilin Woodpecker Medical Instrument Co., Ltd., Guilin, Guangxi, China) and verified radiographically using a 60K file (MANI, Inc. Tochigi, Japan). Cleaning and shaping were performed with hand K-files and ProTaper Universal rotary files (Dentsply Maillefer, Ballaigues, Switzerland) at 300 rpm speed and 2–3 NCm torque as per the manufacturer's instructions. Canal irrigation was done with 3% sodium hypochlorite, saline, and 17% EDTA using a side vented needle followed by drying with sterile paper points.

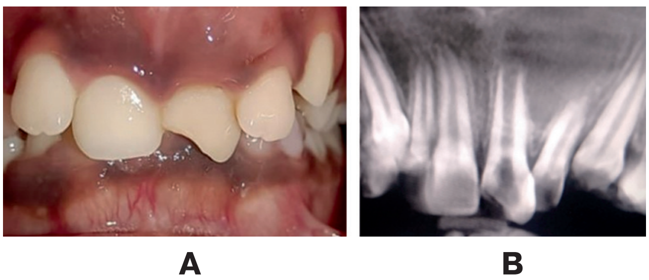


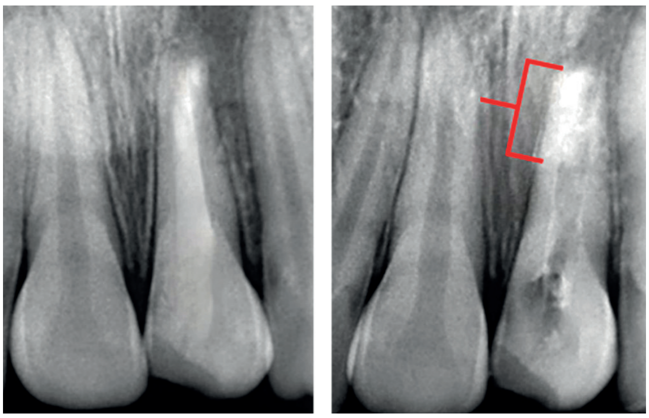
Fig. 1. Preoperative frontal view of tooth 21 in occlusion showing an Ellis Class III fracture (*A*) and preoperative CBCT image of 21 revealing an open apex with a wide blunderbuss canal (*B*)

Рис. 1. Предоперационный фронтальный вид зуба 21 в окклюзии с переломом по Эллису класса III (*A*) и предоперационное изображение КЛКТ зуба 21, демонстрирующее несформированную верхушку и широкий воронкообразный канал (*B*)

A triple antibiotic paste (TAP) (Amoxicillin, Metronidazole, and Ciprofloxacin in a 1:1:1 ratio) was applied for 21 days. The dressing was replaced with $CaOH_2$ applied every 21 days for 2 months until the patient became completely asymptomatic (Fig. 2, *A*).

After the patient became completely asymptomatic, the dressing was carefully removed, and the canal was thoroughly irrigated with a copious amount of solution to ensure complete decontamination. The canal was then dried using sterile paper points to eliminate any residual moisture. A collagen membrane (Healiguide, Advanced Biotech Products [P] Ltd., Chennai, India), precisely trimmed into a 3×3 mm square, was carefully placed at the apical region of the canal. Using a plugger (MANI, Inc., Tochigi, Japan), the membrane was gently positioned up to the predetermined working length, ensuring a proper seal and adaptation to the canal walls. To further enhance stability, an additional collagen membrane was layered above the first, creating a 1–2 mm stable base at the apical region.

Following this, MTA putty (e-MTA Putty, Kids-e-Dental LLP, Mumbai, India) was introduced into the canal using an MTA carrier. The material was incrementally placed, and each layer was carefully compacted using a plugger to form a well-adapted 5 mm apical plug, ensuring an effective seal (Fig. 2, *B*) Once the MTA had achieved its initial set, the canal was obturated with gutta-percha using a bioceramic sealer (BioActive RCS, SafeEndo Dental India Pvt. Ltd., Vadodara, India) to enhance the long-term sealing ability and biocompatibility (Fig. 3, *A*). Finally, the access cavity was restored and the crown build up was done (Fig. 3, *B*) with a light-cured composite (Beautifil II Dental Composite, Shofu Inc., Kyoto, Japan). The patient was followed up for upto 12 months (Fig. 4, *A*, *B*).



A B

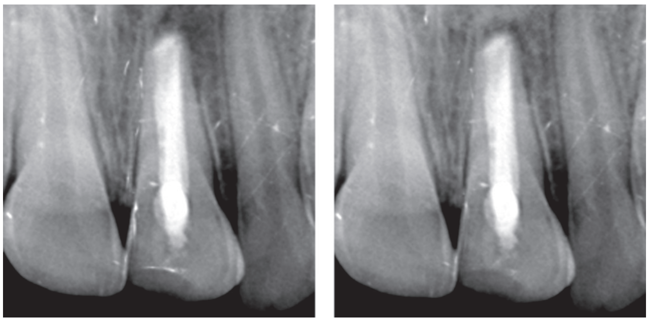
Fig. 2. Radiographic image of tooth 21: *A* – with calcium hydroxide dressing; *B* –following MTA apexification using a collagen membrane (the red mark indicates 5 mm of MTA putty placed within the canal)

Рис. 2. Рентгенологическое изображение зуба 21: *A* – с гидроксидом кальция в качестве временной лекарственной прокладки; *B* – после апексификации с применением МТА и коллагеновой мембраны (красная метка указывает на 5 мм пасты МТА, введенной в канал)

A B

Fig. 3. Immediate postoperative radiographic image of tooth 21 following obturation with gutta-percha and bioceramic sealer (*A*); clinical image of tooth 21 after composite buildup (*B*)

Рис. 3. Рентгенологическое изображение зуба 21 сразу после пломбирования гуттаперчей и биокерамическим силером (*A*); клиническое изображение зуба 21 после восстановления композитным материалом (*B*)



A B

Fig. 4. Follow-up radiographic images of tooth 21: *A* –at 6 months; *B* – at 12 months post-treatment

Рис. 4. Рентгенологические изображения зуба 21 при последующем наблюдении: *A* – через 6 месяцев; *B* – через 12 месяцев после лечения

DISCUSSION

According to the AAE, apexification remains the preferred treatment approach for managing non-vital immature permanent teeth[2]. While Calcium Hydroxide ($Ca(OH)_2$) was historically the material of choice for this procedure, it presents several limitations, including the need for multiple appointments, a prolonged treatment period (typically 12–24 months) for apical closure, unpredictable outcomes, and a reliance on patient compliance throughout the process[3] [3; 10]. To overcome these challenges, single-visit apexification techniques using biocompatible materials such as Mineral Trioxide Aggregate (MTA) and Biodentine have become more widely adopted. These materials offer faster, more predictable results with fewer appointments, enhancing both efficiency and patient satisfaction [7].

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[2] American Association of Endodontists. Clinical considerations for a regenerative procedure. Revised 2021 May 18. Available at: https://www.aae.org/specialty/wp-content/uploads/sites/2/2021/08/ClinicalConsiderationsApprovedByREC062921.pdf (accessed: 27.06.2025).

[3] Ibid.

MTA is ideal for treating open apices due to its excellent sealing ability and ability to set in the presence of moisture or blood [8]. It promotes hard tissue formation, cementogenesis, and osteogenesis by creating a biocompatible environment that supports cell activity [9]. Its high pH gives it antibacterial properties, while its dense seal prevents bacterial ingress, aiding periapical healing [4; 7]. These characteristics made it the preferred material in our case.

Although newer biomimetic materials like Biodentine have gained popularity due to their improved handling properties and faster setting times, MTA was preferred in our case. This decision was based on its superior marginal adaptation [11], reduced microleakage [12], and more predictable apical barrier formation [13] when compared to Biodentine, particularly in wide or blunderbuss canals [14]. Additionally, the extended setting time of conventional MTA, along with the challenges associated with achieving the optimal consistency during manipulation, are often considered limitations. To overcome these drawbacks, a pre-mixed MTA putty was utilized in this case.

It offered a significantly faster setting time compared to traditional MTA and came with a standardized, ready-to-use consistency, facilitating easier handling. The MTA putty allowed for improved working time, enabling precise placement and condensation within the complex canal anatomy [15]. It offered enhanced adaptability in irregular spaces, and set more rapidly than conventional MTA. These properties made MTA putty the material of choice for achieving a reliable and biologically favorable outcome in the present case.

In this case, a 5 mm apical plug of MTA was placed using an MTA carrier, followed by careful condensation with hand pluggers. This thickness was selected based on literature evidence suggesting that a 5 mm apical barrier offers superior sealing ability and resistance to microleakage compared to thinner plugs of 1 mm or 2 mm [16; 17]. Although ultrasonic condensation is an alternative technique for MTA placement, the use of hand pluggers in this case allowed for better control, adaptation, and compaction of the material with fewer voids within the wide apical region [18].

To prevent the extrusion of MTA into the periapical tissues, a resorbable collagen membrane was placed at the apex, serving as a biological scaffold against which the MTA could be compacted [8]. This not only provided a stable base for the material but also helped in maintaining the integrity of the periapical space and supporting optimal healing conditions. Acting as a scaffold, resorbable collagen sponges assist in platelet aggregation, clot stabilization, and tissue healing by attracting fibroblasts and enhancing blood vessel formation at the injury site. Additionally, studies have shown that using collagen sponges in apexification procedures may encourage alveolar bone regeneration [8; 9].

CONCLUSION

The application of pre-mixed MTA putty in this case enabled successful apexification by establishing a reliable apical barrier and creating an environment conducive to periapical tissue healing. The effective outcome was achieved through a combination of appropriate apical plug thickness, and the use of a resorbable collagen matrix to prevent material extrusion. This case reinforces the clinical effectiveness of MTA in treating non-vital immature permanent teeth and supports its continued preference as a material of choice in similar endodontic treatments.

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AUTHOR’S CONTRIBUTION

Rashika Singhania – Contributed to the conception of the case report, data acquisition, analysis, and was responsible for drafting and writing the entire manuscript.

Gauri Kalra – Supervised the case report, provided critical guidance throughout the preparation process, and participated in the final review and approval of the manuscript.

Tanu Nangia – Supervised the clinical case, offered professional oversight, and contributed to the final review and approval of the manuscript.

Madhulika Srivastava – Provided supervision during the clinical case, gave critical input on manuscript development, and assisted with the final review and approval.

Syed Fazil Hasan – Assisted with the literature review and preparation of clinical documentation.

Lakshmi Prasadh N – Supported the literature review process and contributed to organizing clinical data and documentation.

Sakshi Shah – Participated in patient management and contributed to data interpretation.

Namrata Puri – Involved in patient management and assisted with interpreting the clinical findings.

ВКЛАД АВТОРОВ

Р. Сингхания – участвовала в разработке концепции клинического случая, сборе данных, их анализе, а также была ответственна за написание и редактирование основного текста рукописи.

Г. Калра – курировала ведение клинического случая, оказывала критическое сопровождение на всех этапах подготовки работы и участвовала в итоговом рецензировании и утверждении рукописи.

Т. Нангия – осуществляла руководство клиническим случаем, предоставляла профессиональные рекомендации и принимала участие в финальном рецензировании и утверждении рукописи.

М. Шривастава – осуществляла контроль за ведением случая, предоставляла экспертные замечания при написании рукописи и участвовала в окончательной редактуре и утверждении текста.

С.Ф. Хасан – принимал участие в подготовке литературного обзора и оформлении клинической документации.

Л.Прасад Н – помогала в сборе литературных данных и участвовала в систематизации клинической документации.

С. Шах – участвовала в ведении пациента и интерпретации клинических данных.

Н. Пури – принимала участие в ведении пациента и оказывала помощь в интерпретации клинических наблюдений.