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Endodontic treatment of teeth with a wide apical opening – a clinical case

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Abstract
INTRODUCTION. The prevalence of apical periodontitis among the adult population exceeds 60%. This disease also occurs in adolescents in permanent teeth, and it is often detected in a state where the growth zone has died, and it is not possible to treat with calcium hydroxide to achieve apexogenesis. Therefore, there is a need to find and apply the most optimal dental materials for the treatment of dental periodontitis in adolescents.
AIM. Presentation of our own clinical case of endodontic treatment of a tooth with a wide apical opening.
MATERIALS AND METHODS. The article presents the result of treatment of a 15-year-old girl with an established diagnosis according to ICD-10: tooth 2.6 – K04.5 Chronic apical periodontitis (chronic granulomatous periodontitis). The tactics of dental care were aimed at stimulating apexification with calcium hydroxide-based filling material Metapaste (Meta Biomed, South Korea). The functional parameters of the tooth have been restored. The stability of the obtained result was assessed 3 months after the treatment using CBCT of the causal tooth.
CONCLUSIONS. The presented clinical case demonstrates the successful endodontic treatment of a tooth in a teenager, in which treatment tactics aimed at stimulating apexification were applied. Observation of the patient for 1.5 years confirmed the success of the therapy, which manifested itself in the formation of the dentinal bridge and the positive dynamics of the tooth condition. The use of the calcium hydroxide-based drug Metapaste (Meta Biomed, South Korea) played a key role in achieving a stable clinical result. This case highlights the importance of timely and adequate dental intervention to achieve optimal treatment outcomes. A pediatric dentist should have the skills to use modern methods of treating periodontitis of permanent teeth with a wide apical opening to choose the best approach to therapy.

Keywords: wide apical opening, endodontic treatment, apexification, calcium hydroxide, periodontitis

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Эндодонтическое лечение зубов с широким апикальным отверстием – клинический случай

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Резюме
ВВЕДЕНИЕ. Распространенность апикального периодонтита среди взрослого населения превышает 60%. Также данное заболевание встречается у подростков в постоянных зубах, причем часто выявляется в состоянии, когда зона роста погибла, и нет возможности провести лечение с применением гидроксида кальция для достижения апексогенеза. Поэтому возникает необходимость в поиске и применении наиболее оптимальных стоматологических материалов для лечения периодонтита зубов у подростков.
ЦЕЛЬ ИССЛЕДОВАНИЯ. Представление собственного клинического случая эндодонтического лечения зуба с широким апикальным отверстием.
МАТЕРИАЛЫ И МЕТОДЫ. В статье приведен результат лечения девочки 15 лет с установленным диагнозом по МКБ-10: зуб 2.6 – K04.5 Хронический апикальный периодонтит (хронический гранулематозный периодонтит). Тактика оказания стоматологической помощи была направлена на стимулирование апексификации пломбировочным материалом на основе гидроксида кальция «Metapaste» («Meta Biomed», Южная Корея). Восстановлены функциональные параметры зуба. Стабильность полученного результата оценена через 3 месяца после проведенного лечения с использованием КЛКТ причинного зуба.
ВЫВОДЫ. Представленный клинический случай демонстрирует успешное эндодонтическое лечение зуба у подростка, в рамках которого была применена тактика лечения, направленная на стимулирова-

ние апексификации. Наблюдение за пациентом на протяжении 1,5 лет подтвердило успешность терапии, что проявилось в формировании дентинного мостика и положительной динамики состояния зуба. Использование препарата на основе гидроксида кальция «Metapaste» («Meta Biomed», Южная Корея), сыграло ключевую роль в достижении стабильного клинического результата. Данный случай подчеркивает важность своевременного и адекватного стоматологического вмешательства для достижения оптимальных исходов лечения. Врач-стоматолог детский должен обладать навыками применения современных методов лечения периодонтитов постоянных зубов с широким апикальным отверстием для выбора наилучшего подхода к терапии.

Ключевые слова: широкое апикальное отверстие, эндодонтическое лечение, апексификация, гидроксид кальция, периодонтит

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INTRODUCTION

Dental caries and its complications are widespread among people of all age groups worldwide. The lack of timely diagnosis and treatment of caries can lead to severe disorders both in the maxillofacial region and in general health conditions [1].

According to 2019 data, the prevalence of caries in permanent teeth among 15-year-old adolescents in Russia reached 82%, and the DMFT index (Decayed, Missing, and Filled Teeth) was recorded at 3.7 [2].

The prevalence of apical periodontitis among the adult population exceeds 60% [3]. This condition is also observed in adolescents with permanent teeth. However, to date, there is no scientifically confirmed data on the prevalence of apical periodontitis in adolescents. At the same time, according to the data from the State Autonomous Healthcare Institution of Arkhangelsk Region "ADSP," 38,346 cases of children seeking dental care for caries of both primary and permanent teeth were recorded. Of these, 1,682 cases involved complicated caries of permanent teeth, including 338 cases requiring endodontic treatment with temporary root canal filling.

The clinical and morphological features of periodontitis development in adolescents, as well as anatomical characteristics, pose challenges in developing effective treatment strategies that dentists face in outpatient practice [4; 5]. Such features include: irregular cross-sectional shape of the unformed apical foramen; widening of the canal lumen from the orifice toward the apex; pronounced funnel-shaped expansion in the apical third of the root canal; thin and weak root canal walls; low mineralization of root dentin; absence of anatomical apical constriction; and a wide apical foramen lumen [4].

Endodontic treatment of permanent teeth without an apical constriction presents difficulties in determining the working length. As a result, damage to periapical tissues and extrusion of necrotic tissue debris into these tissues may occur, promoting the ingrowth of granulation tissue into the root canals. A wide apical foramen complicates both mechanical and chemical preparation of the canals, as well as obturation. Definitive root canal filling is only possible after the complete formation of a reliable and solid apical barrier at the root apex [6; 7].

In cases of apical periodontitis of a permanent tooth with a wide apical foramen and necrotic root growth zone, a treatment strategy aimed at stimulating apexification may be applied. This process involves the formation of a calcified barrier (dentin bridge) of osteocement within the root canal. The result of apexification is the closure of the apex at the full anatomical root length [5].

According to clinical studies, A.L. Frank (1966) identified the following types of apexification:

1) closure of the root apex in a normal anatomical shape;

2) closure of the root apex in a dome-shaped form while the root canal remains funnel-shaped;

3) absence of radiographic changes despite the presence of a "positive stop" symptom;

4) presence of a "positive stop" symptom and radiographically detectable barrier at the anatomical apex [8].

Although the types of dentin bridges differ structurally, the mechanism of their formation is similar. The use of calcium hydroxide is recommended to promote the formation of a calcified barrier [5].

AIM

Presentation of a clinical case of endodontic treatment of a tooth with a wide apical foramen.

MATERIALS AND METHODS

The report was prepared in accordance with the principles of *The CARE Guidelines: Consensus-based Clinical Case Reporting Guideline Development*, allowing for a detailed and structured presentation of the clinical case.

A 15-year-old male patient presented to the dental clinic with complaints of discomfort when biting in the region of a tooth in the upper left jaw. The medical history revealed that the tooth had previously caused concern and had been treated, but neither the patient nor his mother, who accompanied him, could recall exactly when this occurred.

Extraoral examination showed no facial asymmetry. The mucous membrane of the alveolar process at the projection of the root apices was unchanged, well

vascularized, and the contours of the marginal and alveolar gingiva were preserved. No sinus tract was detected, and the tooth exhibited no mobility. Vertical and horizontal percussion tests were painful, and the tooth showed no response to thermal stimuli (cold or heat).

To clarify the diagnosis, cone-beam computed tomography (CBCT) was performed (Fig. 1). The examination revealed an area of intense shadow corresponding to the limits of previous filling material in the lower third of the coronal portion of tooth 2.6, with an area of radiolucency underneath indicating carious involvement. The tooth had three straight roots and four root canals.

The palatal root was found to be incompletely developed; while root length formation was complete, the apex remained open. The palatal root canal was irregularly widened, showing a wide apical foramen. The palatal canal contained filling material within the upper two-thirds of its length, with the apical third remaining unfilled. The mesiobuccal (MB1 and MB2) and distobuccal canals were free of filling material throughout their lengths.

A radiolucent periapical lesion with distinct borders measuring 8.55 × 11.72 mm was observed in the axial plane at the apex of all three roots. The periodontal ligament space was unevenly widened around all three roots. The cortical plate remained intact, while the interdental septa were flattened.

Following comprehensive clinical and radiographic assessment, the diagnosis was made according to ICD-10: tooth 2.6 – K04.5 Chronic apical periodontitis (chronic granulomatous periodontitis).

A multi-visit treatment plan was adopted. After rubber dam isolation, the old restoration was removed, caries excavation and access cavity preparation were performed. Canal retreatment was conducted using the Endo-Mate TC2 endomotor (NSK, Japan) and Protaper Retreatment files (Dentsply Sirona, USA). Instrumentation was completed with NiTi files to ISO size 35.02.

The canals were irrigated with 3% sodium hypochlorite (“Belodez 3%”, Vladmiva, Russia) and 17% ethylenediaminetetraacetic acid (EDTA, Vladmiva, Russia) [9; 10]. Each canal received 20 mL of solution for 1 minute, followed by activation and drying.

Sodium hypochlorite effectively dissolves organic tissue and eliminates microbial flora due to its cytotoxicity, but alone it does not provide complete debridement of the canal system. EDTA-based solutions help to remove inorganic debris, enhance file penetration, and facilitate canal shaping [9; 10].

Since instrumentation and irrigation only reduce bacterial load, further steps were taken to eliminate pathogenic microorganisms. A long-term calcium hydroxide dressing (“Metapaste”, Meta Biomed, South Korea) containing calcium hydroxide and barium sulfate was placed for intracanal medication [11–13].

The main advantage of calcium hydroxide is its ability to stimulate apical closure and promote the formation of a hard tissue barrier. Calcium hydroxide dissociates into ions that activate alkaline phosphatase, the key enzyme for tissue mineralization. The optimal pH for enzyme activity ranges from 8.6 to 10.3, promoting calcium phosphate crystal formation, reducing capillary permeability, inhibiting osteoclast activity, and slowing bone resorption [14].

Studies show that periapical tissue healing and calcific barrier formation occur rapidly in the presence of calcium hydroxide [15], largely due to the formation of osteocement, a cement-like tissue [5]. Calcium hydroxide creates an alkaline environment (pH 12.5), which has antibacterial properties and promotes necrotic tissue lysis. The high pH stimulates osteoblast activity and suppresses osteoclasts, thereby promoting bone formation.

The gradual ionization of calcium hydroxide releases hydroxyl ions that disrupt bacterial cytoplasmic membranes, leading to protein denaturation and DNA damage. Research indicates that an effective apical barrier forms in the absence of microorganisms and under the antimicrobial action of calcium hydroxide [4; 15; 16].

“Metapaste” (Meta Biomed, South Korea) provides high radiopacity. For temporary coronal sealing, “Parasept” (Vladmiva, Russia) was used.

It should be noted that one of the advantages of calcium hydroxide is the possibility of removing up to 80% of the material from the root canal, which allows it to be used for a period of up to three weeks [6; 12; 17]. Authors emphasize that calcium hydroxide gradually

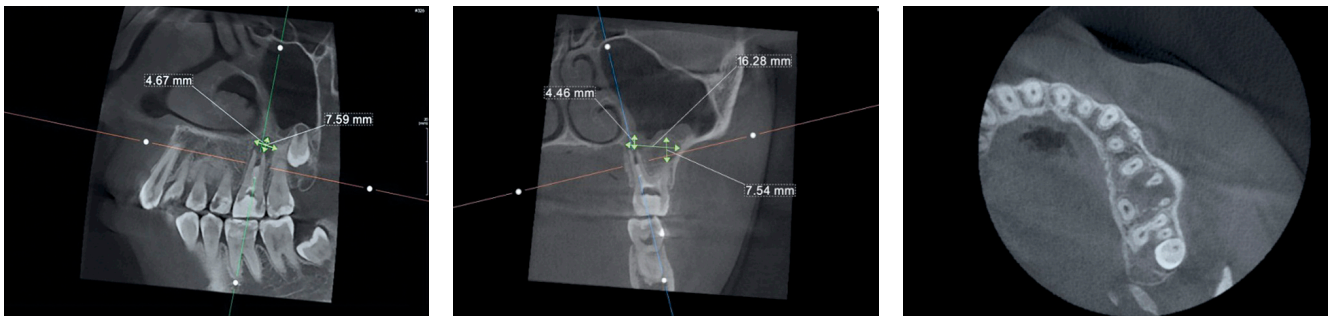

Fig. 1. The initial clinical situation. CBKT of the tooth 2.6:
A – sagittal section; *B* – coronal section; *C* – axial section

Рис. 1. Исходная клиническая ситуация. КЛКТ зуба 2.6:
A – сагиттальный срез; *B* – корональный срез; *C* – аксиальный срез

dissolves in the root canal, necessitating multiple applications. A follow-up visit is recommended after 7–10 days. If at the control appointment the paste appears moist, loose, or completely dissolved, it should be replaced with a fresh portion. However, if the paste remains dry and effectively obturates the root canal, no replacement is necessary, and the next follow-up is scheduled after three months [6].

At the same time, the optimal duration of calcium hydroxide therapy for periodontitis remains a topic of debate among researchers [6]. Some specialists caution against prolonged use due to potential risks such as degradation of dentin proteins and weakening of the tooth structure, which can result in a twofold reduction of tooth elasticity within one year of therapy initiation. There is also a significant risk of reinfection due to possible inadequacy of the temporary restoration, potentially prolonging treatment and worsening the prognosis [6; 16].

According to the *National Guidelines for Pediatric Therapeutic Dentistry* (2017), radiographic control should be performed at 3 and 6 months, with monitoring continued until clear radiographic and clinical signs of apexification are present. The formation of a hard tissue barrier sufficient for subsequent canal obturation typically occurs within 6 to 24 months (average 1 year ± 7 months) after the start of treatment. During this time, the patient must attend clinical check-ups every 3 months [6].

Based on these recommendations, the patient was recalled after 10 days to assess the condition of "Metapaste" (Meta Biomed, South Korea) within the root canals. The paste was found to be dry and had completely filled the canals. The patient was then recalled at 3, 6, 12, 15, and 18 months for replacement of "Metapaste" (Meta Biomed, South Korea) and clinical and radiographic monitoring [18].

Over a period of 1.5 years, the patient regularly attended follow-up appointments and radiographic examinations. By the end of this period, a dentin bridge of sufficient thickness had formed, allowing for the second stage of treatment – permanent root canal obturation using "AH Plus" sealer (Dentsply Sirona, USA) and gutta-percha points by lateral condensation technique (Fig. 2). During the same visit, the anatomical shape of the tooth was restored using composite restorative material.

Three months later, at the follow-up appointment, CBCT showed positive dynamics: no signs of inflammation were present, and a well-formed dentin bridge was observed (Fig. 3). A dense radiopaque area corresponding to the limits of the filling material was visible in the lower third of the coronal part of tooth 2.6. The tooth had three straight roots, and all four root canals showed a continuous, homogeneous shadow of filling material along their entire length. A dentin bridge was visualized in the apical third of the palatal canal. No changes were observed in the periapical area. The periodontal ligament space was within normal limits. The cortical plate was intact, and the interdental septa were flattened.

DISCUSSION

The treatment of periodontitis in permanent teeth with wide apical foramina in adolescents, aimed at stimulating apexification with calcium hydroxide-based materials, requires careful and individualized clinical management. This treatment approach promotes the formation of a reliable dentin bridge, which protects the periapical tissues and contributes to the progressive closure of the apical foramen.

The results of this clinical case confirm the high effectiveness of calcium hydroxide, which not only stimulates tissue regeneration but also possesses antiseptic properties that significantly reduce the risk of complications. It is important to note that timely intervention is a key factor for the successful restoration of dental health in adolescents.

The management of periodontitis in teeth with a wide apical foramen presents a challenging task that demands a meticulous approach and the use of modern diagnostic and therapeutic methods. One of the most promising materials for apexification stimulation is "Metapaste" (Meta Biomed, South Korea).

The main advantage of this therapeutic strategy lies in the ability of calcium hydroxide to create a dentin bridge, which is essential for preventing reinfection and preserving the tooth. Although the ready-to-use root canal filling material "Metapaste" (Meta Biomed, South

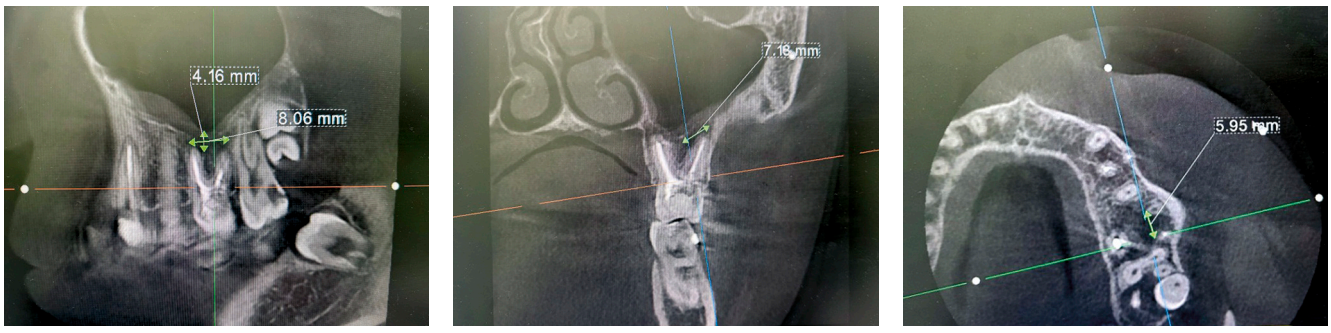

Fig. 2. The result of treatment. CLT of the tooth 2.6 immediately after permanent filling of the root canals:
A – sagittal section; *B* – coronal section; *C* – axial section

Рис. 2. Результат лечения. КЛКТ зуба 2.6 сразу после постоянного пломбирования корневых каналов:
A – сагиттальный срез; *B* – корональный срез; *C* – аксиальный срез

Korea) demonstrates good biocompatibility and biological activity, it must be noted that this treatment protocol requires a prolonged therapy period with multiple clinical visits to monitor the tooth condition and assess outcomes. This increases patient inconvenience and raises the overall time and financial costs of treatment.

Based on the treatment outcomes, it can be assumed that the success of "Metapaste" (Meta Biomed, South Korea) largely depends on the initial condition of the periapical tissues: the less pronounced the inflammatory changes, the higher the likelihood of successful dentin bridge formation. The need for repeated visits is often dictated by the complexity of the clinical situation, highlighting the importance of thorough diagnostics prior to treatment initiation.

Therefore, a personalized approach must be adopted, taking into account the individual characteristics of the patient and the extent of tooth damage. Careful diagnosis and evaluation of the periapical tissues are key factors for selecting the optimal treatment strategy. Regular clinical monitoring during and after treatment allows for early detection of possible complications and timely adjustment of the therapy plan.

It is also essential to inform patients about the treatment process, potential risks, and the need for repeated visits, as this increases their awareness and fosters trust in the treatment process.

RESULTS

The reduction in the size of the periapical radiolucencies indicates the success of the chosen treatment strategy. Follow-up CBCT images in the coronal plane (Fig. 1–3) clearly illustrate this process: initially, the size of the periapical lesion at the palatal and distobuccal roots measured 6.08 mm and 7.23 mm, respectively. After 1.5 years of treatment, permanent root canal obturation was performed.

A follow-up CBCT scan taken 3 months later showed near-complete resolution of the periapical lesion at the palatal root, while the size of the lesion at the distobuccal

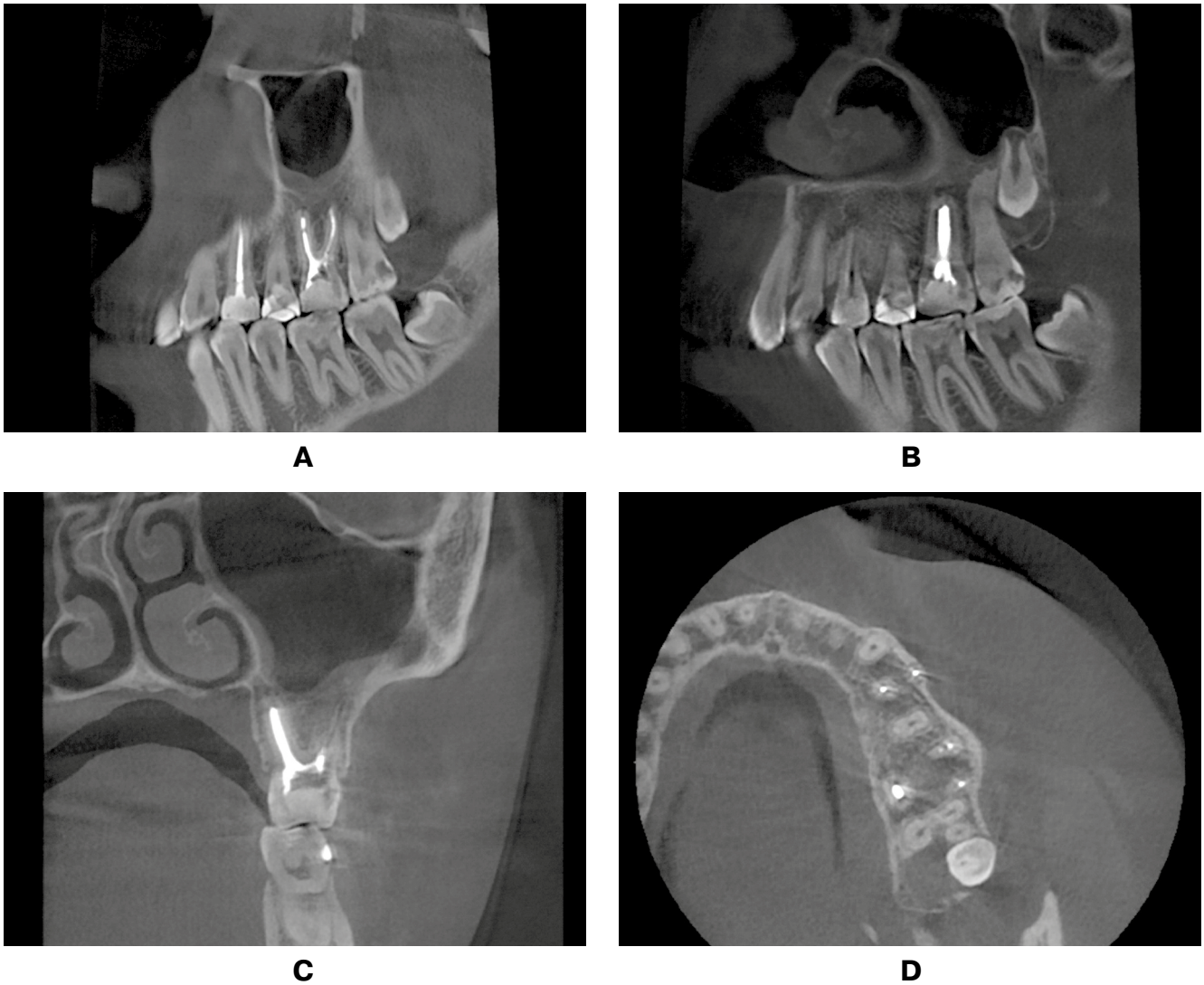

Fig. 3. Dynamic observation after 3 months. CBKT of the tooth 2.6:
A, *B* – sagittal section; *C* – coronal section; *D* – axial section

Рис. 3. Динамическое наблюдение спустя 3 месяца. КЛКТ зуба 2.6:
A, *B* – сагиттальный срез; *C* – корональный срез; *D* – аксиальный срез

root had decreased to 4.39 mm. Continued monitoring with control radiographs at 6 and 12 months was recommended to assess the periodontal condition.

Contact with the patient has been maintained, and the patient has reported no complaints. However, the patient has not attended the scheduled radiographic examinations for further assessment of the treatment outcome of the periodontitis.

CONCLUSION

Thus, the use of "Metapaste" (Meta Biomed, South Korea) for the treatment of periodontitis in a tooth with a wide apical foramen is an effective method, but it requires careful management and consideration of the individual characteristics of each case to achieve the best possible outcomes.

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