Cold Ceramic for Repairing Perforations: A Case Series

Ali Chamani[1], Maryam Forghani[1], and Ghazal Asadi[1]

[1]Mashhad University of Medical Sciences

October 01, 2024

Cold Ceramic for Repairing Perforations: A Case Series

Introduction

Root perforation may happen at any point during endodontic treatments, resulting in communication between the root canal and the surrounding tissues. It can have a pathological origin. However, they are mostly iatrogenic, potentially contributing to up to 10% of unsuccessful endodontic procedures. Perforation negatively influences the prognosis of the tooth. The prognosis depends on the extent of the initial damage to the periodontal tissues, the location of the perforation to the gingival sulcus, the size, the duration of time between the occurrence of the injury and the subsequent treatment, the efficiency of the perforation seal, the presence of microorganisms and contamination at the perforation site, the repairing material, and the final restoration [1,2]. Hence, choosing the most suitable material is crucial [3].

The requirements of an ideal repair material have been described in the literature, including favorable sealing properties, biocompatibility, lack of toxicity, non-carcinogenicity, radiopacity, moisture tolerance, permanence, insolubility, and inexpensiveness. Moreover, it should be easy to manipulate and capable of inducing cementogenesis and osteogenesis [1,4]. Cold Ceramic (CC), a mineral trioxide aggregate (MTA)-like compound, can serve various purposes such as root-end filling material, an apical barrier in teeth with open apices, root perforation repair, pulp capping, and pulpotomy[5]. The characteristics of CC include exquisite sealing ability, biocompatibility, nontoxicity, noncarcinogenicity, radiopacity, easy handling, and minimal adverse effects on tissues. Therefore, CC can be used as the root filling and the perforation repair material[3,6].

Modaresi et al. demonstrated periodontal ligament formation at the root end of teeth after apexification with CC, indicating the potential for cementum formation on the CC surface. Tissue regeneration around the root confirms the positive effects of CC on bone repair and periapical lesion healing [7]. An animal-based research study showed that the presence of CC leads to the development of new bone, cementum, and periodontal ligament in over fifty percent of the samples[6].

The potential of CC material for endodontic applications has been successfully demonstrated. However, existing research on the clinical usage of this material still needs to be investigated. Thus, further studies should be conducted to boost the current knowledge and address the existing gaps [8,9]. This study aims to further investigate the efficiency and clinical outcomes of using CC to repair root perforations by presenting three different cases.

Case series

Three patients were referred to the endodontic department of the faculty of dentistry at Mashhad University of Medical Sciences. All cases were managed by nonsurgical endodontic treatment using CC to repair the perforations. Written informed consent was obtained from patients in every case after explaining the diagnosis, treatment plan, and potential risks to the patients. The procedures conducted for all patients are described below, with detailed radiographic and photographic figures.

Case 1

Case History

A 42-year-old male patient was referred for the right mandibular first molar (tooth #30). The patient's medical history revealed no significant systemic conditions that would contraindicate endodontic treatment.

Examination

Clinical examinations revealed a pocket depth of 10 mm and a coronal abscess of tooth #30 (Figure 1-1). Radiographic examinations showed a former root canal filling of tooth #30. Additionally, two distinct perforations with relatively extensive lesions were diagnosed: a strip perforation located in the coronal half of the mesiobuccal canal and an apical perforation of the mesiolingual canal (Figure 1-2).

Treatment

Following the administration of local anesthetics (2% lidocaine and epinephrine 1:100,000) (Daroupakhsh, Tehran, Iran) and rubber dam isolation, the access was prepared using a high-speed diamond round bur No. 2 (Jota AG, Rüthi, Switzerland) under magnification (Carl Zeiss, Meditec Inc., Dublin, CA, USA) (Figures 1-3 and 1-4). After locating the canals' orifices, Canal-filling materials were removed using size one Gates-Glidden (MANI gates drills, MANI, Japan) and H-files (MANI H-files, MANI, Japan). In addition to radiographic images, both perforations were confirmed using an apex locator (Dempex, DEM Ltd., Barnstaple, Devon, England) (Figure 1-5). The working length was also assessed with an apex locator (Dempex, DEM Ltd., Barnstaple, Devon, England) and radiographic image (Figure 1-6).

Cleaning and shaping were completed by crown-down technique with M3 rotary files (UDG, Changzhou, China) up to size 25/04 under repeated irrigation with 5.25% sodium hypochlorite and sterile saline. The extensive coronal perforation was covered with PTFE tape before using sodium hypochlorite. Root canals were dried with sterile paper points (META, Chugbuk, South Korea). The distal canals were obturated with gutta-percha (META, Chugbuk, South Korea) and AH plus sealer (Dentsply DeTrey, Konstanz, Germany) using the warm vertical technique by FastFill warm obturator (Fast Fill Obturation System, Eighteeth, China).

Following the manufacturer's instructions, the strip perforation was sealed with CC (SJM, Iran). CC (SJM, Iran) was carried into the perforation site using MAP One carrier (Maillefer, Dentsply, Switzerland), under a dental operating microscope (Carl Zeiss, Meditec Inc., Dublin, CA, USA), and a size 20 finger plugger (Maillefer, Dentsply, Switzerland) was used to compact CC (SJM, Iran) (Figure 1-7). A #25 K-file (Mani Inc., Utsunomiya, Japan) was placed in the mesiobeccal canal with strip perforation as a space maintainer (Figure 1-8) [1]. The file was carefully and slowly loosened after cc's initial setting so that it can be easily removed when it sets completely. In order to prevent occlusal interference, the handle of the K-file was cut and covered with Cavit (Cavisol, Tehran, Iran).

At the one-week follow-up appointment, the coronal and apical abscesses were still detectable (Figure 1-9). The apical perforation of the mesiolingual canal was sealed with CC (SJM, Iran), and the mesial canal obturation was completed (Figures 1-10 and 1-11). The mesial canal's orifices were covered with Glass-ionomer (GC Fuji I, Tokyo, Japan) to keep the sealing material intact (Figure 1-12), and the pulp chamber was covered with Cavit (Cavisol, Tehran, Iran).

Postoperative Care

Postoperative guidance were given to the patient, including oral hygiene instructions and analgesic medication (Ibuprofen 400 mg) for postoperative symptoms. Five weeks later, the radiographic examination showed an acceptable root canal filling and complete perforation seal with CC (SJM, Iran) (Figure 1-13). The patient was referred for the final restoration after confirming the lack of clinical signs and symptoms. The twelve-month follow-up exhibited no clinical signs or symptoms and the healing of the lesion and pocket-depth, indicating sufficient coronal and apical seal with favorable periradicular healing and regeneration (Figures 1-14 and 1-15).

Case 2

Case History

A 26-year-old male patient was referred for incomplete endodontic treatment of the left mandibular first molar (tooth #19) due to perforation (Figure 2-1). The patient's medical history showed no systemic disorders and contraindications to endodontic treatment.

Examination

Clinical examination revealed swelling and abscess in the tissues surrounding the tooth (Figure 2-2). Concurrent furcal and strip perforation with lesions were noted in the radiological examination. Calcification of the canals was presumed to be the probable cause of the perforations (Figure 2-3).

Treatment

The treatment was started by administering local anesthetics (2% lidocaine and epinephrine 1:100,000) (Daroupakhsh, Tehran, Iran) and placing a rubber dam. Under magnification (Carl Zeiss, Meditec Inc., Dublin, CA, USA), the temporary restoration was removed (Figure 2-4). After locating all the orifices (Figure 2-5) and estimating the working length with apex locator (Dempex, DEM Ltd., Barnstaple, Devon, England) and radiographic image (Figure 2-6), chemo-mechanical debridement was completed by crown-down technique with M3 rotary files (UDG, Changzhou, China) up to size 25/04 and frequent irrigation with 5.25% sodium hypochlorite and sterile saline.

Following drying the canals with paper points (META, Chugbuk, South Korea), the distal canal and the apical two-thirds of mesial canals were obturated with gutta-percha (META, Chugbuk, South Korea), and AH plus sealer (Dentsply DeTrey, Konstanz, Germany) using the warm vertical technique by FastFill warm obturator (Fast Fill Obturation System, Eighteeth, China). The coronal third of the mesial canals were filled with CC (SJM, Iran) to seal the strip perforation. The furcal perforation was also sealed using CC (SJM, Iran) following the manufacturers' order using MAP One carrier (Maillefer, Dentsply, Switzerland) and condensed by a #20 finger plugger (Maillefer, Dentsply, Switzerland) (Figure 2-7). Cavit (Cavisol, Tehran, Iran) was placed as the temporary restoration (Figures 2-8 and 2-9).

Postoperative Care

Postoperative guidance were given, including oral hygiene instructions and analgesic medication (Ibuprofen 400 mg) for postoperative symptoms. The patient was referred for permanent restoration after confirming the lack of clinical signs and symptoms in the two-week follow-up. In the three-month follow-up, the patient did not complain of any symptoms, and radiographic examination exhibited favorable signs of healing and regeneration in the perforation areas (Figures 2-10 and 2-11)

Case 3

Case History

A 31-year-old female patient was referred with a complaint of left maxillary second premolar (tooth #13). A problematic endodontic treatment was done three years ago, and recently, the patient has been experiencing severe pain and was forced to use analgesic medicine. A review of her medical history indicated a good health condition and no systemic disorder.

Examination

A 31-year-old female patient was referred with a complaint of left maxillary second premolar (tooth #13). A problematic endodontic treatment was done three years ago, and recently, the patient has been experiencing severe pain and was forced to use analgesic medicine. Clinical examination indicated a spontaneous pain accompanied by swelling of soft tissues, excessive bleeding on probing (BOP), and an 8 mm probing depth (Figure 3-1). Radiographic examinations exhibited coronal and apical lesions and mesial perforation. Further examinations revealed that the palatal canal was missed, and an iatrogenic canal extending into the bone was made and obturated due to perforation (Figure 3-2).

Treatment

After anesthesia (2% lidocaine and epinephrine 1:100,000) (Daroupakhsh, Tehran, Iran) and rubber dam isolation, the access was prepared using a high-speed diamond round bur No. 2 (Jota AG, Rüthi, Switzerland) under magnification (Carl Zeiss, Meditec Inc., Dublin, CA, USA) (Figure 3-3). The retreatment was done using size one Gates-Glidden (MANI gates drills, MANI, Japan) for canals' obturation material and H-files (MANI H-files, MANI, Japan) for perforation's obturation material. Upon locating the canals' orifices, including the missed canal, the working length was determined with the apex locator (Dempex, DEM Ltd., Barnstaple, Devon, England) and radiographic image (Figure 3-4).

After chemo-mechanical debridement of the tooth by crown-down technique with M3 rotary files (UDG, Changzhou, China) up to size 25/04 with 5.25% sodium hypochlorite and sterile saline solution, the canals were obturated with gutta-percha (META, Chugbuk, South Korea) and AH plus sealer (Dentsply DeTrey, Konstanz, Germany) using the warm vertical technique by FastFill warm obturator (Fast Fill Obturation System, Eighteeth, China). The perforations were sealed with CC (SJM, Iran) following the manufacturer's instructions using MAP One carrier (Maillefer, Dentsply, Switzerland) and a #20 finger plugger (Maillefer, Dentsply, Switzerland) (Figure 3-5). The Cavit (Cavisol, Tehran, Iran) was used as the temporary restoration (figure 3-6).

Postoperative Care

The patient received postoperative guidance, including oral hygiene instructions and analgesic medication (Ibuprofen 400 mg) for postoperative symptoms. After confirming the lack of signs or symptoms, the patient was referred for the final restoration (figure 3-6). In the eight-month follow-up, the patient did not complain of any signs or symptoms. The examinations displayed the healing of periodontal tissues with the elimination of BOP and reduced probing depth to 3 mm (Figure 3-7). Furthermore, the control radiograph showed favorable healing of the bone and lesions (Figure 3-8)

Conclusion

Successful perforation repair requires an effective perforation seal, bone and periodontium regeneration, and the eradication of any infection, all of which were successfully achieved in the presented cases. Considering the obtained results and the complexities associated with root perforations, it can be concluded that CC is an appropriate repairing material due to its favorable properties.

Discussion

Numerous factors may contribute to root perforation, including pulp stones, calcifications, resorptions, tooth malposition, extra-coronal restorations, or intracanal posts. Perforation may lead to an inflammatory response associated with degeneration of periodontal tissues and alveolar bone. Depending on the extent of the injury and potential risk of bacterial infection and inflammation, it may lead to the formation of granulation tissue, swelling, suppuration, periodontal pocket, alveolar bone resorption, and, in severe cases, extraction of the involved tooth [1,2,10]. Solid coronal seal, bone regeneration, and eradication of infection are necessities for a successful perforation repair [3]. The aim of repairing a root perforation is to preserve the integrity of the adjacent periodontium to prevent inflammation, attachment loss, and tissue regeneration in the event of periodontal breakdown [10].

Perforation management is challenging, and its prognosis depends on numerous factors, including the repairing material. Many materials have been used for perforation repair. However, many have proven inadequate due to insufficient sealing ability or biocompatibility. Consequently, new bioactive materials, such as mineral trioxide aggregate (MTA), Biodentine, and other bio-ceramic materials, have been suggested for perforation treatment because of their superior properties and favorable clinical outcomes [4,10].

MTA has been the most widely used material for repairing root perforations [1,2,11]. Clinical studies have demonstrated that MTA provides a biocompatible and durable root perforation seal with a high success rate. MTA promotes cementum regeneration due to its excellent biocompatibility and osteoconduction properties, thereby facilitating the regeneration of the periodontium[1]. With increasing research on bioceramic materials, the selection of perforation-repairing materials is expanding[12].

Cold ceramic (CC) was first introduced in 2000 by Modaresi from Yazd University, Iran [8]. CC is an MTA-like material that can serve multiple purposes. Like other repairing materials, CC is biocompatible and nontoxic, and multiple studies have approved its biocompatibility [13-15]. Modaresi et al. conducted a comparative analysis of the tissue responses to CC and MTA in rats. The results exhibited that MTA induced less inflammatory responses in a short observation period. However, CC might be more biocompatible for slightly extended periods. Nevertheless, both MTA and CC were confirmed to be biocompatible [14]. Additionally, CC can trigger cementum deposition, bone formation, and periodontal ligament regeneration upon contact with tissues [7].

The sealing ability and marginal adaptation of CC have been assessed through various methods [8,16,17]. An in vitro study compared the sealing properties of MTA and CC in different environments using a dye penetration test. The results indicated that the sealing property of CC is better than MTA in blood-contaminated conditions and similar to MTA in dry and saliva-contaminated conditions[17]. Mokhtari et al. compared the marginal adaptation of CC with MTA using scanning electron microscopy. They concluded that both materials exhibited equivalent marginal adaptation, although there was a tendency toward higher interfacial adaptation in CC [16].

The bond strength of most materials is significantly reduced by moisture contamination from the tissue. In contrast, MTA sets in the presence of moisture and blood [1]. Consequently, set MTA can reach optimal strength and produce an excellent seal in the presence of tissue fluids, which do not affect its sealing ability. This characteristic is similar to CC, a calcium hydroxide-based material, and its powder contains fine hydrophilic particles that set in the presence of moisture[8]. In the present case series, a completely dried-out site was not attainable due to perforations. Nevertheless, the favorable outcomes observed during follow-up indicate the excellent performance of CC in the presence of moisture and blood.

According to the literature, MTA is the repairing material of choice in most cases. Yet, in some cases, MTA presents certain limitations, therefore necessitating the consideration of alternative materials. The main disadvantage of some available MTA formulations is the extended setting time. In such clinical situations, preference should be given to other bioactive materials with shorter setting times[1]. It is reported that the primary setting time of CC is about 15 min, which is significantly shorter than MTA, which has been reported to be around 165 min. Furthermore, the complete setting of CC occurs within 24 hours [17,18].

Perforation size negatively affects the treatment prognosis. This was one of the challenges of the presented cases. The results showed that they were successfully treated with CC. Another challenging factor is the duration between injury and repair. In the third case, three years had passed since the perforation was created, and based on the literature, the prognosis was unfavorable. The perforation was sealed using CC, and the eight-month follow-up exhibited complete healing of the perforation's signs and symptoms.

The aim of repairing a perforation is to achieve mechanical and biological sealing of the connection between the periradicular tissues and the root canals using a biocompatible material that facilitates a favorable tissue healing response [19]. The postoperative radiograph showed that this had been achieved in all presented cases. Additionally, some material was extruded into the tissues, indicating that similar to MTA, CC exhibits minimal adverse effects on healing responses and periradicular tissues[1,3], which was confirmed in the presented cases. Nevertheless, further studies are recommended in this field.

In addition to the current case series, CC has been successfully used in another study for strip perforation treatment [3]. In this study and previous studies, no clinical signs or symptoms in the postoperative follow-up were noted, and the control radiograph has consistently exhibited remarkable tissue healing and regeneration[3]. Moreover, several clinical studies have demonstrated the efficiency of CC in various treatments, including root canal therapy and periapical lesions treatment, thereby further confirming its reliability [5,6]

Evidence confirms that perforations can be successfully repaired with meticulous cleaning and shaping, sufficient disinfection, proficient handling of the repair material, and sufficient filling, followed by appropriate coronal restoration [20]. Nonetheless, additional studies are recommended to investigate the clinical outcomes of CC in long-term follow-ups and to further compare CC with other bio-ceramic materials in clinical practice.

Author Contributions:

Ali Chamani: Conceptualization (equal); Investigation and Resources (lead); Visualization (supporting) ; review (supporting).

Maryam Forghani: Conceptualization (equal); Supervision (lead); validation (lead); review (lead).

Ghazal Asadi: Visualization (lead); Writing – original draft (lead); Writing – review and editing (lead).

References

https://doi.org/10.1111/etp.12075

1. Clauder T. Repair of Pulp Chamber and Root Perforations.*Endodontic Advances and Evidence-Based Clinical Guidelines* . 2022:475-510.2. Estrela C, Decurcio DA, Rossi-Fedele G, Silva JA, Guedes OA, Borges A H. Root perforations: a review of diagnosis, prognosis and materials. *Braz Oral Res* . Oct 18 2018;32(suppl 1):e73. doi:10.1590/1807-3107bor-2018.vol32.00733. Modaresi J, Parashos P, Mousavi R, Mirzaeeian A, Almodaresi Z. Treatment of strip perforation using cold ceramic. *Dent Res J (Isfahan)* . 2023;20:31. 4. Kakani AK, Veeramachaneni C, Majeti C, Tummala M, Khiyani L. A Review on Perforation Repair Materials. *J Clin Diagn Res* . Sep 2015;9(9):Ze09-13. doi:10.7860/jcdr/2015/13854.65015. Modaresi J, Yazdani Rostam A, Mahini F, Nasr N. Cold Ceramic as a Root Canal Filling Material: A Case Series. *Journal of Dental School, Shahid Beheshti University of Medical Sciences* . 06/16 2024;42(1):49-55. doi:10.22037/jds.v42i1.441846. Modaresi J, Nasr N. Nonsurgical Endodontic Management of Large Periapical Lesion with Cold Ceramic: A Literature Review and Case Series. *Iran Endod J* . 2023;18(2):113-121. doi:10.22037/iej.v18i2.401847. Modaresi J, Almodaresi z, Mousavi R, Mirzaeeian A. Successful Root Canal Treatment with Cold Ceramic: A Case Report. *Journal of Mashhad Dental School* . 2021;45(3):309-313. doi:10.22038/jmds.2021.52768.19568. Modaresi J, Hemati HR. The cold ceramic material. *Dental Research Journal* . 2018;15(2):85-88. 9. Khedmat S, Sarraf P, Seyedjafari E, Sanaei-Rad P, Noori F. Comparative evaluation of the effect of cold ceramic and MTA-Angelus on cell viability, attachment and differentiation of dental pulp stem cells and periodontal ligament fibroblasts: an in vitro study. *BMC Oral Health* . Dec 7 2021;21(1):628. doi:10.1186/s12903-021-01979-110. Siew K, Lee AH, Cheung GS. Treatment Outcome of Repaired Root Perforation: A Systematic Review and Meta-analysis. *J Endod* . Nov 2015;41(11):1795-804. doi:10.1016/j.joen.2015.07.00711. Silva RAB, Borges ATN, Hernandez-Gaton P, et al. Histopathological, histoenzymological, immunohistochemical and immunofluorescence analysis of tissue response to sealing materials after furcation perforation. *Int Endod J* . Oct 2019;52(10):1489-1500. doi:10.1111/iej.1314512. Wang Z. Bioceramic materials in endodontics. *Endodontic Topics* . 2015;32(1):3-30. doi:13. ZARE JAHROMI M RSM, BRAHIMI B. . THE COMPARATIVE EFFECT OF COLD CERAMIC AND PROROOT ON THE INFLAMMATION OF PERIODONTAL TISSUES AFTER SEALING FURCAL PERFORATION IN DOG TEETH (A HISTOLOGIC STUDY).*Journal of Dental School, Shahid Beheshti University of Medical Sciences* . 2007;24(4):439-446. 14. Modaresi J, Yavari SA, Dianat SO, Shahrabi S. A comparison of tissue reaction to MTA and an experimental root-end restorative material in rats. *Aust Endod J* . Aug 2005;31(2):69-72. doi:10.1111/j.1747-4477.2005.tb00229.x15. Mozayeni MA, Salem Milani A, Alim Marvasti L, Mashadi Abbas F, Modaresi SJ. Cytotoxicity of Cold Ceramic Compared with MTA and IRM. *Iran Endod J* . Summer 2009;4(3):106-11. 16. Mokhtari F, Modaresi J, Javadi G, Davoudi A, Badrian H. Comparing the Marginal Adaptation of Cold Ceramic and Mineral Trioxide Aggregate by Means of Scanning Electron Microscope: An In vitro Study. *J Int Oral Health* . Sep 2015;7(9):7-10. 17. Hasheminia SM, Nejad SL, Dianat O, Modaresi J, Mahjour F. Comparing the sealing properties of mineral trioxide aggregate

and an experimental ceramic based root end filling material in different environments.*Indian J Dent Res* . Jul-Aug 2013;24(4):474-7. doi:10.4103/0970-9290.11839918. Parirokh M, Torabinejad M. Mineral trioxide aggregate: a comprehensive literature review–Part I: chemical, physical, and antibacterial properties. *J Endod* . Jan 2010;36(1):16-27. doi:10.1016/j.joen.2009.09.00619. Pace R, Giuliani V, Pagavino G. Mineral trioxide aggregate as repair material for furcal perforation: case series. *J Endod* . Sep 2008;34(9):1130-3. doi:10.1016/j.joen.2008.05.01920. Pontius V, Pontius O, Braun A, Frankenberger R, Roggendorf MJ. Retrospective evaluation of perforation repairs in 6 private practices. *J Endod* . Nov 2013;39(11):1346-58. doi:10.1016/j.joen.2013.08.006**Figures' Legends**

Figure 1-1: Clinical examination revealing abscess and deep pocket.

Figure 1-2: A periapical radiographic image showing the lesions around the mesial root.

Figure 1-3: After removing the filling material, massive bleeding is visible.

Figure 1-4: Clinical view of the perforations.

Figure 1-5: A periapical radiographic image showing the strip perforation.

Figure 1-6: Working length assessment and the apical perforation.

Figure 1-7: Repair of the strip perforation with CC.

Figure 1-8: A periapical radiographic image showing the #25 K-file as the space maintainer.

Figure 1-9: A periapical radiography image showing the 10 mm deep pocket of tooth #30.

Figure 1-10: A periapical radiograph showing the negotiation of the perforated canal to the estimated working length.

Figure 1-11: Repair of the perforations with CC.

Figure 1-12: Covering CC with Glass-ionomer.

Figure 1-13: Postoperative radiograph.

Figure 1-14: Clinical examination revealing no signs of inflammation.

Figure 1-15: Twelve-month postoperative radiograph shows favorable healing of the lesions.

Figure 2- 1: A periapical radiographic image showing the misposition of the file due to strip perforation.

Figure 2-2: Clinical examination of tooth #19 exhibiting swelling and abscess.

Figure 2-3: A periapical radiographic image demonstrates furcal and coronal lesions.

Figure 2-4: Clinical view after removing the temporary filling material.

Figure 2-5: Clinical view after locating the actual orifices.

Figure 2-6: Negotiation and working length assessment.

Figure 2-7: Repair of the perforations with CC.

Figure 2-8: Postoperative radiograph.

Figure 2-9: Postoperative angled radiograph showing the furcal and strip perforation.

Figure 2-10: Clinical examinations showing no signs of inflammation.

Figure 2-11: Three-month follow-up shows no signs of inflammation.

Figure 3-1: Clinical examination revealing a deep pocket in the mesial of tooth #13.

Figure 3-2: A periapical radiograph image showing coronal and apical lesion due to mesial perforation and missed canal.

Figure 3-3: Clinical view of the mesial perforation.

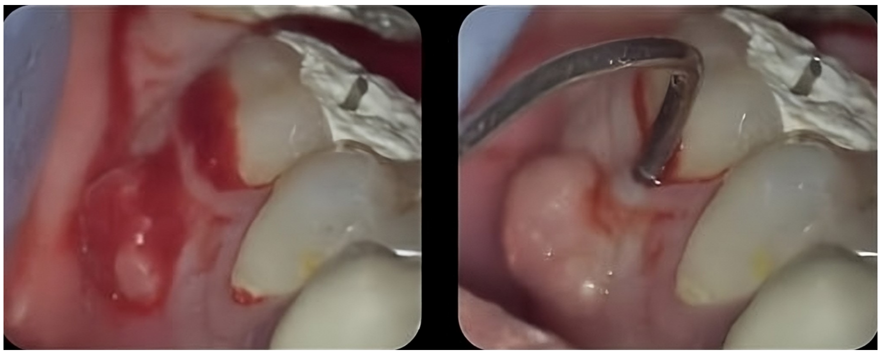
Figure 3-4: Working length assessment.

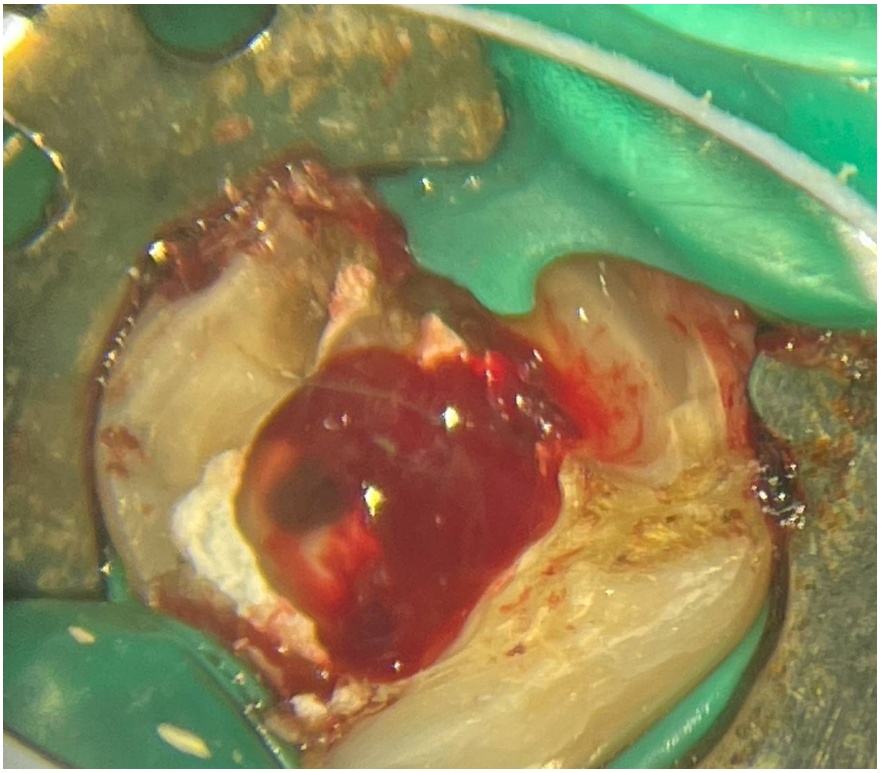
Figure 3-5: Repair of the mesial perforation with CC.

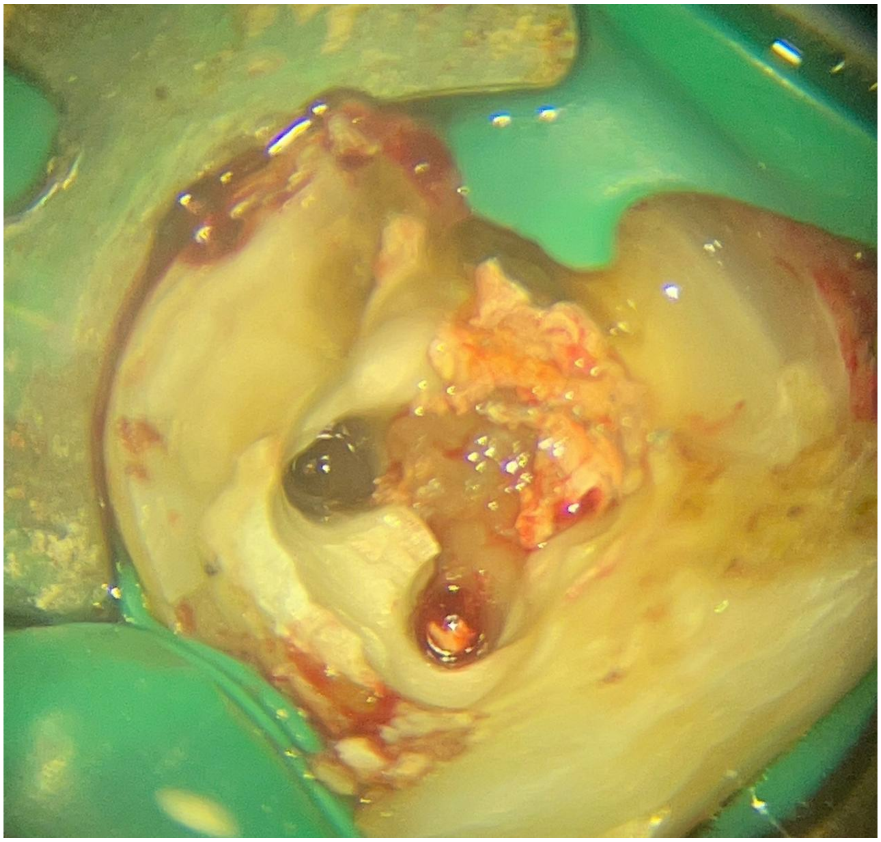
Figure 3-6: Postoperative radiograph.

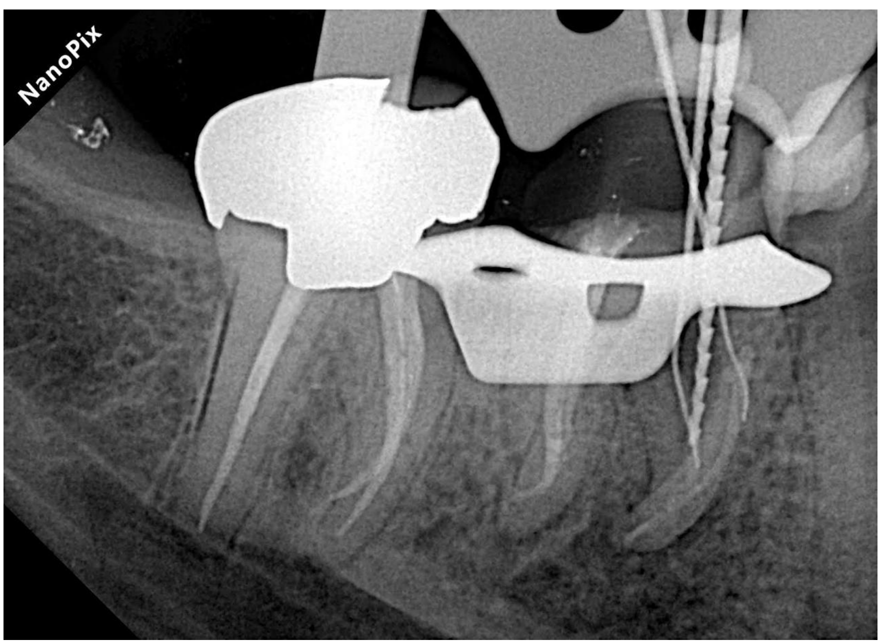
Figure 3-7: Clinical examination showing no sign of inflammation or deep pocket.

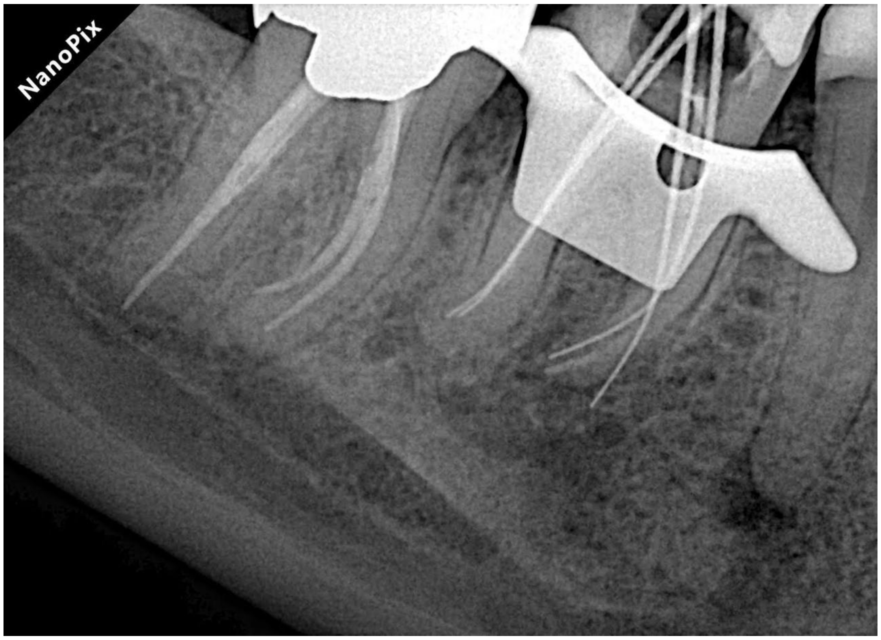
Figure 3-8: Eight-month follow-up shows no signs of inflammation.

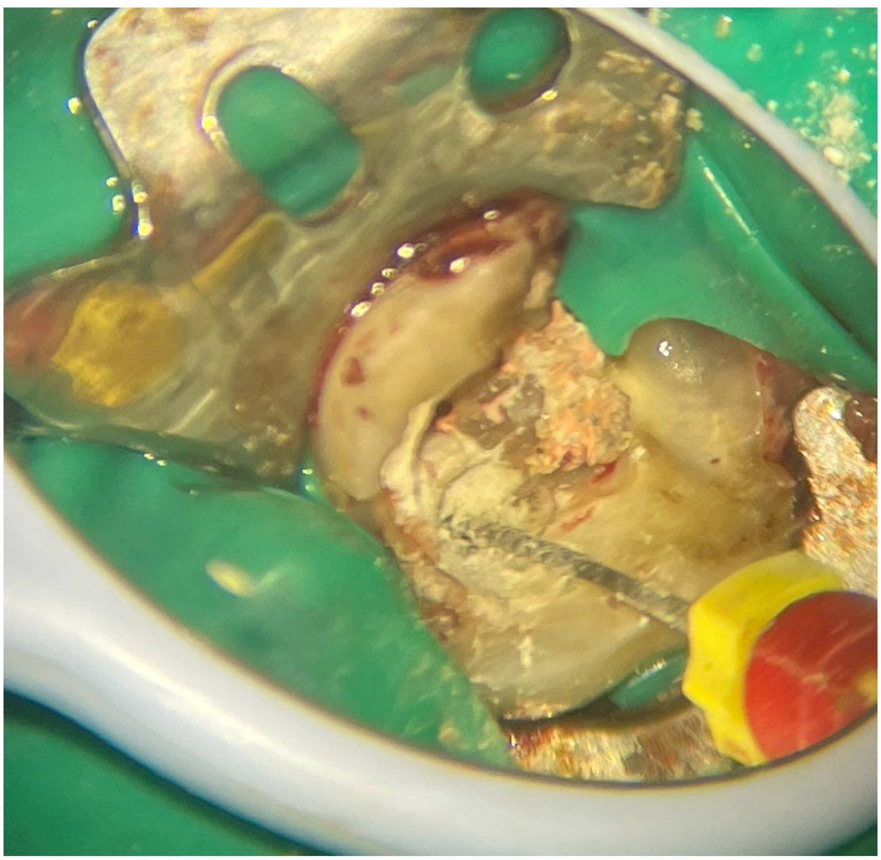






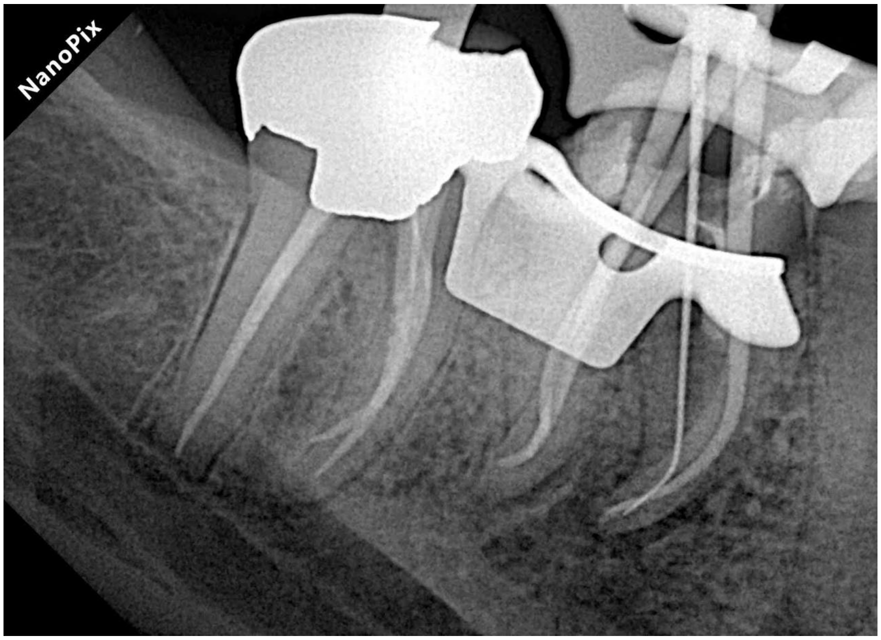

NanoPix

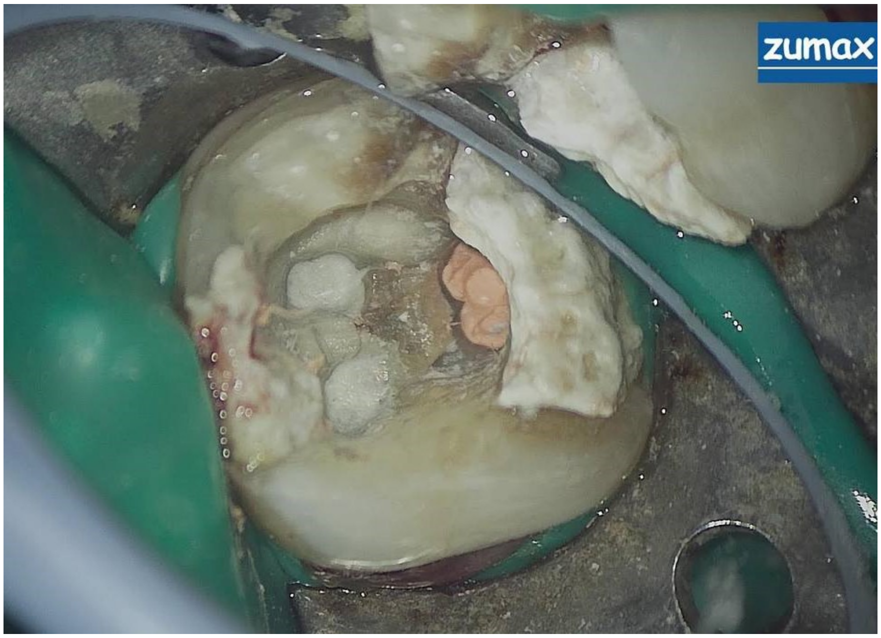

NanoPix

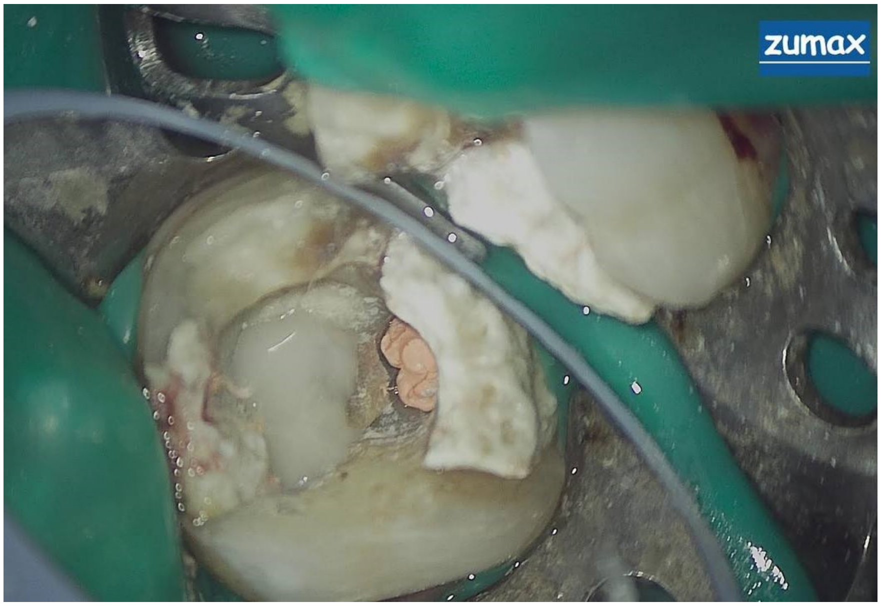


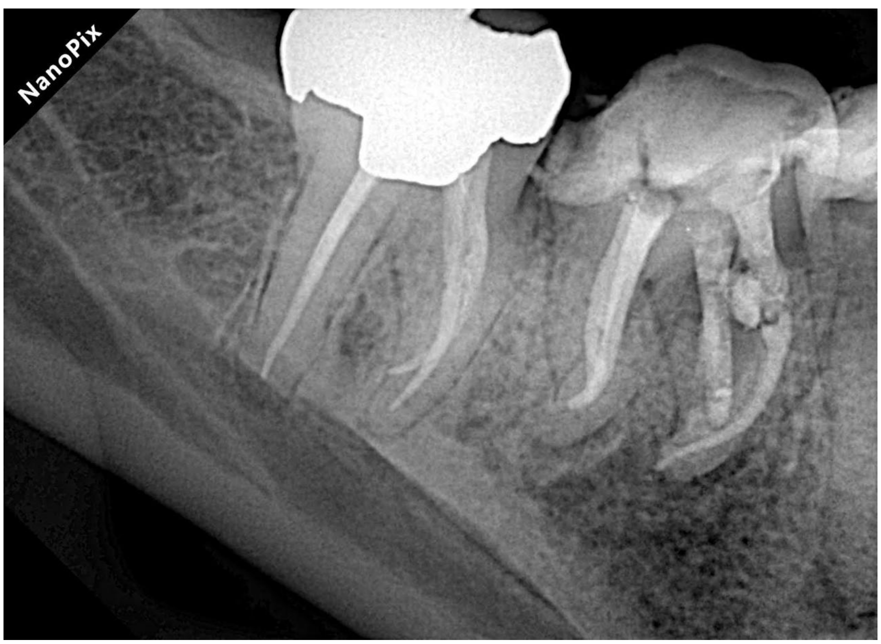

NanoPix


NanoPix

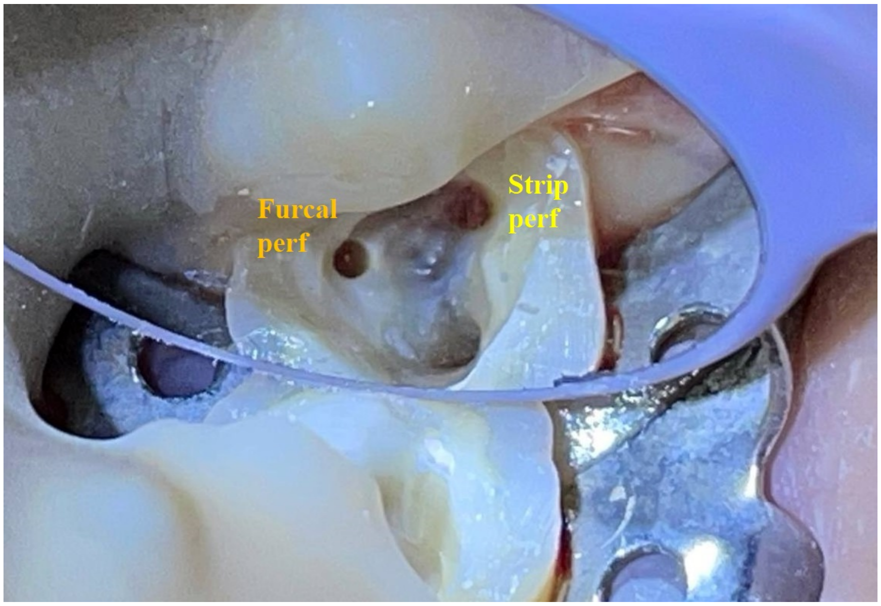

NanoPix

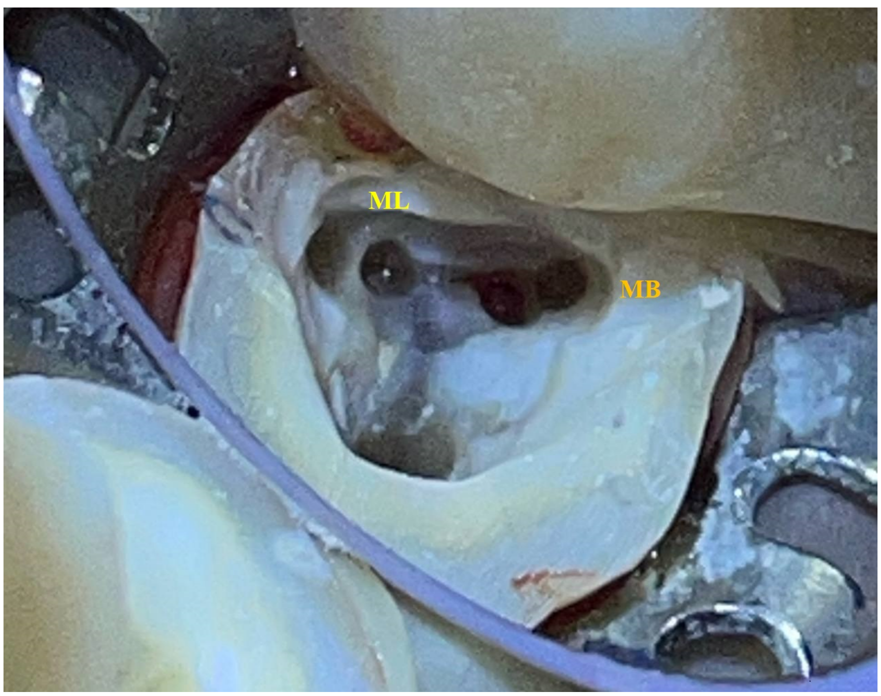

zumax

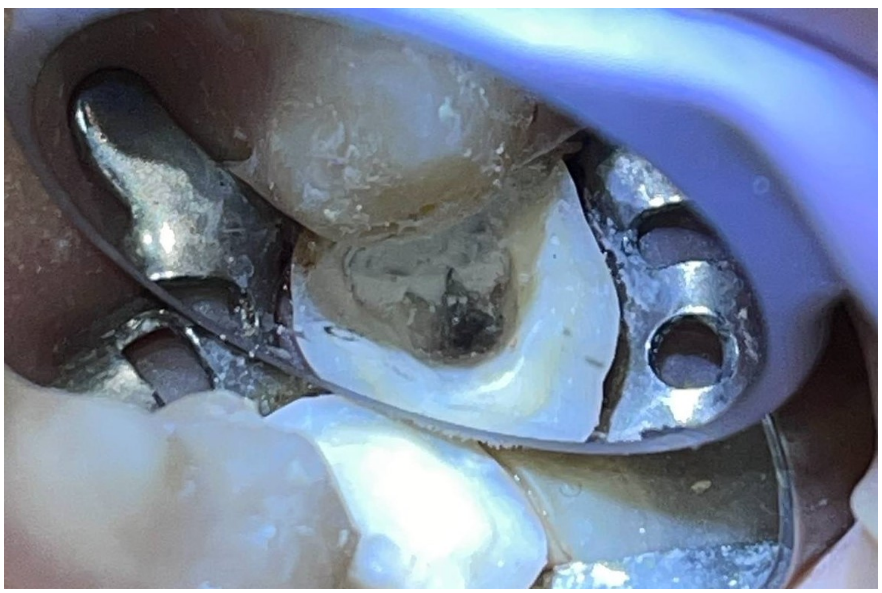

zumax

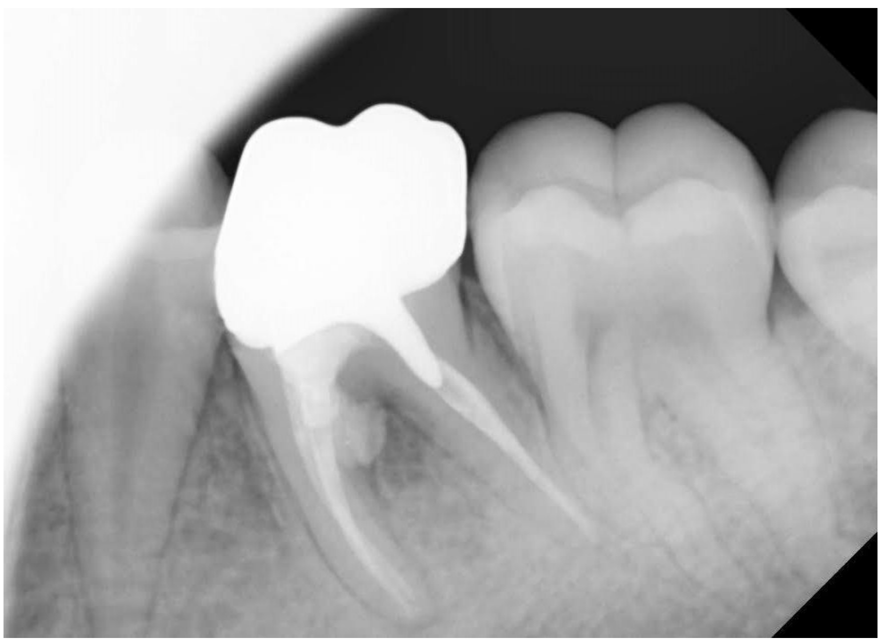

NanoPix

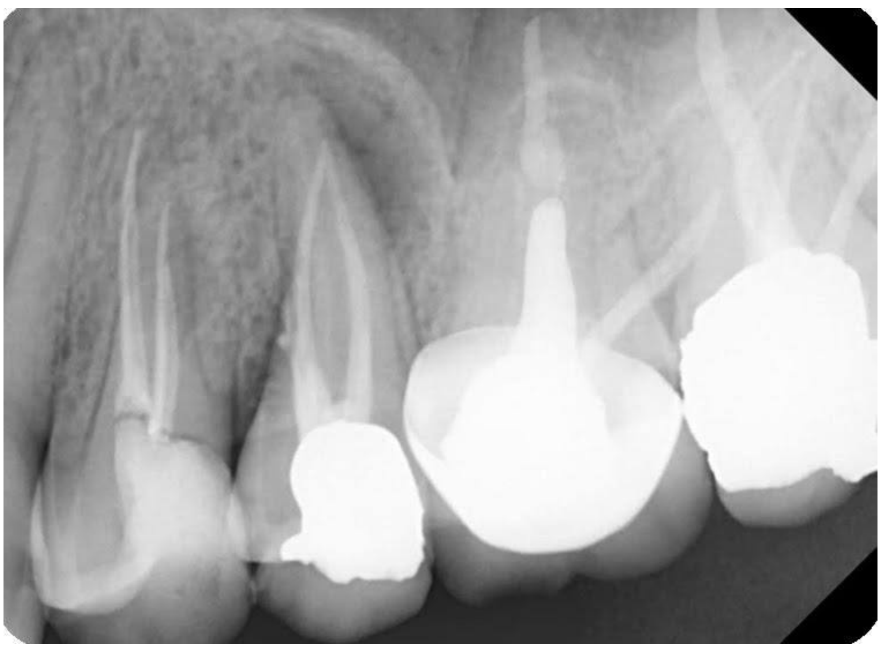

NanoPix

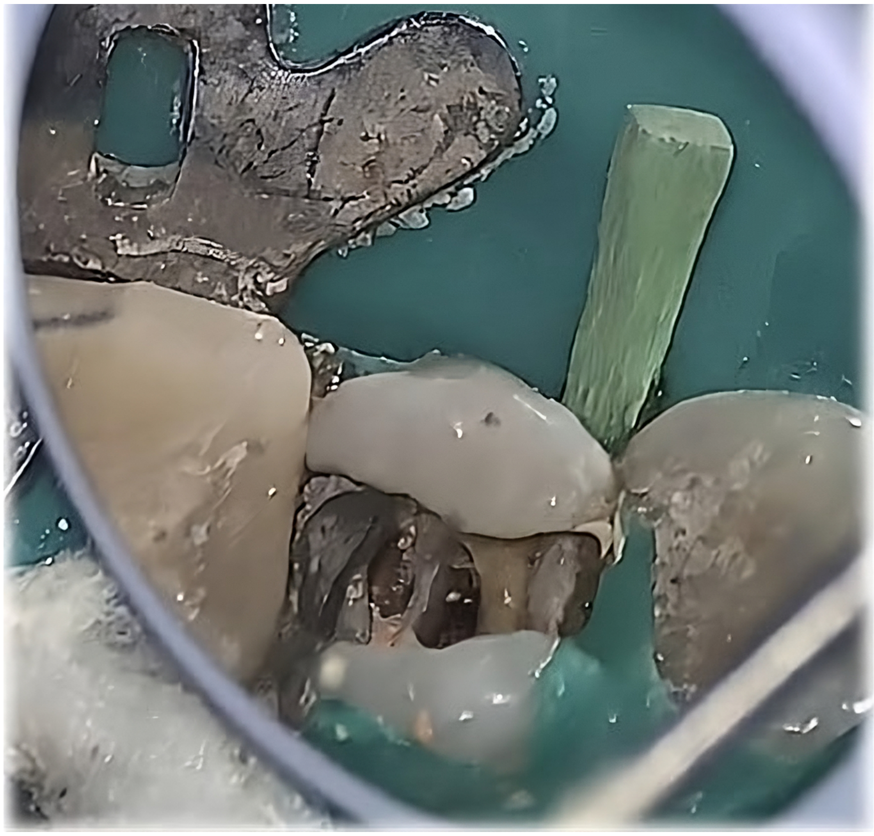

Furcal perf
Strip perf

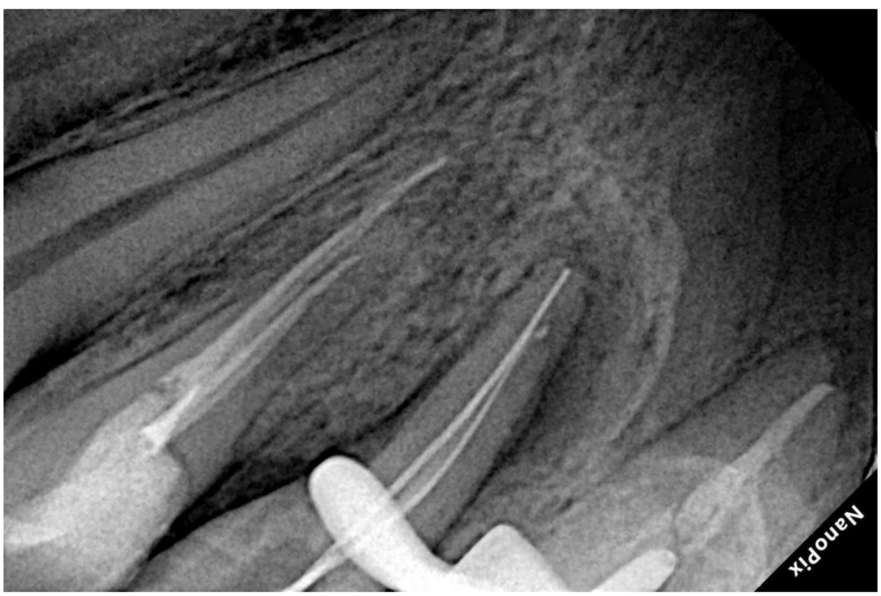

ML
MB

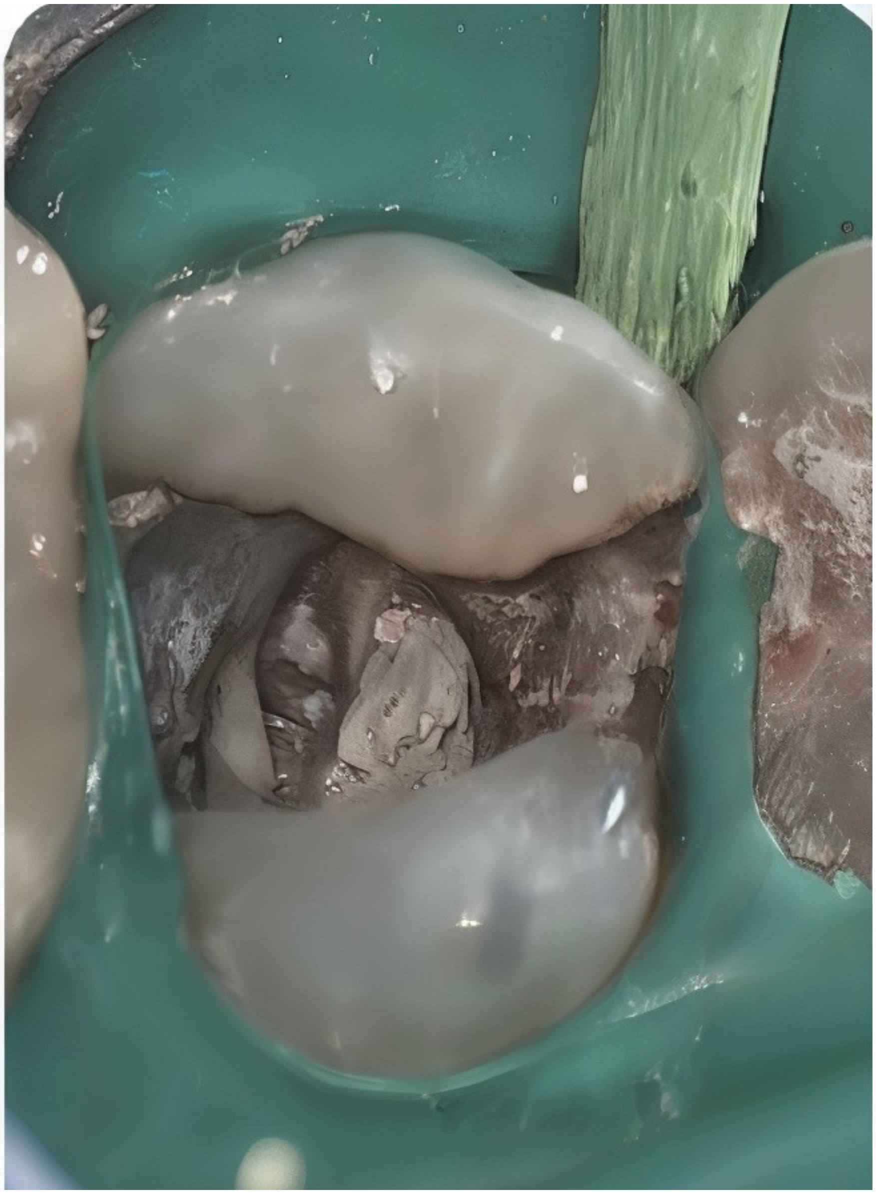


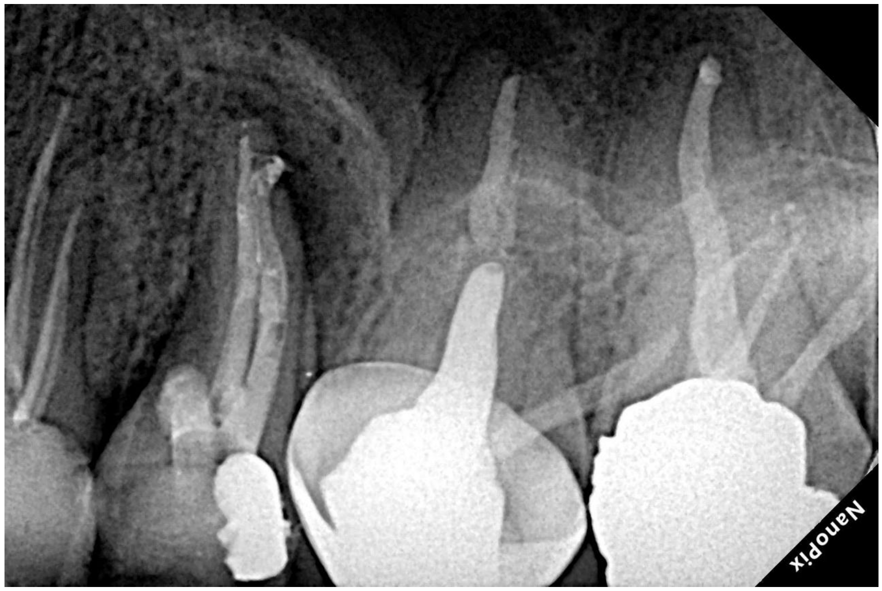







NanoPix




NanoPix