JOMADS
Journal of Maxillofacial and Dental Sport Science

OPEN ACCESS
Journal of Maxillofacial and Dental Sport Science **2026**, Volume 1, Issue 1
E-ISSN Online: xxxx-xxxx
https://doi.org/10.26470/jomads.v1i1.53181

Case Report

Non-Surgical Endodontic Retreatment of Anterior-Lateral Teeth Following Secondary Endodontic Infection: A No-Post Monolithic Zirconia Rehabilitation After Metal Post Removal

Nadia Dwi Maharani[1*]

[1]Department of Dentistry, Faculty of Medicine, Universitas Negeri Surabaya

[*]**Correspondence:** Nadia Dwi Maharani, DDS. Department of Dentistry, Faculty of Medicine, Universitas Negeri Surabaya, Surabaya, East Java, Indonesia. Email: nadiamaharani@unesa.ac.id

Citation: Maharani ND. Non-Surgical Endodontic Retreatment of Anterior-Lateral Teeth Following Secondary Endodontic Infection: A No-Post Monolithic Zirconia Rehabilitation After Metal Post Removal *Journal of Maxillofacial and Dental Sport Science.* 2026, Vol. 1, No. 1. https://doi.org/10.26470/jomads.v1i1.53181

Received: April 29, 2026
Revised: May 26, 2026
Accepted: June 18, 2026

Copyright: © 2026 by the authors. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

Abstract

Background: Secondary endodontic infections often present significant clinical challenges, particularly in athletes where restorative phases must prioritize biomechanical resilience against high-impact orofacial trauma. This clinical report describes the non-surgical retreatment of an anterior-lateral tooth in a 32-year-old male with a history of physical activity-related dental trauma. **Case Presentation:** The patient presented with localized swelling and spontaneous pain in the maxillary right lateral incisor. Clinical and radiographic examinations revealed symptomatic apical periodontitis associated with an underfilled obturation and a radiopaque unimetric post. **Management:** The intervention focused on the precise removal of the unimetric post using ultrasonic tips and the existing gutta-percha with H-files to minimize dentinal damage. Following thorough disinfection with sonic-activated NaOCl and EDTA, the canal was obturated using a single-cone technique with a bioceramic sealer. The restorative phase utilized a "no-post" protocol, employing short fiber-reinforced composite to create a biomimetic core, finalized with a monolithic zirconia crown. **Conclusion:** At the follow-up, the patient was asymptomatic with stable gingival health. This approach demonstrates that replacing rigid posts with biomimetic materials and high-strength zirconia effectively resolves infections while reducing the risk of catastrophic root fractures—a critical consideration in sports dentistry.

Keywords: Endodontic retreatment; Sports dentistry; Monolithic zirconia; Biomimetic Dentistry; Bioceramic sealer; Metal post removal.

INTRODUCTION

Root canal treatment (RCT) is the management of infected pulpal and periapical tissue, this procedure employs the concept of biomechanical debridement that involves the use of rotary mechanical files and chemical irrigants to eliminate the pathogen bacteria in pulpal and periapical tissue[1]. Following the biomechanical debridement, the root canal then obturated with biocompatible sealing material to ensure no bacterial penetration[2]. The clinical success rates of root canal therapy was 92.6% for absence of symptoms and reduction in periapical lesion size and 82.0% for complete of bone healing, with minimum period follow up is 1 year to 4 year[3].

One study mention about the long-term tooth survival rates at 97% after 10 years, decreasing to 68% after 37 years. This study also stated high longevity in symptomless function of endodontically treated teeth (ETT), this indicated ETT has favorable prognosis (up to 30 years), and establishing RCT as reliable treatment modality for pulpal periapical infections[4]. Despite the high clinical success of primary root canal, it often encounters a post treatment disease or secondary endodontic infection that associates with intra radicular and extra radicular periapical bacteria[5]. This secondary infection is characterized with symptomatic clinical presentation and newly developed of periapical lesion in radiograph examination[1]. In the present of persistent of endodontic lesion after initial therapy, endodontic retreatment should carry out as treatment option[5,6]. This non-surgical treatment entails the removal of previous canal fillings (with/ without post), followed by thorough disinfection and the placement of new sealing materials[5].

One of the most challenging for retreatment procedures, is the removal of root canal filling materials and post that retained the previous restoration. Endodontic treated teeth often come with loss coronal structure due to caries or previous restoration, some radicular post may also be found in ETT, even though the benefits of post placement is controversial up until now[7]. Attaining removal of root canal filled material to gain access into a periapical should be done precisely and carefully in order to maintain tooth viability, avoiding root fractures, dentinal microcracks, and excessive tissue loss[8]. As numerous studies stated that removal of post for retreatment purposes is a highly risk procedures that can lead to root fracture and loss of sound remains dentin[7].

The long-term survival of an ETT and endodontically retreated teeth (ERT) is largely dictated by the quality of the post-endodontic restoration. A definitive restoration is essential to preserve and protect the remaining tooth structure while effectively restoring its esthetic appearance, anatomical form, and clinical function[9]. Post retained restoration poses several drawbacks, such as compromised of structural integrity of endodontically retreated teeth due to removal of peri-cervical root canal dentine that leads to crown root fracture[10,11]. Despite the contentious of post placement in ETT and ERT, the longevity of ETT and ERT restorations depend on various factors, such the ferrule effect, root crown ratio, choice of post materials, and the design of coronal restoration[12].

The existing scientific literature underscores a high incidence of maxillofacial and dental trauma within the athletic community and sports injury rates vary from 8% to 45%[13]. Treatment of sports injuries consisted of endodontic and peri-radicular care, splinting, and orthodontics, as well as the implementation of a stabilizing plate[14], studies also show a higher need of endodontic treatment in athletes than non-athletes[15].

Note that for athletes, the choice of restoration for an ETT is even more critical, the restorative phase of endodontic retreatment must prioritize biomechanical resilience against the unique risks of orofacial trauma and intense physical clenching. This clinical report describes the non-surgical endodontic retreatment of an anterior-lateral tooth in a high-impact patient, focusing on the removal of a unimetric post and the subsequent restoration with a post-free monolithic zirconia crown to achieve both biological healing and biomechanical resilience

CASE

32 years old male came to private practice with complaining localized swelling and provoking pain in his right upper anterior teeth. The patient reported a spontaneous pain that persists 5 days prior the emergency treatment. The patient had history of dental trauma approximately 4 years ago due to physical activities, and had, for which root canal treatment was subsequently performed.

Extraoral examination revealed no swelling. Intraoral examination shows a tenderness to palpation at the right lateral incisor, though no fluctuant swelling was detected. Intraoral examination shows that maxillary right lateral incisor had a composite restoration on the labial and

GIC base on the palatal aspect. The tooth was not responding upon pulp testing and exhibit sensitivity to both percussion and bite test (Figure 1). The patient had disclosed no systemic condition or known allergies



Figure 1. Preoperative status of tooth 12 showing existing restorations, pulp necrosis, and symptomatic apical periodontitis

Periapical radiographic examination showed a radiopaque intra radicular restoration suggestive a unimetric post along with underfilled obturation material. Periapical area exhibited a diffuse radiolucency, indicating a periapical pathology (Figure 2). Based on the performed examination, the diagnosis previously treated teeth with symptomatic apical periodontitis. Following thorough discussion regarding treatment options, the patient provided informed consent for a non-surgical endodontic retreatment, the restorative phase consists of a monolithic zirconia crown without intra radicular post to maximize the preservation of remaining tooth structure.



Figure 2. Periapical radiograph of tooth 12 showing a unimetric post, underfilled obturation, and diffuse apical radiolucency

CASE MANAGEMENT

After informed consent and informed to consent attained from patient. The procedure commenced with patient preparation, including a 30 second rinse of 1% povidone iodine, and given local anasthesia, and the tooth was isolated on rubberdam. GIC restoration and remnant caries was removed using a highspeed bur in order to expose the unimetric post. After the unimetric post exposes, ultrasonic smooth tip was (EMS E4) was utilized in clockwise direction to facilitate the unscrewing of the post from coronal third. Once the post was sufficiently loosened, the post was retrieved from the root canal. Copius irrigation of saline also used to prevent overheating.

After gutta-percha was exposed, the removal previous gutta percha was done by using H file (denstply), prior the removal gutta-percha was softened with drop of solvent. Two Hedstrom file (H file) (Dentsply Sirona), were then advanced into the root canal to engage the existing gutta percha from both opposite directions, the H files were then rotated to lock the obturated material and the mass was retrieved with a firm coronal pull (figure 3)



Figure 3. The retrieved of intraradicular post and gutta percha

Root canal negotiation was performed, and the work length was determined using apex locator and confirmed with diagnostic wire photo, it was 23 mm (Figure 4). Macro Glide path obtained with proglider dentsply, A macro glide path was established with a ProGlider rotary file (Dentsply Sirona), and root canal preparation was completed using the crown-down pressure less technique with ProTaper Gold (Dentsply Sirona) files up to F3 (30/09) on canals.

Irrigation technique involved sequential use of 2.5% sodium hypochlorite (NaOCl) after each file change, activated by sonic agitation (NSK TiMax S970, with Eddy tip) to enhance debris removal, followed by sterile water rinse and recapitulation with K-File #10. Final irrigation consisted of 2.5% NaOCl, sterile water, 17% EDTA to remove the smear layer, and a final sterile water rinse, all activated by sonic agitation. The clinical fit of master cone gutta percha was assessed clinically and confirmed by periapical radiograph (Figure 5). The canal was given intracanal medicated CaOH paste (Ultracal) and temporize with GIC IX to ensure proper disinfection before obturation procedure. Patient then told to come back after 2 weeks.



Figure 4. DWP confirmation



Figure 5. Master cone trial

Upon second visit, patient was asymptomatic. The temporized remain intact and clinical testing yielded negative results for percussion and biting sensitivity. Temporized material was removed and intracanal medicaments was eliminated via irrigation protocol. The root canal revealing dry from inflammatory exudates, establishing ideal condition for obturation step.

Final irrigation consisted of 2.5% NaOCl, sterile water, 17% EDTA to remove the smear layer, and a final sterile water rinse, all activated by sonic agitation. Canals were dried using endo suction and paper points. Obturation technique employed the single-cone technique with F3 gutta-percha (30.09) and bioceramic sealer (Ceraseal; Metabiomed), the obturation then confirmed radiographically (Figure 6). A temporary filling was placed, and the patient was scheduled for restoration phase.



Figure 6. Periapical radiograph of obturation

At third visit, patient was asymptomatic and there weren't abnormalities in soft tissue, so this visit is scheduled for restoration phase. Before the procedure, shade selection is begun with VITA 3D master with the help of dental photography and diffuser, to minimize the reflected light. Patient agreed that 3M2 shade is the most resemblance to his dentition (Figure 7). The chosen material and design for this patient was monolithic zirconia full crown without intra radicular post. After the temporary filling was removed, and gutta-percha was reduced 3 mm below the orifice using a heated plugger. A total etch 37% phosphoric acid was used to remove remained smear layer and self-etch adhesive (Single Bond Universal Adhesive; 3M ESPE) was applied to the orifice, air-thinned, and light-cured. The orifice seal obtained with bulkfill flowable resin composite (3M™ Filtek™ Bulk Fill Flowable Restorative) followed by fiber reinforced composite (EverX Posterior; GC) to create the core for crown. The teeth then prepped for a monolithic zirconia crown.



Figure 7. Shade selection using vita 3D master

The impression technique used in this case was double impression technique, and bite registration was made using light body polyvinyl siloxane (Aquasil Ultra+; Dentsply Sirona). During crown fabrication periods, patient was given a provisional crown made from *bis-acryl resin* (Luxatemp Fluorescence, DMG USA). After Zirconia crown is done, it was tried onto the patient to checking colour stability, occlusion and articulation.

After tried onto the cavity, the intaglio surface of crown was cleaned, and air abraded with silica-coated alumina particles (50 µm to 60 µm) at a low pressure. Then apply a 10 MDP containing primer (MonoBond; Ivoclar) onto the intaglio surface, air brush until no mobile film.

The tooth surface was cleaned with a rotary brush and pumice, brushed thoroughly for 10 seconds, and dried, then primer was applied into the tooth surface (Multilink Primer; Ivoclar), then brushed with maximum air pressure fo 5 seconds. The Zirconia crown was cemented with self-adhesive resin cement (Multilink Speed; Ivoclar), and tack cured for 2 seconds for an easier excess cement removal. Light cure each surface or margin fo 20 seconds (LED 700mW/cm^2). After the cement set, occlusion, marginal adaptation, and proximal contacts were verified (Figure 8). Follow-up visits at one-week intervals confirmed no patient complaints, normal gingival health and stable restoration.



Figure 8. Comparison between the finalized tooth preparation (left) and the clinical appearance of the definitive restoration after cementation (right)

DISCUSSION

Maxillary central incisors are prone to injured in contact sports trauma due to their prominent position, when this happen conservative management should be yielded to preserving functional and natural dentition [14]. There are numerous type of trauma that could injured dental hard tissue and periodontal such as enamel infraction, crown root fracture with/ without pulp involvement, luxation, even avulsion [16]. Study mentioned that pulp necrosis was the most frequent complications of all accounted 26.9%, with intrusive luxation in immature teeth shows the highest susceptibility. This finding also aligns with 5 years follow up study that subjects who experienced subluxated, intruded and avulsion type of trauma frequently progress to pulp necrosis[16,17].

Root canal treatment is modality to treat pulpal necrosis and periapical lesions. Because chronic dental infections can negatively impact a athletes' general health and performance. When initial endodontic treatment fails to resolve an infection, management involves tooth-conservative interventions—specifically non-surgical and surgical retreatment protocols. In this case, patient had history of trauma, following this blood supply to the pulp has been interrupted and bacteria have infected the root canal, seen radiographically as a periapical lesion[18]. The teeth were already treated root canal but undergone a failure, this failure may be caused by persistent bacteria species such as *Actinomyces* and *Propionibacterium,* that often forms a extra radicular biofilms[19]. In this patient, poor condensation along with inadequate filling length, and poor-quality coronal seal, became the risk factor of post endodontic treatment disease[20]. First step in retreatment procedures is to remove previous root filling material includes intra-radicular post and gutta-percha, this should ideally be complete to expose areas of the root canal system where infection foci may exist. Despite modern specialized tools, completely removing old filling material remains unpredictable. This is especially difficult in the apical region, where curves and anatomical complexities make thorough cleaning nearly impossible[19].

In this case removal unimetric post were done using ultrasonic tips in order to minimize damage to remaining root dentinal structure, as root canal retreatment procedures tend to cause more dentinal defects in remaining root canal if not done properly. This aligns with study recommend that the removal of screwed post is performed with utilizing ultrasonic instrument[5]. Ultrasonic tips have been shown minimizes tissue loss during metal post (MP) removal, when used in short period of time.

To remove active or screw-retained posts, the surrounding core material is should be removed first to facilitate the ultrasonic tips, then the tip is moved in a circumferential counter-clockwise (CCW) motion to loosen the post. Throughout the process, continuous cooling is essential to prevent heat-induced damage to the periodontal tissues[5,8]. The removal of gutta percha in this case was done using H – file, because there was sufficient space between the old filling material and dentin wall, so the file could enter easily and engage the gutta percha. H – file also produces less residual debris than contemporary rotary techniques it has circular cross section, so it gives a cutting action in longitudinal strokes that is ideal for retrieving gutta-percha[20].

Mechanical preparation done until F3 using crown down pressure less motion, as the initial canal diameter also 30 mm, study stated that final canal preparation should at least the same size as previous diameter and work length to ensure optimal cleaning, but further enlargement of peri cervical dentin should be avoided to lowering the risk of fracture[19]. Instrumentation technique and irrigant protocols also play roles in the outcomes of retreatment procedures[19]. NaOCl with varied concentration effectively removing organic tissue, alongside with EDTA allows for comprehensive smear layer removal. Combination of NaOCl and EDTA has enhances the disinfection and remains the golden standard irrigator in various clinical settings[21].

Mechanical agitated the irrigants solution has significant success in decreasing residual bacterial presence within the root canal system. Sonic agitation system facilitates biofilm removal using acoustic streaming from canal walls[22]. *E. faecalis* is frequently linked to persistent endodontic infections. Studies shows that usage of Calcium hydroxide as an intracanal medicament could reduce bacterial loads, pro-inflammatory cytokines (PICs), and their endotoxins. It also helps minimize the intensity of postoperative pain following treatment[23].

Bioceramic sealer with single cone technique obturation was used in this case, bio ceramic sealer has an osteoconductive and biocompatible capacity so it might help in bone regeneration of periapical lesion. Bioceramic also has a hydraulic property to ensure a better sealer penetration into the dentinal tubules, so it creates a mechanical barrier against bacterial leakage[24]. Bioceramic also shown to be able to reducing inflammation and pain by inhibits the activation of nociceptors[25].

Endodontically retreated teeth have less fracture resistance due to extensive loss of healthy hard tissue than vital teeth. In this case conventional full coverage crown was chosen to protect the remaining teeth, and restore its function, aesthetics and anatomy. No post approach was used in this case, numerous study state that post doesn't significantly affect the strength of root and it dodnt improve the survival of ETT[11,26]. In systematic review study shows that the presence of post is associated with increased risk of failure[26].

Short fiber reinforced composite (Ever X) was used instead of post, because its fibrous structures act as stress absorbing properties in dentino-enamel junction. It also has similar flexural strength and fractures toughness as dentine, so it enhances the fracture resistance of restoration and arrest crack propagation in ETT[27,28]. Zirconia is a biocompatible material with aesthetic appeal, durability, and less plaque accumulation in crowns. Zirconia has excellent mechanical properties, with flexural strength reaching 1200 MPa and toughness reaching 10 MPa. However, it requires aggressive tooth reduction and is expensive[29]. Zirconia enhances aesthetics by effectively masking dark substrates with excellent opacity in infrared and visible spectrum due to its large grain size, low absorption coefficient, high refractive index, and low residual porosity[30]. Athletes face a substantially higher risk of orofacial trauma and intense functional loading, where traditional posts can act as wedges and cause catastrophic vertical root fractures; however, preserving the peri cervical dentin and utilizing the high flexural strength of a monolithic zirconia crown provides the biomechanical resilience and increasing durability for patients in high-impact environments

In conclusion, the successful management of this case demonstrates that non-surgical retreatment combined with a "no-post" protocol effectively addresses secondary endodontic

infections while maximizing structural integrity. By utilizing ultrasonic instrumentation for precise post removal and bioceramic sealers for an optimal biological seal, this approach preserved critical radicular dentin and facilitated periapical healing. Replacing the rigid metal post with short fiber-reinforced composite allowed for a biomimetic restoration that mimics the stress-absorbing properties of the natural dentino-enamel junction, which is especially significant in sports dentistry.

CONCLUSIONS

This case highlights that non-surgical retreatment utilizing a "no-post" protocol effectively resolves secondary infections while maximizing structural longevity. Utilizing material that resemblance natural properties of dentin could enhanced biomechanic stress distribution. This approach is particularly significant in sports dentistry, that the goal is to preserve healthy tissue, substantially reducing the risk of catastrophic root fractures during high-impact athletic trauma.

ACKNOWLEDGEMENT

Type the authorities or persons which contribute to funding or assistance in your case report if any.

REFERENCES

1. Choudhari S, Solete P, Jeevanandan G, Teja KV, Antony DP, Ramesh S. Single-visit versus multi-visit endodontic retreatment: A systematic review of outcomes in patients with secondary endodontic infection. Saudi Endod J [Internet]. 2024;14(3). Available from: https://journals.lww.com/senj/fulltext/2024/14030/single_visit_versus_multi_visit_endodontic.3.aspx
2. Del Fabbro M, Corbella S, Sequeira-Byron P, Tsesis I, Rosen E, Lolato A, et al. Endodontic procedures for retreatment of periapical lesions. Cochrane Database Syst Rev [Internet]. 2016;(10). Available from: https://doi.org//10.1002/14651858.CD005511.pub3
3. Burns LE, Kim J, Wu Y, Mcgowan R, Sigurdsson A. Outcomes of primary root canal therapy: An updated systematic review of longitudinal clinical studies published between 2003 and 2020. 2022;(March):714–31.
4. López-Valverde I, Vignoletti F, Vignoletti G, Martin C, Sanz M. Long-term tooth survival and success following primary root canal treatment: a 5- to 37-year retrospective observation. Clin Oral Investig [Internet]. 2023;27(6):3233–44. Available from: https://doi.org/10.1007/s00784-023-04938-y
5. Zanza A, Reda R, Testarelli L. Endodontic Orthograde Retreatments: Challenges and Solutions. Clin Cosmet Investig Dent [Internet]. 2023 Dec 31;15(null):245–65. Available from: https://www.tandfonline.com/doi/abs/10.2147/CCIDE.S397835
6. Dioguardi M, Stellacci C, La Femina L, Spirito F, Sovereto D, Laneve E, et al. Comparison of Endodontic Failures between Nonsurgical Retreatment and Endodontic Surgery: Systematic Review and Meta-Analysis with Trial Sequential Analysis. Vol. 58, Medicina. 2022. p. 894.
7. Stueland H, Ørstavik D, Handal T. Treatment outcome of surgical and non-surgical endodontic retreatment of teeth with apical periodontitis. Int Endod J. 2023 Jun;56(6):686–96.
8. Pereira KFS, Junqueira-Verardo LB, Zafalon EJ, Tomazinho LF, do Nascimento VR, Santos Bastos HJ, et al. Comparing the Efficiency of Single versus Dual Ultrasonic Devices for Metallic Post Removal in Endodontic Retreatment: A Clinical Study. Iran Endod J. 2024;19(3):189–92.
   Bejoy BM, Anitha S, George L, Mathew J, Paul S, Joy A. "Conservative Bonded Restoration (An Alternative to Full Coverage Crown): A Case Report on Endocrown. Conserv Dent Endod J. 2021; 5:42–7.

9. Gupta R, Thakur S, Pandey NK, Roopa B, Fares KT. Endocrown – A Paradigm Shift in Rehabilitation: A Report of Two Cases. Contemp Clin Dent [Internet]. 2021;12(2).
10. Mannocci F, Bhuva B, Roig M, Zarow M, Bitter K. European Society of Endodontology position statement: The restoration of root filled teeth. Int Endod J [Internet]. 2021 Nov 1;54(11):1974–81. Available from: https://doi.org/10.1111/iej.13607
11. Maklennan A, Roccuzzo A, Kramer EJ, Campus G, Naumann M, Meyer-Lueckel H, et al. Long-term success and survival of post-endodontic restorations without posts after up to 18 years: A practice-based study. J Dent. 2025; 154:105569.
12. Romero-Morales C, López-López D, Almazán-Polo J, Mogedano-Cruz S, Sosa-Reina MD, García-Pérez-de-Sevilla G, et al. Prevalence, diagnosis and management of musculoskeletal disorders in elite athletes: A mini-review. Disease-a-Month [Internet]. 2024;70(1):101629. Available from: https://www.sciencedirect.com/science/article/pii/S0011502923001098
13. Silva-Sousa AC, Oliveira-Aguiar J, Paula-Silva FWG, Sousa-Neto MD, Candemil AP. Management strategies for sport-related traumatic dental injuries: a systematic review based on case reports. BMC Sports Sci Med Rehabil [Internet]. 2025;17(1):208. Available from: https://doi.org/10.1186/s13102-025-01188-1
14. Maraş E, Başar Ö, Yorgancılar N, Berberoğlu G, Çakır G, Köse O. Endodontic status and oral health in athlete and non-athlete young adults in relation to nutrition and psychological factors. Sci Rep [Internet]. 2026; Available from: https://doi.org/10.1038/s41598-026-47464-z
15. Spinas E, Mameli A, Giannetti L. Traumatic Dental Injuries Resulting from Sports Activities; Immediate Treatment and Five Years Follow-Up: An Observational Study. Open Dent J. 2018; 12:1–10.
16. Traebert J. Accidents, Sports, and Physical Leisure Activities are the most Frequent Causes of Traumatic Dental Injury and the Rate of Pulp Necrosis is High Following its Occurrence in Pilsen, The Czech Republic. J Evid Based Dent Pract [Internet]. 2011;11(2):102–4. Available from: https://www.sciencedirect.com/science/article/pii/S1532338211000443
17. St. George G. Dealing with Endodontic Problems Following Sporting Trauma. In: Sports Dentistry [Internet]. 2018. p. 57–84. Available from: https://doi.org/10.1002/9781119332619.ch5
18. Alves FRF, Rôças IN, Provenzano JC, Siqueira JF. Removal of the Previous Root Canal Filling Material for Retreatment: Implications and Techniques. Vol. 12, Applied Sciences. 2022. p. 10217.
19. Virdee SS, Thomas MBM. A practitioner's guide to gutta-percha removal during endodontic retreatment. Br Dent J [Internet]. 2017;222(4):251–7. Available from: https://doi.org/10.1038/sj.bdj.2017.166
20. Rossi-Fedele G, Rödig T. Effectiveness of root canal irrigation and dressing for the treatment of apical periodontitis: A systematic review and meta-analysis of clinical trials. Int Endod J [Internet]. 2023 Oct 1;56(S3):422–35. Available from: https://doi.org/10.1111/iej.13777
21. Dua T, Garg A, Kumar H, Bhasin P, Tandan M, Singla MG. Antibacterial efficacy of different irrigants and activation techniques in primary endodontic infections: A randomized controlled trial. J Conserv Dent Endod [Internet]. 2026;29(1). Available from: https://journals.lww.com/jcde/fulltext/2026/01000/antibacterial_efficacy_of_different_irrigants_and.15.aspx

22. Silva WO, Gonçalves HR, Rodrigues RCV. Use of calcium hydroxide between visits in endodontic treatment. Seven Ed. 2023;1266–85.
23. Pontoriero DI, Ferrari Cagidiaco E, Maccagnola V, Manfredini D, Ferrari M. Outcomes of Endodontic-Treated Teeth Obturated with Bioceramic Sealers in Combination with Warm Gutta-Percha Obturation Techniques: A Prospective Clinical Study. Vol. 12, Journal of Clinical Medicine. 2023. p. 2867.
24. Govindaraju, L., Kalaiselvam, R., Rajendran, M.R., Jakovljevic, A., Jacomovic, J., Duncan, H.F. and Nagendrababu V. Correction to 'Does the Use of a Bioceramic Sealer Reduce Postoperative Pain Compared with an Epoxy Resin-Based Sealer After Primary Root Canal Treatment and Retreatment? — An Umbrella Review.' Int Endod J [Internet]. 2026; n/a(n/a). Available from: https://doi.org/10.1111/iej.70127
25. Riis A, Taschieri S, Del Fabbro M, Kvist T. Tooth Survival after Surgical or Nonsurgical Endodontic Retreatment: Long-term Follow-up of a Randomized Clinical Trial. J Endod. 2018 Oct;44(10):1480–6.
26. Hafez ME, Abd El-ghany AA, Taha AI, Amin A. In vitro assessment of fracture resistance of endodontically treated teeth restored with short fiber reinforced resin based composite and ceramic overlays. BMC Oral Health [Internet]. 2025;25(1):211. Available from: https://doi.org/10.1186/s12903-025-05480-x
27. Gamal W, Abdou A, Salem GA. Fracture resistance and flexural strength of endodontically treated teeth restored by different short fiber resin composites: a preclinical study. Bull Natl Res Cent [Internet]. 2022;46(1):276. Available from: https://doi.org/10.1186/s42269-022-00964-0
28. Alzanbaqi SD, Alogaiel RM, Alasmari MA, Al Essa AM, Khogeer LN, Alanazi BS, et al. Zirconia Crowns for Primary Teeth: A Systematic Review and Meta-Analyses. Vol. 19, International Journal of Environmental Research and Public Health. 2022.
29. Soleimani F, Jalali H, Mostafavi AS, Zeighami S, Memarian M. Retention and Clinical Performance of Zirconia Crowns: A Comprehensive Review. Int J Dent. 2020; 8846534.