

Case report

Long-term follow-up of endodontic microsurgical combined with orthograde retreatment of Oehler's Type III Dens Invaginatus: a case report

Comment [CS1]: Rather than using long-term, I would just say 3-years, since you only follow up to 3 years which is not long term to be honest

ABSTRACT

Aim:

This report describes the management of an unusual case of dens invaginatus in a 48-year-old female patient.

Comment [CS2]: Remove 'AIM'

Case description:

Cone beam computed tomography and initial periapical radiograph showed the presence of type III dens invaginatus with inadequate obturation, poor apical seal, and presence of periapical lesion related to tooth number #22. The case was managed successfully by a combination of nonsurgical and microsurgical endodontic retreatment. Orthograde endodontic retreatment was performed using rotary files and calcium hydroxide paste as intracanal medication. One week later, root canal was obturated with thermoplasticized guttapercha and adsealsealer. Then, microsurgery was done one week later. After 3 years follow up, absence of periapical radiolucency and satisfactory healing was observed.

Comment [CS3]: Remove this subheading

Comment [CS4]: And "an" initial" periapical.... Or change to "pre-operative periapical radiograph"

Comment [CS5]: "The" root canal.....

Comment [CS6]: The absence....

Comment [CS7]: were

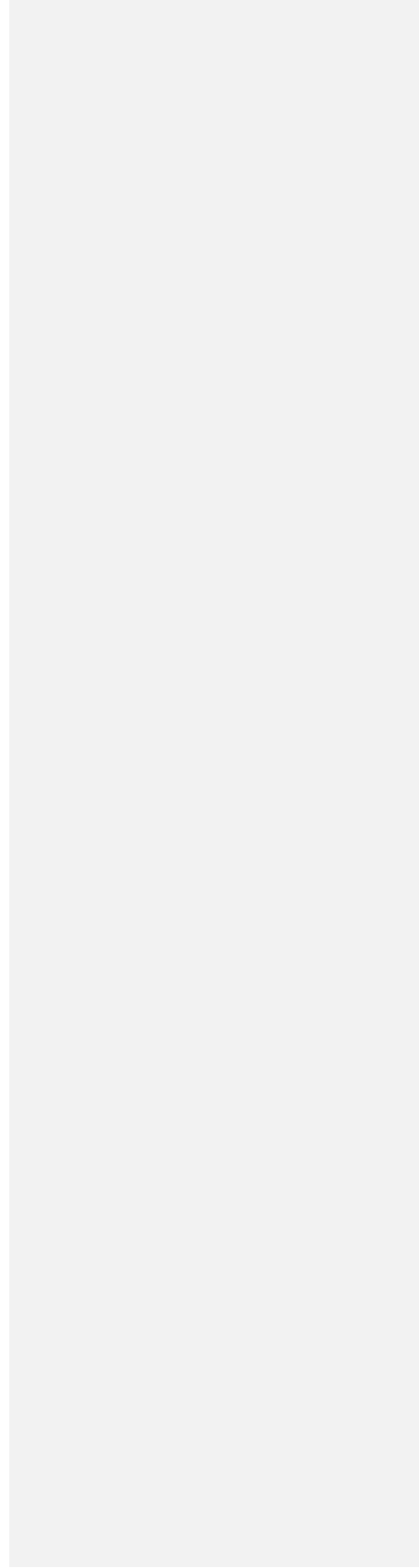
Conclusion:

Microsurgical retrograde with orthograde retreatment of dens invaginatus should be

Comment [CS8]: Remove this subheading

Comment [CS9]: Please be consistent in using your words, kindly refer to the section 'therapeutic intervention' and see, you wrote them differently, be consistent!

UNDER PEER REVIEW



considered to promote periapical healing with complete reconstitution of bone and periodontal ligament regeneration without signs of recurrence over a period of 3 years. Additionally, it preserves the entire tooth.

Keywords: Cone beam CT, Dens invaginatus, Microsurgical endodontics, Periapical lesion, Retreatment.

Introduction

Dens invaginatus, is a developmental dental anomaly characterized by the invagination of the dental papilla before the mineralization stage [1], resulting in the formation of a lateral or accessory canal within the tooth. The precise etiology of DI remained unclear but it tends to include genetic with environmental factors. Numerous theories have been suggested, including infection, trauma, changes in tissue pressure, or local discrepancies in cellular hyperplasia [2]. Nevertheless, the exact etiology is still indistinct. Dens invaginatus is considerably common condition, its incidence between 0.3% and 10% in all teeth [3], with maxillary lateral incisors being the most usually affected, and subsequently by the maxillary central incisors, but it is rarely found in the mandibular incisor [4]. Multiple classification systems for dens invaginatus have been supposed, including dens in dentes, dentoids in dentes, invaginated odontomes, and dilated composite odontomas [5], but the most widely used and clinically relevant classification system was proposed by Oehlers [6]. This classification system divides invagination into three types, according to the depth of enamel invagination observed radiographically. In type I, there is minimal invagination that is limited to the crown; in type II, the invagination extends beyond the cemento-enamel junction (CEJ) in the form of a blind sac. Type III, the invagination invades throughout the root and laterally extends to the periodontal tissues and penetrates through the root and apically opens in the periapical tissues but does not communicate with the pulp. So that, infection in a type III invagination could result in an inflammatory response within the periodontium and periapical tissues, leading to periapical periodontitis [7, 8]. Endodontic treatment of dens invaginatus can be challenging because of the complex anatomy of the tooth, and treatment failure is common. This case report describes a 48-year-old female patient who had failed endodontic treatment before for Oehler's Type III dens invaginatus. The patient reported a periapical lesion on the maxillary lateral incisor, which had previously undergone endodontic treatment twice, 10 and 5 years ago, respectively. Despite previous treatments, a repeated intraoral fistula appeared buccally with pain on percussion.

Comment [CS10]: Remove comma

Comment [CS11]:unclear, but..... (put a comma before "but")

Comment [CS12]: and

Comment [CS13]: Is 'a' considerably

Comment [CS14]: its

Comment [CS15]: Its incidence 'is' between.....

Comment [CS16]: commonly

Comment [CS17]: 'Followed by..'

Comment [CS18]: Proposed

Comment [CS19]: interior

Comment [CS20]: In Type III.....

Comment [CS21]: Remove 'and', replaced with a comma (,)

Comment [CS22]: Hence

Case Description:

A 48-year-old female patient with a medical history free of any significant conditions referred to my clinic with chief complaint dull pain and discomfort in the maxillary lateral incisor, tooth number #22 (According to the Federation Dentaire Internationale (FDI) dental numbering system), and repeated fistula on the buccal gingiva opposite to its root apex. The patient claimed that endodontic treatment was done for this tooth twice before, 10 and 5 years ago. Upon clinical examination, a repeated intraoral fistula appeared buccally, pain on percussion with degree-I tooth mobility. Despite previous treatments, the patient continued to experience pain and discomfort in the affected tooth, leading to the current presentation.

Radiographic digital examination (Vatech, Scientific zone, Korea) showed periapical radiolucency as well as an invagination which had a central invaginated canal extending from the pulp chamber throughout the apical foramen in the maxillary lateral incisors with inadequate old root canal filling (Figure 1). This type of anatomy was consistent with a Diodhlers type III. Cone-beam computed tomography (CBCT) (Vatech, Pax-i3D Smart, Korea) was taken at standardized settings (90 kV, 6 mA, 5 cm × 5 cm, 18 s) as a complementary examination to reach an accurate diagnosis and to assess the information on periapical lesion extent and the proximity to anatomic structures. The preoperative measurements of the lesion extent were viewed in different planes; the sagittal section; coronal section, and axial section (Figure 2). The CBCT images showed an invagination of the lateral incisor extending from the crown throughout to the root canal apex; however, that not communicate with the main root canal. The apical foramen was incomplete and had a periapical radiolucency of approximately 2.2×3.8 mm in the maxillary lateral incisor #22 (Fig. 2). The failure of treatment was attributed to inadequate obturation and inadequate apical seal, leading to leakage of bacteria and microorganisms, that resulted in failure of the endodontic outcome with the appearance of apical lesion.

Therapeutic interventions:

Orthograde retreatment combined with endodontic microsurgery was planned for treatment of maxillary lateral incisor #22. The patient was informed about the risks and benefits of the procedure and a written consent was taken.

Comment [CS23]: Would have been helpful if you could include the Ethnicity/Race of the patient as this is rather crucial in diagnosis as well

Comment [CS24]: Please rephrase this sentence!

Comment [CS25]: Example:.....with no known medical conditions.....

Comment [CS26]: Please REMOVE or rephrase this

Comment [CS27]: Chief complaint of....

Comment [CS28]: No need to include this or if you still want to include it, you can put (FDI system) or just go with 'maxillary left lateral incisor'

Comment [CS29]: Be more clear in your chronological explanation: Endodontic treatment was done on the tooth 10 years ago, however due to persistent/recurrent infection, endodontic retreatment was performed again on the same tooth after 5 years (in year 2009).

Comment [CS30]: recurrent

Comment [CS31]: On the buccal mucosa, exacerbated by pain on percussion and grade I mobility

Comment [CS32]: Remove

Comment [CS33]: remove

Comment [CS34]: remove

Comment [CS35]: I may be wrong, but I don't think you can comment 'invagination' in your PA X-ray, normally we only see the radiolucency or radiopacity from the X-ray. You may comment something like: " radiolucency with some abnormal radiopacity in the canal, suggesting invagination of the root....etc, something like that.

Comment [CS36]: U referring to 1 tooth or 2 teeth?

Comment [CS37]: REMOVE

Comment [CS38]: If you want to use abbreviation, please first introduce the full name...

Comment [CS39]: You sure it is a ...

Comment [CS40]: Your figure 2 only showed ...

Comment [CS41]: Rephrase please! ...

Comment [CS42]: Rephrase, what do u mean ...

Comment [CS43]: REMOVE

Comment [CS44]: Rephrase this sentence

Comment [CS45]: 'The' treatment.....

Comment [CS46]: BE CONSISTENT, do you wd ...

Comment [CS47]: remove

Comment [CS48]: obtained

Local anesthesia (2% lidocaine with 1: 1,00,000 epinephrine) was applied for the patient comfort. Rubber dam isolation was added. The access cavity was opened using round carbide bur #008 (LusterDent, France). Old gutta-percha was removed from the coronal area with a gates glidden size #2 (VDW, Munich). The previous canal filling in the middle third was eliminated by moving H files ISO #30 (FKG Dentaire, Switzerland) up and down. The H file was utilized once again for the apical section with gutta-percha solvent (Eucaliptol, Maquira Industry of Dental Products, Brazil). A radiograph was performed to confirm the complete removal of the gutta-percha. The canal was mechanically prepared utilizing rotary instruments (A3 Azure, endostar Ni-Ti rotary files taper 0.04, Poland). The working length (WL) was 20mm, which was validated both by apex locator (Geosoft, Russia) and radiologically, (Figure 3). Apical gauging was performed with a 0.02 manual K-file NiTi ISO 80, yielding a diameter of 0.80 mm for the apical foramen. Between each instrument change, the root canal was irrigated with 5ml of Dual Rinse HEDP solution. According to the manufacturer's instructions, a Dual Rinse HEDP-based solution was made by mixing 10 mL of 3% NaOCl with one capsule of Dual Rinse etidronic acid (HEDP) powder (Medcem, GmbH, Vienna, Austria) using a syringe with a 28 gauge side vented needle. The depth of the irrigation needle was always 2 mm from the apex. Moreover, an ultrasonic activation (woodpecker, UDS K (LED), china) was employed to attain a more effective debridement. Paper points were used to dry the invaginated canal, followed by application of calcium hydroxide paste, and then temporary filling material (Cavition; GC Co., Tokyo, Japan) was employed to seal the access cavity. During the second appointment after one week, the patient felt well, and the fistula had disappeared. Abundant irrigation using Dual Rinse HEDP solution and ultrasonic activation were used to remove the intracanal medication of the invagination. After that, paper points were employed to dry the invaginated canal, which was then obturated using thermoplasticized gutta percha and a seal sealer (Meta Biomed, Korea). Finally, the access cavity was sealed using GIC and composite resin (Z350; 3M ESPE, St Paul, MN, USA).

In the third appointment, one week later, the microsurgery was done under dental operating microscope DOM (Zumax, China) with magnification 1.2x. After administration of local anaesthesia using 2% lidocaine with 1: 1,00,000 epinephrine, crevicular and vertical releasing incisions were done then reflection of a full-thickness flap. Diseased granulation tissue surrounding the root apices was thoroughly removed using ultrasonic piezo scalpel (US4, SOGA, Shenzhen Soga

Comment [CS49]: 100,000

Comment [CS50]: administered

Comment [CS51]: REMOVE

Comment [CS52]: LA was administered...., followed by single tooth/ multiple teeth rubber dam isolation

Comment [CS53]: remove

Comment [CS54]: Root canal

Comment [CS55]: Brushing Headstrom files in an up-and-down motion against the root canal wall

Comment [CS56]: Rephrase please

Comment [CS57]: What kind of radiograph??

Comment [CS58]: Periapical radiograph

Comment [CS59]: radiograph

Comment [CS60]: spacing

Comment [CS61]: remove

Comment [CS62]: Use a different conjunctive word

Comment [CS63]: Capital letter

Comment [CS64]: Capital letter

Comment [CS65]: Use a better word

Comment [CS66]: remove

Comment [CS67]: remove

Comment [CS68]: Remove

Comment [CS69]: rephrase

Comment [CS70]: Rephrase, example, upon examination, no abnormality detected and the previous fistula has resolved

Comment [CS71]: Copious

Comment [CS72]: Remove

Comment [CS73]: Use a better word

Comment [CS74]: One week after that, on her third visit,.....

Comment [CS75]: remove

Comment [CS76]: of

Comment [CS77]: Be consistent, standardize your word!

Comment [CS78]: 100,000

Comment [CS79]: Rephrase!

Comment [CS80]: remove

Comment [CS81]: The granulation

technology co., Ltd, China), the following parameters were set: 120 VA, working frequency 30KHZ, with physiological saline for cooling, revealing the extent of bone loss. Apicoectomy was done by removing 3 mm from the root apex of #22, using piezoelectric device tips XM-NINJA (SOGA, Shenzhen Soga technology co., Ltd, China), then retro-grade cavity preparation was performed using ultrasonic tips (UE2) and retrograde filling was added using Mineral Trioxide Aggregate (MTA Angelus® Brazil), Figure (4). Surgical site was irrigated with normal saline 0.9%, flap repositioned, and sutured with 4-0 nylon suture (Ethicon; Johnson & Johnson). Antibiotics and nonsteroidal inflammatory drugs as well as 2% chlorhexidine

mouthwash was prescribed.



Fig. 1: Initial periapical radiograph showing a poor quality

Obturation with periapical radiolucency

Comment [CS82]: Standardize your wording please!!

Comment [CS83]: Rephrase, because you keep repeating 'retrograde', make it simple text to read please

Comment [CS84]: Flap repositioned? Or approximated? Please be CAREFUL with your words, because some reader may misunderstand this term as apically repositioned flap!

Comment [CS85]: were

Comment [CS86]: The PA was rather poorly taken and constricted, for a case report you should be able to take a PA X-ray with paralleling technique to showcase the inadequacy of the root canal filling & PA lesion

Comment [CS87]: And since you have a CBCT images, why not use the CBCT image in the sagittal view, which could give us, the readers, more insight into how well/poor the condition of the tooth

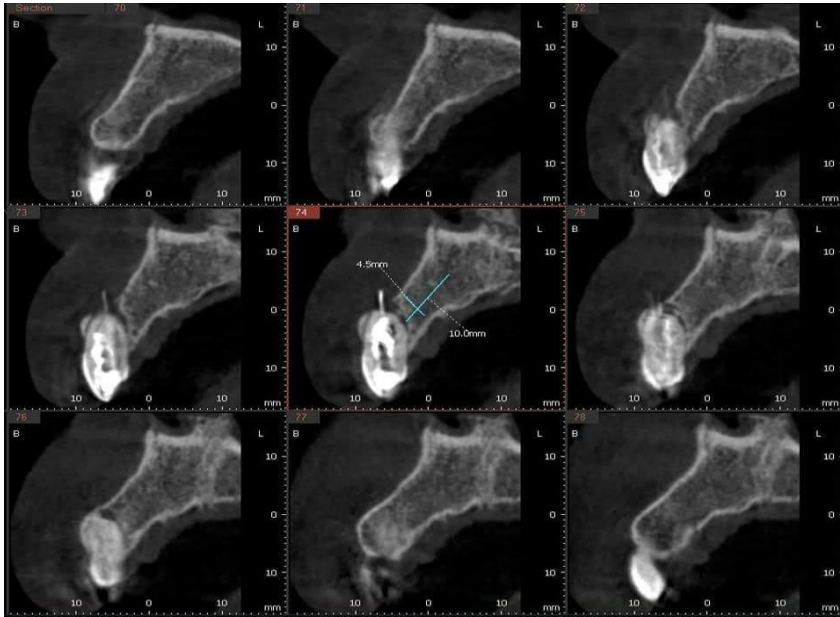


Fig. 2: Cone Beam Computed Tomography: Sagittal view

Comment [CS88]: Where are coronal and axial view? And for the sagittal view, it does not give the reader additional information by putting in all the slices and you just measured the bone height and width on one of the slice (by the way, why are you measuring the height and width of the bone on the center slice? It may confuse people that you are planning for implant instead of looking for the point of entry for your retrograde microsurgery)



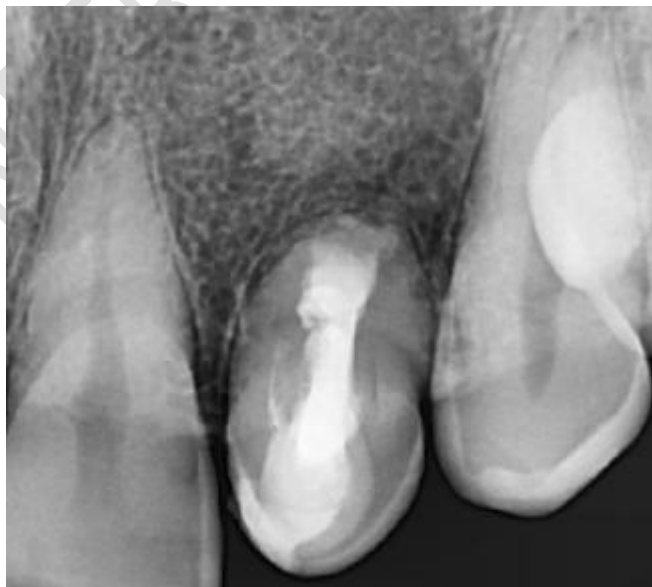
Fig. 3: working

length determination

Fig. 4: Periapical radiograph after root canal obturation

Follow-up and Outcomes:

The patient was followed-up 7 days post-surgery, sutures were removed. After one week, an intraoral check confirmed that healing had progressed. On palpation, the gingiva was smooth, pink, and humid, with no discomfort. The tooth's movement was within physiological limitations (Grade 1 Miller mobility index). The treated teeth reacted negatively to vertical and horizontal percussion. PD max = 2 mm. Follow-up appointments were scheduled six months, a year, two and three years. The last visit was scheduled three years after the procedure was completed, (Figure 5).



Comment [CS89]: Again, rather poor quality of periapical image that we as a reader could not even judge if the root canal was obturated properly. This may even give an image of poorly condensed root canal fillings

Comment [CS90]: And the sutures were.....

Comment [CS91]: Please rephrase, the earlier sentence you mentioned 7 days which is one week and this do not need to be repeated in the subsequent sentence

Comment [CS92]: Please use a better sentence, what do u mean by healing had progressed? Progress from bad to worse? Progress from what to what? As you are submitting to a scientific paper, be more specific in describing a healing wound, otherwise your writing shows that you do not have in depth understanding of your post-operative tissue condition and seemed as amateurish

Comment [CS93]: Can you palpate PINK?? How?

Comment [CS94]: I have never come across people describing gingiva as humid!! PLEASE use a better description!

Comment [CS95]: Are you talking about mobility or orthodontic tooth movement?? Again, USE A BETTER WORD

Comment [CS96]: If you want to describe the mobility within physiologic limitation, rather than saying grade 1 Miller mobility index, better be more specific on how much horizontal mobility and vertical mobility that you can observe or measure

Comment [CS97]: Use a positive expressive sentence rather than a negative sentence

Comment [CS98]: PLEASE PUT IN SENTENCE. This is a scientific writing, not a note-taking

Comment [CS99]: After six months....

Comment [CS100]: One-, two- and three-years

Comment [CS101]: Remove

(Figure 5): satisfactory healing of periapical lesion

Discussion:

Dental anomalies such as Dens Invaginatus (DI) exhibit a wide range of morphologic changes and can lead to dental caries, pulpitis, and apical periodontitis in more severe cases [9, 10]. According to the case report, Oehler's Type III Dens Invaginatus is the most severe form of the anomaly, characterised by a deep infolding of the enamel and dentin in the affected tooth that extends into the root and forms a pseudo foramen to communicate laterally with the periodontal space [11, 12]. The enamel lining in these defects is frequently hypomineralized and incomplete with various channels that communicate with the pulp thereby allowing easy access for irritants from the invagination to reach the pulp space [13, 14]. Treatment options include preventive sealing of the invaginated pit in teeth that are asymptomatic as well as regular evaluations. Endodontic therapy of the invaginated area alone or of the invaginated section and the root canal has been recommended in cases of pulp necrosis [15]. When nonsurgical methods fail to address significant periapical lesions or when gaining a coronal access prevents nonsurgical treatment, surgical endodontics should be considered in addition to conventional endodontics. The apical part of the invagination and/or root canal will be disinfected and retrogradely sealed during surgery, eliminating the possibility of an infection source [9, 16–20]. Because Type III DI is frequently linked to modifications in the root canal's morphology, endodontic procedures are challenging because of the abnormal anatomy in the invaginated track and pulp space. Furthermore, as this case report illustrates, if the invagination expands into the periodontal space (Figure 1), there may not be a real apical constriction, which adds to the complexity of endodontic procedures [9, 17]. Cases of DI with its complicated anatomy always pose a diagnostic and treatment challenge to the clinician. Due to the intrinsic limitations of the conventional radiographs, they are unable to reveal the details of the DI three-dimensionally. In cases of DI, CBCT images show the details in terms of type, extension, and morphologic changes in the tooth [21, 22]. CBCT uses low effective radiation dose and besides generating undistorted 3D reconstruction of the teeth and surrounding soft tissues provides interrelational images in three orthogonal planes: axial, sagittal, and coronal [23,

Comment [CS102]: Which case report? Please quote

Comment [CS103]: Otherwise rephrase this

Comment [CS104]: Are you using British English or US English, because the word 'hypomineralized' below is US English. STANDARDISE please

Comment [CS105]: British or US English?

24]. Based on these CBCT images we decided to retreat the main root canal with nonsurgical endodontic therapy and do a surgical endodontic approach with retrograde filling for the apical portion of the invagination. A similar combination of conventional and surgical endodontics has also been reported in a case report by Vier-Pelisser et al. [25]. Since calcium hydroxide's high alkalinity promotes healing in necrotic teeth with periapical lesions, it was utilised as an intracanal medication in the root canal for a week. Even though MTA has been the preferred root end material, It was first developed for the endodontic treatment of root perforations. Nevertheless, MTA's application has grown over time [26]. Because of its bioactive qualities, excellent sealing ability, antibacterial effect, and osseointegrative and conductive power that promotes tissue regeneration when it comes into touch with the pulp and periradicular tissues, it is currently regarded as the gold standard [27]. Moreover, it is readily detectable on control radiographs due to its radiopacity [28].

Conclusion:

Endodontic treatment of dens invaginatus can be challenging because of the complex anatomy of the tooth.

Inadequate obturation and inadequate apical seal are common causes of treatment failure in dens invaginatus.

Orthograde retreatment combined with endodontic microsurgery is an effective treatment option for failed endodontic treatment of the dens invaginatus.

References:

- [1] Alani A, Bishop K. Dens invaginatus. Part 1: classification, prevalence and aetiology. *Int Endod J.* 2008;41(12):1123–36.
- [2] Zhu J, Wang X, Fang Y, Von den Hof JW, Meng L. An update on the diagnosis and treatment of dens invaginatus. *Aust Dent J.* 2017;62(3):261–75.
- [3] Hamasha AA, Alomari QD. Prevalence of dens invaginatus in Jordanian adults. *Int Endod J.* 2004;37(5):307–10.

Comment [CS106]: I could not see a clear image in your CBCT, so it's all in your word against mine/the readers. Please provide much clearer images

Comment [CS107]: Again please be vigilant and standardize your style of writing, if you want to put that symbol then standardize this to all your trade name as well. The word MTA in your text above was different

Comment [CS108]: Your discussion was more on the diagnostic radiographs and just a small portion of treatment options, you did not discuss or address how is the survival rates of those treatment options and alternative techniques and critical review of treatment protocol with risk or possible complications that can give a much more in-depth novelty to the case report. Overall I could not find a new novel value/ knowledge from your case report, sadly

Comment [CS109]: Please write in scientific format style, not note taking style/bullet format

[4] Zhang P, Wei X. Combined therapy for a rare case of type III dens invaginatus in a mandibular central incisor with a periapical lesion: a casereport. *J Endod.* 2017;43(8):1378–82.

[5] Kirzioglu Z, Ceyhan D. The prevalence of anterior teeth with dens invaginatus in the western Mediterranean region of Turkey. *Int Endod J.* 2009;42(8):727–34.

[6] Oehlers FA. Dens invaginatus (dilated composite odontome). I. Variations of the invagination process and associated anterior crown forms. *Oral Surg Oral Med Oral Pathol.* 1957;10(11):1204–18.

[7] Carvalho-Sousa B, Almeida-Gomes F, Gominho LF, Albuquerque DS. Endodontic treatment of a periradicular lesion on an invaginated type III mandibular lateral incisor. *Indian J Dent Res.* 2009;20(2):243–5.

[8] Keles A, Cakici F. Endodontic treatment of a maxillary lateral incisor with vital pulp, periradicular lesion and type III dens invaginatus: a case report. *Int Endod J.* 2010;43(7):608–14.

[9] M. Hulsmann, “Dens invaginatus: aetiology, classification, prevalence, diagnosis, and treatment considerations,” *International Endodontic Journal*, vol. 30, no. 2, pp. 79–90, 1997.

[10] A. Alani and K. Bishop, “Dens invaginatus. Part 1: classification, prevalence and aetiology,” *International Endodontic Journal*, vol. 41, no. 12, pp. 1123–1136, 2008.

[11] W. G. Shafer, M. K. Hine, and B. M. Levy, *Shafer’s Textbook of Oral Pathology*, section I, Elsevier, 6th edition, 2009.

[12] F. A. C. Oehlers, “Dens invaginatus (dilated composite odontome): I. Variations of the invagination process and associated anterior crown forms,” *Oral Surgery, Oral Medicine, Oral Pathology*, vol. 10, no. 11, pp. 1204–1218, 1957.

[13] M. Yamada, M. Nagayama, A. Katsumata et al., “Hypomineralized Enamel of Dens Invaginatus: its distinct images and pathogenesis of the type III invagination using micro-focusing computed tomography,” *Journal of Hard Tissue Biology*, vol. 23, no. 4, pp. 449–453, 2014.

Comment [CS110]: Please standardize your citation/bibliography format

Comment [CS111]: Please standardize your citation/bibliography format

Comment [CS112]: Please standardize your citation/bibliography format

Comment [CS113]: Please standardize your citation/bibliography format

- [14] K. T. Ceyhanli, D. C. elik, S. H. Altintas, T. Tas, demir, and O. "Sezgin, "Conservative treatment and follow-up of type III dens invaginatus using cone beam computed tomography," *Journal of Oral Science*, vol. 56, no. 4, pp. 307–310, 2014.
- [15] A. H. Borges, A. S. Segundo, M. R. Nadalin, F. L. M. Pedro, A.M. D. Filho, and M. D. Sousa-Neto, "Conventional treatment of maxillary incisor type III dens Invaginatus with periapical lesion: a case report," *ISRN Dentistry*, vol. 2011, Article ID 257609, 5 pages, 2011.
- [16] K. Bishop and A. Alani, "Dens invaginatus. Part 2: clinical, radiographic features and management options," *International Endodontic Journal*, vol. 41, no. 12, pp. 1137–1154, 2008.
- [17] U. X. da Silva Neto, V. H. G. Hirai, V. Papalexiou et al., "Combined endodontic therapy and surgery in the treatment of dens invaginatus type 3: case report," *Journal of the Canadian Dental Association*, vol. 71, no. 11, pp. 855–858, 2005.
- [18] E. R. Fregnani, L. F. B. Spinola, J. R. O. Sonego, C. E. S. Bueno, and A. S. De Martin, "Complex endodontic treatment of an immature type III dens invaginatus. A case report," *International Endodontic Journal*, vol. 41, no. 10, pp. 913–919, 2008.
- [19] H. Ozbas, "Rustem Kemal Subay, MelikeOrdulu, Surgical Retreatment of an invaginated maxillary central incisor following overfilled endodontic treatment," *European Journal of Dentistry*, vol. 4, p. 324, 2010.
- [20] G. Sauveur, F. Roth, M. Sobel, and Y. Boucher, "Surgical treatment of a periradicular lesion on an invaginated maxillary lateral incisor (dens in dente)," *International Endodontic Journal*, vol. 30, no. 2, pp. 145–149, 1997.
- [21] H. Kato, "Non-surgical endodontic treatment for dens Invaginatus type III using cone beam computed tomography and dental operating microscope: a case report," *The Bulletin of TokyoDental College*, vol. 54, no. 2, pp. 103–108, 2013.
- [22] D. D. A. Decurcio, J. A. Silva, R. D. A. Decurcio, R. G. Silva, andJ. D. Pecora, "Influence of cone beam computed tomography on dens invaginatus treatment planning," *Dental Press Endodontics*, vol. 1, no. 1, pp. 87–93, 2011.

- [23] C. William Scarfe, M. D. Levin, D. Gane, and G. Allan Farman, Use of cone beam computed tomography in endodontics. *International Journal of Dentistry*, vol. 2009, Article ID 634567, 20 pages, 2009.
- [24] S. Patel, A. Dawood, T. Pitt Ford, and E. Whaites, “The potential applications of cone beam computed tomography in the management of endodontic problems,” *International Endodontic Journal*, vol. 40, no. 10, pp. 818–830, 2007.
- [25] F. V. Vier-Pelisser, R. D. Morgental, G. Fritscher, A. C. Ghisi, M.G. de Borba, and R. K. Scarparo, “Management of type III dens invaginatus in a mandibular premolar: a case report,” *Brazilian Dental Journal*, vol. 25, no. 1, pp. 73–78, 2014.
- [26] Agrafioti A, Tzimpoulas N, Chatzitheodoridis E, Kontakiotis EG. Comparative evaluation of sealing ability and microstructure of MTA and Biodentine after exposure to different environments. *Clin Oral Investig*. 2016; 20:1535–40.
- [27] Aydemir S, Cimilli H, Gemi PM, Bozkurt A, Orucoglu H, Chandler N. Comparison of the sealing ability of Biodentine, Iroot BP Plus and mineral trioxide aggregate. *CDJ*. 2016; 19:166–71.
- [28] Biočanin V, Antonijević Đ, Poštić S, Ilić D, Vuković Z, Milić M. Marginal gaps between 2 calcium silicate and glass ionomer cements and apical root dentin. *J Endod*. 2018; 44:816–21.