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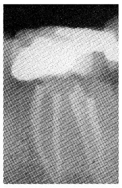

CASE REPORT

Dens invaginatus and treatment options based on a classification system: report of a type II invagination

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Abstract

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Aim To give an overview of treatment options for dens invaginatus based on a classification system.
Summary Dens invaginatus is a dental malformation which may give endodontic complications. Treatment may vary in relation to anatomy, and a classification system for dens invaginatus forms the basis for discussion. A clinical case, classified as a type II invagination (Oehlers' classification), is also presented. Clinical and radiographic examination revealed an invagination penetrating into the apical third of the root canal in tooth number 12. The tooth was immature with an open apex, apical pathosis and a labial fistula. To control the infection, ultrasonic removal of the invagination was necessary, as the invagination prevented complete cleaning and shaping of the root canal. After chemomechanical preparation and dressing with calcium hydroxide, an apical plug of MTA was placed, followed by restoration of the tooth with resin-bonded composite. Healing of the lesion with hard tissue formation was confirmed at follow-up.
Key learning points
- Knowledge about classification and anatomical variations of teeth with dens invaginatus is important in endodontic decision making.
- A classification system may be helpful when treatment options are considered.
- Classification of dens invaginatus requires a thorough preoperative radiographic examination.

Keywords: apexification, dens invaginatus, endodontic treatment.

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Introduction

Dens invaginatus, a developmental anomaly caused by infolding of the dental papilla during early morphogenesis, may give rise to endodontic complications. The malformation shows a broad spectrum of morphological variations, and different classification systems have been used. The first classification was published by Hallett (1953), but a more commonly used classification system was proposed by Oehlers (1957). He described three forms of the anomaly (Fig. 1). Type I is a minor form with an enamel-lined infolding confined to the crown, not extending beyond the amelo–cemental junction (Figs 1a and 2a). Type II is an enamel-lined form, invading the root, but remains confined as a blind sac. It may or may not communicate with the dental pulp (Figs 1b and 2b). Type III is an infolding penetrating through the root as a separate entity, with a second foramen located laterally in the periodontium (Figs 1c and 2c) or apically (Figs 1d and 2d). Irritants entering the invagination gain access to an area that is separated from the pulpal tissue by a thin layer of enamel and dentine. In some areas, the enamel lining may be incomplete, and channels may also exist between the invagination and the pulp (Kronfeld 1934, Hitchin & McHugh 1954). Pulp necrosis may therefore occur early, often before root-end closure (Swanson & McCarthy 1947, Morfis & Lentzari 1989, Hülsmann & Radlanski 1994). Depending on the severity and extent of the malformation, the treatment options may vary from prophylactic fissure sealing to root canal treatment or extraction. Until the 1970s, extraction of teeth with severe invaginations was the preferred therapy (Hülsmann 1995). Extraction is still the preferred therapy for severe cases, and when abnormal crown morphology presents aesthetic or functional problems, as proposed by Rotstein *et al.* (1987). The classification system presented by Oehlers (1957) may be helpful when establishing general treatment guidelines for the different types of malformations. For type I invaginations, early detection and filling of the invagination in severe cases or prophylactic sealing of the invagination in minor cases is the recommended therapy (Rotstein *et al.* 1987, Hülsmann & Radlanski 1994). Strict observation is recommended for these cases. If communication with the root canal results in pulp pathosis, root canal treatment is indicated and is usually uncomplicated. For type III cases, Grossman (1974)

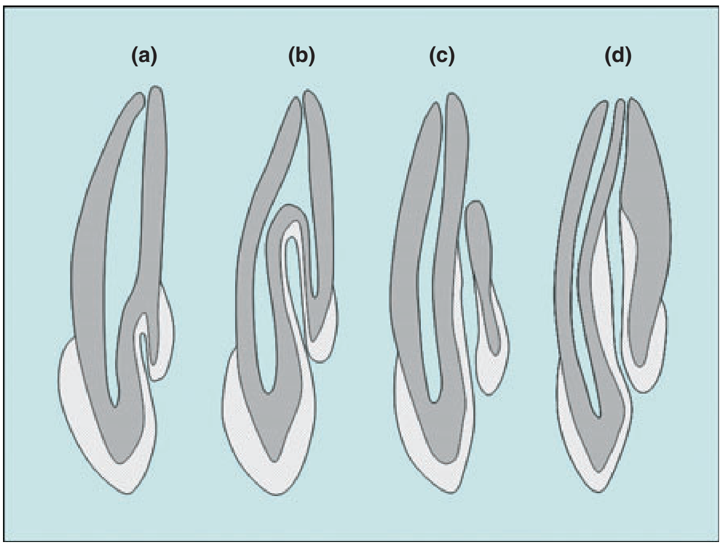

Figure 1 Classification of dens invaginatus according to Oehlers (modified from Oehlers 1957). Type I (a), type II (b), type III (c,d).

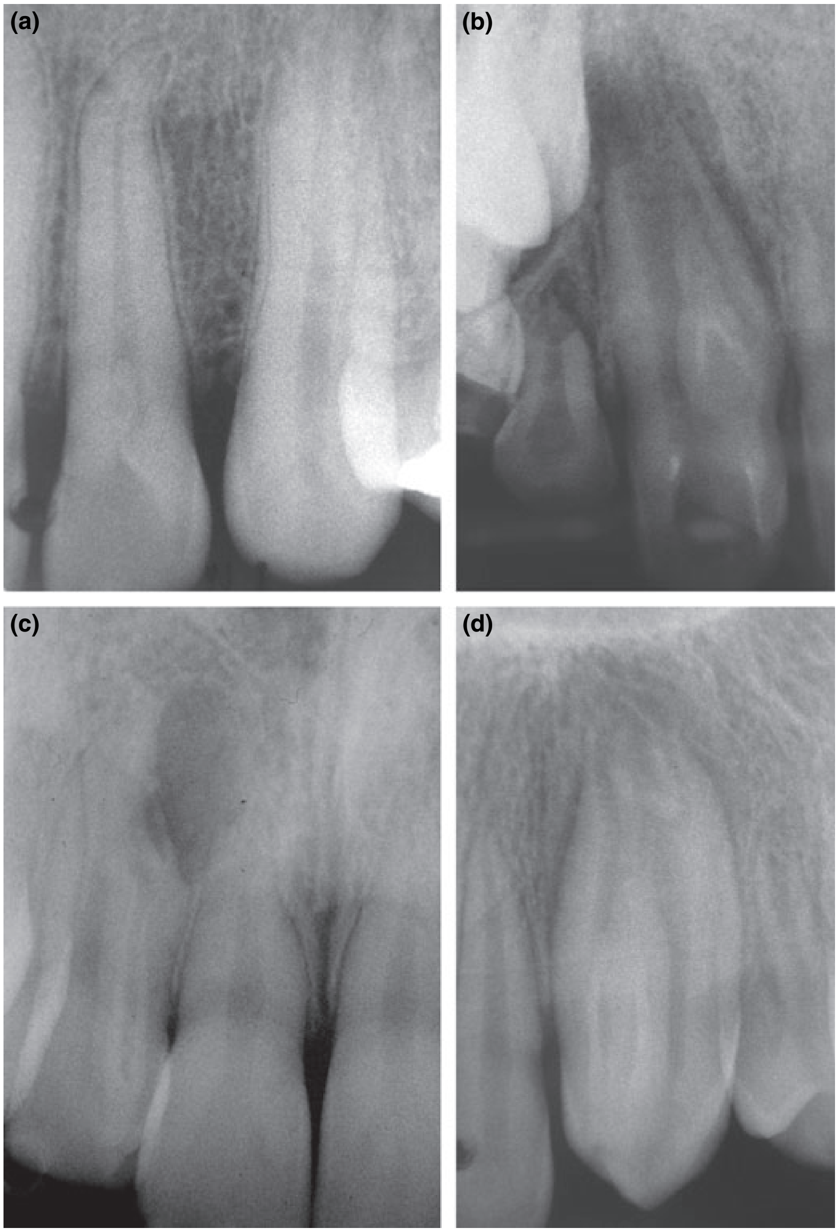

Figure 2 Radiographic appearance of dens invaginatus. Type I (a), type II (b), type III (c,d).

was the first to describe treatment of the invagination only. Subsequent case reports indicate that the invagination in type III cases is most often a separate entity, and that treatment of the invagination in many cases is sufficient (Creaven 1975, Fristad & Molven 1998, Pitt Ford 1998). From a clinical point of view, the type II invaginations often represent the most complicated cases, because pulp pathosis usually requires treatment of both the invagination and the main root canal. The invagination often prevents proper cleaning and shaping of the root canal system (Girsch & McClammy 2002, Sathorn & Parashos 2007). The present case report demonstrates a type II invagination in an immature tooth, where the invagination made access to the main canal difficult. A multi-disciplinary evaluation of the patient was undertaken preoperatively, concluding that preservation of the tooth would be beneficial if a successful endodontic outcome was possible. Ultrasonic removal of the invagination was necessary to gain access to the main canal.

Case report

A 12-year-old male patient was referred to the clinic for post-graduate endodontic training (University of Bergen, Norway). The referral was based on clinical and radiographic findings: tooth number 12 had a dens invaginatus invading deep into the root, combined with apical pathosis and a labial fistula. The tooth was immature with an open apex (Fig. 3a). Attempts to control the infection chemo-mechanically had failed because of complicated anatomy. The crown morphology was normal, and a comprehensive evaluation of the patient concluded that preservation of the tooth was preferable if a conservative approach could eliminate the endodontic infection.

A preoperative evaluation of the tooth, classified the invagination as a type II according to Oehlers (1957). A visual inspection through the access preparation, with the aid of a dental surgical microscope, showed that the main root canal was partly blocked by the invagination, making proper cleaning and shaping difficult (Fig. 3b). To overcome the infection in the main root canal, a decision was made to attempt removal of the invagination. The treatment option was based on written consent from the patient's parents. During the first visit, the invagination was partly removed with the help of ultrasonics and visual inspection using a dental surgical microscope. Bleeding from granulation tissue apically was noted during the procedure. Calcium hydroxide paste was applied in contact with the vital tissue. At the next appointment, 2 weeks later, the fistula was closed. The rest of the invagination was removed with ultrasonics, and the loosened invagination was collected with a small diameter suction. As bleeding tissue was noted in the apical part, the working length was set at a distance of 2 mm from the radiographic apex. The root canal was cleaned with buffered sodium hypochlorite 0.5% in combination with ultrasonic activation, followed by calcium hydroxide applied in contact with the vital tissue apically (Fig. 3c). The invagination was decalcified and processed for microscopic evaluation.

After calcium medication of the canal for 2 months, the apical vital wound surface could be inspected in the microscope before MTA application. Finally, an apical barrier, 3 mm in thickness, was created with grey mineral trioxide aggregate (MTA, Dentsply, Tulsa, OK, USA), followed by bonded composite (Tetric Flow and Tetric Ceram, Ivoclar Vivadent AG, Liechtenstein) in the remaining part of the root canal at the next appointment (Figs 3d and 4a,b). Follow-ups, including radiographic and clinical examination, were performed at 9 and 15 months (Fig. 3e,f).

Histological examination (Haematoxylin & Eosin and Gram positive staining) revealed an invagination canal filled with debris (Fig. 5a–c). The invagination ended blindly, with a short barrier of dentine separating the invagination from the main root canal. The extent of enamel coverage was difficult to evaluate because of the demineralization procedure.

Discussion

Treatment decisions for teeth with dens invaginatus should be based on a thorough preoperative evaluation of the severity and complexity of the invagination. The importance of the tooth should also be taken into account, as abnormal crown morphology may present insurmountable aesthetic or functional problems (Rotstein *et al.* 1987). The classification system presented by Oehlers (1957) may be useful when treatment options

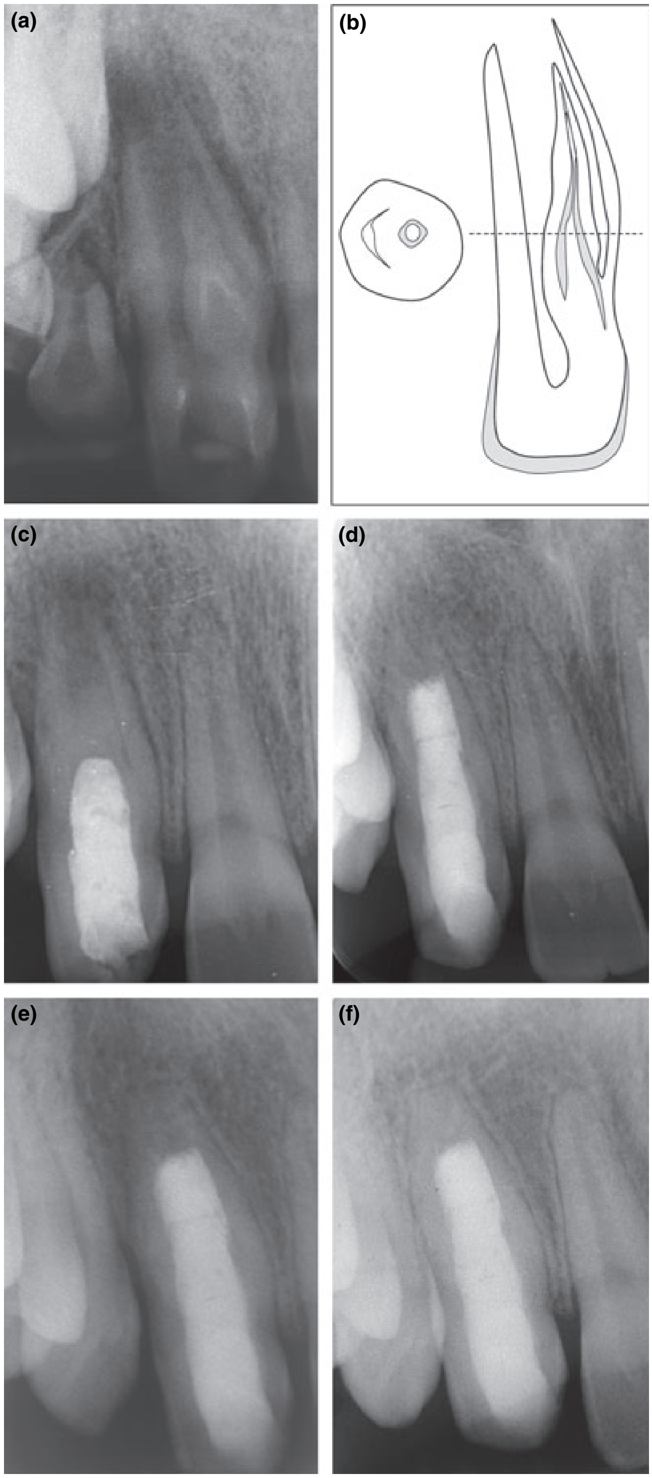

Figure 3 Radiographs (a,c–f) and schematic illustration (b) of the invaginated 12. (a) Preoperative radiograph showing arrested root development, invagination and apical pathology. (b) Schematic illustration of the invaginated 12. The invagination blocks proper cleaning and shaping of the root canal. (c) Radiograph after removal of invagination and dressing with calcium hydroxide. (d) Postoperative radiograph. (e) Nine months follow-up. (f) Fifteen months follow-up with complete healing apically.

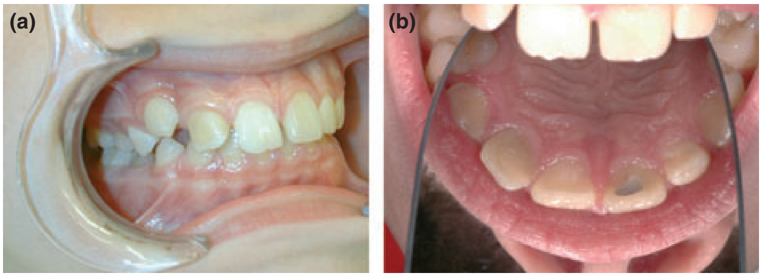

Figure 4 Clinical illustrations (a,b) showing postoperative status of invaginated 12. The crown has normal morphology.

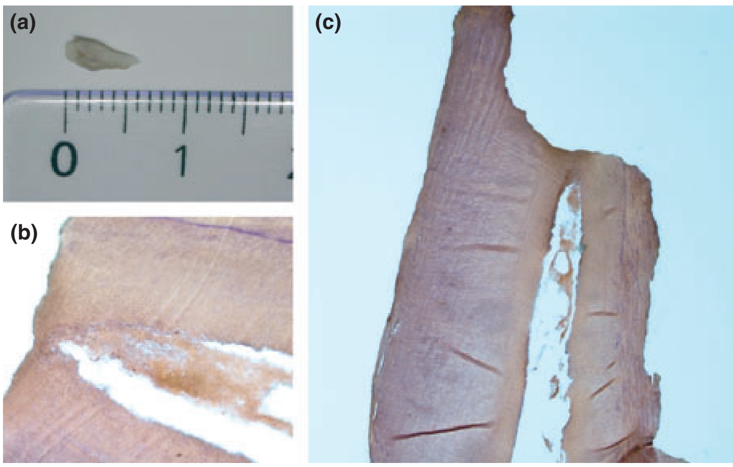

Figure 5 Clinical appearance (a) and histological sections of the invagination (b,c). Histological evaluation shows a deep invagination filled with debris.

are considered. To identify the type of invagination, a thorough preoperative radiographic evaluation, often with radiographs taken at different angles, is important. Advanced radiographic techniques with cone-beam CT imaging may in addition be useful, as a three-dimensional reconstruction of the affected tooth is possible (Mikrogeorgis *et al.* 1999, Peters *et al.* 2000, Patel *et al.* 2007). The distinction between type II and III is particularly important as they may be misinterpreted radiographically.

Type II invaginations, as presented here, are often difficult to treat as the root canal system is complex, and the invagination prevents access to perform proper cleaning and shaping necessary for infection control. When communication also exists between the invagination and the main root canal, early pulp necrosis may occur soon after eruption, often before root end closure (Swanson & McCarthy 1947, Morfis & Lentzari 1989, Hülsmann & Radlanski 1994). This should also be considered during treatment planning, as the tooth is immature and may be prone to fracture. Treatment in these cases also relies on an apexogenesis/apexification procedure and a restorative treatment plan that considers fracture risk and fracture resistance. Calcium hydroxide dressing has until recently been considered the optimal treatment for apexogenesis/apexification (Cvek 1972, Rafter 2005). The procedure, however, requires a prolonged treatment period, and lately MTA has been introduced as a material with the potential of reducing treatment time and cost (Witherspoon & Ham 2001). MTA as a filling material has the advantageous ability to stimulate hard tissue formation *in vivo* (Koh *et al.* 2001). For apexogenesis to occur, it has been suggested that continued root development is dependent upon preservation of Hertwig's root sheet and odontoblasts in the apical area (Webber 1984, Yeh *et al.* 1999). In the present case, vital tissue was noted clinically and by use of a surgical microscope at a distance 2–3 mm from the radiographic root end. The apical wound was therefore set at this level to avoid trauma to tissues having great healing potential. To reduce the fracture risk, a composite restoration was placed in the canal in contact with the set apical MTA barrier (Trope *et al.* 1985, Katebzadeh *et al.* 1998, Lawley *et al.* 2004, Carvalho *et al.* 2005).

Conclusion

Root canal treatment of teeth with dens invaginatus should be based on a thorough clinical and radiographic evaluation. The classification system presented by Oehlers (1957) is useful during the evaluation procedure and in treatment planning.

Disclaimer

Whilst this article has been subjected to Editorial review, the opinions expressed, unless specifically indicated, are those of the author. The views expressed do not necessarily represent best practice, or the views of the IEJ Editorial Board, or of its affiliated Specialist Societies.

References

Carvalho CA, Valera MC, Oliveira LD, Camargo CH (2005) Structural resistance in immature teeth using root reinforcements *in vitro*. *Dental Traumatology* **21**, 155–9.

Creaven J (1975) Dens invaginatus-type malformation without pulpal involvement. *Journal of Endodontics* **1**, 79–80.

Cvek M (1972) Treatment of non-vital permanent incisors with calcium hydroxide. I. Follow-up of periapical repair and apical closure of immature roots. *Odontologisk Revy* **23**, 27–44.

Fristad I, Molven O (1998) Root resorption and apical breakdown during orthodontic treatment of a maxillary lateral incisor with dens invaginatus. *Endododontics and Dental Traumatology* **14**, 241–4.

Girsch WJ, McClammy TV (2002) Microscopic removal of dens invaginatus. *Journal of Endodontics* **28**, 336–9.

Grossman LI (1974) Endodontic case reports. *Dental Clinics of North America* **18**, 509–27.

Hallett GE (1953) Incidence, nature and clinical significance of palatal invaginations in the maxillary incisors teeth. *Proceedings of the Royal Society of Medicine* **46**, 491–9.

Hitchin AD, McHugh WD (1954) Three coronal invaginations in a dilated composite odontome. *British Dental Journal* **97**, 90–2.

Hülsmann M (1995) Der Dens invaginatus – Ätiologie, Inzidenz und klinische Besonderheiten. *Schweizer Monatsschrift für Zahnmedizin* **105**, 765–76.

Hülsmann M, Radlanski R (1994) Möglichkeiten der konservativen Terapie des Dens invaginatus. *Deutsche Zahnärztliche Zeitschrift* **49**, 804–8.

Katebzadeh N, Dalton BC, Trope M (1998) Strengthening immature teeth during and after apexification. *Journal of Endodontics* **24**, 256–9.

Koh ET, Ford TR, Kariyawasam SP, Chen NN, Torabinejad M (2001) Prophylactic treatment of dens evaginatus using mineral trioxide aggregate. *Journal of Endodontics* **27**, 540–2.

Kronfeld R (1934) Dens in dente. *Journal of Dental Research* **14**, 49–66.

Lawley GR, Schindler WG, Walker WA 3rd, Kolodrubetz D (2004) Evaluation of ultrasonically placed MTA and fracture resistance with intracanal composite resin in a model of apexification. *Journal of Endodontics* **30**, 167–72.

Mikrogeorgis G, Lyroudia KL, Nikopoulos N, Pitas I, Molyvdas I, Lambrianidis TH (1999) 3D computer-aided reconstruction of six teeth with morphological abnormalities. *International Endodontic Journal* **32**, 88–93.

Morfis AS, Lentzari A (1989) Dens invaginatus with an open apex: a case report. *International Endodontic Journal* **22**, 190–2.

Oehlers FA (1957) Dens invaginatus (dilated composite odontome). I. Variations of the invagination process and associated anterior crown forms. *Oral Surgery, Oral Medicine and Oral Pathology* **10**, 1204–18.

Patel S, Dawood A, Ford TP, Whaites E (2007) The potential applications of cone beam computed tomography in the management of endodontic problems. *International Endodontic Journal* **40**, 818–30.

Peters OA, Laib A, Ruegsegger P, Barbakow F (2000) Three-dimensional analysis of root canal geometry by high-resolution computed tomography. *Journal of Dental Research* **79**, 1405–9.

Pitt Ford HE (1998) Peri-radicular inflammation related to dens invaginatus treated without damaging the dental pulp: a case report. *International Journal of Paediatric Dentistry* **8**, 283–6.

Rafter M (2005) Apexification: a review. *Dental Traumatology* **21**, 1–8.

Rotstein I, Stabholz A, Heling I, Friedman S (1987) Clinical considerations in the treatment of dens invaginatus. *Endodontics and Dental Traumatology* **3**, 249–54.

Sathorn C, Parashos P (2007) Contemporary treatment of class II dens invaginatus. *International Endodontic Journal* **40**, 308–16.

Swanson WF, McCarthy FM (1947) Bilateral dens in dente. *Journal of Dental Research* **26**, 167–71.

Trope M, Maltz DO, Tronstad L (1985) Resistance to fracture of restored endodontically treated teeth. *Endodontics and Dental Traumatology* **1**, 108–11.

Webber RT (1984) Apexogenesis versus apexification. *Dental Clinics of North America* **28**, 669–97.

Witherspoon DE, Ham K (2001) One-visit apexification: technique for inducing root-end barrier formation in apical closures. *Practical Proceedings of Aesthetic Dentistry* **13**, 455–60.

Yeh SC, Lin YT, Lu SY (1999) Dens invaginatus in the maxillary lateral incisor: treatment of 3 cases. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontics* **87**, 628–31.