Dens invaginatus and the paediatric dental patient: two case reports

Précis

Dens invaginatus in paediatric dental patients presents both patient management and technical challenges for the general dental practitioner. Awareness of clinical features and preventive strategies is essential.

Clinical relevance statement

With a prevalence of up to 10% in the permanent dentition, practitioners are likely to encounter dens invaginatus in the paediatric population. Timely identification and intervention if required, or referral for treatment, may yield better clinical outcomes for these patients.

Abstract

Background: Dens invaginatus (DI) in paediatric patients presents a challenge in treatment planning, patient management and potentially complex endodontic treatment. DI has been reported to be as prevalent as 0.3-10% in permanent teeth. Clinicians may be challenged in managing both the patient and the dental anomaly.

Aims: The aim of these case reports is to highlight the presenting features of DI, treatment strategies, and to highlight the need for a national clinical care pathway for children affected by dental anomalies such as DI, in addition to complex traumatic dental injuries and developmental defects of enamel and dentine.

Conclusions: Awareness of the clinical features of, and early identification of teeth affected by DI can allow for prevention, minimally invasive management and, where necessary, appropriate referral for specialist management of these cases. Sealing the palatal surfaces of young permanent incisors can limit the sequelae of pulpal necrosis in teeth with DI. Teeth with DI and complex anatomical presentation are predisposed to pulpal pathology and restorative management can be extremely challenging. There are currently limited referral options for general dental practitioners who identify cases of DI in primary care settings in Ireland. This may lead to delayed treatment, prolonged symptoms, and suboptimal outcomes for patients. A national clinical care pathway is recommended.

Journal of the Irish Dental Association Published online September 2022

Introduction

Dens invaginatus (DI), also known as 'dens in dente', is a developmental dental anomaly resulting from the invagination of the enamel organ in the dental papilla before the dental tissues are calcified. DI is reported to affect 0.3-10% of permanent teeth, with estimated prevalence among patients ranging from 0.25-26.1%.[1] The permanent maxillary lateral incisors are the most commonly affected teeth. However, DI has been reported in the permanent maxillary central incisor, canine and premolar, in mandibular teeth, and in the primary dentition.

The aetiology of DI is unclear, although theories include genetic factors, trauma, infection, and external growth pressure.[1,2] The genetic basis of DI is supported by the findings of familial tendency, bilateral presentation, and

Dr Shane O'Dowling Keane
BDS NUIreland
Senior House Officer
Restorative Dentistry
Cork University Dental School and Hospital

Dr Siobhán Lucey
Consultant/Senior Lecturer
Paediatric Dentistry
Cork University Dental School and Hospital

Dr Graham Quilligan
Consultant/Senior Lecturer
Restorative Dentistry (Endodontics)
Cork University Dental School and Hospital

Corresponding author: Dr Shane O'Dowling Keane, Cork University Dental School and Hospital
E: s.odowlingkeane@ucc.ie

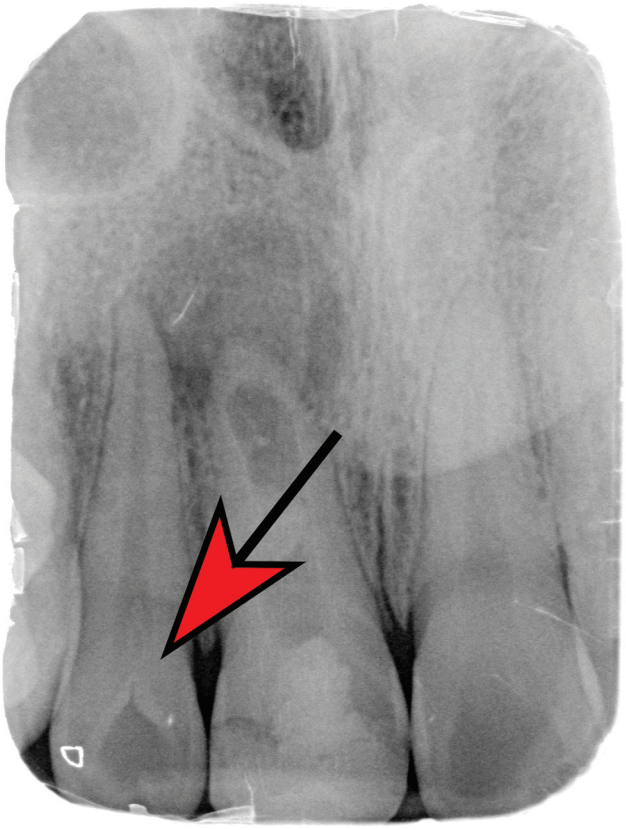

FIGURE 1: Teeth with dens invaginatus may present as asymptomatic, with little external deformity, but may become apparent on radiographs as incidental findings.

Table 1: Oehler's classification of dens invaginatus.

Oehler's classification	Description
Class I	Partial invagination that does not extend beyond the cemento-enamel junction (CEJ) or involve the pulp.
Class II	Partial invagination extending beyond the CEJ, which may or may not involve the pulp but remains within the root anatomy. There is no communication with the periodontal ligament (PDL).
Class IIIa	Complete invagination extending beyond the CEJ and communicating with the PDL through a second foramen on the lateral surface of the root. Usually, no direct involvement of the pulp but significant anatomical variation.
Class IIIb	Complete invagination extending beyond the CEJ and communicating with the PDL at the apical foramen. Usually, no direct communication with the pulp but significant anatomical variation.

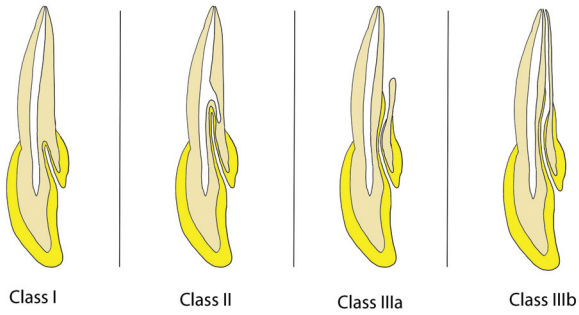

FIGURE 2: Oehler's classification for dens invaginatus.

association with other dental anomalies such as gemination, microdontia, hypodontia, taurodontism, dentinogenesis imperfecta and mesiodens.[1,2]

The infolding of the enamel organ creates a pocket of organic material and may result in plaque-retentive features in tooth morphology.[1] Communication between the oral cavity and the invagination can lead to the development of carious lesions and facilitate rapid progression to pulpal necrosis.

Early identification and management of teeth with DI can reduce the risk of pulpal necrosis. Unfortunately, DI is regularly identified only after symptoms of pulpitis develop. Pulpal necrosis in an immature tooth may disrupt root formation. The anomalous tooth morphology, associated complex root canal anatomy, and potential immaturity of the tooth in a young child can complicate endodontic management of affected teeth.

Presentation and diagnosis

Teeth with DI may present as asymptomatic teeth with little external deformity. They may become apparent on radiographs as incidental findings (**Figure 1**). Teeth with more significant structural defects may be more easily identified. Clinical features include increased width mesiodistally or buccolingually, talon cusps, pronounced palatal cingulum, deep grooving, incisal notching, or conical shape.[1] There is some evidence for bilateral presentation of DI.[1,2] If DI is suspected, thorough investigation of the contralateral tooth should take place. Unfortunately, patients often present after the onset of symptoms such as pain and swelling, usually in the absence of an obvious carious lesion or a history of trauma.

As DI can predispose teeth to pulpal pathology, thorough assessment is required to inform the diagnosis. Clinical examination should include visual assessment of tooth morphology and colour. Percussion testing, grading of mobility and checking for sulcular tenderness are recommended. Sensibility testing (including cold and electric stimuli) is also indicated. If DI is suspected, radiographic examination of the tooth is indicated. Assessment of the roots of developing teeth can be challenging; therefore, comparison with contralateral teeth is useful to differentiate apical pathology from immature root formation.

The radiographic features of DI are variable. However, DI lesions often present as areas of radiolucency underneath the cingulum or incisal edge of affected teeth, usually surrounded by a radio-opaque enamel margin.[2,3] Periapical radiographs have been described as the imaging modality of choice, although two images at different horizontal angulations may be required to ensure visualisation of the lesion.[2,4] The use of cone-beam computed tomography (CBCT) may be indicated to diagnose and plan complex endodontic treatment, particularly if surgical management is required.[5,6] However, the use of increased radiation should be carefully considered in the paediatric patient.

Classification system

The most commonly used classification system for DI is Oehler's classification.[3] This classification divides affected teeth into three categories based on their radiographic appearance (**Table 1**; **Figure 2**).

Table 2: Treatment options for management of dens invaginatus.

Treatment option	Indications
Prophylactic sealing of invaginations	■ Clinically and radiographically disease-free teeth affected by minor invagination ■ Severe invaginations with no evidence of pulpal, clinical or radiographic disease, where operative intervention may lead to frank exposure
Caries removal and debridement of invaginations with ultrasonic instruments	■ Teeth with moderate to severe invaginations with evidence of caries in the invagination ■ No communication between invagination and the pulp ■ Absence of pulpal pathology
Vital pulpotomy	■ Vital teeth with mild, moderate or severe invagination and carious or traumatic exposure of the pulp ■ Absence of periapical pathology clinically or radiographically
Orthograde root canal treatment	■ Non-vital teeth with mild, moderate or severe invagination ■ Pulp and/or invagination anatomy amenable to orthograde endodontic treatment
Apexification/pulp revascularisation	■ Non-vital permanent teeth with mild, moderate or severe invagination ■ Pulp and/or invagination anatomy amenable to orthograde endodontic treatment ■ Immature root formation
Surgical endodontic treatment	■ Re-treatment of teeth affected by DI with previous unsuccessful endodontic treatment ■ Non-vital DI-affected teeth with complex pulp and/or invagination anatomy that contraindicates conventional orthograde endodontic treatment
Extraction	■ Teeth of poor prognosis ■ Teeth severely affected by DI with complex anatomy unamenable to restorative treatment

Management

DI encapsulates a wide range of anatomical variations and, as such, there is a vast array of treatment options available. The management options for teeth with DI are detailed in **Table 2**.[2,4,6] At all times, treatment planning must take account of the developing dentition in a growing child. Teeth with DI and complex internal anatomy can be extremely technically challenging to manage. This can be further complicated by immaturity of the affected tooth, particularly if non vital, resulting in an open or 'blunderbuss' apex.[2,4,6] These teeth may require complex endodontic management including apexification or pulp revitalisation, depending on the pulpal status and stage of root development.[7,8]

Behaviour management can also be difficult due to the young age of affected patients. A child's co-operative ability must be taken into consideration when selecting the most appropriate treatment option. Assessment and treatment may be co-ordinated and provided by the experienced paediatric dental team. However, a multidisciplinary team may be required in more complex cases.

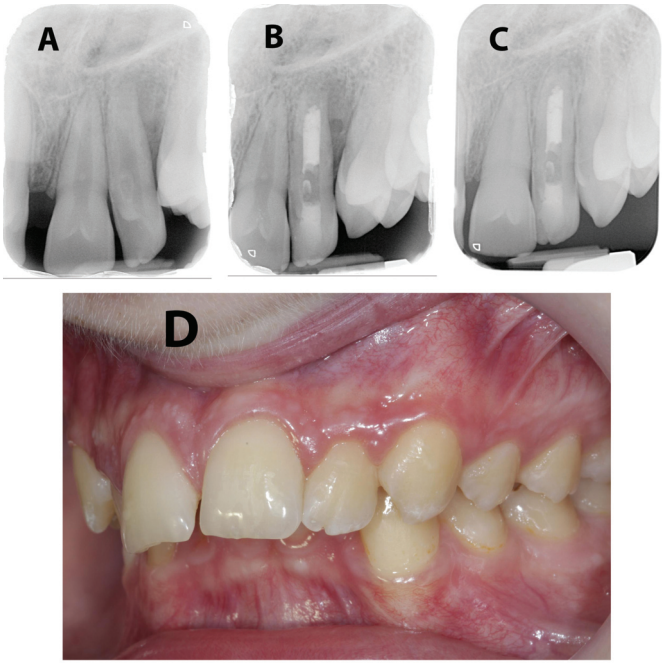

FIGURE 3: Case 1: Dens invaginatus Class II with an immature, open apex, a potential lateral canal and periapical periodontitis.

The first-line approach for all options will be to consider treatment in the dental surgery, under local anaesthesia as required, and aided by non-pharmacological behaviour management techniques, aiming to retain the tooth where possible. Considering the very complex internal anatomy of some teeth with DI, and the patient's age and co-operative ability, there may be a reasonable justification for endodontic treatment under general anaesthesia, if available, particularly where the tooth is deemed to have a good prognosis following treatment. Some clinicians may consider a 'surgical-first' approach where extremely complex anatomy contraindicates an orthograde approach.[9,10] The tooth is accessed surgically, the apical 3mm of root resected (similarly to apicectomy), the complex anatomy is disinfected with retrograde chemomechanical preparation, and the canal is obturated via a retrograde approach. This has the advantage of keeping the crown intact and reducing the need for lifelong maintenance of a coronal restoration. Any invagination should also be sealed coronally in this instance.

Teeth with DI should be carefully followed up at an appropriate and individually tailored, risk-based recall interval.[11] Review should include assessment of colour, mobility, sulcular tenderness, percussion testing and pulpal sensibility. A peri-apical radiograph may be indicated if concerns emerge following the clinical assessment. Teeth with DI that have had endodontic treatment should be reviewed radiographically after one year, in line with European Society of Endodontology (ESE) guidelines.[12]

Case reports

Case 1

Patient A, a healthy 10-year-old boy, was referred to the paediatric dental team at Cork University Dental School and Hospital (CUDSH) by his general

dental practitioner (GDP) with pain and swelling associated with the permanent maxillary left lateral incisor (tooth 22). The GDP had diagnosed "tooth 22 with DI", and prescribed a course of antibiotics to manage the patient's acute symptoms. When he presented for a consultation, the pain and swelling associated with this tooth had subsided. The patient also had a history of a mesiodens, which had been removed three years previously.

Clinical examination revealed a buccal draining sinus associated with tooth 22, which had a deep palatal pit, a talon cusp and incisal notching. Sensibility testing indicated that the tooth was non vital. A periapical radiograph revealed a radiolucent area underneath the cingulum, surrounded by a radio-opaque margin extending beyond the cemento-enamel junction (**Figure 3**). The apex of tooth 22 had not fully formed, and a periapical radiolucency was noted. A further radiolucency was identified on the distal aspect of the mid-third of the root of tooth 22, indicative of a potential lateral canal. The tooth had a deep palatal groove. DI Class II with an immature, open apex, a potential lateral canal and periapical periodontitis was diagnosed (**Figure 3a**). CBCT was not indicated as the anomaly was clearly imaged on plain film radiography.

Initial management

Initial management of the patient involved oral hygiene instruction, dietary advice and fissure sealants of the first permanent molars, the maxillary central and the right lateral incisors.

Endodontic management

Following assessment by a paediatric dentist and an endodontist, it was determined that the tooth would be managed in the first instance via orthograde root canal treatment. Conventional endodontic treatment with apexification was selected due to the increased evidence for long-term predictability of outcome compared to revitalisation techniques, and the clinical experience of the clinicians.[9,10]

The tooth was isolated with rubber dam and an access cavity prepared using long diamond and tungsten carbide burs in a fast handpiece. The access cavity was widened to incorporate the entire invagination using a combination of ultrasonic tips (Start-X; Dentsply Sirona), goose-neck burs in a slow handpiece, and an orifice-opening rotary file (Protaper Next Xa; Dentsply Sirona). This was undertaken using the dental operating microscope.

The tooth was gently irrigated without pressure with 1% sodium hypochlorite (NaOCl) using a side-venting needle measured at least 2mm short of the full working length. The tooth was dressed with non-setting calcium hydroxide as an interappointment medicament between visits, while the tooth was monitored for resolution of symptoms and healing of the draining sinus.

The clinicians progressed to obturation when the draining sinus had healed, two weeks after the first stage of endodontic treatment. Bioceramic putty and sealer (TotalFill BC; RRM, and TotalFill BC Sealer; Scottlander) were used to create an apical plug. It was noted that the putty did not fully extend to the apical third, but patient co-operation was not sufficient to repeat the procedure. The access cavity was initially sealed with high-viscosity glass ionomer cement (Fuji II LC; GC) due to time constraints and patient co-operation.

Figure 3c shows the periapical bony healing six months post obturation. The apex of tooth 22 also shows signs of successful apexification following endodontic treatment. The patient has been asymptomatic since obturation. Eight appointments over 15 months were required to complete the full course of treatment. Treatment duration was extended to ensure that informed consent was obtained from the parents and legal guardians of the patient, and due to the outbreak of the Covid-19 pandemic. In line with ESE guidelines, the follow-up of such teeth will involve annual radiographic review, until normal periapical architecture returns.[12]

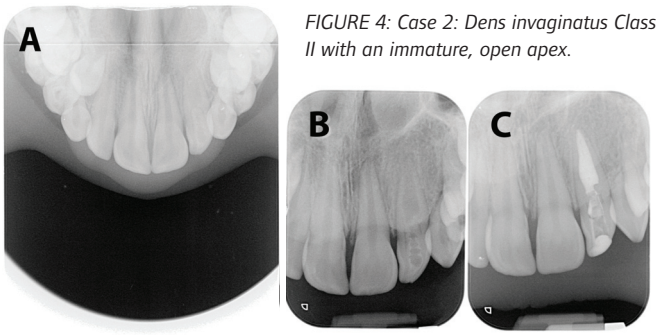

FIGURE 4: Case 2: Dens invaginatus Class II with an immature, open apex.

Case 2

Patient B, a healthy eight-year-old girl, presented to the paediatric dental department of CUDSH complaining of a newly erupted and "pointy" tooth 22. The appearance of tooth 22 was "bothering her on and off". She had previously attended the paediatric dental department for routine dental visits and fissure sealants of the first permanent molars. The patient was dentally anxious.

Clinical examination revealed a partially erupted, unaesthetic and conically shaped upper left lateral incisor. Findings regarding colour, mobility, percussion and sensibility testing were unremarkable. Radiographic examination (**Figure 4a**) revealed DI Class II with an immature, open apex. Tooth 23 was also congenitally absent.

Initial management

The patient and her mother were informed of the diagnosis, oral hygiene instruction was delivered, and the patient was booked for review following further eruption of tooth 22. At the subsequent review appointment, six months after initial presentation, tooth 22 was asymptomatic but had erupted into edge-to-edge occlusion. No caries was evident clinically or radiographically; therefore, a resin-based fissure sealant was placed on the palatal pit and a recall appointment was scheduled.

Unfortunately, one month later the patient presented with severe pain from tooth 22. Clinical and radiographic examination (**Figure 4b**) demonstrated that the tooth was non-vital with a periapical diagnosis of symptomatic periapical periodontitis. Following assessment by a paediatric dentist and an endodontist, conventional orthograde endodontic treatment was initiated.

Endodontic management

Using a similar protocol to Case 1, conventional endodontics was initiated on tooth 22. The patient was apprehensive of dental treatment and became restless during appointments, limiting the amount of progress in each treatment session. The clinicians progressed to obturation once the symptoms had resolved, eight months after the initial endodontic treatment.

Bioceramic putty and sealer were again used to achieve an apical plug. The tooth was obturated with gutta percha using a warm vertical obturation technique, and the access cavity was restored as in Case 1. **Figure 4c** shows tooth 22 immediately post obturation.

The tooth has been asymptomatic since obturation eight months ago and will be reviewed annually, clinically and radiographically, until normal periapical architecture returns. Patient B has been referred to a specialist orthodontist to consider treatment for her developing malocclusion.

Discussion

DI is not a rare dental anomaly, with reported prevalence as high as 10% in examined teeth and 26.1% of examined patients.[1] The wide variation in reported prevalence is likely a result of the often-asymptomatic presentation, potential absence of clinical signs associated with DI, the various methods used to assess the presence of DI, and the methods of sample selection in the prevalence studies. The prevalence of DI is comparable to hypodontia, and is likely to be more common than peg-shaped laterals, gemination and taurodontism.[1,2]

DI can predispose teeth to caries, pulpal necrosis, periodontitis, and peri-invaginatus periodontitis, and can require complex endodontic treatment.[5] Early identification of cases of DI can facilitate successful and minimally invasive interventions and consequently good outcomes for patients. In particular, the authors advocate for careful evaluation of the palatal surfaces of erupting permanent maxillary incisors of all paediatric patients and the routine sealing of clinically sound, deep grooves and pits identified. Accurate diagnosis of the anomaly, pulpal status and root maturity is vital for appropriate management of teeth with DI. Teeth with DI and complex internal anatomy have been recognised by the NHS as a condition that merits treatment by a consultant paediatric dentist.[13]

The Oelher's classification system allows for rapid assessment of the complexity of DI cases and gives an indication of the potential treatment required to manage cases.[3] Understanding of this classification by GDPs may facilitate greater understanding of when preventive treatment in general practice is appropriate and when to refer complex cases.

Patient A had previously received treatment for a mesiodens and had clinical features of DI; greater awareness of the clinical features of DI and association with other dental anomalies might have allowed earlier identification of the tooth with DI and potentially preventive treatment and improved outcomes.

These case reports demonstrate the potential complexity and increased burden of care of paediatric patients with non-vital and immature teeth with DI. The majority of specialist paediatric dentistry services in Ireland are delivered in private practice funded by parents.[14] Consideration should be given to the formation of a national clinical care pathway for paediatric patients with complex dental needs, originating in primary care. Smile agus Sláinte, the national oral health policy, advocates for advanced oral healthcare centres, anticipated to include dental hospitals, with appropriately qualified and trained staff who can provide treatments beyond the scope of GDPs.[15] Further research is needed to understand the oral health needs of children and young people in Ireland, as well as the barriers to and enablers of access to oral healthcare in Ireland, to facilitate workforce planning and economic cost evaluation.

These advanced oral healthcare centres would be ideally suited to fulfil the role of the tertiary care provider within a clinical care pathway for paediatric patients with DI, in addition to complex traumatic dental injuries, and developmental defects of enamel and dentine.

The authors support the formation of an appropriately resourced and funded clinical care pathway structure that ensures equitable access to multidisciplinary care for all patients throughout the country, including children with disabilities or in other vulnerable groups.

Conclusion

DI in paediatric patients presents a range of technical and patient management challenges. Awareness of the common clinical features and classification systems of DI among the dental profession can enable early diagnosis and appropriate preventive treatment. Consideration should be given to sealing deep cingulum pits on the palatal or lingual surfaces of incisors in children. If a tooth is severely compromised by DI and specialist management is required, it is essential that clinicians have access to appropriate referral pathways to facilitate access to timely and appropriate care. Multidisciplinary collaboration between specialties is essential to facilitate successful outcomes.

References

1. **Alani, A., Bishop, K.** Dens invaginatus. Part 1: classification, prevalence and aetiology. *Int Endod J* 2008; 41 (12): 1123-1136.
2. **Gallacher, A., Ali, R., Bhakta, S.** Dens invaginatus: diagnosis and management strategies. *Br Dent J* 2016; 221 (7): 383-387.
3. **Oehlers, F.A.C.** Dens invaginatus (dilated composite odontome): I. Variations of the invagination process and associated anterior crown forms. *Oral Sur Oral Med Oral Pathol* 1957; 10 (11): 1204-1218.
4. **Bishop, K., Alani, A.** Dens invaginatus. Part 2: clinical, radiographic features and management options. *Int Endod J* 2008; 41 (12): 1137-1154.
5. **Patel, S.** The use of cone beam computed tomography in the conservative management of dens invaginatus: a case report. *Int Endod J* 2010; 43 (8): 707-713.
6. **Zhu, J., Wang, X., Fang, Y., Von den Hoff, J., Meng, L.** An update on the diagnosis and treatment of dens invaginatus. *Aust Dent J* 2017; 62 (3): 261-275.
7. **Krastl, G., Weiger, R., Filippi, A., Van Waes, H., Ebeleseder, K., Ree, M., *et al.*** European Society of Endodontology position statement: endodontic management of traumatized permanent teeth. *Int Endod J* 2021; 54 (9): 1473-1481.
8. **Galler, K.M., Krastl, G., Simon, S., Van Gorp, G., Meschi, N., Vahedi, B., *et al.*** European Society of Endodontology position statement: Revitalization procedure. *Int Endod J* 2016; 49 (8): 717-723.
9. **Monaghan, L., Jadun, S., Darcey, J.** Endodontic microsurgery. Part one: diagnosis, patient selection and prognoses. *Br Dent J* 2019; 226 (12): 940-948.
10. **Coraini, C., Mascarello, T., de Palma, C.M., Gobbato, E.A., Costa, R., de Micheli, L, *et al.*** Endodontic and periodontal treatment of dens invaginatus: Report of 2 clinical cases. *Giornale Italiano di Endodonzia* 2013; 27 (2): 86-94.
11. **Irish Oral Health Services Guideline Initiative.** Oral Health Assessment: Best practice guidance for providing an oral health assessment programme for school-aged children in Ireland. 2012. Available from: https://www.ucc.ie/en/media/research/ohsrc/OralHealthAssessmentFull.pdf.
12. **European Society of Endodontology.** Quality guidelines for endodontic treatment: consensus report of the European Society of Endodontology. *Int Endod J* 2006; 39 (12): 921-930.

13. **NHS England.** Commissioning Standard for Dental Specialties: Paediatric Dentistry. 2018. Available from: https://www.england.nhs.uk/publication/commissioning-standard-for-dental-specialties-paediatric-dentistry/.
14. **Health Service Executive.** A National Model of Care for Paediatric Healthcare Services in Ireland. Chapter 21: Paediatric Dentistry. 2015. Available from: https://www.hse.ie/eng/services/publications/clinical-strategy-and-programmes/paediatric-dentistry.pdf.
15. **Department of Health.** Smile agus Sláinte: National Oral Health Policy. Department of Health; 2019. Available from: https://assets.gov.ie/9613/39736ac409d94a6194b52bdae5e3d1b0.pdf.

CPD questions

To claim CPD points, go to the MEMBERS' SECTION of www.dentist.ie and answer the following questions:

IDA irish dental association
CPD

1. Dens invaginatus has a reported prevalence as high as:

- ○ A: 1%
- ○ B: 10%
- ○ C: 34%

2. An Oehler's Class II invagination:

- ○ A: Extends beyond the CEJ
- ○ B: Communicates with the apical foramen
- ○ C: Always communicates with the pulp

3. Clinical features of dens invaginatus include:

- ○ A: Increased clinical width, talon cusps, pronounced palatal cingulum, deep grooving, incisal notching, and conical shape
- ○ B: Increased clinical height, pronounced palatal cingulum, discolouration, and increased periodontal probing depths
- ○ C: Talon cusps, deep grooving, peg-shaped lateral incisors, and hypomineralisation