European Journal of Molecular & Clinical Medicine
ISSN 2515-8260 Volume 07, Issue 5, 2020

DENS INVAGINATUS CLINICAL DIAGNOSIS AND MANAGEMENT: A REVIEW

Running title: Dens Invaginatus-a review

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ABSTRACT

Dens invaginatus is a kind of malformation with varying anatomical features, posing challenges to treatment. Early and accurate diagnosis plays a significant role in selecting the acceptable treatment. This review discusses regarding the classification, clinical and radiographic features,diagnostic methods and treatment options for teeth with dens invaginatus

Key words: Dens invaginatus, radiographic features, management

INTRODUCTION

Dens invaginatus (DI) or Dens in dente is a developmental anomaly resulting from the invaginations of the enamel organ into the dental papilla during the soft tissue stage of development. The invaginated enamel organ produces a small tooth within the future pulp chamber during hard tissue formation. In other word it's an invagination of the enamel and the dentine inside the pulp, which may be limited to the pulp chamber or it may extend up to the root apex. It is also called as 'tooth within a tooth'. It has a tendency of early pulpal necrosis and subsequent periapical pathoses. This type of tooth malformation was first described by Ploquet (1794) in a whale's tooth and Socrates (1856) in a human tooth[1].

PREVALENCE AND INCIDENCE

The prevalence of DI ranges 0.3–10% [2]. DI is most often found in the maxillary lateral incisors, followed by the maxillary central incisors, while it's rare within canines, premolars and molars [3].Also, the bilateral occurrence of DI is not uncommon [4]. This anomaly may occur concomitantly with other dental anomalies like hypodontia, hyperdontia or macrodentia [5]. Dens invaginatus mostly affects the permanent teeth, but sometimes the deciduous teeth could also be affected [6].

AETIOLOGY

- Focal failure of growth of the internal enamel epithelium followed by engulfment of the surrounding normal epithelium during proliferation (Kronfeld 1934) [7].
- Rapid and aggressive proliferation of a part of the internal enamel epithelium invading the dental papilla by Rushton (1937)
- During tooth development distortion of the enamel organ and subsequent protrusion of a part of it will lead to the formation of an enamel-lined channel ending at the cingulum or occasionally at the incisal tip. The latter could be related with irregular crown form by Oehlers (1957) [8].
- External forces exerting an effect on the tooth germ during development by Atkinson (1943) [9].
- During tooth development the ectomesenchymal signalling systems occur between the dental papilla and the internal enamel epithelium these have specific roles such as the

regulation of growth and the folding of the enamel organ regulates tooth morphogenesis[10]. The absence of certain molecules may result in abnormally shaped teeth also as defects within the developing tooth germ. Thus genetic may also be one of the etiological factors in dens invaginatus. Genetic factor has also been proposed to be the cause in various case reports[11, 12].

CLASSIFICATION

The first documented attempt to classify 18 dens invaginatus was by Hallet in 1953 . However, the system described by Oehlers (1957)[8] appears to be the most widely used,

- Type I: The invagination is minimal and enamel-lined; it is confined within the crown of the tooth and does not extend beyond the level of the external amelocemental junction.
- Type II: The invagination is enamellined and extends into the pulp chamber but remains within the root canal with no communication with the periodontal ligament.
- Type IIIA: The invagination extends through the root and communicates laterally with the periodontal ligament space through a pseudo-foramen. There is usually no communication with the pulp, which lies compressed within the root.
- Type IIIB: The invagination extends through the root and communicates with the periodontal ligament at the apical foramen. There is usually no communication with the pulp.

Radicular dens invaginatus (RDI) originates from an infolding of Hertwig's root sheath into the root after the completion of crown development [13]. It has two subtypes.

- In the first subtype, the invagination is cementum-lined and associated with an axial root groove.later it had been preferred to define it as a distinct tooth abnormality. This type is more sort of a variation of root morphology. In 1968, Lee et al. termed this anomaly as a palatogingival groove [14]. Afterwards, other terms were also proposed, like radicular groove (RG), or a developmental radicular anomaly. Nowadays, the term RG rather than RDI is widely used in clinic. Treatment option for RG involves endodontic-periodontal management which differs from DI treatment.
- The second subtype of RDI consists of an enamel-lined invagination within the root. The aetiology of this type of RDI could be associated with the differentiation of epithelial cells from Hertwig's root sheath into ameloblasts. Radiographically, the presentation of RDI and CDI type III could be confused because both have swollen roots. According to the reported cases, both the crown and the root are involved in the invagination in CDI type III, whereas only the root is involved in RDI

CLINICAL DIAGNOSIS

Clinically, unusual crown morphology ('dilated', 'peg-shaped', 'barrel-shaped', talon cusp) or a deep foramen coecum Microdontic teeth The presence of talon cusp or dens eviginatus ,labial groove palatal pit or groove are the important hints, but affected teeth also may show no clinical signs of the malformation [8].

RADIOGRAPHIC FEATURES

The angulation of the film is especially important because the presence of an invagination might not be apparent on standard parallel views .Thus when an invagination is suspected it is advisable to obtain a second radiograph with a 15˚ change in the horizontal angulation of the beam and the tube more mesially placed.

The radiographic image may include:

1. The shape of the invagination varying from an undilated fissure and narrow to a tear-shaped loop pointing towards the main body of the pulp [15].

2. The invagination appears to be a radiolucent pocket surrounded by a radioopaque enamel border. The pocket may vary in distance from the incisal edge and proximity to the dental pulp although the presence of this radiopaque border won't always be apparent.
3. The pulpal morphology is more complex compared to normal and difficult to delineate from the root canal.
4. The invagination completely separated from the pulp with its own opening into the periodontal ligament and manifest as a deep enamel-lined fissure. This is also been described as a 'pseudo-canal' [16].
5. The associated lesion could be extensive with abnormal form and shape.
6. An alteration within the pulpal outline when in proximity to the invagination. For example, there could also be an abrupt change within the border of the pulp chamber or blunting of the pulp horns in anterior teeth.
7. Root development ceases when vitality is lost soon after eruption, which may be radiographically apparent with time. However, the early radiographic identification of dens invaginatus in a developing tooth are often difficult and therefore the implications related to pulp disease in an immature tooth could also be unavoidable

Cone-beam computed tomography (CBCT) is a three-dimensional imaging technique available in vivo,it is the best choice in imaging complicated root canal systems However, routine application of CBCT in Endodontics is still controversial because the radiation dose is still higher than that of two-dimensional radiographs. CBCT should be recommended to the patient only if it offers significant advantages over conventional imaging techniques [17].

TREATMENT

CORONAL DENS INVAGINATUS (CDI)

CDI type I

The most common type of DI is CDI type I[3]. In this type of DI, the invagination is minimal and confined to the crown.

- When pulp is not infected Prophylactic filling is the treatment choice. Flowable composite resin is a good material to fill the entrance of the invagination. However, if the entrance of the invagination is too small to be checked clinically, fissure sealant is recommended with periodic follow up[4].
- When pulp is infected the treatment varies depending on the extent of pulpal infection and the status of the apical foramen. For teeth with limited pulpitis, especially for immature teeth, pulpotomy is recommended. If periapical lesion exists or when the pulp is infected extensively, RCT is needed. It is essential to clean the invagination and debride the root canal thoroughly, to ensure dense filling of the root canal.41 If the affected teeth with extensive pulpitis or a periapical lesion have an immature root, apexification or pulp revascularisation (PR) is more appropriate[18].

In general, surgery is needed only when endodontic treatment fails to control symptoms or when there is periodontal involvement

CDI type II

The invagination in CDI type II is deeper than in CDI type I. It invades the pulp chamber and could interconnect with the pulp.

- If affected teeth present with pits or grooves without caries, preventive filling should also be the first choice as for CDI type I.
- If affected teeth is vital but with caries at the entrance of the DI, treatment should be confined to the invagination. A failure rate of 13.4% was reported for invagination treatment and all failed cases were teeth with CDI type II. .This result indicates filling materials like Composite resin, amalgam or glass ionomer which may chronically irritate the pulp or cause microleakage leading to loss of pulp vitality the materials can

be chosen after caries removal. However, confirmation of the interconnection with the pulp is difficult even with three dimensional imaging. To increase the success rate of invagination treatment in CDI type II a better filling material should be considered. MTA is recommended as filling material as long as the pulp is vital. It increases the survival rate of the pulp, which is of great significance for a tooth with an immature root[19].

- If tooth has pulpal infection or periapical lesion, RCT is needed. The treatment is more complex compared to CDI type I because the invagination extends deeper into the root. If the invagination is close to the enamel-cementum junction, it should be removed during coronal flaring. Alternatively, the invagination has to be removed thoroughly if it extends deeper into the middle third or apical third of the root [20], this has become feasible through application of microscopic and ultrasonic techniques.
- In an immature root with CDI type II and a periapical lesion were treated successfully with Apexification and PR to allow further root development [21].

CDI type III

- This type of DI is more complex compared to other types of DI. Clinically, many teeth with CDI type III are found to possess pulpal disease or a periapical lesion .The key in planning the treatment may be correct assessment of the condition of the main pulp.
- If the main canal pulp is vital, cleaning and filling of the invaginated canal alone is done. Maintaining pulpal vitality of the main canal is of great significance [22, 23].
- If the main canal and the invaginated canal are both infected, it's necessary to debride both of them separately and fill them densely [24].
- If the main canal is immature with a wide open apex, apexification of the main canal is suggested [25]. PR is another good treatment option suitable for such cases [26].
- If the invaginated canal is with a wide open foramen, apexification of the invaginated canal failed to form a hard tissue barrier if the invagination was located laterally to the main canal [27]. This is often caused by the low regenerative ability of cells round the pseudo-foramen. In such cases, MTA is an acceptable apical barrier.
- In cases where the invagination is located centrally in the main canal, the main canal obtains further development through apexification or PR of the invaginated canal [26].In such cases, the effect of medication within the invaginated canal is analogous to direct application within the main canal because the invagination and the main canal communicate with the periodontal ligament. In this type of DI, some authors also removed the invagination during treatment using similar methods as for CDI type II[28].This process of removal of invagination is more difficult and not suitable for all cases hence the decision to remove the invagination has to be decided with caution.

During the treatment, engine-driven nickel-titanium rotating instruments have to be used cautiously for cleaning and shaping the invaginated canal due to the irregular shape and enamel lining of this area.Low-speed Gates Glidden drills and manually operated instruments such as a H-file or K-file can be controlled easily by the operators during preparation, and are used in DI cases by many authors[29].If conservative treatment fails or if the invaginated canal cannot be cleaned and filled by traditional methods then surgery is needed [27].

Extraction is the last choice when endodontic treatment, surgery or combined therapy fails.

RADICULAR DENS INVAGINATUS

Only a fEw cases have been reported and the affected teeth were all extracted [30]. PR and intentional replantation are other options. The insufficient understanding of the internal structure of the root in the

reported cases of RDI may incline the clinicians and the patients to choose extraction rather than extensive efforts to save the teeth. If affected teeth are indispensable for aesthetics or chewing function, extraction should be considered with great caution.Although access to the invagination is difficult, locating the entrance with the aid of three-dimensional imaging is not impossible. Furthermore, a three-dimensional plastic model may contribute to endodontic treatment planning in advance just like for CDI type III [31].Now, with the development of three-dimensional imaging, we can easily analyse the inner structure of a tooth, and successful treatment for RDI is possible.

CONCLUSION

Thus the successful management of dens invaginatus is possible by thorough knowledge of the condition for the clinician to diagnose followed by early detection and correct treatment procedure with the use of advanced technologies

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