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Research Article

A Literature-Based Discussion of Root Canal Treatment of Teeth with Developmental Anomalies

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Abstract

Aim: To review the literature pertaining to root canal management in different types of tooth abnormalities.

Methodology: An electronic search was conducted through databases PubMed and Google Scholar for different dental anomalies. Also, classical textbooks on dental anatomy, endodontics, and oral biology were searched. The search terms were: dental anomalies, root canal treatment in tooth anomaly, classification of tooth anomalies, gemination, fusion, dilacerations, and other different types of anomalies.

Results: Twenty-five studies related to root canal management in different types of tooth abnormalities have been included in this review. These studies used both periapical radiographs and cone-beam computed tomography for investigation and treatment, including a conservative approach, regenerative endodontics, root canal treatment, intentional replantation, and extraction. Most of the studies involved were case reports with follow-up periods ranging from 6 months to 18 years.

Conclusion: Comprehensive understanding of tooth anomalies and their clinical and radiographic appearance, correct diagnosis, case selection, and treatment planning are important factors in managing root canal treatment with tooth anomalies.

Keywords: Dental Anomalies; Developmental Anomalies; Root Canal Treatment; Root Canal Anatomy

Introduction

To accurately identify tooth abnormalities, dental practitioners should have a clear understanding of the process of tooth development and the main tissue types of teeth and supporting tissues; this knowledge is applicable to day-to-day clinical practice. This paper aims to review the literature related to the management of root canal treatment in teeth with developmental anomalies. This review is focused on the available literature pertaining to the management of teeth with developmental abnormalities during root canal treatment. In general, anomalies that arise during morphogenesis in the bell stage of tooth development affect the size of teeth. On the other hand, if tooth development is disturbed in the initiation stage, it affects the tooth number [1]. Abnormalities of tooth positions occur in the eruption stage when teeth move from their development site towards their functional positions [2].

Methods

An electronic search was conducted through databases PubMed and Google Scholar for different dental anomalies. In addition, classical textbooks on dental anatomy, endodontics, and oral biology were searched. A total of research papers which were published between 2010 and 2017 were included, with keywords such as dental anomalies, root canal treatment in tooth anomaly, classification of tooth anomalies, gemination, fusion, dilacerations and other different types of anomalies (Appendix 1).

Results and Discussion

Gemination and endodontic treatment

Gemination of permanent teeth, especially if the anterior teeth are involved, could disturb the aesthetic appearance. Germination, in general, is asymptomatic and does not need treatment. However, dental caries or periodontal destruction could lead to pulpal necrosis [3]. Thus, a multidisciplinary approach to treatment is required. One approach of treating geminated teeth is to perform hemisecting and orthodontic treatment following endodontic treatment [4]. In such cases, clinicians should appreciate the variety of root canal systems and perform two coronal access cavities for the two root canals [5].

Talon cusp and endodontic treatment

Talon cusp is a dental anomaly that occurs as an extra cusp-like structure in the cingulum area of mandibular or maxillary anterior teeth [6]. The talon cusp's size can vary from small to very large and prominent. The clinical complications of this anomaly vary from asymptomatic with no need for treatment, to occlusal interference, compromised aesthetics, caries lesions, pulpal necrosis, and periapical pathosis [6]. The treatment of teeth involving a talon cusp is dependent on whether the cusp contains a pulp horn. Some studies based on radiographic examination indicate that the talon cusp contains extensions of pulp [6]. However, using a radiographic view to trace the root canal system has an important limitation: superimposition of the cusp upon the affected tooth crown affects the validity of these studies. In attempting to overcome this limitation, histological studies of extracted teeth with a talon cusp have been conducted. However, these studies have failed to reveal pulp horn extension into the talon cusp. Nowadays, using cone-beam computed tomography (CBCT) could provide valuable information on the root canal systems of affected teeth and help clinicians in treatment planning [7]. The management of such cases varies from no treatment to grinding, pulp therapy, full crown coverage, and extraction [8,9].

Dens evaginatus and endodontic treatment

Dens evaginatus is a developmental anomaly that shows an accessory cusp containing enamel, dentin, and pulp tissue [10]. This type of anomaly is clinically important as wearing or fracture of the tubercle can lead to a compromised pulp, pulp necrosis, and periapical infection. The mandibular premolars are the most susceptible teeth to dens evaginatus. Thus, a thorough investigation (both clinically and radiographically) into all cases with an accessory tubercle on the occlusal surface should be embraced. The treatment option when pulpal inflammation occurs depends on the formation of the root. In immature teeth, the complexity of treatment is increased, and the treatment options comprise apexogenesis or apexification [11]. In a recent study, a conservative access cavity for root canal treatment was performed using splints as guidance [12]. In this study, the case was diagnosed by using CBCT, the access cavity was planned by using osseointegrated implant planning software, and a stereolithographic splint was used to guide the minimally invasive access cavity preparation. The authors concluded that using CBCT scans in such cases helps clinicians to obtain better information on the internal root canal morphology. Also, using the splint to guide an access cavity helps to preserve the tooth structure. However, using this equipment has some limitations, such as high cost, long treatment time, the need for skills, and a high percentage of inaccuracy.

Dens invaginatus and endodontic treatment

Dens invaginatus is a developmental anomaly resulting in a deepening of the enamel organ into the dental papilla before calcification of dental tissues [13]. In the past, teeth affected by dens invaginatus were considered to have a poor prognosis, and the treatment of choice was extraction. This approach is still the correct option with severe cases [14,15]. However, with a greater understanding of the internal morphology of root canal systems of invagination, less invasive procedures are now recommended.

One option involves coronal instrumentation followed by coronal restoration or gutta-percha [16,17]. Another technique involves filling the pulp chamber with calcium hydroxide and zinc oxide eugenol, using either a composite, glass-ionomer cement or amalgam. However, a study reported that 11.3% of the cases treated with this approach developed irreversible pulpitis [18]. The third option concerns when invaginated teeth develop pulp disease or have a high risk of doing so; thus, root canal treatment and extraction are the only options. These types of teeth are associated with a complex root canal system, which makes achieving adequate chemomechanical instrumentation more difficult [19]. The factors which contribute to increasing the difficulty of conducting successful shaping, cleaning, and filling include: the presence of enamel lining on the body of invagination; variation in internal anatomy; and the absence of apical constriction if the dens invaginatus opens

into periodontal ligament. Even though the treatment of infected dens invaginatus teeth is difficult, multiple studies have described successful treatment outcomes [17,20].

Type I: Minimal invaginatus

When the invaginatus is limited in the crown with no signs or symptoms of pulpal disease, a minimally invasive approach should be embraced. Fissure sealant or flowable composite resin could be used to seal the entrance [21]. If pulp disease develops, root canal treatment can be attempted. The complexity of root canal morphology is limited to the area adjacent to the invaginatus.

Type II: Moderate invaginatus

The extent of invaginatus is increased in this type, which allows for direct visualization of the whole invaginatus so as to detect possible caries impossible. Thus, coronal preparation of the entrance is recommended for successful investigation, followed by filling and sealing the invaginatus.

Type III: Severe invaginatus

In this type, the extension of the lesion is increased. If there is no evidence of pulp disease and caries, a minimally invasive approach should be taken, followed by monitoring the case. If pulp health is compromised, root canal treatment is the choice. Furthermore, the complexity of the root canal system with this type of lesion increases the risk of post-treatment diseases.

Taurodontism and endodontic treatment

In teeth with taurodontism, the pulp chamber is very large and elongated with apico-occlusal height, which means that the pulpal floor extends apically below the cementoenamel junction [22]. Root canal treatment becomes challenging because this type of tooth has a varying degree of obliteration, with different sizes and shapes of the pulp chamber, and the canal orifices positioned more apically.

Dilaceration and endodontic treatment

It is an exception rather than normality to find a tooth with a straight root and canal system. Most teeth have some curvature or show multiple planes of curvature throughout their length [23]. A root is considered to have a dilaceration if there is a 90-degree angle or greater from the axis of the root towards the mesial or distal direction [24].

When root canal treatment is attempted in a tooth with a dilacerated root, a variety of factors might complicate this procedure. Thus, the basic root canal techniques should be followed strictly, including: high-quality preoperative radiographs, straight-line access to the apical third of the canals, using pre-curve files, and thorough use of irrigation [25]. Recognizing root dilaceration before commencing root canal treatment is important so as to allow safe and proper use of endodontic instruments in the curved canals [24]. This can be achieved with periapical radiographs or by using CBCT to confirm the direction of the dilaceration [26]. Using scout files in such cases provides critical information with respect to the direction and extent of root canal dilaceration [23]. It is mandatory to preserve all file instruments – especially files larger than size 20 – to allow files to follow the curvature direction and not just cut a dentinal wall in a straight direction [23]. The prognosis of root canal treatment of dilacerated teeth depends on a variety of factors, such as the practitioner's skills, the reason why the root canal treatment is required, the remaining tooth structure, and the quality of the coronal restoration.

C-shaped canal and endodontic treatment

Due to the C-shaped canal system's complexity, the endodontic intervention might be more complicated [27]. Therefore, a thorough understanding of the root canal morphology is important for successful diagnosis and treatment. Identification of C-shaped canals based on an intraoral radiograph is not easy; however, clinicians should be familiar with the radiographic appearance of this type of abnormality. It has been noted that the radiographic appearance of a semicolon type of C-shaped canal has the following characteristics: (i) close proximity or fusion of two roots, (ii) a vague image of a third canal in between, (iii) a large distal root canal, and (iv) a narrow mesial canal and root [28]. Thus, it is imperative to take preoperative radiographs from more than one angle; in addition, bitewings, a panoramic radiograph, could contribute to the successful identification of C-shaped canals [29]. In general, attention should be paid to the cleaning and shaping steps, particularly to the isthmus and fin areas [27]. These structures communicate between two root canals, which may contain pulp tissues and be considered a bacterial reservoir. However, there is a high risk of root perforation, specifically on the thinner lingual wall of C-shaped canals. Therefore, it is preferable to prepare canals with files no larger than size 25 and avoid using Gates-Glidden burs [30].

Appendix 1 provides a summary of the electronic search findings for clinical case reports related to root canal management of teeth with developmental dental anomalies between 2010 and

2017. It is clear from these studies that there is a short follow up period for the outcome of treatment, only one case report documents a follow up for about 18 years.

Conclusion

Endodontists should be familiar with the anatomical and radiographic appearance of dental anomalies. It is imperative to gain a thorough understanding of the abnormal root canal morphologies, which also affect diagnosis accuracy and treatment. Treatment could be conservative or by attempting root canal treatment. Successful management can be achieved with the necessary knowledge on dental anomalies' internal anatomy, careful diagnosis, and case selection. However, there have been few studies with long follow-up times for such cases; thus, it becomes more difficult to evaluate treatment outcomes.

Appendix 1

Type of anomaly	Author(s)/Year of publication	Management	Radiographic investigation	Follow-up
Dens invaginatus Type II	Kumar., *et al.* (2014) [31]	Regenerative endodontics and RCT	CBCT and periapical radiographs (PA)	28 months
Dens invaginatus Type II	Macho., *et al.* (2015) [32]	RCT, access cavity by using guided implant placement and splint guide	CBCT	NM
Dens invaginatus Type II	Fayazi., *et al.* (2013) [33]	RCT with MTA plug	PA	6 months
Dens invaginatus Type II	Abazarpour., *et al.* (2017) [34]	RCT with CEM plug	PA and CBCT	36 months
Dens invaginatus Type III	Teixido., *et al.* (2014) [35]	Conservative treatment	CBCT	1 year
Dens invaginatus	Narayana., *et al.* (2012) [36]	Revascularisation technique	CBCT/PA	1 year
Dens invaginatus Type III	Brooks and Ribera (2014) [37]	Conventional RCT	PA	4.5 years
Dens invaginatus	Wayama., *et al.* (2014) [38]	RCT and retrograde surgical procedure	PA	18 years
Dens invaginatus	Patel (2010) [39]	RCT on invagination	PA and CBCT	18 months
Dens invaginatus Type III	Agrawal., *et al.* (2016) [40]	RCT in two visits MTA for apexification	PA and CBCT	2 years
Talon cusp (with fusion and dens invaginatus II)	Juneja and Kumar (2016) [41]	RCT	PA and CBCT	1 year
Gemination	Weinstein., *et al.* (2010) [42]	RCT	PA	6 months
Taurodontism	Surendar., *et al.* (2013) [43]	Extraction to protect the permanent tooth bud	PA and OPT	NM
Taurodontism	Mokhtari., *et al.* (2012) [44]	RCT	PA and CBCT	1 year
Hypo-, meso- and hyper-taurodontism	Parolia., *et al.* (2012) [45]	RCT with full crown coverage	PA and OPT	NM
C-shaped	Martins., *et al.* (2013) [46]	RCT	CBCT	10 months
Palatogingival groove	Garrido., *et al.* (2016) [47]	Endodontic treatment with intentional replantation after restoration with flowable composite	PA	12 months

Concrescence	Foran., *et al*. (2012) [48]	RCT	PA	18 months
Enamel pearl	Mao (2014) [49]	RCT	PA and CBCT	NM
Fusion	Sammartino., *et al*. (2014) [50]	Multidisciplinary approach (orthodontics, endodontics, endododontic surgery and prosthetics treatment)	PA and OPT	6 months
Radix entomolaris	Lopez-Rosales., *et al*. (2015) [51]	RCT	PA and CBCT	14 months
Crown dilaceration	Bolhari., *et al*. (2016) [52]	RCT with removing incisal third of crown and then building up with composite	PA	12 months
C-shaped canal	Jang., *et al*. (2016) [53]	Intentional replantation Retrospective study (from 2002 to November 2015)	———	Survival rates: 4 years = 83.4%, 11 years = 73%
Palatogingival groove (three cases)	Cho., *et al*. (2017) [54]	Case 1: RCT, open flap debridement, odontoplasty and guided tissue regeneration Case 2: RCT, Apicoectomy, open flap debridement and odontoplasty Case 3: RCT, crown restoration, root planning and odontoplasty	PA	NM
Different types of dental anomalies	Tymofiyeva., *et al*. (2013) [55]	Diagnosis of dental abnormalities	MRI	_____

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