

CASE REPORT

Dens invaginatus in an impacted mesiodens: a morphological study

M. CANTÍN^{1,2)}, G. M. FONSECA³⁾

¹⁾Doctoral Program in Morphological Science,
Faculty of Dentistry,
Universidad de La Frontera, Temuco, Chile

²⁾Center of Research in Biomedical Sciences,
Universidad Autonoma de Chile, Temuco, Chile

³⁾Department of Oral Pathology,
Faculty of Dentistry,
National University of Cordoba, Cordoba, Argentina

Abstract

Dens invaginatus (DI) is a dental anomaly originated from invagination of the enamel organ into the dental papilla, during odontogenesis. DI may be associated with other abnormalities such as dysmorphic mesiodens, and this unusual condition may be detected by chance on the conventional radiography. However, the three-dimensional nature and the exact morphological patterns of DI are impossible to appreciate from this method. We present a morphological study of impacted mesiodens in a 9-year-old girl, which the three coronal invaginations were detected only by Cone-Beam Computed Tomography (CBCT) in the pre-surgical examination. CBCT, radiographic and microscopic reproductions allow transfer of images to facilitate cooperation of working groups, examination as well as for teaching purposes.

Keywords: *dens invaginatus*, mesiodens, cone beam computed tomography, Hunter–Schreger bands.

Introduction

Dens invaginatus (DI) is a dental anomaly originated from invagination of the enamel organ into the dental papilla, during odontogenesis. According to the literature, this condition most commonly occurs in permanent maxillary lateral incisors, followed by maxillary central incisors, premolars, canines and less frequently in molars [1]. DI may be associated with other abnormalities such as microdontia, macrodontia, taurodontism, gemination and fusion, and *amelogenesis imperfecta*, and even dental or medical syndromes [1]. These teeth may have normal morphology but different variations in the crown morphology may be seen including peg shaped, barrel shaped, conical, and a greater bucco-palatal dimension and talon cusp [2].

The most popular and commonly used classification is the one proposed by Oehlers in 1957, who described three forms of coronal invaginations based on the X-ray appearance [1]. In type I, the invagination is confined within the crown, and does not extend beyond the level of the external cemento–enamel junction. In type II, an enamel-lined invagination invades the tooth but remains confined as a blind sac; there may be a communication with the pulp and the invagination may or may not be grossly dilated. In 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. In 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. The enamel-lined sac is usually causes the crown or root to be dilated; the site of invagination may be marked by a deep pit, usually the palatal pit of the maxillary lateral incisor, or the tip of a molar cusp [3].

In most cases, a DI is detected by chance on the radiograph [1, 4]. The radiographic appearance reflects the severity of the invagination: it may appear simply as a radiographic representation of the occlusal or palatal pit, a loop invagination confined within the tooth and pointing towards its apex, a radiolucent pocket with or without a radiopaque border, or a fissure, separate from the main canal and communicating with the periodontal ligament through its own foramen to produce a “pseudo-canal” [5]. While conventional radiographic methods may be sufficient for diagnosis, the three-dimensional nature of the anomaly may require the use of a second radiograph with a 15° change in horizontal angulation of the beam with a more mesial placement of the tube [6]. However, Durack C and Patel S (2011) report that it is impossible to appreciate the exact anatomical nature of invaginated teeth from conventional radiographic images [5].

A supernumerary tooth is a developmental anomaly of number characterized by the presence of tooth, in addition to the normal series [7, 8]. The atypical and often unerupted supernumerary teeth present between the central maxillary incisors are called *mesiodens* because of its central position; they have been categorized according to their shape and size: eumorphic (resembling the central incisors with normal shape and size) or dysmorphic (teeth with variable size and shape) [9]. The etiology most widely accepted is the hyperactivity of the dental

lamina and the theories includes the combination of genetic and environmental factors in human odontogenesis as dynamic interactions [7, 9]. Only 25% of the maxillary anterior supernumerary teeth erupt, and they cause complications including retention of the permanent teeth, abnormal root development, crowding, and spacing of the anterior teeth [9]. They are usually asymptomatic and may be discovered during radiological examination of the premaxillary area [7, 8]. In children and adolescents, extraction of mesiodens have been recommended in order to avoid possible effects on adjacent, as well as cyst formation; in the early mixed dentition stage, extraction of the mesiodens has been suggested to facilitate spontaneous eruption and alignment of incisors [9, 10].

Because of the scant report of the association between mesiodens and DI in the recent literature [2, 10, 11], we present an unusual case of coronal triple DI occurring in impacted mesiodens, and different morphological patterns are discussed.

☐ Patient, Methods and Results

A 9-year-old girl was referred to our Dental Surgery Center in Curicó (Chile), by her orthodontist because of the presence of a supernumerary tooth precluding eruption of the maxillary right central incisor, and persistence of the deciduous homolateral central incisor. Clinical examination revealed the tip of the palatally impacted supernumerary tooth emerging through the palatal mucosa. The mesiodens was asymptomatic. The patient exhibited fairly good oral hygiene. Family and medical history were no contributory.

Image examination

The orthopantomography (OPG) revealed a multilobulated calcified tooth like structure (supernumerary tooth) erupting at the midline (supernumerary tooth) erupting at the midline (*). This supernumerary tooth precluded eruption of the maxillary right central incisor in its normal position in the dental arch (Figure 1). Two intraoral periapical radiographs were taken with a 15° change in horizontal angulation with a more mesial placement of the tube to evaluate the position of the

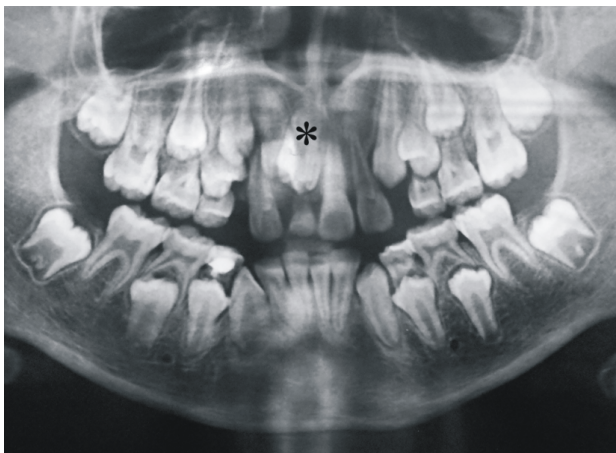


Figure 1 – The OPG shows a multilobulated calcified tooth like structure (supernumerary tooth) erupting at the midline (*), and the relationship to included permanent and persistent deciduous right central incisors. Note the difficult interpreting of these two-dimensional images.

tooth. They showed two invaginations lined by enamel and dentin but remained confined as two blind sacs with minimal contact with the pulp (Figure 2).

Because of the surgical treatment planned, the cone beam computed tomography (CBCT) was indicated. The patient and her parents were informed of the intended benefits of the CBCT scan as well as the associated risks. The estimated dose of radiation to the patient was explained and put into context and written informed consent to carry out the procedure was obtained. A small volume CBCT scan of the area of interest was taken. The images confirmed the palatally position of the mesiodens. The morphology of the tooth crown was found to be unusual. Careful examination of cross-sectional images of the invaginated tooth in all orthogonal planes reveals the presence of not two, but three invaginations, which begin coronally with a narrow undilated fissure, and did not communicate with the root canal and appeared to be entirely lined with enamel. One of them was located palatally (with an oblique path), and the other two were located buccally (Figures 3 and 4).

Surgical procedure and *in vitro* findings

Treatment planning comprised extraction of mesiodens and deciduous tooth. Surgical procedure was carried out under local anesthesia. Once the deciduous tooth was removed, a palatal flap was raised from permanent left maxillary central incisor to permanent right maxillary lateral incisor, showed the presence of DI like supernumerary tooth, and it was removed. This tooth was fixed in 10% neutral buffered formalin solution.

Gross appearance of the supernumerary tooth shows a premolariform crown shape with four pits, and a single short root with a wide-open apex. The tooth was placed in such a way that buccopalatal view was obtained and then altered to obtain mesiodistal view, and radiographs and digital photographs (Nikon Coolpix S3000) were taken in both positions to document the morphological features (Figure 5).

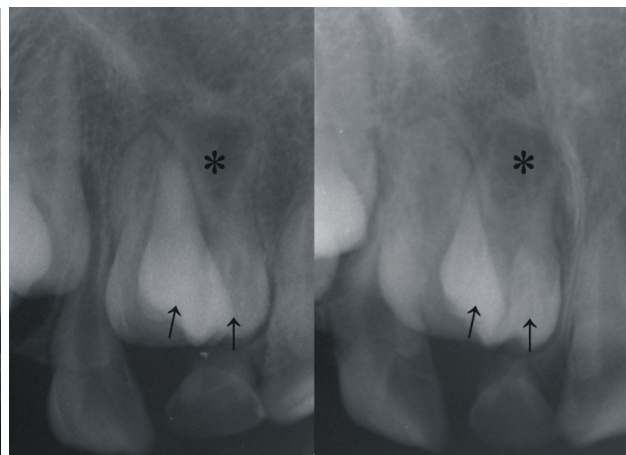


Figure 2 – While the 15° change in horizontal angulation of the beam allows detect the position of the mesiodens (*) related the other teeth, these views only show two enamel-lined invaginations inside it (arrow).

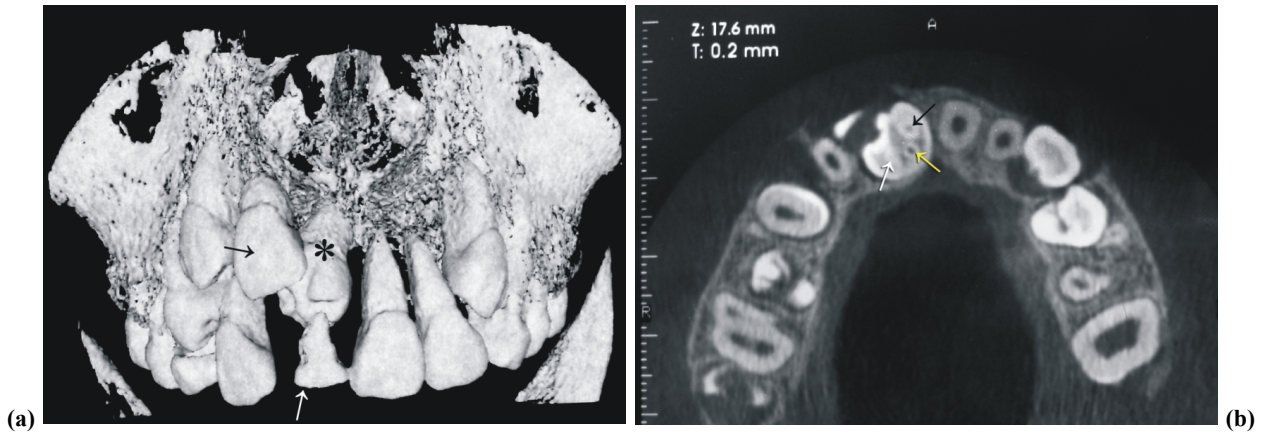


Figure 3 – Reconstructed CBCT images: (a) The reconstructed three-dimensional frontal view of the DI (*), and the relationship to the permanent included central incisor (black arrow) and the deciduous tooth (white arrow); (b) Axial view, note the three enamel-lined invaginations positioned on the mesio-buccal (black arrow), disto-buccal (white arrow) and palatal (yellow arrow) sides.

Figure 4 – Reconstructed CBCT sagittal views showing the three enamel-lined invaginations: (a) The P 61.0 mm slide shows the disto-buccal (white arrow) and palatal (yellow arrow) invaginations with their grooves; (b) The P 63.0 mm slide shows a vague density of the palatal invagination (yellow arrow) and no presence of its groove; (c) The P 65.0 mm slide shows the mesio-buccal invagination (black arrow) with its groove, and the blind sac of the palatal invagination (yellow arrow). The CBCT views confirm the oblique path of the palatal invagination.

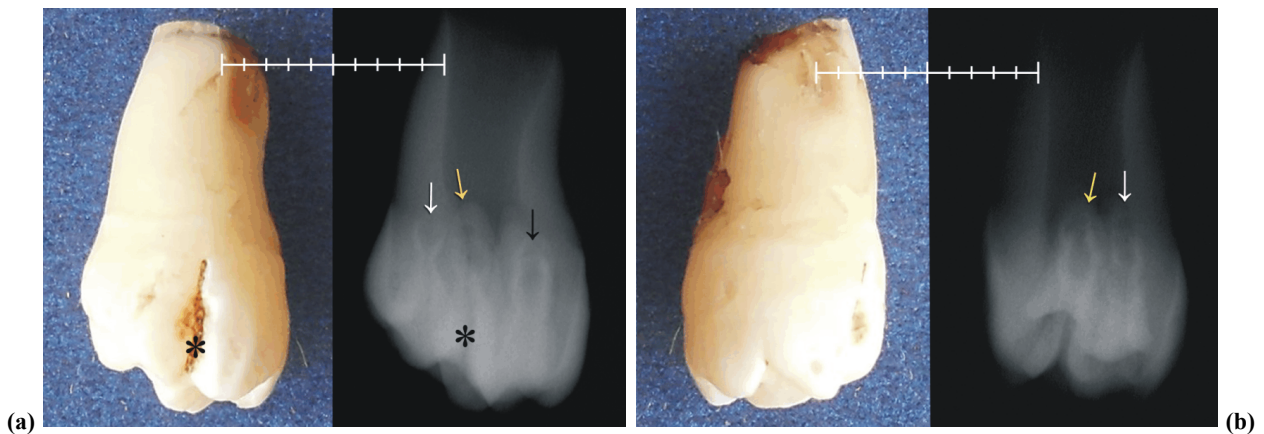
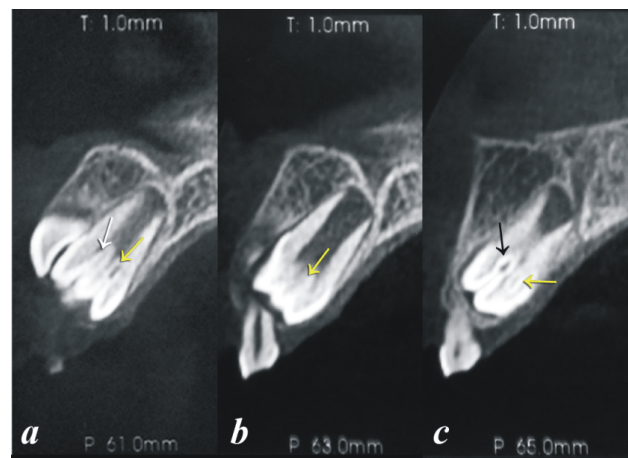


Figure 5 – In vitro photographs and radiographs. (a) Mesio-distal view, buccal surface of the tooth. The radiograph shows the disto-buccal (white arrow), the mesio-buccal (black arrow) and the obliquely palatal (yellow arrow) invaginations. Note the longitudinal defect (*) on the buccal side of the tooth (also visible in CBCT on Figure 3, a and b); (b) Bucco-palatal view, distal surface of the tooth. The radiograph shows the palatal (yellow arrow) and the disto-buccal (white arrow) invaginations hiding the mesio-distal invagination.

Histological findings

The specimen was sliced longitudinally (mesio-distally) with carborundum disk washed thoroughly, into two halves and examined. Both halves were serial sectioned, and all sections were polished on grinding stone slabs of various grades using pumice and water paste, in thickness about ~200 µm. The selected specimens were mounted on glass slides using synthetic Canada balsam with care being taken

to ensure that the plane of the cut surface of the tooth was parallel to the surface of the glass. The specimens were examined with conventional transmitted light and oblique incident light using a Zeiss Axioskop 40 Trinocular microscope (Carl Zeiss, Oberkochen, Germany) with a ×4 objective lens. The oblique incident light was provided by a compact LED light source focused directly on the lateral surface of the specimen, and adjusted

to give an optimal image. The photomicroscope was fitted with a Canon camera (PowerShot G6). Carl Zeiss microscope objectives were chosen for observation and photomicrography.

The conventional transmitted light microscopic observations showed a pathological structure considering DI. Examination of this pathologic finding revealed the abnormal enamel-lined invaginations with no pulp involvement, confined as blind sacs moderately dilated. While the external enamel surface (EES) shows no abnormality, the enamel was found markedly hypomineralized and irregularly structured at the base of the

invaginations. This internal enamel surface (IES) exhibited interruptions and pits which could potentially act as a portal for contaminants to the dentine. The dentine surrounding the invaginations showed no hypoplastic signs but minimal irregularities in the tubules disposition in the adjacency of the amelodentinal junction (ADJ). Oblique incident light revealed the appearance of small, scanty Hunter–Schreger bands (HSBs) in the cuspal EES but the absence of HSBs in the IES. The major “white spot” of the IES than the EES revealed the hypomineralized nature of its structure (Figures 6 and 7).

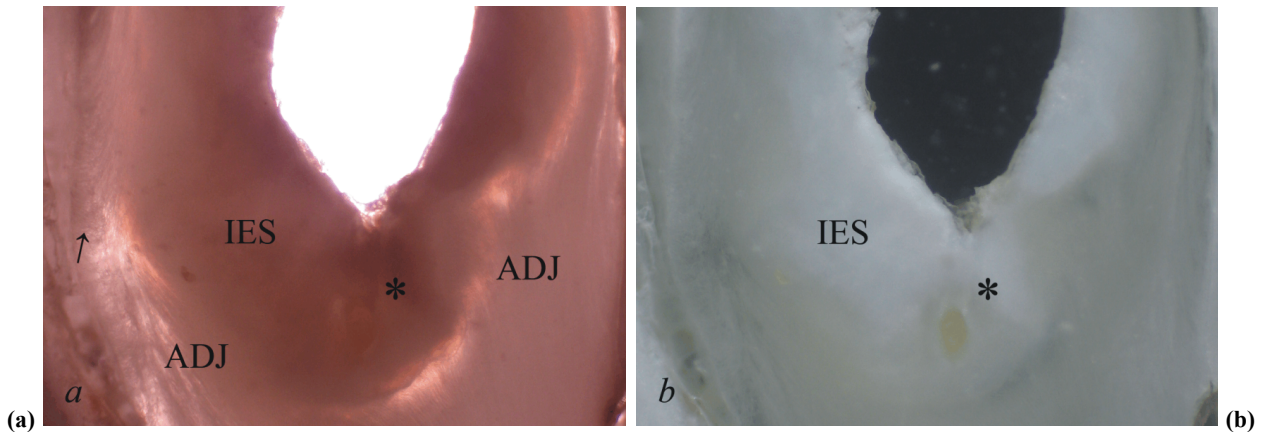


Figure 6 – Morphologic findings in DI, mesio-buccal invagination ($\times 10$): (a) Conventional transmitted light shows the internal enamel surface (IES) of the invagination exhibiting a pit (*). The dentine surrounding the invaginations shows irregularities in the tubules disposition (arrow). Note the irregularity and vagueness of the amelodentinal junction (ADJ); (b) Oblique incident light shows the absence of HSBs in the IES. The major “white spot” surrounding the IES reveals the hypomineralized nature of its structure. Note the improved image of the pit (*).

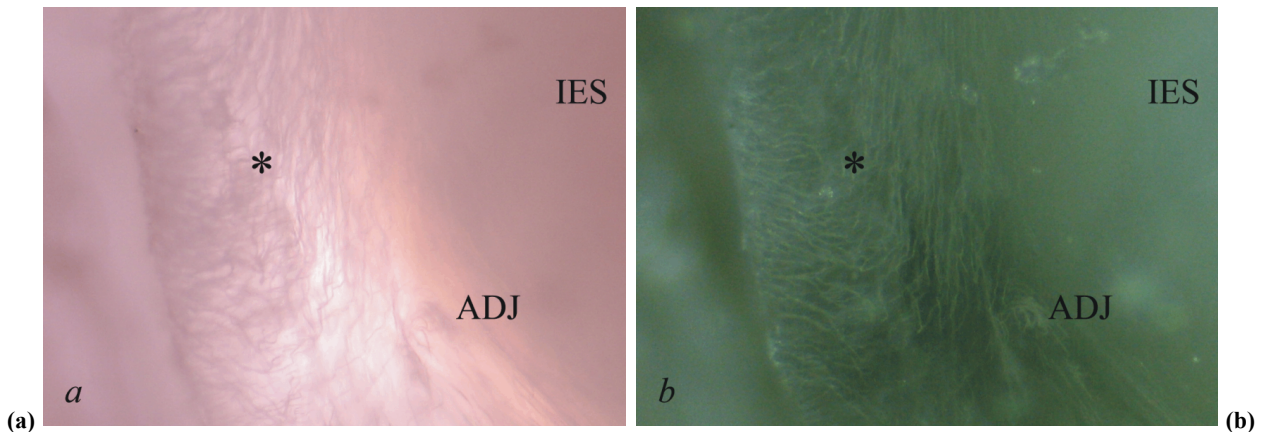


Figure 7 – Morphologic findings in DI, mesio-buccal invagination ($\times 40$): (a) Note the irregularities in the tubules disposition surrounding the IES (*) through conventional transmitted light. The ADJ shows vagueness and undefined; (b) The tubules are been exposed through oblique incident light (*).

Discussion

Of the various terms (*Dens in dente*, invaginated odontome, dilated gestant odontome, dilated composite odontome, tooth inclusion, *dentoid in dente*), “dens invaginatus” would appear to be the most appropriate as it reflects the infolding of the outer portion (enamel) into the inner portion (dentine) with the formation of a pocket and dead space [12]. The varied nomenclature probably reflects the lack of consensus on the formation, etiology and classification of the condition [12]. Several theories have been proposed to explain the etiology of this malformation with failures of growth resulting of

buckling, abnormal proliferating, distortion, protrusion or fusion of the enamel organ; genetic, infection and trauma cannot be excluded [1, 2, 13].

This case coincide with some authors in that the palatal placed, vertical position, presence of a single tooth, and non-eruption are the most common findings in mesiodens but sex of the patient and the tuberculate shape disagreed with the frequencies reported [7–9]. Most cases are usually detected as a radiograph finding; affected tooth has an enamel–dentin access extending into the pulp chamber, root and sometimes apex [4, 11, 13]. In this case, the persistence of the deciduous maxillary right central incisor and the palatal emergence

of the supernumerary tooth advised the OPG detection of the abnormality, situation also reported by GÜNGÖR HC *et al.* (2005) [10]. Nevertheless, the periapical radiography allowed the diagnosis of DI, but only the CBCT specified the presence of three invaginations in the pre-surgical examination. According to Oehler's classification, the type II identified in this case disagreed with the most common type I reported by Kirzioğlu Z and Ceyhan D (2009) [13].

When treating cases of DI, especially those with more complex anatomy, it is essential to develop an appreciation of the course of the invagination and how it relates to the main canals of the tooth [5]. According with Anegundi RT *et al.* (2008) [11], the severe anatomical irregularities and the impacted supernumerary tooth indicated a necessary image protocol for the treatment. We coincide with the limitations associated with the use of conventional radiography in the identification of dental abnormalities or more specifically, the classification and management of DI may be overcome in the future with the increasing availability of computerized 3D imaging [12]. Some authors demonstrate the use of CBCT as an effective diagnostic tool for the management of a DI, and it is particularly useful in assessing the true nature of the invagination, in particular, the relationship of the invagination with the root canal [5, 14]. Although the invagination within the tooth is generally single, double and triple occurrences are even rare anomalies and have been reported scantily [4]. In the reported case, triple invagination did not make conditional to the surgical procedure, and it was detected only by CBCT in the pre-surgical examination.

Investigations into the histological nature of DI have provided conflicting results. Alani A and Bishop K (2008) described the invaginated surface as being uniform and regular with no defects [12]. In this study, we detected interruptions in IES, which could potentially act as a portal for irritants to the pulp. The IES is usually aprismatic and hypomineralized, with atypical rod shapes and absence of perikymata [1, 2, 6]. The histological appearance of a white spot lesion in oblique incident light described a developmental hypomineralization because of the demarcated lesion and the implicit unerupted nature of the tooth. According with some authors, the dentin below the invagination was scantily irregular structured but communications towards the pulp were no detected [12].

When light is reflected off an enamel surface that has been created longitudinally sectioning a tooth, an alternating series of dark and light bands may be seen, so-called Hunter-Schreger bands (HSBs), and its appearance is related to the synchronous decussation of enamel prisms in the horizontal plane and is probably caused by reflection of light by interprismatic material [15]. The lack of HSBs in IES indicated an absence of prisms or that prisms are present but do not decussate. We coincide with Lynch CD *et al.* (2010) that defects can arise during the formation of occlusal fissures because of crowding of the ameloblasts and reduce access of these cells to nutrition [15].

In DI, the invaginated enamel could be largely or entirely aprismatic or conditions are such decussation is

not possible, and all of the prisms are similarly orientated. Lynch CD *et al.* referred HSBs should be considered as a factor in the development and progress of certain clinical conditions that affect enamel, including the resistance of enamel to fracture [15]. These authors suggested further investigation of the role of HSBs patterns in the understanding of these clinically significant areas were warranted. The evaluation of specimens in oblique incident light allows color temperature to show tooth substances with their natural interplay of colors and optical peculiarities largely intact. Observation in transmitted light provides a visual impression that is quite different from this. The oblique incident light microscope provides an economically attractive alternative to the conventional transmitted light microscope for a complementary study of calcified tissue morphology.

Early detection of dental development anomalies is very important. A supernumerary tooth is one of the most common developmental abnormalities found in children and frequently observed in orthodontic patients. Moreover, a possible relationship between supernumerary teeth and other developmental anomalies, such as DI has been proposed [8]. The complex morphology of DI makes the normal treatment modality of such teeth difficult and unpredictable when the tooth is normally erupted [1, 14]. DI resulting in a qualitative phenomenon: the lower values of the mechanical properties, hardness and modulus of elasticity and the interruptions acting as potential portal for external contaminants represent the well-known problems in clinical management [16]. In this case, though the complexity of the anomaly that indicates the extraction, the thorough morphologic study of the tooth allows extrapolate these findings to the clinical management of unusual situations as DI with three invaginations.

☐ Conclusions

Although some authors refer panoramic radiograph is thus essential for the detection of these dental conditions, conventional clinical techniques do not provide images of sufficient quality to fully evaluate the morphology of an invagination *in situ* although for extracted teeth sufficient detail can be obtained. CBCT, radiographic and microscopic reproductions allow transfer of images to facilitate cooperation of working groups, examination as well as for teaching purposes.

Acknowledgments

The support from Program of Attraction and Insertion of Advanced Human Resources, MEC – Conicyt (80120014), are gratefully acknowledged.

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Corresponding author

Gabriel M. Fonseca, DDS, PhD, Department of Oral Pathology, Faculty of Dentistry, National University of Cordoba, Av. Haya de la Torre s/n, X5000MRS Córdoba, Argentina; Phone +54–0351–4687615, e-mail: gabriel_fonseca@argentina.com

Received: May 9, 2013

Accepted: September 18, 2013