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Dental Root Abnormalities in Four Children with PHACE Syndrome

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Abstract

PHACE(S) syndrome is a condition characterized by posterior fossa malformations, hemangiomas, arterial anomalies, cardiac defects, eye abnormalities, sternal cleft and supraumbilical raphe. We present four children with PHACE(S) syndrome who have absence of or severe malformation of the roots of their permanent first molars (PFMs). Root abnormalities in the children's molars were bilateral and not restricted to the segments affected by cutaneous hemangioma. The reason for root abnormalities is unknown, but given the rarity of these findings in healthy children, it is likely an additional dental manifestation of PHACE syndrome. The absence of functional roots in the PFMs can result in significant consequences. Therefore, we recommend a panoramic dental x-ray during transitional dentition for children with PHACE syndrome to screen for dental root abnormalities.

Keywords

hemangiomas/vascular tumors; developmental defects

Introduction:

PHACE(S) syndrome is an association of a large infantile hemangioma combined with one or more additional developmental defects including posterior fossa malformations, arterial anomalies, cardiac defects, eye abnormalities, sternal cleft and supraumbilical raphe. The exact pathogenesis remains unknown, although it is hypothesized to be due to a somatic mosaic genetic mechanism and rare copy-number variations have been discovered¹. Additional clinical features of the syndrome continue to be recognized.² Dental enamel hypoplasia has been reported in children with PHACE syndrome who also had intraoral

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hemangiomas.³ We describe four children with PHACE syndrome who have confirmed abnormalities of dental roots in permanent first molars (PFMs).

Description of Cases:

Case 1 is a Caucasian female born at 36 5/7 weeks' gestation with a large segmental hemangioma involving her frontonasal, bilateral frontotemporal, and left maxillary and mandibular segments. Additional arterial, ocular, and brain abnormalities related to PHACE syndrome were identified (Table 1). Dental x-rays showed bilateral mandibular PFMs with absent roots and dysmorphic roots on the bilateral maxillary PFMs (Figure 1).

Case 2 is a Caucasian male born at 39 weeks' gestation with a segmental hemangioma involving his left frontotemporal and bilateral maxillary segments. Additional findings included arterial anomalies and a sternal scar (Table 1). Dental x-rays obtained at 6 years of age showed bilateral mandibular PFMs with dysmorphic roots with calcifications in the all four of the PFM pulp chambers (Figure 2).

Case 3 is a Caucasian female born at 40 weeks' gestation with a segmental hemangioma involving her right frontotemporal and maxillary segments, and bilateral mandibular segment. Additional findings included cerebellar hypoplasia and arterial anomalies (Table 1). Dental x-rays showed absent dental roots of the right maxillary PFM and bilateral mandibular PFMs, and a dysmorphic root of the left maxillary PFM (Figure 3).

Case 4 is a female with a segmental hemangioma involving the left mandibular segment, including lower lip involvement with ulceration. Numerous arterial abnormalities were identified (Table 1). Dental x-rays obtained at 4 years of age showed dysmorphic root development of all four PFMs with calcifications in the pulp chambers of mandibular bilateral primary first and second molars. The distal roots of the primary second molars appeared to be resorbed (Figure 4a, 4b).

Discussion:

Dental root abnormalities may be primary developmental or secondary in nature. Secondary abnormalities usually result from periodontal trauma or inflammation and typically lead to short and/or misshapen roots of a single tooth or small group of adjacent teeth⁴. In this case series, the complete absence or severe malformation of dental roots in non-adjacent teeth is indicative of a disorder of root development.

The anatomy of a tooth can be divided into the crown, neck and root. For the PFM, the completion of crown formation occurs between 2.5 to 3 years of age. After crown formation is complete, dental root formation begins through a complex interaction between the Hertwig epithelial root sheath (HERS) and the dental papilla. The HERS is formed from enamel epithelium and grows in an apical direction, inducing dental papilla cells to become odontoblasts and later to form root dentin⁵.

Interestingly, there is a recently described disorder of root development that consistently affects the PFMs. Published in 2014 by Witt et al, the condition is termed "root malformation associated with a cervical mineralized diaphragm" (RM-CMD).⁶ The report

describes two patients who exhibited normal dental crowns but with roots of the PFMs “could barely be seen or were very short, tapered stumps.” The pulp cavities of these teeth appear as narrow slits. MicroCT scans of the extracted PFMs showed ectopic mineralized plates at the pulp cavity floors. The authors proposed that the vascular plexus at the base of the dental papilla suffers an early insult during crown development, leading to the development of calcified globules and formation of the CMD. We suggest that an abnormality in the vascular plexus could potentially explain the cause of the root malformations in individuals with PHACE syndrome. Another study by Lee et al, described 12 children with similar findings of PFMs with a normal crown but thin and short roots on x-ray⁷. However, some of these patients also demonstrated incisor enamel defects and/or root abnormalities of the second molars. The authors termed their finding “molar-incisor malformation” (MIM) and postulated that it occurred secondary to an epigenetic factor associated with a systemic disease occurring at 1 to 2 years of age. In the prior reports of RM-CMD and MIM, none of the patients are described to have a hemangioma or arterial anomalies.

We present four individuals with PHACE(S) syndrome who have absence or severe malformation of the roots of their PFMs. These findings were coincidental and without symptoms. We do not have follow-up dental information for the children in this case series, so the full clinical significance of these findings remains unknown. In all of the cases, the hemangioma involved the maxillary and/or mandibular segment which could perhaps alter the vascular plexus at the base of the dental papilla. However, root abnormalities in the patients’ molars were bilateral and not restricted to the segments affected by cutaneous hemangioma. These individuals exhibit a disorder of root development that resembles RM-CMD and MIM on x-ray. The reason for root abnormalities is unknown, but given the rarity of these findings in healthy children, it is likely an additional dental manifestation of PHACE syndrome. The absence of functional roots in the PFMs can result in significant consequences, including impaction, early exfoliation, and mesial tilting causing obstructed eruption of adjacent teeth. Furthermore, the PFMs are critical for contact between teeth and chewing⁷.

We have identified four children with PHACE syndrome who have absent or severely malformed roots of the PFMs. Dental radiographic recommendations, endorsed by the American Dental Association (ADA) and the American Academy of Pediatric Dentistry (AAPD), vary on the age, development, and medical history of the patient⁸. For a patient with transitional dentition (after eruption of the first permanent tooth), the ADA and AAPD guidelines recommend posterior bitewings with panoramic or posterior bitewings and selected periapical X-rays. However, for patients requiring additional monitoring of dentofacial growth and development (such as children with PHACE(S) syndrome), the guidelines recommend the use of clinical judgement as to the types of radiographic images needed. From a practical point of view, a panoramic radiograph is considerably easier to obtain with much less discomfort, and provides a larger field of view than do selected periapical radiographs, without a substantial increase in exposure to ionizing radiation. While any radiographic survey judged appropriate by a dentist will suffice, a panoramic radiograph is most likely to easiest to obtain while still providing appropriate diagnostic information. Therefore, due to our report of abnormalities in the roots of the PFMs for four

children with PHACE syndrome, we emphasize adherence to these imaging guidelines, specifically considering panoramic dental x-ray during transitional dentition.

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Figure 1.
(Case 1) Panoramic radiograph demonstrating dysmorphic root development on the maxillary right and left permanent first molars (PFM) and absent root development on the mandibular right and left PFMs (arrows). In addition, the mandibular right permanent second pre-molar is congenitally missing and the mandibular right PFM is ectopically positioned under the mandibular right primary second molar

Figure 2.
(Case 2) Bitewing radiographs demonstrating dysmorphic root development on the mandibular right and left PFMs (black arrows) with calcifications in all four of the PFM pulp chambers (white arrows)

Figure 3.
(Case 3) Panoramic radiograph demonstrating absent root formation on the maxillary right and bilateral mandibular PFMs with dysmorphic root formation on the maxillary left PFM (arrows). Pulp chambers on the mandibular PFMs appear to have calcifications, but the quality of the picture prohibits definitive conclusion

Figure 4.

A, (Case 4) Panoramic radiograph demonstrates dysmorphic formation of all PFMs (arrows). B, (Case 4) Bitewing and the right periapical radiographs demonstrate calcifications in the pulp chambers of mandibular bilateral primary second molars (white arrows) as well as dysmorphic root formation and early resorption of the distal roots of the primary second molars/ectopic eruption of the mandibular PFMs (black arrows)

Table 1.

Case-specific PHACE syndrome diagnostic criteria

	Hemangioma Location	Additional PHACE-Related Complications
Case 1	Frontonasal, bilateral frontotemporal, and left maxillary and mandibular segments	Dandy-Walker malformation [*] Aberrant origin of the subclavian artery [*] Bilateral staphylomas of the eyes [*] Hypoplastic pituitary ^{**}
Case 2	Left frontotemporal and bilateral maxillary segments	Absence of the left vertebral artery [*] Narrow left internal carotid artery [*] Aortic dilation [*] Sternal scar [*]
Case 3	Right frontotemporal and maxillary segments, and bilateral mandibular segment	Hypoplastic right internal carotid artery, right anterior cerebral artery, left posterior communicating artery [*] Right cerebellar hypoplasia [*]
Case 4	Left mandibular segment	Aberrant origin of right subclavian artery from the distal aortic arch [*] Early bifurcation of the left common carotid artery [*] Duplication of the left vertebral artery [*] Ectasia of the left carotid artery [*]

^{*} Major diagnostic criteria

^{**} Minor diagnostic criteria