REGIONAL ODONTODYSPLASIA: AN OVEREVIEW

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ABSTRACT

Regional odontodysplasia is a rare developmental anomaly involving dental tissues. The precise etiology is not yet known. The affected teeth are usually small with atypical morphology with yellow or brown discoloration. One hundred and seventy six cases of regional odontodysplasia have been published to-date. Analysis of the published cases shows that the age at the time of diagnosis ranges from 1-23 years. Maxilla is more commonly affected with predilection for anterior teeth. Radiographic images of the involved teeth show a ghost-like appearance. Histologically, almost all dental tissues are altered. Enamel and dentin appear as hypoplastic and hypocalcified and the pulp is larger than normal. Treatment of regional odontodysplasia needs to be individualized and requires a multidisciplinary approach. Although regional odontodysplasia is known for more than six decades, the literature is almost limited to case reports only. Further epidemiological, experimental and genetic studies are needed.

Key Words: *Odontodysplasia, Regional, overview.*

INTRODUCTION

Regional odontodysplasia (RO) is defined as a localized developmental anomaly involving both deciduous and permanent dentitions with adverse effects on the formation of enamel, dentin, and pulp.[1,2] It was first described by Hitchin in 1934.[3] It has been designated by various terms, such as "arrested tooth development"[4], "shell teeth"[5], "unilateral dental malformation"[6], and "ghost teeth"[7]. Zegarelli et al. (1963)[10] coined the most widely used term "odontodysplasia". Later in 1970, Pindborg[8] added the term, "regional" emphasizing the localized nature of this disease. It is usually found isolated, however, it can be associated with some developmental anomalies such as ectodermal dysplasia, hypophosphatasia, unilateral facial hypoplasia, neurofibromatosis, and vascular and epidermal nevi.[9]

The purpose of the present article was to review the English-language literature and to provide an overview of various aspects of RO. The etiology, pathogenesis, epidemiology, clinical presentation, radiographic, macroscopic, ultrastructural, light microscopic, immunohistochemical features, and treatment of RO are discussed.

ETIOLOGY & PATHOGENESIS

The exact etiology of odontodysplasia is not clear, although several theories have been suggested. Some authors suggest a correlation with trauma and infection;[6,10] however, this correlation was not proved, since the correlation was based on patient history alone. The distribution of affected teeth in all four quadrants makes some authors suggest that somatic mutation may be the causative factor.[11] Witkop also suggested that a somatic mutation in early development could cause alterations in the ontogenesis.[12] Nagai et al.[13] had transplanted tooth germs in mice and found alterations in the tooth formation after inducing polyoma virus. Thus, viral infection of odontogenic epithelium was also suggested as a possible cause.[7] Nevertheless, no evidence of virus is present in any of the reported cases in the literature. Dahllöf et al. presented a case of a patient with concomitant regional odontodysplasia and hydrocephalus, and suggested a neural origin.[14] Sibley and Zimmermann[15] reported a patient with a history of hypocalcaemia and correlated this with RO. Moreover, it has been suggested that an imbalance of important proteins, such as metalloproteinases, might lead to the structural disorganization seen in this anomaly.[16]

The most prevalent theory relates RO to vascular etiology. Numerous reported cases are associated with a disturbance in the local circulation overlying the affected area. Walton et al.[17] reported three cases of regional odontodysplasia with a birthmark occurring on the skin, overlying the affected teeth. This vascular disturbance seems to be a consistent finding amongst patients with odontodysplasia, as reported by several authors.[2,18-22] This theory is further supported by animal experimental studies, as resection or ligation of different head and neck arteries resulted in similar disturbances of the dental hard tissues.[23,24] All the reports agree that this is a non-inherited condition, because no cases were reported in other family members.[16,25-27] Fujiwara et al.[28] suggested that the developmental anomaly in the case they reported may not be genetically determined, but rather environmentally induced. Conclusive evidence

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of the aforementioned theories is still lacking, since the studies were based on the case reports. The newer reports revolve around idiopathic etiology, as most of them failed to identify any local or systemic etiological factors.[29,25,30,31] However, whatever is the etiology, the causative factor must be active in both primary and secondary dentitions of the affected area.

EPIDEMIOLOGY & CLINICAL PRESENTATION

Many authors have considered RO to be an uncommon condition.[9,32,33] Tervonen et al[34] reviewed 138 cases of RO published in the international literature during 1934-2002, and assembled the epidemiological data. In the present review, all well-documented case reports of RO from 2002 and until the reporting of the present study, were retrieved from PubMed database search, and the epidemiological data were evaluated. Since 2002, 38 cases[16,25-61] of RO have been reported in the literature, making a total of 176 cases. The present review showed a 1.2:1 ratio of females to males, a somewhat similar finding to that of Tervonen et al. (1.7:1). The age at the time of diagnosis ranges from 1-23 years and shows bimodal peaks at 4 and 10 years of age.

The maxilla was more commonly affected with predilection for the anterior teeth, which is in accordance with Tervonen et al. The most common clinical symptom is failure of tooth eruption, which was also found by Tervonen et al.[34] Other symptomes include hyperplastic tissue overlying the unerupted or partialy erupted teeth, inflammation of the gingiva, periapical infection, fistulas, and localized pain. RO was also associated with facial asymmetry in 5% of patients, and with facial hemangioma in 7.4% of the cases.[34] The affected teeth generally show yellow or brown discoloration.[34,62] The teeth are usually small with atypical morphology. The teeth surface show a varying appearance, such as an irregular contour, shallow furrows and pitting, and grooves predominate.[9] The enamel has been reported to be soft on probing and tends to be hypoplastic and hypocalcified.[31,32] The condition usually affects one quadrant.[34] However, some cases cross the midline.[43,45,62] Three cases reported in the literature showed generalized involvement.[17,63,64] It has been shown that this condition is not limited to any specific ethnic group.[9]

RADIOGRAPHIC FEATURES

Previous case reports of RO have stated distinctive and characteristic radiographic findings.[36,62,65,66] Radiographic images of the involved teeth show a ghost-like appearance, due to reduced radio-density of the thin enamel and dentin, and enlarged radiolucent pulp. The teeth appear with an abnormal morphology, a hypoplastic crown, and a faint outline of hard tissue. There is absence of contrast between enamel and dentin. In some cases, the affected teeth show features of arrested development, such as short roots with open apices and abnormally large pulp chambers. Additionally, the teeth are usually associated with enlarged follicles. Pulp stones may occasionally be visible.[9,34] The unerupted teeth are sometimes surrounded by large radiolucency with distinct borders, which resemble cysts or neoplasms. The adjacent alveolar bone sometimes appears thin, with a decrease in trabeculae.[67,68] Few reports have described computed tomography (CT) findings of RO.[26,69] These findings indicated that hypocalcification is more severe in enamel than in dentin. The reports also suggested that dense fibrous connective tissue or hard tissue-like structures were present in the dental follicles of the affected teeth.[26,69]

MACROSCOPIC/ULTRASTRUCTURAL/LIGHT MICROSCOPIC/IMMUNO-HISTOCHEMICAL FEATURES

Macroscopically, the altered teeth shows an irregular morphology, rough surfaces, and yellowish to brownish discoloration.[30] Scanning electronic microscopic (SEM) and transmission electron microscopic (TEM) studies showed wide-ranging defects of the involved teeth.[30,70] The enamel is generally thin, and the enamel prisms are irregular. The enamel appears laminated due to alterations in the hydroxyapatite crystals and inter-prismatic regions.[30,71] The coronal dentin is usually more affected than the radicular dentin. Dentin appears thin and globular in structure. Interglobular spaces and cellular and amorphous areas are prominent. Dentinal tubules show changes of orientation, density, size, distribution and shape.[30,72,73]

Histologically, all dental tissues are usually altered.[36,65,72] In most of the reports, enamel was not evaluated histologically, because of the decalcification processes.[36,50] However, in ground sectional studies, the enamel appears as hypoplastic and hypocalcified, with variable thickness and irregular surfaces.[9,45] The dentin is also hypoplastic and reduced in thickness. Clefts of various sizes, interglobular dentin, focally-widened predentin zones, and decreased number of dentinal tubules are prominent features of the affected dentin.[44,65] Cellular dentin and amorphous areas are remarkable features of dentin in some cases.[1] The pulp chamber is usually larger than normal showing various forms of fibrosis and calcifications.[30] The odontoblasts appear flattened, rimming the margin of the predentin.[36] Pulpal extensions sometimes extend to the cuspal or incisal enamel.[19] The follicular tissues surrounding un-erupted teeth may be enlarged and exhibit scattered odontogenic rests, whorled fibrous tissue, and focal basophilic calcifications.[30] In some cases, the cementum appears normal;[65] however, when it is affected, it is altered at a lower grade. It may be thinner than normal with no structural changes[30], or with globular structures.[70]

The gingival and alveolar mucosa surrounding the affected teeth may show foci of calcification and islands of odontogenic epithelium.[30,74,75] It was found that the soft tissue calcification were associated with mesenchymal vimentin-positive cells and with odontogenic cytokeratin-positive epithelial remnants, as shown by the immunohistochemical investigations.[30] Courson et al.[16] examined the gingival tissues surrounding the affected teeth and found a decreased collagenic network and extremely fragmented collagen fibers.

Additionally, quantitative measurements showed an imbalance between MMP-1 and MMP-2 and their inhibitors TIMP-1 and TIMP-2, which suggested that the increase in enzymatic activity could explain the disorganization of the connective tissue.[16]

MANAGEMENT

The management of RO is often challenging, requiring cooperation among multiple disciplines. The objective of the management is to maintain a good oral function, improve the esthetics, and facilitate normal jaw growth.[25,36] There has been a considerable controversy about whether to remove the affected teeth. Many of the reports recommended removal of the affected teeth, as these teeth are considered to be potential source of infection,[39,62,68] while others suggested a conservative approach of preserving the involved teeth for as long as possible.[25,76] The conservative approach would maintain the alveolar bone and enhance normal jaw development.[9,25,76] There is no general agreement on the management of this disease. However, several factors should be considered, including the patient's age, relevant medical history, previous dental experience, degree of involvement, and attitudes of both child and parent regarding dental treatment.[25,77]

SUMMARY

Regional odontodysplasia is a rare non-hereditary condition causing severe dental disturbances. The etiology of this disease remains unknown. Treatment of RO needs to be individualized and requires multidisciplinary approach. Although RO is known for more than six decades, the literature on RO is mostly limited to case reports only. Further epidemiological, experimental and genetic studies are needed.

REFERENCES

1 Gardner D, Sapp J. Regional odontodysplasia. Oral Surgery, Oral Med Oral Pathol. 1973; 3(4): 6-9.

2 Lustmann J, Klein H, Ulmansky M. Odontodysplasia. Report of two cases and review of the literature. Oral Surg Oral Med Oral Pathol. 1975 May; 39(5): 781-93.

3 Hitchin AD. Unerupted deciduous teeth in a youth aged 15 1/2. Br Dent J. 1934; 56(3): 631-33.

4 McCall JO, Wald SS. Clinical Dental Roentgenology. 2nd ed. Philadelphia: Saunders; 1947.

5 Rushton MA. A new form of dentinal dysplasia: shell teeth. Oral Surgery, Oral Med Oral Pathol. 1954; 7(5): 543-49.

6 Bergman G, Lysell L, Pindborg JJ. Unilateral dental malformation. Oral Surgery, Oral Med Oral Pathol. 1963 Jan; 16(1): 48-60.

7 Rushton MA. Odontodysplasia: "ghost teeth." Br Dent J. 1965 Aug 3; 119: 109-13.

8 Pindborg JJ. Pathology of the dental hard tissues. Copenhagen: Munksgaard; 1970.

9 Crawford PJ, Aldred MJ. Regional odontodysplasia: a bibliography. J oral Pathol Med. 1989 May 1; 18(5): 251-63.

10 Zegarelli EV, Kutscher AH, Applebaum E, Archard HO. Odontodysplasia. Oral Surgery, Oral Med Oral Pathol. 1963 Feb; 16(2): 187-93.

11 Sabah E, Eden E, Unal T. Odontodysplasia: report of a case. J Clin Pediatr Dent. 1992 Jan 1; 16(2): 115-18.

12 Witkop CJ. Hereditary defects of dentin. Dent Clin North Am. 1975 Jan; 19(1): 25-45.

13 Nagai I, Yoshioka W, Kumegawa M, Arita J, Ikeda J, Tooth T. Early Influence of Polyoma Virus on Transplanted Tooth Germs. J Dent Res. 1963 Sep 1; 42(5): 1131-39.

14 Dahllöf G, Lindskog S, Theorell K, Ussisoo R. Concomitant regional odontodysplasia and hydrocephalus. Oral Surgery, Oral Med Oral Pathol. 1987 Mar; 63(3): 354-57.

15 Sibley LC, Zimmermann ER. Odontogenic dysplasia. Oral Surgery, Oral Med Oral Pathol. 1962 Nov; 15(11): 1370-73.

16 Courson F, Bdeoui F, Danan M, Degrange M, Gogly B. Regional odontodysplasia: expression of matrix metalloproteinases and their natural inhibitors. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2003 Jan; 95(1): 60-66.

17 Walton J, Witkop CJ, Walker P. Odontodysplasia: report of three cases with vascular nevi overlying the adjacent skin of the face. Oral Surgery, Oral Med Oral Pathol. 1978; 46(5): 676-84.

18 Guzman R, Elliott MA, Rossie KM. Odontodysplasia in a pediatric patient: literature review and case report. Pediatr Dent. 1990 Feb; 12(1): 45-48.

19 Fearne J, Williams DM, Brook AH. Regional odontodysplasia: a clinical and histological evaluation. J Int Assoc Dent Child. 1986 Apr; 17(1): 21-25.

20 Schmid-Meier E. Unilateral odontodysplasia with ipsilateral hypoplasia of the mid-face. A case report. J Maxillofac Surg. 1982 May; 10(2): 119-22.

21 Steiman HR, Cullen CL, Geist JR, Claire MS, Cullen L. Bilateral mandibular regional odontodysplasia with vascular nevus. Pediatr Dent. 1991; 13(5): 303-06.

22 Kahn MA, Hinson RL. Regional odontodysplasia. Oral Surgery, Oral Med Oral Pathol. 1991 Oct; 72(4): 462-67.

23 Kraus BS, Myers RE, Clark GR. Teratogenic effects of carotid ligation on the developing dentition of the Rhesus monkey. Teratology. 1969 May; 2(2): 163-72.

24 Lunin M, Devore D. Etiology of regional odontodysplasia. J Dent Res. 1976; 55B: 109.

25 Cahuana A, González Y, Palma C. Clinical management of regional odontodysplasia. Pediatric dentistry. 2005: 34-39.

26 Matsuyama J, Tanaka R, Iizawa F, Sano T, Kinoshita-kawano S, Hayashi-sakai S, et al. Case Report Clinical and Radiographic Findings and Usefulness of Computed Tomographic Assessment in Two Children with Regional Odontodysplasia. Case reports in dentistry. 2014. 1-5.

27 Grover N. Ghost Teeth: A Rare Developmental Anomaly of the Dental Tissues. Sci J Med Clin Trials. Science Journal Publication; 2014; 2014: 1-5.

28 Fujiwara T, Nakano K, Sobue S, Ooshima T. Simultaneous occurrence of unusual odontodysplasia and oligodontia in the permanent dentition: report of a case. Int J Paediatr Dent. 2000 Jul 7; 10(4): 341-47.

29 Pundir, siddharth. Saxena, susmita. Adlakha V. Regional odontodysplasia: a unique dental anomaly with an insight into its possible etiologic factors. Ann Essences Dent. 2011; 3(4): 47-52.

30 Carlos R, Contreras-vidaurre E, Almeida OP de, Silva KR, Abrahão PG, Miranda AMMA, et al. Regional odontodysplasia: morphological, ultrastructural, and immunohistochemical features of the affected teeth, connective tissue, and odontogenic remnants. J Dent Child (Chic). 2008; 75(2): 144-50.

31 Gündüz K, Zengin Z, Çelenk P. Regional odontodysplasia of the deciduous and permanent teeth associated with eruption disorders: A case report. Med Oral Patol Oral Cir Bucal. 2008; 13(9): 7-10.

32 Gibbard PD, Lee KW, Winter GB. Odontodysplasia. Br Dent J. 1973; 135(12): 525.

33 Lucas RB, Eveson JW. Atlas of oral pathology. Springer Science & Business Media; 2012.

34 Tervonen S a, Stratmann U, Mokrys K, Reichart P a. Regional odontodysplasia: a review of the literature and report of four cases. Clin Oral Investig. 2004 Jun; 8(2): 45-51.

35 Chinn C, Kohli K. Regional odontodysplasia. A case report. N Y State Dent J. 2003 Nov 1; 69(9): 27-29.

36 Hamdan M a, Sawair F a, Rajab LD, Hamdan AM, Al-Omari IKH. Regional odontodysplasia: a review of the literature and report of a case. Int J Paediatr Dent. 2004 Sep; 14(5): 363-70.

37 Özer L, Çetiner S, Ersoy E. Regional Odontodysplasia: Report of a case. J Clin Pediatr Dent. 2004 Sep 1; 29(1): 45-48.

38 Cho S. Conservative management of regional odontodysplasia: case report. J Can Dent Assoc. 2006 Oct; 72(8): 735-38.

39 Rosa, Monica CT and Marcelino, Gracy A and Belchior, Renata S and Souza, Ana Paula P and Parizotto SC. Regional odontodysplasia: report of case. J Clin Pediatr Dent. 2006; 30(4): 333-36.

40 Magalhães AC, Pessan JP, Cunha RF, Delbem ACB. Regional odontodysplasia: case report. J Appl Oral Sci. Faculdade De Odontologia De Bauru - USP; 2007 Dec; 15(6): 465-69.

41 Spini TH, Sargenti-Neto S, Cardoso SV, Souza KCN, de Souza SOM, de Faria PR, et al. Progressive dental development in regional odontodysplasia. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007 Sep; 104(3): 40-45.

42 Ferguson F, Schlissel E, Kucine A, Alexander S, DeSantis A, Hendricks R, et al. Long-term management of a child with regional odontodysplasia: a case report. Pediatr Dent. 2008; 31(4): 346-49.

43 Volpato L, Botelho G, Casela L. Regional odontodysplasia: report of a case in the mandible crossing the midline. J Contemp Dent Pract. 2008; 9(3): 142-48.

44 Gondim JO, Pretel H, Ramalho LTO, Santos-Pinto L a M, Giro EM a. Regional odontodysplasia in early childhood: a clinical and histological study. J Indian Soc Pedod Prev Dent. 2009; 27(3): 175-78.

45 Kappadi D, Ramasetty PA, Rai KK, Rahim AMB. Regional odontodysplasia: An unusual case report. J Oral Maxillofac Pathol. Medknow Publications and Media Pvt. Ltd. 2009; 13(2): 62-66.

46 Quinderé LB, Cavalcante RB, Nonaka CFW, Miguel MCDC, de Souza LB. Regional odontodysplasia involving three quadrants of the jaws: a case report. Quintessence Int. 2010 Jan; 41(1): 13-16.

47 Gurunathan D, Krishnan Rr, Tandon S, Kalra M. Solitary odontodysplasia: A rare entity. J Indian Soc Pedod Prev Dent. 2011; 29(6): 56.

48 Mehta DN, Bailoor D, Patel B. Regional odontodysplasia. J Indian Soc Pedod Prev Dent. 2011; 29(4): 323-26.

49 Srindhi G, Raghavendra S. Regional odontodysplasia: report of a rare case and review of literature. J Int Dent Med Res. 2011; 4(3): 145-50.

50 Turgut MD, Çeliik B, Nazikoğlu A, Ataç AS, Müftüoğlu S. Clinical, Radiographical and Histological Evaluation of an Unusual Regional Odontodysplasia Case. Turkiye Klin J Med Sci. 2011; 31(1): 274-79.

51 Canela AHC, Rezende KMPEC, Benitez M, Bönecker M. Early diagnosis of regional odontodysplasia in an infant. J Craniofac Surg. 2012 Mar; 23(2): 134-36.

52 Ganguly R, Ramesh A. Regional odontodysplasia: a case of progressive tooth development. J Indian Soc Pedod Prev Dent. 2012; 30(2): 176-78.

53 Ponranjini VC, Jayachandran S, Bakyalakshmi K. Regional Odontodysplasia: Report of a Case. J Dent Child. American Academy of Pediatric Dentistry; 2012; 79(1): 26-29.

54 Hema H, Preetha A. Regional odontodysplasia — an unusual case occurring along with supernumerary teeth. Indian J Dent. 2012 Jan; 3(1): 29-32.

55 Scariot R, Morosini I, Pereira CT, Amenabar JM, Rebellato N, Gugisch R. Regional odontodysplasia: A case report. Rev Odonto Cienc. Edipucrs; 2012; 27(3): 246-50.

56 Ziegler S, Neukam FW. Regional odontodysplasia: orthodontic treatment and transplantation of premolars. Am J Orthod Dentofacial Orthop. American Association of Orthodontists; 2012 Nov; 142(5): 710-19.

57 Ibrahim Mostafa M, Samir Taha N, Ismail Mehrez MA. Generalised versus Regional Odontodysplasia: Diagnosis, Transitional Management, and Long-Term Followup-A Report of 2 Cases. Case Rep Dent. 2013 Jan; 2013: 1-5.

58 Rashidian A, Afsharian Zadeh M, Azarshab M, Zarrabian T. Regional Odontodysplasia: Report of a case. J Dent. 2013 Dec; 14(4): 197-200.

59 Zilo JA, Ringler D, Mandel L. Single tooth odontodysplasia. Case report. N Y State Dent J. 2013; 79(4): 35-37.

60 Al-tuwirqi A, Lambie D, Seow WK. Regional Odontodysplasia: Literature Review and Report of an Unusual Case Located in the Mandible. Pediatr Dent. American Academy of Pediatric Dentistry; 2014; 36(1): 62-67.

61 Damasceno JX, Couto JLP, Alves KS da S, Chaves CM, Costa FWG, Pimenta A de MV, et al. Generalized odontodysplasia in a 5-year-old patient with Hallermann-Streiff syndrome: clinical aspects, cone beam computed tomography findings, and conservative clinical approach. Oral Surg Oral Med Oral Pathol Oral Radiol. 2014 Aug; 118(2): 58-64.

62 Barbería E, Coarasa S, Sanz Coarasa A, Hernández A, Cardoso-Silva C. Regional odontodysplasia. A literature review and three case reports. Eur J Paediatr Dent. 2012 Jun; 13(2): 161-66.

63 Haun F. Ein seltener Fall einer besonders ausgedehnten Odontodysplasie (I). Quintessenz. 1981; 32: 433-36.

64 Herman NG, Moss SJ. Odontodysplasia: report of case. ASDC J Dent Child. 1976; 44(1): 52-54.

65 Kahn MA, Hinson RL, Kahn. Regional odontodysplasia. Case report with etiologic and treatment considerations. Oral Surg Oral Med Oral Pathol. 1991 Oct; 72(4): 462-67.

66 Ansari G, Reid JS, Fung DE, Creanor SL. Regional odontodysplasia: report of four cases. Int J Paediatr Dent. 1997 Jun; 7(2): 107-13.

67 Iizawa F, Kinjoh N, Taguchi Y. Regional odontodysplasia: Long-term observation of a case on the mandibular left side. Pediatr Dent J. Elsevier; 2010; 20(1): 103-09.

68 Kinirons MJ, O'Brien F V, Gregg TA. Regional odontodysplasia: an evaluation of three cases based on clinical, microradiographic and histopathological findings. Br Dent J. 1988; 165(4): 136.

69 Pandis N, Polido C, Bell WH. Regional odontodysplasia: a case associated with asymmetric maxillary and mandibular development. Oral surgery, oral Med oral Pathol. Elsevier; 1991; 72(4): 492-96.

70 Lustmann J, Ulmansky M. Structural changes in odontodysplasia. Oral Surgery, Oral Med Oral Pathol. 1976. Feb; 41(2): 193-202.

71 Rohanizadeh R, Pouezat J, Bohne W, Ajacques JC. Ultrastructural organization and microanalysis studies of deciduous enamel crystallites in regional odontodysplasia (RO). J oral Pathol Med. Wiley Online Library; 1998; 27(10): 501-07.

72 Kerebel B, Kerebel LM. Structural, ultrastructural, microradiographic, and electron-probe studies of an unusual case of regional odontodysplasia. J Dent Res. 1982; 61(9): 1056-62.

73 Gardner DG, Sapp JP. Ultrastructural, electron-probe, and microhardness studies of the controversial amorphous areas in the dentin of regional odontodysplasia. Oral Surgery, Oral Med Oral Pathol. 1977; 44(4): 549-59.

74 Kerebel B, Kerebel LM, Heron D, Le Cabellec MT. Regional odontodysplasia: new histopathological data. J Biol Buccale. 1989; 17(2): 121-28.

75 Fanibunda KB, Soames JV. Odontodysplasia, gingival manifestations, and accompanying abnormalities. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1996; 81(1): 84-88.

76 Melamed Y, Harnik J, Becker A, Shapira J. Conservative multidisciplinary treatment approach in an unusual odontodysplasia. ASDC J Dent Child. 1993; 61(2): 119-24.

77 Hanks, PA and Williams B. Odontodysplasia: report of two cases. Pediatr Dent. 1998; 20(3): 199-203.