Focal dermal hypoplasia: a case report and literature review

Christiana Murakami, DDS, MSc,[a] Adriana de Oliveira Lira Ortega, DDS, MSc, PhD,[b] Antônio Sérgio Guimarães, DDS, MSc, PhD,[c] Daniela Gonçalves-Bittar, DDS,[d] Marcelo Bönecker, DDS, MSc, PhD,[e] and Ana Lídia Ciamponi, DDS, MSD, PhD,[f] São Paulo, Brazil
UNIVERSIDADE DE SÃO PAULO AND UNIVERSIDADE FEDERAL DE SÃO PAULO

Focal dermal hypoplasia (FDH), also known as Goltz-Gorlin syndrome, is an autosomal dominant disease affecting tissues derived from the ectoderm and mesoderm. Knowledge and early diagnosis of the craniofacial alterations commonly found in patients with FDH provide oral health care professionals with effective preventive and therapeutic tools. This article aims to review the craniofacial characteristics present in FDH and the main systemic manifestations that have implications for dental management, while presenting a new case of the syndrome with novel oral findings. **(Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;112:e11-e18)**

Focal dermal hypoplasia (FDH) (OMIM # 305600)[1] is a congenital polydysplastic disorder affecting tissues derived from the ectoderm and mesoderm. The term FDH was first used by Goltz et al.[2] and Gorlin et al.,[3] thus FDH is also known as Goltz-Gorlin syndrome or Goltz syndrome. It is important to emphasize that FDH should not be confused with Gorlin-Goltz syndrome, a completely different entity involving nevoid basal cell carcinomas.[4,5]

Even though the exact prevalence of FDH is unknown,[6] there is evidence that it is a rare multisystem disorder[6,7] and only 200 to 300 cases have been previously reported in the literature.[8] FDH affects primarily females (9:1),[5,9] with no ethnic or racial predilection.[10] Most males affected by FDH die in utero[11] and reports of living males[12,13] represent cases of sporadic new mutations or mosaic,[9] as nonmosaic hemizygous males are not viable.[7]

[a]PhD Student, Specialist in Pediatric Dentistry, Department of Orthodontics and Pediatric Dentistry, Faculdade de Odontologia, Universidade de São Paulo, Brazil.
[b]Professor, Department of Pediatric Dentistry of Universidade Cruzeiro do Sul (UNICSUL); Affiliate Professor, Department of Pediatric Dentistry of the University of São Paulo, Brazil.
[c]Coordinator of the Orofacial Pain and TMJ Dysfunction, Department of Morphology, Escola Paulista de Medicina, Universidade Federal de São Paulo, Brazil.
[d]MSc Student, Specialist in Pediatric Dentistry, Department of Orthodontics and Pediatric Dentistry, Faculdade de Odontologia, Universidade de São Paulo, Brazil.
[e]Professor and Chair, Department of Orthodontics and Pediatric Dentistry, Faculdade de Odontologia, Universidade de São Paulo, Brazil.
[f]Professor of Pediatric Dentistry, Department of Orthodontics and Pediatric Dentistry, Faculdade de Odontologia, Universidade de São Paulo, Brazil.
Received for publication Aug 23, 2010; returned for revision Mar 7, 2011; accepted for publication Mar 8, 2011.
1079-2104/$ - see front matter

doi:10.1016/j.tripleo.2011.03.012

ETIOLOGY

Heterozygous and mosaic mutations in the PORCN gene of the X chromosome,[14,15] at the gene map locus Xp11.23, are responsible for the pathogenesis of FDH. Although the biochemical functions of the PORCN gene have not been completely characterized, it is known to target Wnt signaling proteins that are key regulators of embryonic development[14] of the skin, bone, and other structures. The types of mutations that have been identified in patients with FDH are deletions, duplications, missense and nonsense mutations, and insertions.[14]

The pattern of inheritance is autosomal dominant and X-linked.[16] Moreover, 95% of female cases and 100% of male cases appear de novo (sporadically), with no family history.[14,16] There appears to be no evident genotype-phenotype correlation[11,17] for FDH, as neither the mutation nor the level of X-chromosome inactivation correlates with the severity of the phenotype.[7,17,18]

DIAGNOSIS

Because the clinical characteristics are pathognomonic, diagnosis is usually made on the basis of clinical examination. Additionally, molecular genetic tests (sequence analysis for males and females and fluorescent in situ hybridization or array CGH for females) may be conducted.[7,19] Oral findings may contribute to the final diagnosis of FDH in cases with few clinical manifestations.[16] Prenatal diagnosis is advised for pregnancies at increased risk, such as when the disease-causing mutation has been identified[7] in the family.

Table I. Systemic characteristics of focal dermal hypoplasia reported in the literature and observed in the present case

Characteristic	*References*
Dermatologic abnormalities	
Blaschko-linear or reticulate atrophic macules	2, 6, 7, 9, 11, 14, 16, 17, 18, 22
Dystrophic nails*	7, 8, 11, 14, 18, 23, 24
Linear streaks of hyper and hypopigmentation of the skin*	2, 6, 7, 9, 14, 17, 18, 23
Multiple papillomas*	2, 5, 6, 9, 11, 16, 17, 18, 24
Sparse and brittle hair*	5, 7, 8, 11, 14, 17, 18, 22, 23
Skeletal abnormalities (reported in 80% cases)	
Ectrodactyly ("lobster-claw" hand deformity)*	9, 11, 14, 17, 18, 22, 24
Microcephaly	9, 18, 25
Oligodactyly*	2, 6, 7, 9, 14
Osteopathia striata*	6, 7, 8, 9, 14, 18, 22, 23
Polydactyly*	9, 23
Scoliosis	11, 21, 23
Short stature*	8, 9, 14, 17, 18, 23
Skeletal immaturity	26
Spina bifida	12
Syndactyly*	6, 9, 11, 14, 22
Ocular abnormalities (reported in 40% of cases)	
Colobomas*	5, 6, 9, 14, 18, 24
Microphthalmia*	2, 5, 6, 9, 14, 18, 23, 24
Nystagmus	19, 21
Strabismus	9, 11, 23
Cardiac abnormalities	
Septal defects, overriding aorta, bicuspid aortic valve	17, 18
Renal abnormalities	
Horseshoe kidney, hydronephrosis, or renal agenesis	17, 18
Gastrointestinal abnormalities	
Malrotation of the gut and abdominal wall defect (omphalocele)*	9, 11, 14, 17, 18, 24
Cognitive development	6, 14, 17, 18, 23, 24, 27

Normal* or delayed (delayed cognitive development was reported in approximately 15% of patients with FDH).
*Indicates characteristic was observed in the reported (present) case.

Table II. Orofacial characteristics of focal dermal hypoplasia reported in literature and observed in the present case

Characteristic	*References*
Facial abnormalities	
Asymmetry*	5, 6, 27, 28
Low-set protruding ears*	6, 8, 9, 11, 12, 14, 17, 18, 21
Midfacial hypoplasia*	11, 16
Narrow nasal bridge	6, 9
Skeletal abnormalities	
Cleft lip or palate	8, 11, 13, 14, 17, 18
High-arched palate*	4, 5, 6, 8, 12, 27
Micrognathia	21, 30
Pointed chin*	5, 8, 9, 11, 12, 14, 21
Dental abnormalities (reported in nearly 50% of cases)	
Enamel hypoplasia*	4, 5, 6, 8, 12, 16, 19, 20, 21, 22, 28
Anomalous tooth form*	5, 8, 17
Delayed or ectopic eruption*	5, 6, 9, 12, 19, 26, 29
Extensive dental caries*	12, 22, 26, 28
Hypodontia or oligodontia*	4, 5, 6, 11, 12, 14, 17, 18, 20, 29
Microdontia	4, 6, 12, 20, 23, 29
Supernumerary teeth	20
Taurodontism	22; 6
Gemination or fusion	12; 6
Decreased dentine quantities*	12
Irregular spacing or malocclusion*	4, 5, 8, 18, 20, 21, 23, 28
External root resorption	4
Short, abnormal roots*	6, 22
Talon cusp†	
Odontodysplastic appearance of unerupted teeth*	5
Soft tissue abnormalities	
Arborescent papillomas of the oral mucosa	4, 5, 6, 16, 19, 21, 27, 28
Gingival hypertrophy and gingivitis	4, 12, 21, 27
High/double labial frenum*	5, 12, 26, 29, 28
Ability to touch nose with tongue*	16
Absent lingual frenulum†	

*Indicates characteristic was observed in the reported (present) case.
†Indicates characteristic was observed in the reported (present) case that is believed to be associated with focal dermal hypoplasia, and has not been previously reported in the literature.

PROGNOSIS

Severely affected individuals often do not survive past infancy and family pedigree analysis shows a high prevalence of miscarriages and stillbirths. Individuals with minor expression may have a normal life span, depending on the associated presence of systemic alterations.[8]

CLINICAL PRESENTATION

Clinical manifestations of FDH involve mainly the skin, bones, eyes (Table I),[20] and the oral cavity (Table II). The most evident sign of FDH is the hypoplastic dermis with thin, sparse collagen bundles and areas of partial to complete replacement of connective tissue in the dermis by adipose tissue, producing yellowish herniations.[12,21,23,29] Another common feature of FDH is the presence of linear streaks of hyper- and hypopigmentation of the skin, following Blaschko's lines (cell

migration pathways evident during embryonic fetal skin development).[12,16,19,25] Multiple papillomas, mostly not related to human papilloma virus (HPV), can also be observed in the skin and mucosa.[4,25] As in other types of ectodermal dysplasia, the hair and eyelashes of individuals with FDH are sparse and the nails are hypoplastic and dystrophic.[7,12,19,21,22,25]

Skeletal anomalies found in FDH include syndactyly,[5-7,14] polydactyly,[7,14] "lobster-clawlike" oligodactyly,[7,14] short stature,[14] and osteopathia striata (linear striations of denser bone running parallel to the long axis of long bones, observed in radiographs).[4,12-14,19,21,25] Regarding ophthalmic alterations, patients with FDH usually present with microphthalmia,[4,6,14] coloboma,[5] strabismus, and photophobia.[4,12,13,19,21,25,26]

Furthermore, abdominal wall defects, such as omphalocele (protrusion of abdominal contents through an opening at the nave), may also be present in FDH.[7,12,14] There have also been reports of renal and heart defects. Depending on the type of cardiac septal or valvular defects present, antibiotic prophylaxis against infectious endocarditis should be implemented before dental procedures according to the American Heart Association's guidelines.[30] Regarding cognitive aspects, although some authors[12,16] claim that there are no signs of mental deficiency in FDH, others[7,13,14] state that it is present in some cases.

Surgical interventions are often needed during childhood for the correction of skin, skeletal, intestinal, and ophthalmologic alterations. The removal of recurring multiple papillomas may require repeated surgeries. Early correction of skeletal alterations in upper and lower limbs, such as syndactyly, may be beneficial to the development of motor coordination, including oral hygiene skills.[19] Another type of intervention that is common in children with FDH is surgical correction of omphalocele. Painful and pruritic erosive skin lesions are prone to infection and demand regular visits to the dermatologist. Photodynamic therapy with flash lamp–pumped pulse dye laser may relieve itching symptoms in the skin and improve the esthetic appearance of telangiectatic and erythematous lesions.[7,9,11] Young women who are affected benefit from genetic counseling.

Because all tissues of ectodermal origin are affected in FDH, a variety of orofacial and dental manifestations can be observed in this syndrome, as listed in Table II.[24,31] By far the most prevalent oral alteration found in FDH is generalized enamel hypoplasia, with malformed teeth that are more susceptible to dental caries.[7,12,21] In 2004, Balmer et al.[6] reported the pattern of enamel hypoplasia as another manifestation of the lyonization that occurs in FDH, similar to that of X-linked amelogenesis imperfecta. Papillomas in the oral mucosa are also frequently cited as a characteristic of FDH.[4,19,21,27,28]

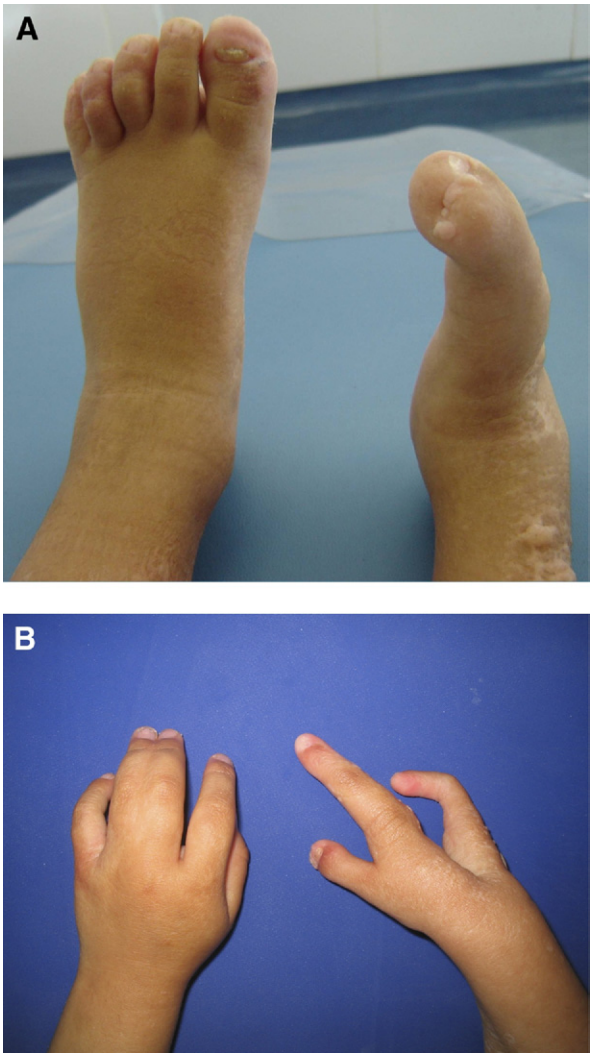

Fig. 1. Alterations in upper and lower limbs. **A,** Oligodactyly of the right foot and dystrophic nails. **B,** Syndactyly of the left hand and lobster-claw deformity of the right hand.

CASE REPORT

A 4-year-old girl with unremarkable family history, born to nonconsanguineous parents, presented with FDH. The diagnosis of FDH was based on confirmatory clinical findings. Histopathological examination and gene sequence analysis were not conducted because the parents did not give their consent. Upon acknowledgment of the diagnosis of FDH, the parents received proper genetic counseling, emphasizing the X-linked dominant inheritance. The patient's parents provided written consent allowing the use of her extra- and intraoral photographs and imaging studies for publication.

Medical history revealed that the patient had undergone surgical closure of an abdominal wall defect (omphalocele) at

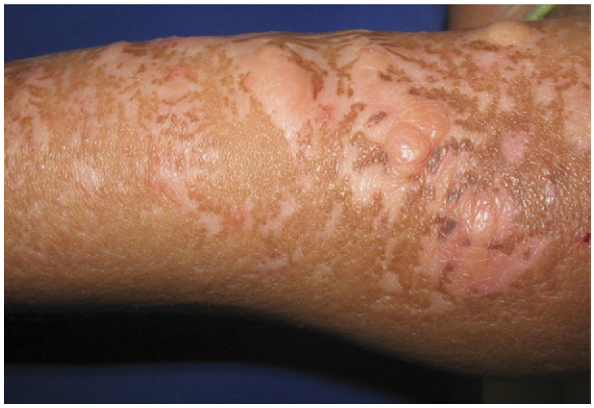

Fig. 2. Right leg showing characteristic skin alterations with adipose tissue herniations found all over the body.

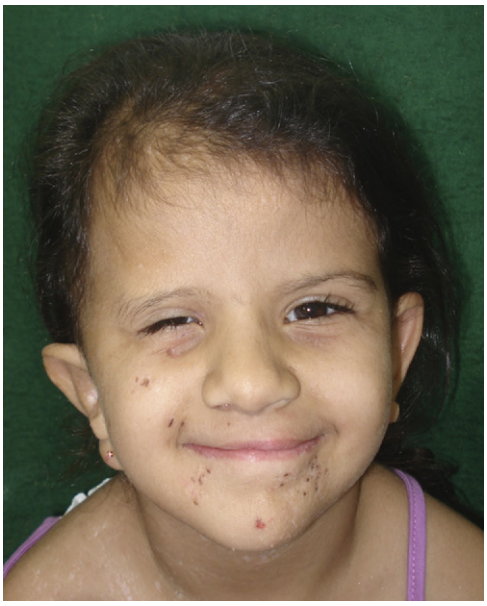

Fig. 3. Extraoral photographs illustrating facial asymmetry, erythematous cribriform scar tissue, broad nasal tip, low-set protruding ears, coloboma of the right eyelid, microphthalmia of the right eye, sparse and brittle hair, and a pointed chin.

birth and had recently undergone corrective surgery of the syndactyly between the fourth and fifth fingers of her left hand (Fig. 1, *B*). Physical examination also revealed systemic alterations (Table I), such as ectrodactyly (lobster-claw deformity) of the right hand (Fig. 1, *B*) and oligodactyly of the right foot (Fig. 1, *A*). Several other characteristic signs of FDH were present, such as generalized fat herniations (Fig. 2), Blaschko-linear defects with areas of hyper- and hypopigmentation of the skin (Fig. 2), multiple papillomas, dystrophic nails (Fig. 1, *A*), sparse and brittle hair (Fig. 3), short stature, osteopathia striata, microphthalmia (Fig. 3), coloboma of the right eyelid (Fig. 3), low-set and protruding ears (Fig. 3), and a pointed chin and facial asymmetry (Fig. 3). No mental impairment was observed and the patient attends normal school with good results.

Intraoral examination of the patient showed (Table II) enamel hypoplasia (Fig. 4, *A* and *B*), mulberrylike molars (Fig. 4, *A* and *B*), irregular spacing (Fig. 4, *A* and *B*), low insertion of the upper labial frenum, and a high-arched palate. In the primary dentition, she initially had delayed eruption of the upper right second molar and the lower right canine. Also, the upper right molars had an odontodysplastic appearance (Fig. 5), and her upper right canine had an abnormally large size. In spite of the clinically evident facial asymmetry associated with FDH,[5,27] our patient's computerized tomography scans revealed normal anatomical structures of temporomandibular joints, with preserved intra-articular spaces and intact corticals (Fig. 6, *A* and *B*).

Enamel hypoplasia was complicated by poor oral hygiene, causing multiple carious lesions. Thus, initial management was aimed at improving oral hygiene, reducing the cariogenic potential of her diet and restoring carious lesions with composite resin (Filtek Z250, 3 M ESPE, St. Paul, MN, USA) or resin-modified glass ionomer (Vitremer, 3 M ESPE, USA). Because hypoplastic enamel is more susceptible to dental caries, 4 weekly topical applications of fluoride varnish (22,600 ppm NaF, Duraphat, Colgate, Germany) were done in an attempt to further mineralize the enamel and prevent caries. Interestingly, no oral papillomas were observed in this patient. Follow-up sessions were every 6 months to prevent relapse and monitor unerupted teeth.

At age 5, the patient suffered dental traumatism. A pathologic internal root resorption of the primary right upper central incisor (51) and excessive mobility and periodontal abscess of the primary right upper lateral incisor (52) were observed in the follow-up session after 6 months. Both teeth (51, 52) had to be extracted and a removable space maintainer was installed for esthetic and functional purposes.

The patient and her caretakers complied with the preventive measures suggested and, 3 years later, she remains caries-free. Early surgical correction of the syndactyly made the patient's left hand completely normal, enabling her to learn how to conduct proper oral hygiene procedures. Her parents and grandparents also help her brush her teeth because she is still young.

At age 7, the patient's mixed dentition now presents with talon cusp on the permanent left central incisor (Fig. 7) and hypodontia of the permanent upper right first and second molars and upper left second molar (Fig. 8). There is also transposition of the lower right lateral incisor and of the second bicuspid. Misalignment of the teeth, supernumerary cusps on the lower first molars, and delayed root formation on the right side were also noted. Gingival ulectomy (excision of fibrous gingival tissue that was preventing the tooth from erupting) was performed owing to the delayed eruption of the upper right central incisor (Fig. 9, *A* and B), which is one of the characteristics of FDH but may have been caused by the history of dental trauma and installation of the removable acrylic space maintainer.

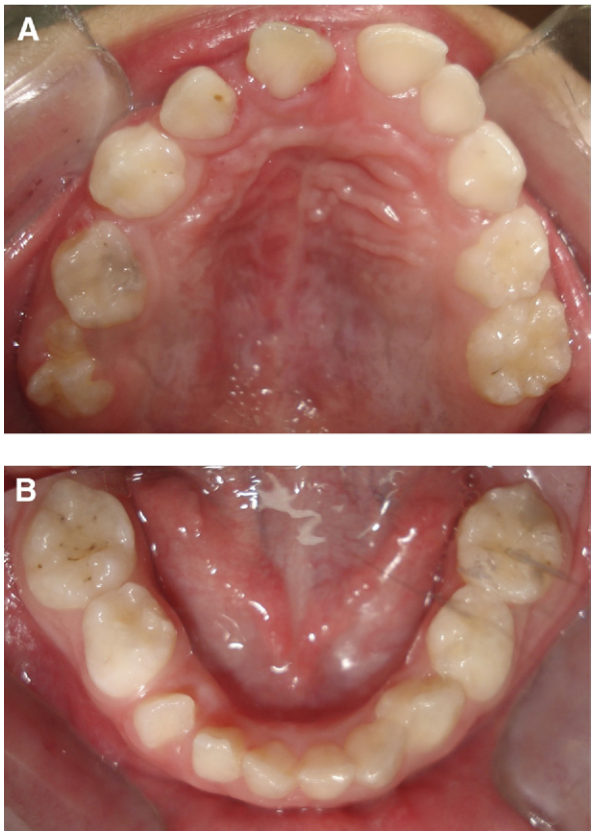

Fig. 4. Primary dentition at age 4. Observe irregular spacing of teeth with anomalous forms. **A,** Upper arch showing more severe enamel hypoplasia on the right side, with mulberry-like molars. **B,** Lower arch showing delayed eruption of lower right canine.

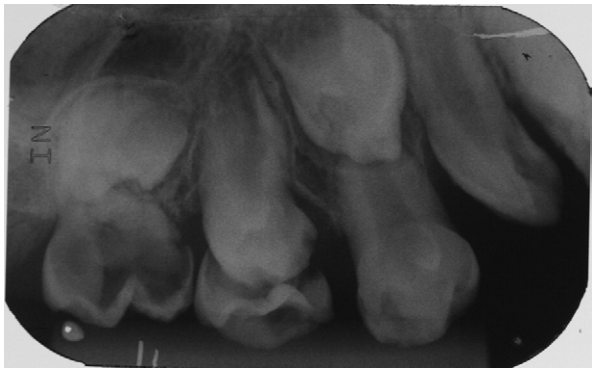

Fig. 5. Odontodysplastic appearance of primary upper right molars, with decreased dentine quantities.

After Seoane et al.[16] noted that their patient had the ability to hyperextend her tongue to make it touch her nose, we observed that our patient is also able to do this (Fig. 10, *A*) and she apparently has an absence of the lingual frenum (Fig. 10, *B*).

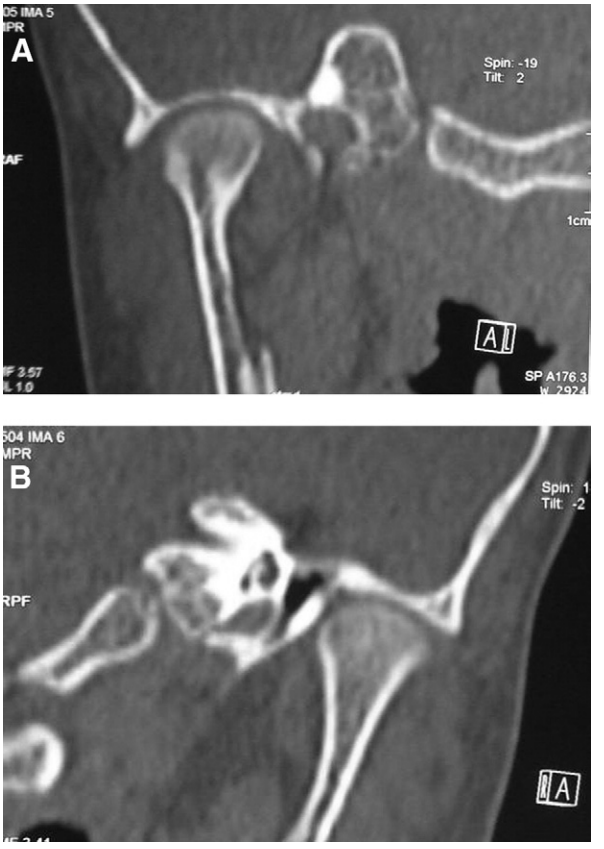

Fig. 6. **A and B,** Computerized tomography scans of the temporomandibular joints.

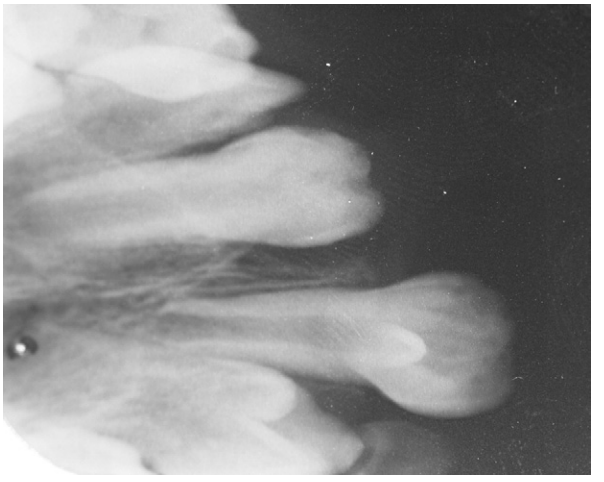

Fig. 7. Talon cusp on the permanent left central incisor.

Currently, the patient comes to regular follow-up visits for procedures of plaque control and topical fluoride application because of the generalized enamel hypoplasia.

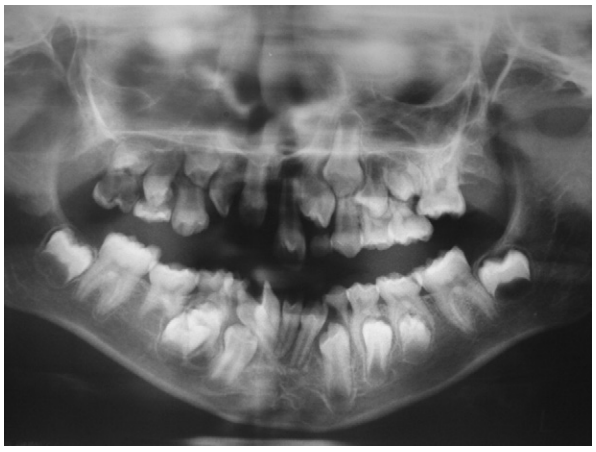

Fig. 8. Hypodontia of the permanent upper right first and second molars and upper left second molar. Transposition of the lower right lateral incisor and of the second bicuspid.

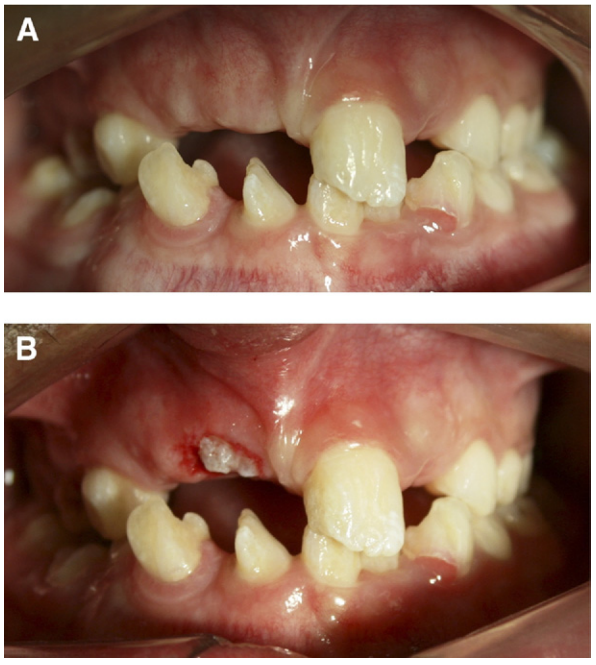

Fig. 9. **A,** Delayed eruption of the upper right permanent central incisor and unilateral anterior cross bite. Anomalous anatomy of the lower right lateral incisor. **B,** Postoperative aspect of gingival ulectomy (surgical excision of fibrous gingival tissue that was preventing the tooth from erupting).

DISCUSSION

In the literature, a great number of oral and dental anomalies have been described in connection with FDH. The FDH case presented in this article has many of the systemic (Table I) and orofacial (Table II) characteristics that have been described in the literature for this syndrome. Although papillomas in the oral mucosa have been frequently cited as a characteristic of FDH,[21,27,28] no such lesions were observed in our patient during a 3-year follow-up period.

This is the second article to discuss and the first to present a radiograph of teeth with odontodysplastic appearance in a patient with FDH.[5] It is also the second report of the observation of FHD patients' ability to hyperextend their tongues to touch their noses, showing an absent lingual frenulum. Moreover, no previous studies in the literature have reported the novel finding of talon cusp in individuals with FDH.

Some authors have suggested that the signs of FDH may be more severe on one side of the body than on the other.[26,27] In the present case, this characteristic was unmistakably present. The patient's right side is more severely affected than her left side throughout her entire body. Moreover, this is also evident in the dental arches, where teeth on the right side had more severe enamel hypoplasia, developmental disturbances, and misalignment. It was very interesting to observe that not all of her teeth had enamel hypoplasia and the ones that did also had irregular positions.[4]

An important issue that has not yet been explored about the oral conditions associated with FDH is that the characteristic skeletal abnormalities in the lower limbs may predispose children to the occurrence of dental traumatism. Balmer et al.[6] also reported a history of dental trauma to the incisor in 2 of their FDH patients. Our patient's parents reported that she would often easily lose her balance because of the uncoordinated gait caused by oligodactyly in the right foot. Therefore, individuals with FDH should wear mouth guards when engaging in physical activities.

Children with FDH should attend their first dental visit as early on as possible so as to prevent the occurrence of dental caries. Enamel hypoplasia may make plaque control difficult and skeletal hand anomalies may limit the dexterity needed to conduct proper oral hygiene.[19] In older individuals, esthetic restorative treatments are often necessary because of the presence of generalized enamel hypoplasia.

A final but not least important aspect of the dental treatment of patients with FDH involves their psychological and behavioral management, particularly when dealing with children. Most individuals with FDH have mild or no mental impairment[12] but present with very severe morphologic alterations that are esthetically unfavorable and involve their skin, upper and lower limbs, face, and teeth. By improving esthetics and function, dental professionals can have a tremendous psychological impact and enhance these patients' self-esteem.[19]

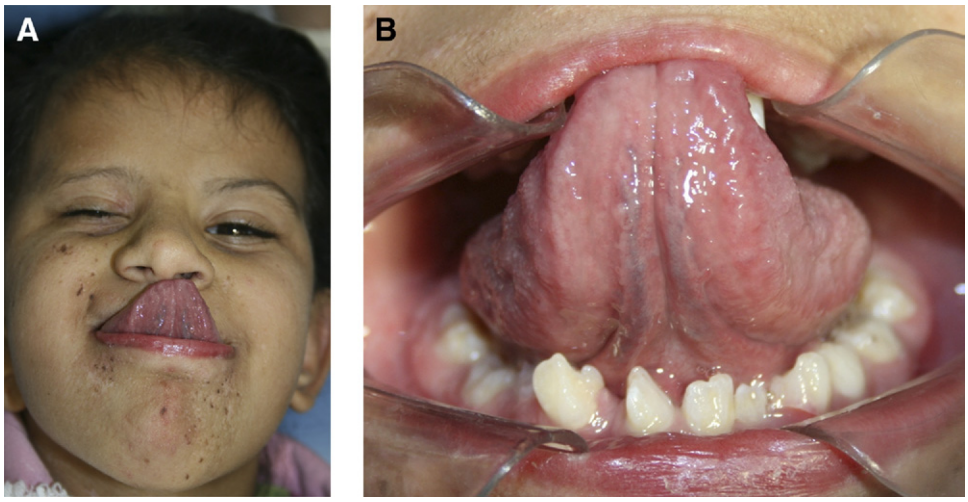

Fig. 10. **A,** Note the ability to hyperextend tongue to touch the nose. **B,** Apparent absence of lingual frenulum.

CONCLUSIONS

In spite of the often-complex medical history of individuals with FDH, there are no impediments to dental treatment. Therefore, children with FDH should attend their first dental visit as early on as possible so as to prevent the occurrence of dental caries. Also, dental traumas may be more prevalent among children with FDH because of skeletal deformations in their feet, such as oligodactyly, which cause uncoordinated gait. In older individuals, esthetic restorative treatments may often be necessary because of the presence of generalized enamel hypoplasia.

Clinical management of individuals with FDH requires a transdisciplinary approach and the dentist should be attentive to the innumerable orofacial alterations, enabling early diagnosis and treatment.

We are indebted to the patient I.T.R. and her family who gave us permission to publish this article in the hope of enlightening dentists and oral health professionals to help other individuals with FDH.

REFERENCES

1. OMIM. Online Mendelian Inheritance in Man #305600; 2010. Available at: http://www.ncbi.nlm.nih.gov/omim/305600.
2. Goltz RW, Peterson WC, Gorlin RJ, Ravits HG. Focal dermal hypoplasia. Arch Dermatol 1962;86:708-17.
3. Gorlin RJ, Meskin LH, Peterson WCJ, Goltz RW. Focal dermal hypoplasia syndrome. Acta Derm Venereol 1963;43:421-40.
4. Baxter AM, Shaw MJ, Warren K. Dental and oral lesions in two patients with focal dermal hypoplasia (Goltz syndrome). Br Dent J 2000;189:550-3.
5. Al-Ghamdi K, Crawford P. Focal dermal hypoplasia—oral and dental findings. Int J Paediatr Dent 2003;13:121-6.
6. Balmer R, Cameron AC, Adès L, Aldred MJ. Enamel defects and Lyonization in focal dermal hypoplasia. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2004;98:686-91.
7. Sutton VR, Van Dan-Veyver IB. Focal dermal hypoplasia. Gene Review. University of Washington; 2008. Bookshelf ID: NBK1543 PMID: 20301712. Available at: http://www.ncbi.nlm.nih.gov/books/NBK1543/.
8. Goltz RW. Focal dermal hypoplasia syndrome. eMedicine dermatology: Medscape; 2010. p. 1-23. Available at: http://emedicine.medscape.com/article/1110936-overview.
9. Jain A, Chander R, Garg T, Nikita, Shetty GS. A rare multisystem disorder: Goltz syndrome—case report and brief overview. Dermatol Online J 2010;16:2.
10. Scott RW, Pivnick EK, Dowell SH, Eubanks JW, Huang EY, Van den Veyver IB, Wang X. Goltz syndrome: report of two severe cases. BMJ Case Rep 2009. Online ISSN 1757-790X. Available at: http://casereports.bmj.com/content/2009/bcr.09.2008.0909.abstract.
11. Clements SE, Mellerio JE, Holden ST, McCauley J, McGrath JA. PORCN gene mutations and the protean nature of focal dermal hypoplasia. Br J Dermatol 2009;160:1103-9.
12. Ureles SD, Needleman HL. Focal dermal hypoplasia syndrome (Goltz syndrome): the first dental case report. Pediatr Dent 1986;8:239-44.
13. Mizuno A, Motegi K. Focal dermal hypoplasia syndrome with incomplete transverse facial cleft and tumour of the lips. Br J Oral Maxillofac Surg 1989;27:71-6.
14. Wang X, Reid-Sutton V, Omar-Peraza-Llanes J, Yu Z, Rosetta R, Kou YC, et al. Mutations in X-linked PORCN, a putative regulator of Wnt signaling, cause focal dermal hypoplasia. Nat Genet 2007;39:836-8.
15. Paller AS. Wnt signaling in focal dermal hypoplasia. Nat Genet 2007;39:820-1.
16. Seoane J, Gibson RL, Almagro M, Pintos E. Oral manifestations associated with focal dermal hypoplasia. Dermatology (Basel) 2009;219:368-70.
17. Maas SM, Lombardi MP, van Essen AJ, Wakeling EL, Castle B, Temple IK, et al. Phenotype and genotype in 17 patients with Goltz–Gorlin syndrome. J Med Genet 2009;46:716-20.
18. Harmsen MB, Azzarello-Burri S, García González MM, Gillessen-Kaesbach G, Meinecke P, Müller D, et al. Goltz-Gorlin (focal dermal hypoplasia) and the microphthalmia with linear skin defects (MLS) syndrome: no evidence of genetic overlap. Eur J Hum Genet 2009;17:1207-15.

19. Tejani Z, Batra P, Mason C, Atherton D. Focal dermal hypoplasia: oral and dental findings. J Clin Pediatr Dent 2005;30:67-72.
20. Hall EH, Terezhalmy GT. Focal dermal hypoplasia syndrome. Case report and literature review. J Am Acad Dermatol 1983;9:443-51.
21. Bucci E, Lo Muzio L, Mignogna MD. Oral and dental anomalies in Goltz syndrome. J Pedod 1989;13:161-8.
22. Clements SE, Wessagowit V, Lai-Cheong Je, Arita K, McGrath JA. Focal dermal hypoplasia resulting from a new nonsense mutation, p. E300X, in the PORCN gene. J Dermatol Sci 2008;49(1):39-42.
23. Miranda SB, Delmaestro D, Bertoli R, Marinho T, Lucas E. Focal dermal hypoplasia with exuberant fat herniations and skeletal deformities. Pediatr Dermatol 2005;22:420-3.
24. Froyen G, Govaerts K, Van Esch H, Verbeeck J, Tuomi ML, Heikkilä H, et al. Novel PORCN mutations in focal dermal hypoplasia. Clin Genet 2009;76:535-43.
25. Sacoor MF, Motswaledi MH. Three cases of focal dermal hypoplasia (Goltz syndrome). Clin Exp Dermatol 2005;30:35-7.
26. Ginsburg LD, Sedano HO, Gorlin RJ. Focal dermal hypoplasia syndrome. Am J Roentgenol Radium Ther Nucl Med 1970; 110:561-71.
27. Bilgen HÖE, Canpolat C, Gürbüz O, Tunger M. Focal dermal hypoplasia (Goltz' syndrome) in a male infant. Turkish Journal of Medical Sciences 1999;29:191-4.
28. Stephen LX, Behardien N, Beighton P. Focal dermal hypoplasia: management of complex dental features. J Clin Pediatr Dent 2001;25:259-61.
29. McNamara T, Trotman C, Hahessy A, Kavanagh P. Focal dermal hypoplasia (Goltz-Gorlin) syndrome with taurodontism. Spec Care Dentist 1996;16:26-8.
30. Wilson W, Taubert KA, Gewitz M, Lockhart PB, Baddour LM, Levison M, et al. Prevention of infective endocarditis: guidelines from the American Heart Association: a guideline from the American Heart Association Rheumatic Fever, Endocarditis and Kawasaki Disease Committee, Council on Cardiovascular Disease in the Young, and the Council on Clinical Cardiology, Council on Cardiovascular Surgery and Anesthesia, and the Quality of Care and Outcomes Research Interdisciplinary Working Group. J Am Dent Assoc 2008; 139(Suppl):3S-24S.
31. Dias C, Basto J, Pinho O, Barbêdo C, Mártins M, Bornholdt D, et al. A nonsense porcn mutation in severe focal dermal hypoplasia with natal teeth. Fetal Pediatr Pathol 2010;29: 305-13.

Reprint requests:

Christiana Murakami, DDS, MSc
Avenida Professor Lineu Prestes
Department of Orthodontics and Pediatric Dentistry
Faculdade de Odontologia
Universidade de São Paulo
2227 − 05508 − 000 São Paulo, SP, Brazil
chrismurakami@gmail.com