Published in final edited form as:

J Orthod. 2013 March ; 40(1): 47–52. doi:10.1179/1465313312Y.0000000032.

The use of cone beam computed tomography for the assessment of trichorhinophalangeal syndrome, type I – a case report

Ahmed Ghoneima¹, Kanwar Sachdeva¹, James Hartsfield^{1,2}, David Weaver³, and Katherine Kula¹

¹Department of Orthodontics and Oral Facial Genetics, Indiana University School of Dentistry, Indianapolis, IN, USA

²Department of Oral Health Science, University of Kentucky College of Dentistry, Lexington, KY, USA

³Department of Molecular Genetics, Indiana University School of Medicine, Indianapolis, IN, USA

Abstract

Trichorhinophalangeal syndrome type I is a rare autosomal dominant disorder characterized by cone-shaped epiphysis, sparse fine hair, pear-shaped nose and variable growth retardation. The typical craniofacial features include thin upper lip, elongated philtrum, large outstanding ears, shortened posterior facial height associated with short mandibular ramus and reduced and superiorly deflected posterior cranial base. This report describes a 17-year-old male patient with trichorhinophalangeal syndrome type I and a detailed description of the craniofacial radiographic findings, including the use of cone beam computed tomography images for determination of the airway and temporomandibular joint discrepancies.

Keywords

Cone beam computed tomography; trichorhinophalangeal syndrome

Introduction

Trichorhinophalangeal syndrome type I (TRPS I) is a rare disorder of autosomal dominant inheritance typically involving abnormalities of the hair, face and skeletal bones. The first description of TRPS is attributed to Klingmuller¹ in 1956 who reported two cases. A more detailed description of the clinical and radiographic features of the disorder along with the actual naming was given by Giedion.² This group of abnormalities is caused by deletion or heterozygous mutations in the *TRPS I* gene on chromosome 8q24.12.^{3–5} This gene encodes

Address for correspondence: A. Ghoneima, Department of Orthodontics & Oral Facial Genetics, Indiana University School of Dentistry, 1121 West Michigan Street, Indianapolis, IN 46202, USA. aghoneim@iupui.edu.

Contributor statement

Ahmed Ghoneima, Kanwar Sachdeva, James Hartsfield, David Weaver and Katherine Kula were responsible for the clinical and genetic diagnosis, data collection and interpretation. Obtaining funding, critical revision and final approval of the article were undertaken by Katherine Kula. Ahmed Ghoneima is the guarantor.

a specific zinc finger protein that acts as a putative transcription factor. Mutation in the same gene has also been found to cause TRPS III.⁶

Clinical manifestations in TRPS are heterogeneous and classically classified into three types according to phenotypic and cytogenetic/molecular findings.⁷ Patients affected with TRPS I have disproportionate short stature, finger deformities and dysmorphic facial features including sparse hair, pyriform-shaped nose and medially thick eyebrows. The epiphyses of the fingers are cone-shaped.⁸ Type II, which is also known as Langer–Giedion syndrome, is characterized by multiple cartilaginous exostoses that are the hallmark of this variant. In addition, mental retardation, microcephaly, loose skin, slight growth retardation, shortening of hands and feet and redundant skin are also reported in type II. The rarest and most recently recognized form of TRPS is type III, which is characterized by severe brachydactyly and growth retardation.⁹

Here, we report a case of TRPS I. In addition to the clinical features of the patient, the results of cephalometric analysis and three-dimensional (3D) cone beam computed tomographic (CBCT) examination of the craniofacial complex are presented.

Case report

A 17-year-old Caucasian male was referred to the Graduate Orthodontic Clinic at Indiana University School of Dentistry for evaluation and counselling regarding his dental malocclusion. The subject was diagnosed with TRPS I and associated early onset arthritis and hyperflexibility. The diagnosis of TRPS I was based on characteristic physical features and a consistent pedigree for the condition. The patient's father and one of two older brothers were also diagnosed with TRPS I and associated arthritis. Two paternal aunts, grandfather and great grandfather also had signs of TRPS, although they were not formally diagnosed.

The patient expressed the classic facial features of the syndrome including sparse, slow growing and fragile hair, thinning of the lateral portion of the eyebrows, protruding ears, pear shaped nose with a bulbous tip, long and flat philtrum and thin upper vermilion border. Cranial and facial asymmetry was reported suggesting cranial synostosis. The patient appeared in good general health with normal intelligence, stature and axial skeleton. The patient's fingers were irregularly deviated with short, thin and broad nails. Despite the deviation of fingers, brachydactyly and painless swelling at the interphalangeal joints, joint movements were normal. The patient also had clinodactyly of the fourth and fifth fingers bilaterally. The intraoral examination revealed a severe overbite with crowding, posterior open bite, multiple retained primary teeth and multiple missing permanent teeth in both arches. The maxillary posterior teeth were supra-erupted into the edentulous opposing areas. Periodontal pathology or dental caries were not detected (Figure 1).

CBCT was taken for the patient and lateral, posteroanterior cephalograms, panoramic radiographs and virtual 3D models were constructed in order to perform a complete radiographic evaluation of the jaws and craniofacial region. According to the panoramic radiograph and the 3D study models, the patient had multiple retained primary, impacted and supernumerary teeth. The mandibular first molars, mandibular and maxillary second and

third molars on both sides were completely impacted with well-developed root structures. Lateral cephalometric analysis on the digital cephalograms constructed from the CBCT revealed a slightly convex profile with prominent chin button, mild class II skeletal relationship, steep mandibular plane with an obtuse gonial angle. Maxillary and mandibular incisors were lingually inclined. Increased upper and lower face height was also detected. Decreased posterior facial height that was associated with shortened mandibular ramus, reduced and superiorly deflected posterior cranial base were evident. Analysis of the digital frontal cephalogram revealed decreased nasal width, increased nasal height, decreased maxillary and facial width and postural asymmetry of the craniofacial relation (Figure 2).

CBCT data allowed sectioning of multiple slices of the jaws to identify the exact position and relationship of the impacted teeth to the erupting teeth and the different anatomical structures. Reduced vertical height of the alveolus associated with the impacted mandibular posterior teeth was detected. In addition, supra-eruption of the opposing maxillary posterior teeth was evident in the 3D skull volume.

The dual volume superimposition of the CBCT volumetric data and the airway allowed comprehensive examination of the airway area. A reduced dimension of the airway area posterior to the tongue and soft palate as well as small size maxillary sinuses was detected. These findings were further confirmed by measuring the airway volume using Dolphin imaging software (Dolphin Imaging and Management Solutions, Chatsworth, CA, USA), which showed that the most constricted area (MCA) of the airway passage was the area just behind the tongue and soft palate. The MCA was measured in the three different planes giving values of 79.6 mm² on the axial section, 3.7 mm on the sagittal section and 19.7 mm on the coronal view. The airway passage of the patient was abnormal in form and dimensions, being wide from the frontal view and narrow from the lateral view (Figure 3).

The structure and morphology of the osseous components of the TMJ was evaluated using the 3D volumetric information. After clipping the mandible as a 3D volume, irregularly sized and shaped right and left condyles were obvious. In addition, evidence of osseous remodelling with reduction of the posterior articular spaces was detected (Figure 4).

Discussion

Among the group of developmental malformations characterized by skeletal dysplasia is TRPS. This syndrome was originally described in detail by Giedion in 1966.² The syndrome was later divided into three subgroups, namely, I, II and III. Mutations in the TRPS I gene have been found to be responsible for both TRP I and TRP III. TRPS I is characterized by sparse, slowly growing scalp hair, short and deformed fingers with cone-shaped epiphyses of some of the middle phalanges of the hands. Additional features may occur, such as short stature, Perthes-like changes in the hips, short toes, a long philtrum, a thin upper lip, and medially thick, laterally thin, or absent eyebrows 'the Herthoge sign'. Craniofacial abnormalities associated with TRPS I may also include a pear-shaped broad nose, mandibular hypoplasia, maxillary prognathism and receding chin with prominent mentolabial groove.¹⁰ Patients with TRPS II (Langer-Giegion syndrome) exhibit almost the same anomalies in addition to numerous exostoses and sometimes mental retardation, while

patients with TRPS III (Sugio–Kajii syndrome) suffer from extremely short stature and severe brachydactyly with short metacarpals but without any exostoses. Some authors have considered it a severe form of TRPS I, rather than a distinct entity.^{11–13}

The patient reported in this study had almost all the characteristic features of TRPS I. The facial and hand features were typically presented. Intraoral and radiographic examination of the jaws revealed crowding, multiple retained primary teeth, impacted and supernumerary teeth, all features previously reported in some but not all TRPS I cases¹⁴ However, the number of supernumerary and impacted teeth reported in this case is more than that reported previously in the literature. One interesting finding that was detected on the panoramic radiograph and confirmed on the digital model constructed from the CBCT data was that the patient had six impacted molar teeth with completely formed roots. The 3D CBCT images also allowed spatial identification of teeth position for ease of surgical removal.

The results from the CBCT airway analysis of the present case showed an area of severe constriction posterior to the tongue and soft palate. A finding was further confirmed by measuring the airway as a volume from the CBCT data. This finding suggests that the patient should be considered as a high risk for obstructive sleep apnea. To our knowledge, these findings which have not been previously described, could in part clarify the previous reports of unexplained repeated cyanotic attacks in some TRPS I patients.¹⁴

Irregularly shaped and sized right and left condyles were evident on the 3D volume of the mandible. Similarly, an underdeveloped left condyle was reported. These findings could be explained as a part of the slightly delayed skeletal maturation and joints deformities consistently described in TRPS I patients. Recent diagnostic tools such as the 3D imaging technology used in the present study allowed description of these craniofacial abnormalities of the airway and the joints.

In conclusion, the present study described the clinical, radiographic, oral and maxillofacial findings in a TRPS I case. The data of the airway abnormalities and the TMJ malformation suggest the importance of including the examination of these two critical structures as an integral part of TRPS I dentoskeletal evaluation.

Acknowledgments

The authors would like to thank the patient and his family for consenting to the use of his records and data for this report. This work was supported by the Indiana University Purdue University Indianapolis Three-Dimensional Imaging of the Craniofacial Complex Signature Center.

Funding for the present study was provided by the Jarabak Endowed Professorship and the Indiana University Purdue University Three-Dimensional Imaging of the Craniofacial Complex Center.

References

1. Klingmuller G. Uber eigentumliche Konstitutionsanomalien bei 2 Schwestern und ihre Beziehung zu neuen entwicklung-spathologischen Befunden. *Hautarzt*. 1956; 7:10513.
2. Giedion A. Tricho-rhino-phalangeal syndrome. *Helv Paediatr Acta*. 1966; 21:475–85. [PubMed: 5991804]
3. Buhler EM, Buhler UK, Buetler C, Fessler R. A final word on the trichorhinophalangeal syndromes. *Clin Genet*. 1987; 31:273–75. [PubMed: 3594935]

4. Gorlin, RJ.; Cohen, M.; Levin, LS. Syndromes of the Head and Neck. New York: Oxford University Press; 1994.
5. Machuca G, Martinez F, Machuca C, Bullon P. Craniofacial and oral manifestations of trichorhinophalangeal syndrome type I (Giedion's syndrome). Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1997; 84:35–39. [PubMed: 9247947]
6. Momeni P, Glockner G, Schmidt O, von Holtum D, Albrecht B, Gillessen-Kaesbach G. Mutations in a new gene, encoding a zinc finger protein, cause tricho-rhino-phalangeal syndrome type I. Nat Genet. 2000; 24:71–74. [PubMed: 10615131]
7. Kantaputra P, Miletich I, Ludecke H, et al. Trichorhinophalangeal syndrome with supernumerary teeth. J Dent Res. 2008; 87:1027. [PubMed: 18946009]
8. Giedion A, Burdea M, Fruchter Z, Meloni T, Trosch V. Autosomal dominant transmission of the tricho-rhino-phalangeal syndrome: report of 4 unrelated families, review of 60 cases. Helv Paediatr Acta. 1973; 28:249–59. [PubMed: 4723882]
9. Ludecke HJ, Schaper J, Meinecke P, Momeni P, Gross S, von Holtum D. Genotypic and phenotypic spectrum in tricho-rhinophalangeal syndrome types I and III. Am J Hum Genet. 2001; 68:81–91. [PubMed: 11112658]
10. Noltorp S, Kristoffersson U, Mandahl N, Stigsson L, Svensson B, Werner C. Trichorhinophalangeal syndrome type I: symptoms and signs, radiology and genetics. Ann Rheum Dis. 1986; 45:31–36. [PubMed: 3954456]
11. Goodman R, Trilling R, Hertz M, Horoszowski H, Merlob P, Reisner S. New clinical observations in the tricho-rhinophalangeal syndrome. J Craniofac Genet Dev Biol. 1981; 1:15–29. [PubMed: 7341639]
12. Seitz CS, Ludecke HJ, Wagner N, Brocke EV, Hamm H. Trichorhinophalangeal syndrome type I, clinical and molecular characterization of 3 members of a family and 1 sporadic case. Arch Dermatol. 2001; 137:1437–42. [PubMed: 11708946]
13. Karacay S, Saygun I, Tunca Y, Imirzalioglu N, Guvenc G. Clinical and intraoral findings of a patient with tricho-rhino-phalangeal syndrome type I. J Indian Soc Pedod Prev Dent. 2007; 25:43–45. [PubMed: 17456968]
14. Hussels IE. Trichorhinophalangeal syndrome in two sibs. Birth Defects Orig Artic Ser. 1971; 7:301–03. [PubMed: 5173236]

Figure 1.

(A and B) Facial photographs showing all the characteristics craniofacial features, e.g. sparse hair, thinning of the lateral portion of the eyebrows, protruding ears, pear shaped nose, thin vermillion border, steep mandibular plane, as well as asymmetry. (C) Hand photograph showing deviation of the fingers and clinodactyly. (D–H) Intraoral photographs showing deep bite, retained primary teeth and missing posterior teeth

Figure 2.

(A) Panoramic radiograph showing multiple retained, supernumerary and impacted teeth with long well-developed root structure in both maxillary and mandibular arches. (B and C) Lateral and PA cephalograms showing prominent chin button, mild class II skeletal relationship, lingually inclined maxillary and mandibular incisors, steeply inclined lower border of the mandible, obtuse gonial angle, shortened posterior facial height with short mandibular ramus. (D) Virtual models showing development of roots and multiple impacted teeth

Figure 3.

(A and B) Dual volume superimposition of the cone beam volume and airway tract. (C–E) Airway volume evaluated on the CBCT data. (F) Small size maxillary sinuses and (G) the marker represent the position of the MCA along the airway passage

Figure 4.
(A and B) Sagittal section of the CBCT data with a 3D volume render. (C) Cone beam volume of the mandible showing irregularities in size and shape, evidence of remodeling and mild degenerative joint disease of both sides